UiO : **Department of Physics**
University of Oslo

MN-Fakultetet

v/Ellen Solheim

Date: Feb. 28., 2012

Re. : Utlysning av midler til Forskningsinfrastruktur kategori I, 2011

Fysisk institutt oversender med dette tre søknader til Universitetets utlysning av Forskningsinfrastruktur kategori I - 2012:

New-generation scintillation detectors for the use at Oslo Cyclotron Laboratory. 1.amanuensis Andreas Görgen, gruppen for Kjerne- og energifysikk og SAFE. Søknad til UiO ca 1.1 MNOK.

HASI-Hyper sensitive all-sky imager for romværsstudier, Professor Jøran Moen, gruppen for Plasma og romfysikk og STAR. Søknad til UiO ca. 1.88 MNOK

High Power Impulse Magnetron Sputtering system (HiPIMS), Professor Edouard Monakhov, gruppen for Fysikalsk elektronikk og LENS (SMN). Søknad til UiO ca. 1.97 MNOK

Søknadene kommer fra fagområder med høy prioritet ved instituttet, områder med høy faglig aktivitet, og med et større antall Master- og PhD studenter.

Görgens søknad er ikke ny, miljøet har tidligere søkt både Forskningsrådet og UiO's Forskningsinfrastrukturmidler om utskiftning av sine NaI(Tl) detektorer i CACTUS – detektorarrayen i Oslo Syklotronlaboratorium med $LaBr_3$(Ce) detektorer. Dette er en oppgradering som er nødvendig for å kunne ta OCL inn i sitt neste tiår med fullverdig vitenskapelig aktivitet. For den foreliggende søknaden satses det imidlertid å gjøre dette over en flere års prosess og miljøet søker nå om midler til kun to av de 28 gamma-detektorene i CACTUS-oppsettet. Gruppen har nylig lånt 6 detektorer fra Milano og disse er nettopp nå installert på OCL og tatt i bruk i et større samarbeidsprosjekt mellom grupper i Italia, Tyskland og Oslo (detektorene skal i April til GSF etter Oslo). Detektorer som dette vil inngå i en europeisk 'pool' av moderne detektorer som kan benyttes ved flere kjernefysiske laboratorier og ved dette fremme europeisk samarbeide innen kjernestrukturfysikk. Instituttet støtter denne søknaden som en god strategi for at OCL skal forbli synlige og sentrale forskningspartnre i det europeiske kjernestrukturfysikk-

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miljøet.

Moens søknad omhandler to stk. eksemplar av de nye, høyoppløselige kameraene som gruppen ønsker å installere på Svalbard. Disse kameraene skal bl.a. benyttes for å observere elektronskyer som drifter over nordkalotten, slike elektronskyer som er objekt for de rakett- og satelittbaserte studiene gruppene utfører gjennom sin STAR satsning. Disse kameraene gir en dramatisk forbedring i følsomhet og oppløsning enn de eldre kameraene en delvis benytter enda. Delvis, fordi gruppen i 2009 fikk finansiert ett nytt kamera gjennom instituttets egen småutstyrsbevilgning. Dette erstattet ett av de tre kameraene en tidligere har benyttet og med dette ble det klart demonstrert hvilket potensiale den nye kameragenerasjonen har i form av økt hastighet, bedre følsomhet, redusert støy og fjernoperasjon (f.eks. fra Oslo). Instituttet mener at installasjon av to nye kamera sammen med det ene som står der er av sentral betydning for de rakettprogrammer som STAR inngår i gjennom de neste 10 årene.

Monakhovs søknad omhandler et utstyr som benyttes for produksjon av metall-oksyd filmer, p/n doping av metalloxsyder samt båndgaps'engineering' av halvledermaterialer, med bruksområde innenfor fornybar-energi applikasjoner. Spesifikke anvendelsesområder er 1/ transparente elektroder og absorbere for solceller; 2/ LEDs og 3/ proton- og 'mixed-fuel' ledere i brenselsceller. HiPIMS er en teknologi som ansees å være neste-generasjons teknologien for metalloksyd deponering etter 'pulsed laser deposition' (PLD) teknologien. Fysikalsk elektronikk/LENS/MiNa lab har de siste årene fått betydelige utstyrsmidler gjennom Forskningsrådet (FME, NORFAB) og Fysisk institutt småforskmidler, men er også et meget aktivt og vel profilert miljø både nasjonalt og internasjonalt innen fornybar-energi forskning.

Alle disse søknadene er viktige for instituttet og alle søknadene er etter forholdene beskjedne, men dersom det insisteres på en prioritering mellom disse vil en helhetlig vurdering fra instituttets side gi følgende rangering:

1. *New-generation scintillation detectors for the use at Oslo Cyclotron Laboratory.*
2. *HASI-Hyper sensitive all-sky imager for romværsstudier*
3. *High Power Impulse Magnetron Sputtering system (HiPIMS)*

Vennligst,

E. Sagstuen

Søknad om midler til forskningsinfrastruktur 2012 (over 1 mill kroner)

Prosjektittel:
New-generation scintillation detectors for use at the Oslo Cyclotron Laboratory

Søker	Utstyrsansvarlig/ prosjektansvar	Administrativt ansvar
Navn	**Andreas Görgen**	
Stilling & Akademisk grad	**Førsteamanuensis**	
Divisjon/Avdeling	**Fysisk Institutt**	
Fakultet/Enhet	Mat.-Nat.	
Postadresse	Postboks 1048 Blindern	
Epostadresse	andreas.gorgen@fys.uio.no	
Telefon	22844456	
Forskningsgruppe som skal drifte utstyret	Kjernestrukturgruppe ved SAFE	

Prosjektsammendrag (maks. 200 ord):

We apply for funds to acquire two large-volume $LaBr_3$(Ce) scintillation detectors for use at the Oslo Cyclotron Laboratory (OCL). This investment can be considered the first step in our effort to upgrade the CACTUS array with modern, more powerful detectors which offer the possibility to extend the research program at OCL beyond present limitations. $LaBr_3$(Ce) detectors have a vastly superior energy resolution compared to the present NaI(Tl) detectors of CACTUS, allowing the detection of discrete gamma rays. The availability of high-resolution gamma-ray detectors will attract an increased number of international scientists to perform experiments at the Oslo cyclotron. It is also envisioned to use the detectors for campaigns at other laboratories such as CERN-ISOLDE, where such resources would greatly strengthen the position of the Oslo group. The total investment cost is estimated to be 1213 kNOK including VAT; we request 90% of the investment cost from UiO funds.

Type utstyr (kort beskrivelse av infrastrukturen og hva det skal brukes til):

We intent to acquire two LaBr3(Ce) detectors with a crystal size of 3.5” diameter and 8” length, including photomultiplier tubes, voltage dividers, signal processing electronics, and cables. The detectors would replace two of the 28 NaI(Tl) detectors of the CACTUS array and will be used for spectroscopy experiments at the Oslo Cyclotron Laboratory.

Budsjett

Kostnadsplan (i 1000 kr)	**2012**	**2013**	**2014**	**Sum**
Anskaffelsessum	970			970
mva	243			243
Brutto anskaffelsesum	**1213**			**1213**

Finansieringsplan (i 1000 kr)	**2012**	**2013**	**2014**	**Sum**
Egne midler				
NFR-midler	121			121
Andre offentlige midler				
Andre private midler				
Internasjonale midler				
Søkes UiO (max 90%)	1092			1092
Totalsum	**1213**			**1213**
Merk: Totalsum for rubrikkene i kostnadsplan og finansieringsplan skal være like år for år.				

Vedleggsoversikt. Kryss av for vedlegg.

X	**Prosjektbeskrivelse (maks 5 sider)**		**Veiledende/uforpliktende pristilbud fra aktuelle leverandører i NOK inkl. mva. (Ikke brosjyrer)**
	Beskrivelse av forskningsmiljøet (ca. 10-20 linjer)		
	Samarbeidende miljøer, interne og eksterne, ev. rolle som kjernefasilitet		
	Nødvendig utskifting av gammel infrastruktur (beskrivelse)		**Vurdering av innpassing i fakultetets/enhetens og UiOs strategiske planer.**
	Teknisk avdeling IT/Bygg/Innkjøp Egenmelding om avklaring og synliggjøring av ulike følgekostnader		

Fakultetets/museets/senterets prioritering nr. ________

Underskrifter:

Dato:		
	Søker/Utstyrsansvarlig	**Fakultetsleder/Muesumsleder/Senterleder**

Fylles ut av fakultet/museum/senter	**Kommentarer**
Fakultetets/museumets/senterets prioriteringer	
UiO’s vedtatte strategi	
Faglig kvalitet	
Sambruk med andre, internt og eksternt	
Nødvendig utskifting av gammelt utstyr	
Annet	

Application for UiO funds for research infrastructure – Project description
Coordinator/scientific contact person: Andreas Görgen

New-generation scintillation detectors for use at the Oslo Cyclotron Laboratory

Introduction

We apply for funds to acquire two large-volume $LaBr_3(Ce)$ scintillation detectors for use at the Oslo Cyclotron Laboratory (OCL). This investment can be considered the first step in our effort to upgrade the CACTUS array with modern, more powerful detectors which offer the possibility to extend the research program at OCL beyond present limitations.

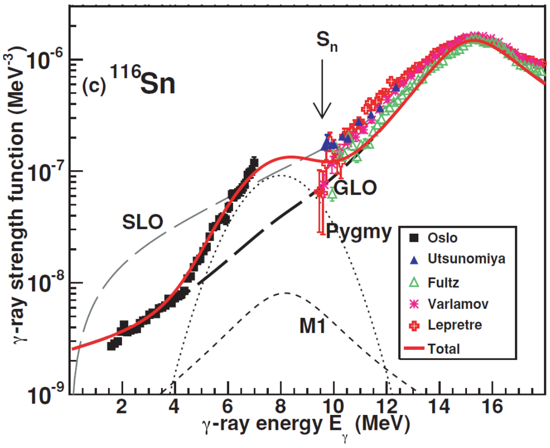
The nuclear physics group at the University of Oslo has earned its reputation by studying the properties of highly excited nuclei at the transition from quantum order to chaos using light-ion beams from the Oslo Cyclotron. The group has developed a unique technique to simultaneously determine the nuclear level density and the radiative strength function (RSF), which has become known as the *Oslo Method*. Using this technique it is possible to investigate thermodynamical properties of nuclei such as the transition from a paired superfluid phase to a gas of unpaired fermions as the nuclear temperature increases. At the same time the measurement of the RSF allows investigating collective modes of nuclear excitation in the form of so-called *pygmy* resonances. The success of the program is based on innovative ideas and techniques, and on the fact that it occupies a specific niche where it is possible to compete with much larger international facilities. Further assets are the availability of substantial amounts of beam time, which makes systematic studies possible over a wide range of nuclei, and the university environment, which provides steady access to well-educated Master and PhD students. The experiments rely on the use of the CACTUS array of 28 large-volume NaI(Tl) scintillation detectors coupled to the SiRi array of segmented ΔE-E silicon telescopes. The main feature of the CACTUS array is its high total absorption efficiency for gamma rays of high energy. Because of the poor energy resolution of NaI(Tl) scintillators, experiments are limited to measuring statistical gamma rays, where high resolution is not essential, whereas the measurement of discrete gamma rays between low-lying nuclear states is not feasible with the present detector infrastructure. With the availability of new scintillator materials such as $LaBr_3(Ce)$, it is for the first time possible to build detectors that have at the same time a very good energy resolution and high efficiency even for high-energy gamma rays. It is our long-term goal and strategy to gradually replace the NaI(Tl) detectors of the CACTUS array with modern and vastly superior $LaBr_3(Ce)$ detectors. The present application can be considered the first step in our endeavour to replace CACTUS with $LaBr_3(Ce)$ detectors. Already the availability of two such detectors will enable us to extend the Oslo method and will furthermore provide us with valuable experience with the new detector material. It is our intention to seek funds from the Norwegian Research Council and other sources to continue the upgrade of CACTUS in the future.

Scientific goals

The combination of light-ion beams from the Oslo Cyclotron, the powerful silicon detector telescopes of SiRi, and an array of efficient and high-resolution $LaBr_3(Ce)$ detectors represents a unique facility, which will enable the nuclear physics program at OCL to remain competitive on the highest level for many years to come. New $LaBr_3(Ce)$ detectors will allow not only the continuation of the existing research program, but a significant expansion due to their superior energy resolution, which will make it possible for the first time to perform spectroscopy of discrete energy levels at OCL. This new quality offers the possibility to perform entirely new classes of experiments. It will allow the nuclear physics group at the

University of Oslo to maintain their competitiveness on an international level and will attract many more international scientists to perform their research in Norway.

Present experiments using the Oslo method are only sensitive in the energy range up to the neutron binding energy, at which point neutron and gamma emission start to compete. Once neutron emission becomes energetically allowed, it is no longer determined from which nuclide a detected gamma ray was emitted. By detecting discrete gamma rays, which can be associated with a specific isotope, potential neutron emission becomes detectable, allowing the studies to be extended to higher excitation energies. In this way the use of $LaBr_3$(Ce) detectors not only improves the resolution of the experiments, but extends the scope of the entire program into a new energy regime that was not accessible before. This is particular important for the study of the RSF, where new types of collective phenomena are expected to occur in this energy region. An example is the so-called *pygmy* resonance, which is predicted to be found when the neutron density extends to larger radii than the proton density, creating a *skin* of neutrons, which can oscillate against a core of protons and neutrons. A possible candidate for such a resonance is shown in figure 1. A stringent proof for this interpretation, however, is difficult, since there is an energy gap between the Oslo data at low energy and the giant dipole resonance (GDR) data at higher energy. It is therefore an important challenge to extend the Oslo measurements to higher energies, closing the gap to the GDR measurements and covering the entire region of interest for pygmy resonances.



RSF for ^{116}Sn below the neutron binding energy (S_n) from OCL compared to data at higher energies measured elsewhere. The apparent excess at 8 MeV is interpreted as a pygmy resonance. The figure is taken from H.K. Toft et al., Phys. Rev. C 81, 064311 (2010).

The proposed $LaBr_3$(Ce) detector array will furthermore allow investigating the spin dependence of the nuclear level density. Present experiments at OCL measure the level density for a specific spin (and parity) distribution, which is characteristic for the reaction in which a given nucleus is populated. By using high-resolution detectors to identify discrete low-lying transitions between states of known spin the virtually unknown spin dependence of the nuclear level density can be investigated. Since the spin dependence enters into the Oslo method in a model-dependent way, such studies would be important in order to reduce systematic uncertainties of the Oslo method.

A further extension of the Oslo method concerns its application to heavier nuclei, in particular in the actinide region. These studies are motivated by the necessity to evaluate cross sections for reactions occurring in nuclear reactors. Precise knowledge of the cross sections and their uncertainties are crucial for the design of reactors based on thorium fuel, fast neutron reactors, and nuclear waste transmutation. By providing experimental measurements of level densities and RSF, experiments at OCL can improve the precision and reliability of cross section calculations. Recent experiments using ^{232}Th and ^{235}U targets have demonstrated the possibility to apply the Oslo method in the actinide region and to obtain valuable results relevant for reactor physics. At present we are constructing parallel plate avalanche counters (PPAC) for the detection of fission fragments to be used in combination with SiRi and CACTUS. This program would also strongly benefit from the improved resolution and efficiency of $LaBr_3$(Ce) detectors. With considerable need for experimental data, measurements at OCL in this mass region have the potential to lead to a long-term experimental program with strong international participation. The potential for such measurements has been recognized recently when the OCL was invited to join a consortium of European Research Infrastructures for Nuclear Data Applications (ERINDA), which provides transnational access to its member facilities through the Euratom FP7 Program.

International collaboration

The results obtained over the last years at OCL have drawn much attention internationally, as is for example illustrated by the success of the series of bi-annual Oslo workshops on level densities and RSF that was initiated in 2007 and has gathered an increasing number of world experts of the field in Oslo. It is certain that the availability of $LaBr_3$(Ce) detectors will attract a significantly increased number of international scientists to perform experiments in Oslo, which will further enlarge the scope of the physics program at OCL. The interest of the international community to perform experiments with $LaBr_3$(Ce) detectors at OCL is clearly demonstrated by the fact that INFN Milano has brought a total of six large-volume $LaBr_3$(Ce) detectors to Oslo for a campaign that will take place in March 2012. Three experiments are planned to be performed during this period in collaboration between the University of Oslo and INFN Milano. Two experiments under the leadership of the Oslo group aim at demonstrating the feasibility to extend the Oslo method to higher energies and to investigate the spin dependence of the level density, respectively. The third experiment, led by INFN Milano, aims at studying high-lying resonances in carbon isotopes with high resolution. This latter experiment is a good example for how the availability of high-resolution $LaBr_3$(Ce) detectors opens up opportunities for new physics beyond the present program based on the Oslo method. Scientists from the University of York (UK) and ATOMKI Debrecen (Hungary) are intending to join the experiments of this campaign.

Since $LaBr_3$(Ce) scintillators can be easily transported, the detectors could also be used for campaigns in other laboratories. This is especially appealing for the envisioned extension of the Oslo method to exotic nuclei in experiments with radioactive ion beams at the HIE-ISOLDE facility, which is presently under construction at CERN. To be able to bring such resources to large-scale laboratories like ISOLDE would significantly strengthen the position of the Oslo group at these facilities and open up opportunities for new collaborations.

There is also a strong interest in $LaBr_3$(Ce) detector technology from the nuclear medicine, nuclear energy, and nuclear safety communities, both in Norway and internationally, providing opportunities for cooperation with applied researchers and industry. Scientists from the Institute for Energy Technology (IFE) are investigating the potential use of $LaBr_3$(Ce) detectors for industrial applications, for example in the petroleum industry. The characterization of the new detectors could lead to prototype development and potentially to new commercial products in this field.

Technical description and performance

The potential of $LaBr_3(Ce)$ as a new scintillator material for gamma-ray spectroscopy has been widely recognized. However, crystals of sufficient size to be interesting for the Oslo physics case became only recently available. Large-volume $LaBr_3(Ce)$ detectors have been thoroughly tested in several laboratories, so that their properties are well known and documented by now. $LaBr_3(Ce)$ scintillator crystals are characterized by a very high light yield, high linearity, and fast decay time. As a consequence, $LaBr_3(Ce)$ detectors have much better energy and time resolution and higher efficiency compared to NaI(Tl) detectors. The energy resolution (ΔE) and relative efficiency (ε) for $LaBr_3(Ce)$ and NaI(Tl) detectors of equal size (3”×3”) are summarized for various energies in the table below.

Energy (keV)	ΔE, $LaBr_3(Ce)$	ΔE, NaI(Tl)	ε ($LaBr_3$/NaI)
122	6.6%	8.9%	1.05
662	2.9%	7.0%	1.18
1332	2.1%	5.4%	1.43
2615	1.6%	4.5%	1.65

$LaBr_3(Ce)$ detectors are commercially available under the brand name BrilLanCe380 from the manufacturer Saint-Gobain Crystals. Cylindrical crystals with a diameter of 3.5 inches and a length of up to 8 inches are routinely grown today. We have performed Monte Carlo simulations to evaluate the performance of an array of $LaBr_3(Ce)$ detectors and compare it with the present CACTUS array. The geometry of the CACTUS array has been modeled in the GEANT4 simulation package, including the detector crystals themselves, their housing and lead collimators, the lead shielding between the detector crystals, and the beam tube and scattering chamber. The amount of energy absorbed in the NaI(Tl) and $LaBr_3(Ce)$ crystals, respectively, was smeared using the experimentally known energy resolution of the respective detector materials. To investigate the impact of the improved energy resolution under the conditions typically found in experiments at OCL, a set of gamma-ray cascades for the decay following the reaction ^{163}Dy(^{3}He,α)^{162}Dy was simulated using the code DICEBOX. These cascades were then used as input for GEANT4 simulations of the present CACTUS array of NaI(Tl) detectors and an array of 4×6 inch $LaBr_3(Ce)$ detectors of the same geometry. The results are shown in figure 2. Due to the much better resolution of the $LaBr_3(Ce)$ detectors it will be possible to resolve and identify several low-lying transitions even for well-deformed nuclei in the rare earth region where the level density is high already at low excitation energy. The peak-to-background ratio for individual transitions is significantly improved, so it will become feasible to analyze coincidences between individual low-lying transitions and gamma rays from the continuum, which was the prerequisite to extend the Oslo method to higher excitation energies and investigate the spin dependence of the level density. Such an analysis will require a particularly high level of statistics in the gamma-ray spectra, which requires high count rates in the detectors. Due to the fast decay time of only 16 ns compared to 250 ns for NaI(Tl), $LaBr_3(Ce)$ detectors can be operated at higher count rates, making such measurements feasible. To take advantage of the excellent timing properties of the $LaBr_3(Ce)$ detectors it is necessary to equip the detectors with new timing filter amplifiers.

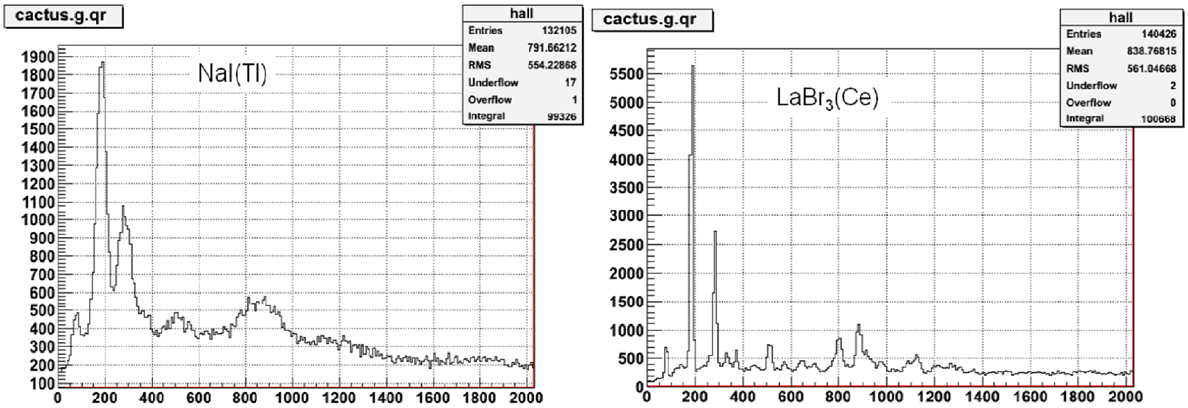


Fig. 5. Simulation of gamma-ray cascades following the reaction $^{163}Dy(^{3}He,\alpha)^{162}Dy$ and their detection with the present CACTUS array of NaI(Tl) detectors and $LaBr_3(Ce)$ detectors in the same geometry.

Budget and funding plan

We request funding to acquire two large-volume $LaBr_3(Ce)$ scintillation detectors of 3.5" diameter and 8" length at an estimated cost of 435 kNOK (excluding VAT) per detector. The operation of the detectors furthermore requires photo multiplier tubes, voltage dividers, signal processing electronics and cables, at an estimated total cost of 100 kNOK. We request 90% of the total investment cost, i.e. 1092 kNOK including VAT, to be covered by the UiO funds for research infrastructure, while the remaining 10% will be covered by on-going NFR grants. The construction of new collimators and small mechanical parts for the support frame is assured by the mechanical workshop at the Physics Department. The installation and operation of the new detectors is assured by the permanent staff at OCL (A. Görgen, S. Siem, M. Guttormsen, J. Rekstad). It will give an excellent opportunity for PhD students and postdocs to acquire hands-on experience with new, state-of-the-art gamma-ray detectors. Experience shows that $LaBr_3(Ce)$ detectors are robust, and scintillation detectors generally require little maintenance. Additional funds above the present level are therefore not needed in order to operate the new detectors over many years to come.

Research environment at the Oslo Cyclotron Laboratory

The Oslo Cyclotron Laboratory is jointly operated by the Physics and Chemistry Departments at the University of Oslo within the Center for Accelerator-based Research and Energy Physics (SAFE). The cyclotron is used for fundamental research in nuclear physics and nuclear chemistry, to produce isotopes for medical applications, and for other applications such as radiation-hardness tests. Approximately half the available beam time is presently used by the low-energy nuclear physics group for experiments in fundamental nuclear physics research. The Oslo Cyclotron Laboratory represents the core facility for the research program of the group, and the new detector infrastructure will ensure the competitiveness of this research program. The group comprises at present four permanent staff (S. Siem, M. Guttormsen, A. Görgen, J. Rekstad), two postdoctoral researchers, five PhD and two Master students. Currently there are two NFR research grants (S. Siem and A. Görgen) and one personal postdoc grant (A.-C. Larsen) connected to this activity. The research program involving the CACTUS detector array has produced 18 Master and 9 PhD theses at the University of Oslo over the last 15 years, and has led to more than 50 scientific publications in peer-reviewed journals such as Physical Review Letters and Physical Review C over this time span. There has been a significant increase in international collaborations over the last few years, and most experiments are now performed with participation of researchers from abroad. OCL has furthermore seen an increase in the number of experiments that are proposed and led by researchers from other institutions. The international collaborations are listed and described in a separate appendix.

The low-energy nuclear physics group is in the process of extending its research program by performing complementary experiments at large-scale laboratories abroad, in particular the ISOLDE facility at CERN. The new scintillation detectors are easily transportable and it is envisioned that they will be used also for campaigns at other laboratories in experiments led by the Oslo group. The availability of this resource will hence strengthen the position of Norwegian researchers at international laboratories and further increase the visibility of the Oslo group internationally.

There is also a strong interest in the new scintillation detector technology from the nuclear medicine, nuclear energy, and nuclear safety communities, both in Norway and internationally, providing opportunities for cooperation with applied researchers and industry. Scientists from the Institute for Energy Technology (IFE) are investigating the potential use of such detectors for industrial applications, for example in the petroleum industry. The characterization of the new detectors could lead to prototype development and potentially to new commercial products in this field. There is already a close collaboration between UiO and IFE within the SAFE Center, where two IFE researchers are holding Professor II positions, and even closer collaboration is envisioned in the context of the recently created Birkeland Center. Researchers from IFE (T. Bjørnstad et al.) are actively supporting the present application and intent to use the new detector infrastructure both at OCL and IFE Kjeller.

International collaboration

The low-energy nuclear physics group at the University of Oslo has close collaborations with many institutions world-wide. The number of international researchers who come to the Oslo Cyclotron Laboratory to participate in experiments has been increasing in recent years, and several experiments have been proposed by scientists from abroad. It is expected that the availability of new $LaBr_3$(Ce) scintillation detectors will further increase the number of international scientists proposing and participating in experiments at OCL. The interest of the international community to perform experiments with such detectors at OCL is clearly demonstrated by the fact that INFN Milano has brought a total of six large-volume $LaBr_3$(Ce) detectors to Oslo for a campaign that will take place in March 2012. Three experiments are planned to be performed during this period in collaboration between the University of Oslo and INFN Milano. This campaign also demonstrates that the accelerator infrastructure at OCL is well suited to host such advanced detection equipment.

There is also a strong international interest in using the infrastructure at OCL for measuring nuclear data relevant for nuclear energy applications. The potential for such measurements has been recognized recently when the OCL was invited to join a consortium of European Research Infrastructures for Nuclear Data Applications (ERINDA), which provides transnational access to its member facilities through the Euratom FP7 Program. Experiments at OCL which are relevant for this program will receive financial support through ERINDA in the form of travel and subsistence support for international visitors.

The following international researchers have been visiting OCL to participate in nuclear physics experiments over the last 12 months. Spokespersons for experiments are shown in bold and upcoming experiments during the present semester are also included. Long-term visitors who stay longer than one month (supported by external funding) are marked by *.

- L.A. Bernstein, **D. Bleuel**, D. Sayer (Lawrence Livermore National Laboratory, USA)
- J.N. Wilson, B. Leniau (IPN Orsay, France)
- M. Wiedeking*, D. Negi (iThemba Laboratories, South Africa)
- F. Gunsing (CEA Saclay, France)
- **O. Kirsebom**, H. Fynbo (Univ. Århus, Denmark)
- J. Cederkäll, (Univ. of Lund, Sweden)
- D.G. Jenkins, O. Roberts (Univ. York, UK)
- **A. Voinov***, **A. Schiller***, Youngshin Byun (Ohio Univ., USA)
- **A. Bracco**, S. Leoni, F. Camera, B. Milion, N. Blasi (INFN Milano, Italy)
- **B. Jurado** (CEN Bordeaux-Gradignan, France)
- R. Firestone* (Lawrence Berkeley National Laboratory, USA)
- **T. Tornyi***, A. Krasznahorkay (ATOMKI Debrecen, Hungary)
- R. Schwengner (FZ Dresden-Rossendorf, Germany)
- G. Sletten (Niels Bohr Institute, Copenhagen, Denmark)

On 14. sep. 2010, at 09:15, Kniest, Frans wrote:

Dear Magne,

Here is our renewed offer:

1) Model 89 S 152 /3,5 /Brillance 380

Drawing to be assigned (similar to the attached drawing 2-3-7338 but for use with positive high voltage)

Specifications	88,9mm dia x 151,6mm long B380 crystal Hamamatsu PMT 3,5'' R10233 Note: Option with a 5" PMT can be discussed For use with positive HV Aluminium housing End on radiation entrance window 0,8mm thick
Performance	End-on PHR @ 662kev to be less 3,5% - target value, not guaranteed End-on PHR @ 1,335MeV will be measured End-on PHR @ 2,615MeV will be measured

Quantity: 30 pieces

Unit price: Euro 43.990

Lead time: 30 pieces

2 to 3 pieces in 14-16 weeks after acceptance of the order by SGC and drawing validation
then 2 to 4 pieces every 6-8 weeks
note: to guarantee delivery schedule, PO should be anticipated at least 4 months before PO is placed

2) AS20 Voltage divider

Specifications	SHV connector for the HV input BNC connector for the signal output
Quantity:	30 pieces
Unit price:	Euro 295

The 4x6 crystal size could be proposed as prototype prior to commitment to a large quantity

PROTOTYPE QUOTE

Note: Products covered by this offer are prototypes. They will be designed and produced on a best effort basis. Lead time and performance are estimated on our best knowledge at the time of the proposal and subject to change during the fabrication process. SGC reserves the right to modify the order if we failed to produce the product.

3) PROTOTYPE 102 S 152 /4 /B380

Drawing to be assigned (similar to the attached drawing 2-3-7197 except for the length of the crystal: 151,6mm instead of 127mm)

Specifications 101,6mm dia x 151,6mm long B380 crystal
Hamamatsu PMT 4" R10806
Note: option with a 5" PMT can be discussed
For use with positive HV
Aluminium housing
End on radiation entrance window thickness. 0,8mm

Performance End-on PHR @ 662kev to be less 3,5% - target value, not guaranteed
End-on PHR @ 1,335MeV will be measured
End-on PHR @ 2,615MeV will be measured

PROTOTYPE PHASE

Unit Price

1 Prototype 58000 EUROS

Lead time: 1 Prototype on a best effort basis, 14-16 weeks after acceptance of the order and drawing validation can be taken as an objective

BUDGETARY PRICE FOR 30 PIECES - If the first piece successfully passed the prototype phase, a final price and specifications will be set up.

Unit Price: Euro 53500 ±5% can be considered

Lead time: to be determined at the end of the prototype phase

4) AS20 Voltage divider

Specifications SHV connector for the HV input
BNC connector for the signal output
Quantity: 30 pieces
Unit price: Euro 295

General specifications for these offered detectors:
No shock, vibration
Operating Temperature: 5°C to 50°C - rate: 8°C/hour
Storage Temperature: -20°C to 50°C - rate: 8°C/hour
227Ac Background between 1,6 and 2,6MeV to be less or equal to 0,15 cps/cc
Notes: SGC warrants that the product shall comply with the functional specification that SGC has under its knowledge and control at the time of the quote.

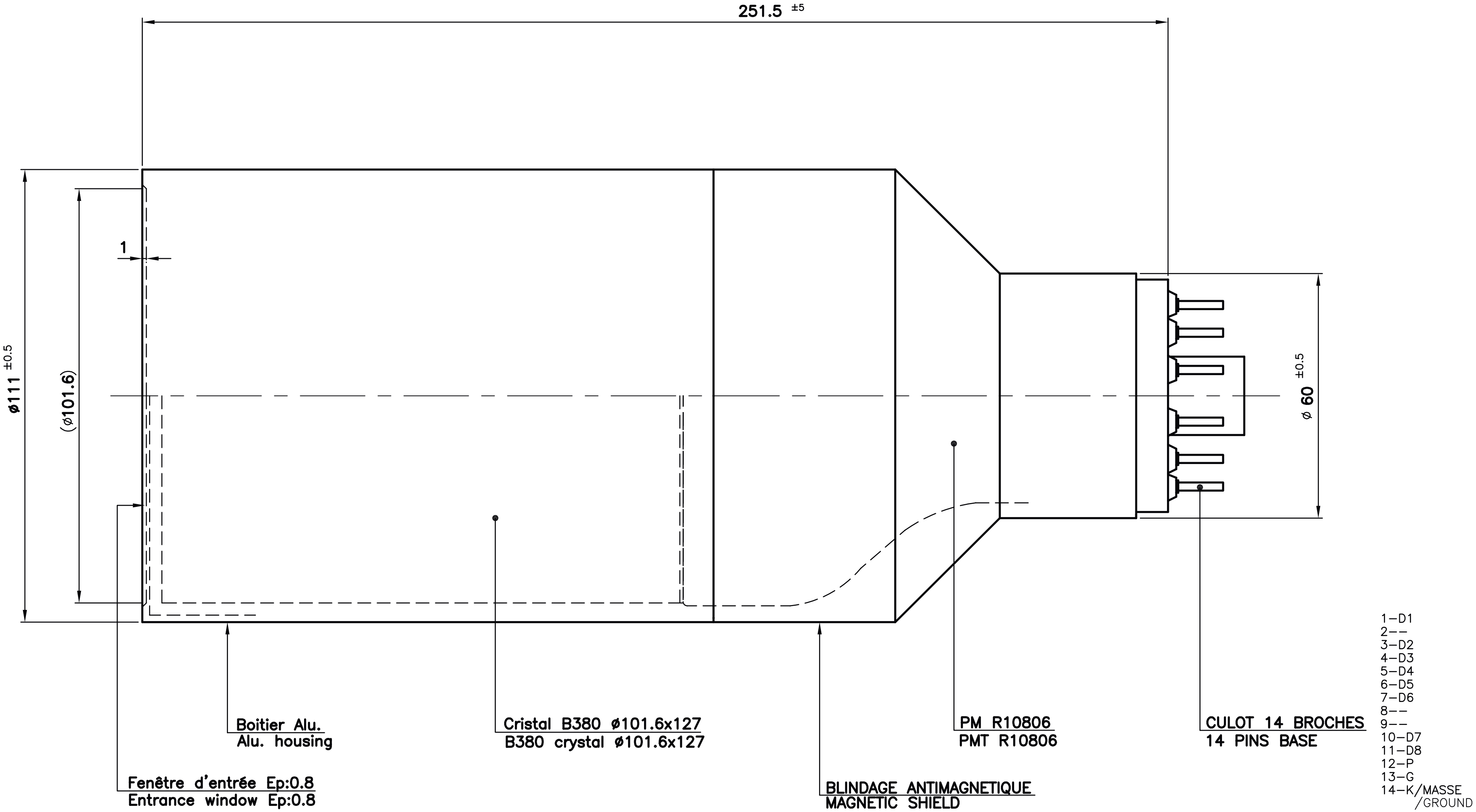
Other requirements not expressed or not under SGC control will be excluded of the warranty
Incoterms 2000: EXW Nemours France
Payment: 30 days (pending credit approval)
Validity of offer: 60 days
Our general conditions of sale apply, unless otherwise stated in this offer.

In case of placing an order, please let us know your preferred shipper and account number.
Good luck with your application!

Best regards,

Frans Kniest

Saint-Gobain Crystals
Holland Office
P.O. Box 3093
3760 DB Soest
The Netherlands
Tel: +31 35 60 29700
Fax: +31 35 60 29214
Mobile: +31 612 092 645
www.crystals.saint-gobain.com



PROTOTYPES:
Performances nucleaires non garanties.
Design sur la base de notre meilleure connaissance.

PROTOTYPES:
No nuclear performances guaranteed.
Design on a best effort basis.

7653CI

Ind.	Date	Dess.	MODIFICATIONS	Date	Vérif.
–	–	–	–		

TOLERANCES GENERALES : (ISO 2768–mK) SAUF INDICATIONS CONTRAIRES

Date: 08/05/09
Dess: C.J
Date: 16/05/09
Vérif: JF
Ech: 1:1

Ensemble: SCINTIBLOC 102 S 127 /4 /B380

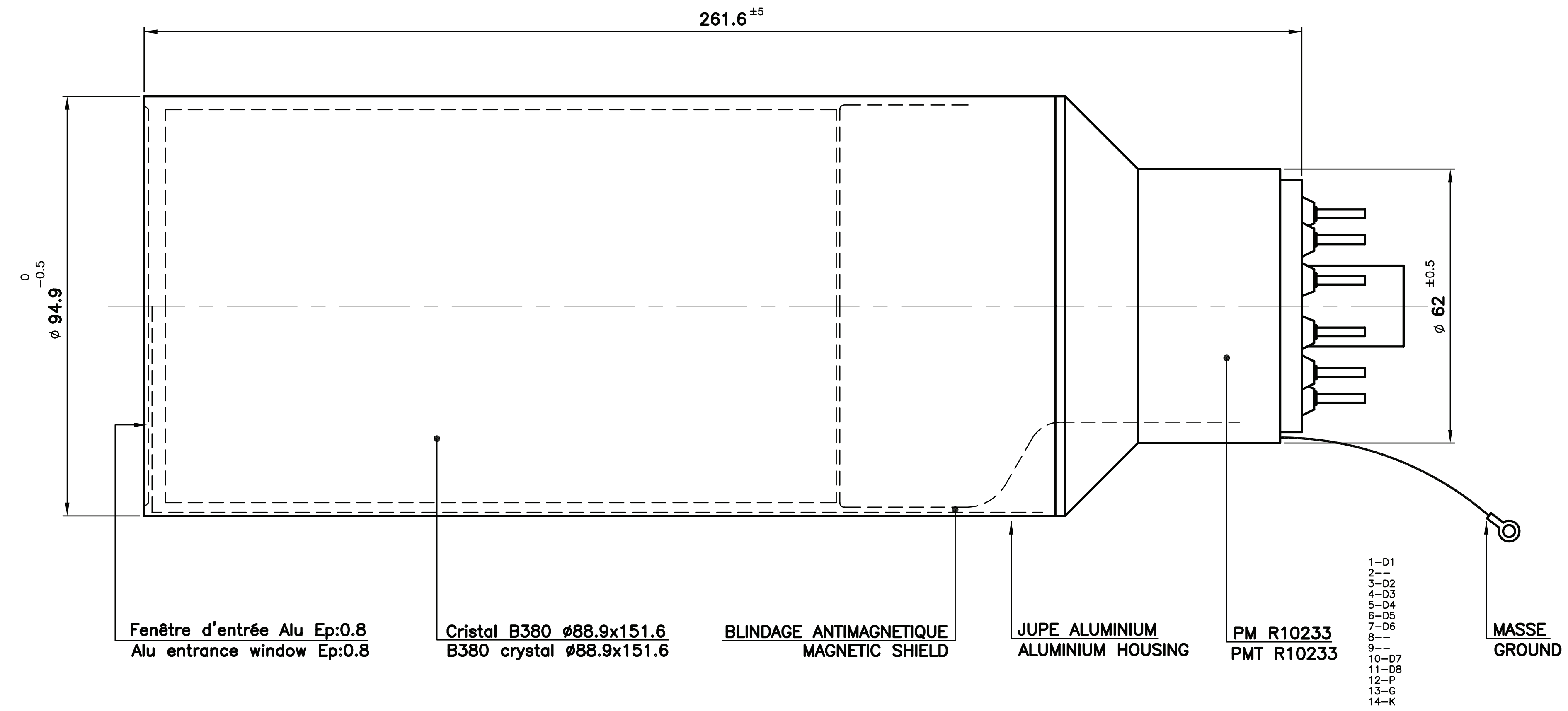
Détail: –
–

Ref.BE: 2-3-7196

SAINT–GOBAIN CRYSTALS
Saint Pierre les Nemours – France

2 – 3 – 7 1 9 7

Indice – –



MONTAGE EN HT<0
NEGATIVE HV

7819CI

Ind.	Date	Dess.	MODIFICATIONS	Date	Vérif.
–	–	–	–	–	–

TOLERANCES GENERALES : (ISO 2768–mK) SAUF INDICATIONS CONTRAIRES

Propriété de la societé **SAINT–GOBAIN CRISTAUX** ce plan ne peut être utilisé, reproduit ou communiqué à des tiers qu'avec notre autorisation écrite.

Date: 25/01/10	Ensemble: SCINTIBLOC 89 S 152 /3.5 /B380 –		
Dess: cj			
Date: 25/01/10			
Vérif: JF	Détail: – –	Ref.BE: –	FORMAT A3
Ech: 1:1			

SAINT–GOBAIN CRYSTALS
Saint Pierre les Nemours – France

2 – 3 – 7 3 3 8

Indice – –

UNIVERSITETET I OSLO
Forskningsadministrativ avdeling

Egenerklæring
Vedlegg til søknad om vitenskapelig utstyr over 1 mill kr

Gjelder innkjøp av 2 $LaBr_3$ (Ce) detektorer (Navn på utstyret)

Fysisk Institutt – SAFE – OCL (Angi utstyrsenhet)

" (Enhet utstyret skal plasseres ved)

Behov for IT-støtte

X Utstyrenhetenes IT-behov passer inn i universitetets IT-infrastruktur

¤ Utstyrsenhetens IT-behov passer ikke inn i universitetets IT-infrastruktur
- ¤ Utstyrsenhetens IT-behov er avklart med USIT
- ¤ Kostnader i forbindelse med tilpasning av infrastruktur NOK....................

Behov for laboratorieinvesteringer

X Utstyrsenheten vil ikke innbære vesentlige endringer med hensyn til arealdisponering

¤ Utstyrsenheten vil innebære vesentlige endringer i arealdisponering, og dette er avklart med Teknisk Avdeling

X Utstyrsenheten vil ikke innebære omkostninger til ombygging av lokaler, bygningstekniske-, vvs- eller elektroniske arbeider

¤ Utstyrsenheten vil innebære omkostninger til ombygging av lokaler, bygningstekniske-, vvs- eller elektroniske arbeider
- ¤ Ombygging er avklart med Teknisk avdeling
- ¤ Kostnader i forbindelse med laboratorieombygging osv er ca NOK...................

Driftskostnader

X Det vil ikke påløpe vesentlige driftskostnader ved utstyret
¤ Det vil påløpe driftskostnader ved utstyret årlig tilsvarende ca NOK...................

Prosedyrer og retningslinjer for anbud og kjøp

X Instituttet er kjent med universitetets retningslinjer for anbud og innkjøp
¤ Instituttet har hatt kontakt med innkjøpsseksjonen for avklaring av retningslinjer for anbud og innkjøp

Underskrift

[signature]
....
Prosjektleder | Administrativt ansvarlig

Lawrence Livermore National Laboratory

Physics & Advanced Technologies

October 9, 2010

Prof. Sunniva Siem
Department of Physics and SAFE
University of Oslo
P.O.Box 1048, Blindern
N-0316 Oslo, Norway

Dear Prof. Siem,

I strongly support your new project to replace all the NaI detectors in CACTUS with BrilLanCe 380 detectors. This new detector system will help build on your well-established program in measuring statistical properties of highly excited nuclei.

The "Oslo method" pioneered by your group is world-recognized as a unique tool for measuring the properties of highly excited nuclear levels. The ability of these levels to absorb and emit photons (the photon strength function) is a key parameter of models of explosive nucleosynthesis in astrophysical settings. The dramatically improved resolution and timing of the BrilLanCe 380 detectors will enable a new class of experiments studying the variation in the strength function with nuclear temperature.

In addition to the added insight into astrophysics, the new detectors will also help in the development of nuclear science experiments at the National Ignition Facility (NIF) at LLNL. The high photon and electron densities at NIF ($>10^{36}$ $cm^{-2}s^{-1}$) will for the first time allow for the observation of reactions on the same highly excited states that your group has been studying for the past two decades. NIF, as an inertial confinement fusion research lab, relies on accurate statistical nuclear physics data, including level densities and strength functions, for the accurate modeling of reactions in high temperature plasma environments. The data from Oslo will help in the development of Laser-Initiated Fusion-fission Energy (LIFE) at NIF, which offers the possibility of a new clean, renewable energy source.

The LLNL group has been collaborating with the nuclear physics group at the University of Oslo for many years and we would certainly like to come to Oslo participate in experiments in 2010. I therefore strongly support the present NFR project of implementing BrilLanCe 380 detectors at the Oslo Cyclotron Laboratory. Please feel free to contact me if I can be of any further assistance.

Lee Bernstein

Lee Bernstein
Senior Staff, Physics division,
Physical and Life Sciences Directorate

IFE Institute for Energy Technology

The Norwegian Research Council

Instituttveien 18
P.O. Box 40, NO-2027 Kjeller, Norway
Tel: +47 63 80 60 00
Fax: +47 63 81 11 68
Org. no: NO 959 432 538
Web: www.ife.no

Our ref.:
Dir. tel: +47 63 80 60 66
E-mail: tor.bjornstad@ife.no

Your ref.:

Date: 2010-10-02

Support letter for the AVIT application from the Oslo Cyclotron Laboratory (OCL): "New Generation Scintillator Detectors for Nuclear Research in Norway"

IFE has a cooperation agreement with the Faculty of Natural Sciences at the University of Oslo through the recently created Birkeland Centre. The nuclear physics and nuclear chemistry activity at the SAFE center and OCL is defined as one of the cooperation areas.

The proposed upgrading of the CACTUS detector array with the new generation scintillation detectors based on $LaBr_3$(Ce) represents a major improvement and offers new possibilities in experimental nuclear physics. In addition, the new detectors are highly interesting in devlopment of nuclear-based methods for the industry. IFE is presently working on/considering various subject areas where these detectors should be tested and possibly exchanged with existing NaI(Tl)-scintillation detectors in order to improve on energy resolution, detection efficiency and ruggidized construction. Examples are:

- Non-destructive study of mineral precipitation (scaling) kinetics and development of a method for scale inhibitor qualification using a combination of radiotracers and ruggidized nuclear detectors in a scanner-setup.
- Non-destructive process control in the petroleum industry based on the combined use of an isotopic neutron source and gamma spectrometry by detecting neutron-induced reaction prompt gammas where a ruggidized gamma detector with improved energy resolution is essential.
- Improve detection quality in industrial Residence Time Distribution (RTD) experiments based on the simultaneous use of various gamma-emitting tracers. A new acquisition system based on 16 NaI(Tl)-detectors and multispectrum analysis with time resolution < 100μs has recently been developed at IFE. $LaBr_3$-detectors would better exploit the potential of this system.
- Development of a compact on-line monitoring technology for sub-sea processing in the petroleum industry (volume measurements, fluid flow measurements, oil-in-water, water-in-oil …) based on a combination of short-lived radiotracers from a radiotracer generator and a ruggidized and high-efficiency detection equipment with improved energy resolution.

The present application offers these possibilities to IFE through the defined cooperation arrangement.

IFE intends to use these detectors in development experiments both at the University of Oso and at the IFE-Kjeller laboratories. Such experiments may lead to new monitoring methods for the industry, an improved service and possibly commercialization. IFE therefore strongly supports the present application.

Tor Bjørnstad

Tor Bjørnstad
Principle Scientist
Head of Department for Reservoir and Exploration Technology

Prof. Magne Guttormsen
Department of Physics,
University of Oslo
P.O.Box 1048 Blindern,
N-0316 Oslo,
NORWAY

Athens, October 4, 2010

Dear Professor Guttormsen

I would like herewith to express the strong support of our group to your application to the Norwegian Research Council concerning the upgrade of the CACTUS array with the new generation scintillators LaBr3(Ce). Such an upgrade is of key importance for the continuation of carrying out forefront research at the Oslo Cyclotron Laboratory (OCL). The planned replacement of the old NaI detectors will provide CACTUS with worldleading features such as superior efficiency, excellent time and, especially, energy resolution. These features in combination with the increased solid angle coverage to be provided by the silicon detector array SIRI that will be installed to sustain considerably higher counting rates make the upgraded CACTUS array a top instrument worldwide. Such an instrument will be characterized by a superb sensitivity to nucleus' statistical properties. As such, it will contribute decisively to new discoveries by the Oslo group and to its current world-leading position. I would like to stress here that the "new" upgraded CACTUS will have no "competitor" worldwide. This justifies fully the necessary investment and I am convinced that OCL will gain a lot in terms of international reputation.

Apart from our support to your application, I would like to kindly ask you to consider our group as a potential user of the upgraded CACTUS array. As you know our group is one of the top-leading groups in nuclear astrophysics studies aiming at the understanding of certain explosive nucleosynthesis scenarios in the Universe, such as the so-called p-process that is taken to occur during supernovae explosions. The upgrade of CACTUS will enable us not only to continue our fruitful collaboration in nuclear structure studies that was realized in the last years with joint experiments at OCL but also to deconvolute our research program with new measurements using the upgraded CACTUS array as a γ-calorimeter to

Dr. Sotirios V. Harissopulos
TANDEM Accelerator Laboratory, Institute of Nuclear Physics, NCSR "Demokritos", POB 60228, GR-153.10 Aghia Paraskevi, Athens, Greece
E-mail: sharisop@inp.demokritos.gr – Phone: +30. 210. 6503493 – Fax: +30. 210. 6511215

determine extremely low cross sections of capture reactions at astrophysical relevant energies achievable at very few laboratories, with OCL being one of them. In our efforts towards this goal the scientific expertise of your group combined with the upgraded CACTUS array will be irreplaceable.

Wishing you success in your application!

Sincerely

Dr. Sotirios V. Harissopulos
Director of Research
Head, Tandem Accelerator Laboratory

Dr. Sotirios V. Harissopulos
TANDEM Accelerator Laboratory, Institute of Nuclear Physics, NCSR "Demokritos", POB 60228, GR-153.10 Aghia Paraskevi, Athens, Greece
E-mail: sharisop@inp.demokritos.gr – Phone: +30. 210. 6503493 – Fax: +30. 210. 6511215

THE UNIVERSITY *of York*

Prof. A Goergen and S. Siem
Department of Physics
University of Oslo
NO-0316 OSLO
Norway

Department of Physics
University of York
York YO10 5DD
United Kingdom
Tel: +44 1904 432248
Email: dj4@york.ac.uk
16th September 2010

Dear Andreas and Sunniva,

I am writing in support of your project to develop an array of large $LaBr_3$(Ce) detectors in replacement of your existing NaI scintillator detectors for use in the Cyclotron Laboratory in Oslo. As you know, we have been working for a number of years here at York in developing $LaBr_3$(Ce) detectors within the PARIS collaboration with the aim of building an array at a future European radioactive beam facility. I think there will be opportunity for us to exchange information on our research and development activities to our mutual benefit.

I am excited by your project since it will allow you to make a step change in sensitivity in the ongoing measurements of nuclear level densities which you have been making at Oslo for many years, profiting from the very much improved energy resolution of the new detectors. In addition to this, I can see opportunities for us to come and pursue some exciting research programmes with what would constitute a unique European facility in terms of efficiency and energy resolution. Let me briefly mention three potential scientific programmes, with which I are presently involved, and which could be pursued with the new array:

- Study of two-photon emission from nuclei: All electromagnetic transitions have as a second-order process the emission of two-photons. This is well known in atomic systems but only a handful of examples exist in nuclei where two-photon emission has been seen. The best cases for study are those nuclei with the lowest excited state, 0+, which can decay only by internal conversion to first order. Examples of relevant nuclei include ^{72}Ge,^{90}Zr,^{96}Zr and ^{98}Mo. The 0+ states can be readily excited by inelastic proton scattering using protons from the Oslo cyclotron. An array of $LaBr_3$(Ce) detectors would be uniquely sensitive to detection of two-photon emission and form arguably the best system for detection of such an exotic process.

- Nuclear Astrophysics: The astrophysical p-process is responsible for creating a subset of proton-rich isotopes in core collapse supernovae. Key to the understanding of this process is the study of reaction networks involving (γ,n) and (γ,α) reactions; the latter can be studied via the inverse process of (α,γ) reactions on stable nuclei. It is possible to measure (α,γ) cross-sections solely by means of calorimetry with a very high efficiency/high resolution array such as the new $LaBr_3$(Ce) array which you propose. Neutron discrimination which is intended in your design will be essential for such measurements.

- Alpha clustering in light nuclei: It has long been suggested that alpha clustering is important in light nuclei and recent theoretical calculations using the AMD model have brought the predictions of this behaviour to a new level of detail. Such predictions could be tested through (a,g) reactions on alpha-conjugate light nuclei. High energy resolution for high energy gamma rays would be key for such studies e.g. $^{24}Mg(\alpha,\gamma)^{28}Si$. The proposed $LaBr_3(Ce)$ array could again be a unique tool for such an experimental programme.

In summary, I have a strong interest in making use of your proposed new array and would also be keen to exchange with you our experience and expertise in achieving the best performance from $LaBr_3(Ce)$ detectors. I would therefore strongly support your grant application.

Yours sincerely,

D.G. Jenkins (Dr.)
Reader in Nuclear Physics

Alexander Voinov
Research Assistant Professor
Edwards Accelerator Laboratory
Physics and Astronomy Department
Ohio University
Athens, OH 45701 USA
Office phone: 740-593-0992

September 10, 2010

Prof. John Rekstad
Department of Physics
University of Oslo
P.O.Box 1048 Blindern
N-0316 Oslo, Norway

LETTER OF SUPPORT

I have been a close collaborator of the nuclear physics group at the Oslo Cyclotron Laboratory, University of Oslo in the last six years and I am very familiar with the kind of nuclear experiments and the detector equipment available there.

The experiments done in Oslo are complementary to the experiments performed at the Edwards Accelerator Laboratory at Ohio University, where my current employment is. I believe that technique the Oslo group developed is very unique and does not have analogues in the world. It allows one to study new physics phenomena not achievable so far. In order to be able to move forward and get new physics results, the upgrade of the Oslo experimental setup is highly desirable.

The prospect of purchasing new scintillator gamma-ray detectors of the type BrilLanCe 380 seems very promising. By exchanging the NaI detectors used today with such $LaBr_3$ crystals, new experimental opportunities will be achievable. The efficiency is much better than for NaI crystals, and the energy resolution and the timing properties are excellent. With such detectors, the quality of the data from Oslo experiments will be substantially improved that, as experience show, almost always leads to the discovery of new physics phenomena.

I personally would be very interested in coming to Oslo and proposing new experiments with this new detector system. This is going to be the first place in the world where such detector system is installed that makes the Oslo University attractive centre of nuclear physics research.

I therefore strongly support the project of implementing BrilLanCe 380 detectors in the Oslo experimental setup.

Sincerely yours,

Alexander Voinov

Søknad om midler til forskningsinfrastruktur 2012 (over 1 mill kroner)

Prosjektittel:
HASI –Hyper sensitive All-Sky Imager for romværstudier

Søker	**Utstyrsansvarlig/ prosjektansvar**	**Administrativt ansvar**
Navn	Jøran Moen	Lars Bernhardsen
Stilling & Akademisk grad	Professor	Adm. leder
Divisjon/Avdeling	Fysisk institutt	Fysisk institutt
Fakultet/Enhet	MNF	MNF
Postadresse	Boks 1048 Blindern	Boks 1048 Blindern
Epostadresse	jmoen@fys.uio.no	lars.bernhardsen@fys.uio.no
Telefon	22855666	22856429
Forskningsgruppe som skal drifte utstyret	Plasma og romfysikk	

Prosjektsammendrag (maks. 200 ord):

De nye kameraene vil gi oss ny dimensjon i PICCAP24, et pågående forskningsprogram for å studere romvær gjennom solflekksyklus 24. Den polare atmosfæren er sterkt påvirket av solstormer som skaper forstyrrelser på radiobølger mellom satellitt og bakke. Vi ønsker å finne ut hvorfor! Det store situasjonsbildet kartlegges med radar og optikk fra bakke. Raketter og satellitter brukes for mikroskala målinger på bølger, instabiliteter og turbulens. I tillegg til vårt rakettprogram (ICI-serien), er vi involvert i tre satellittprosjekter som alle skal settes i bane rundt solar maximum i 2014; vår egen CubeSTAR, PICASSO (en Belgisk cubesat) og QB50 (et EU prosjekt). QB50 er et unikt prosjekt hvor vi skal instrumentere 20 satellitter som vil gå i bane rundt jorda som perler på ei snor. Det vil gi oss en første mulighet til å studere utvikling av romvær i jordatmosfæren i rom og tid. All-sky kamera blir svært viktig for det vitenskapelige utbyttet. For raketter er det helt avgjørende å identifisere hvilket fenomen vi skal skyte på og bestemme et gunstig skytetidspunkt. De nye kameraene vil uten anstrengelse kunne observere elektronskyer som drifter over polkalotten, som er et objekt for satellittstudiene. Prosjektet har høy relevans for den voksende offshoreaktiviteten i Barentshavet.

Type utstyr (kort beskrivelse av infrastrukturen og hva det skal brukes til):

2 stk all-sky kamera:
4” telesentrisk inngangsoptikk med monokromatiske interferensfiltre i et filterhjul med 6 posisjoner for studier av atmosfæriske emisjoner av nordlys og airglow fenomen.

Selve kamerahodet er av CCD-type med kjøling ned til -80 grader for maksimal følsomhet og signal/støyforhold. Som en følge av større optikk, fravær av støyende bildeforsterker og mer følsom bildesensor (5 Rayleigh mot dagens 20-30 Rayleigh). Nye kamera har også vesentlig enklere og raskere interface mot PC (USB2.0) enn de gamle som bruker proprietære PCI-kort. Dette gjør at vi kan øke tidsoppløsningen med minst tre ganger i forhold til dagens situasjon.

De gamle systemene er også knyttet til 32-bits Windows XP eller tidligere utgaver på grunn av gamle drivere. Dette vil også bli en datasikkerhetsutfordring etterhvert som support/oppdateringer for WinXP blir faset ut. For å holde driftsutgiftene nede, er vi helt avhengig av å ha maskinene på nett med mulighet for remote login og datafremvisning på web. De nye kameraene har selvsagt oppdaterte drivere med støtte for Windows 7, noe som gir oss bedret fleksibilitet og sikkerhet. Systemene vil normalt bli fjernoperert fra Oslo.

1 stk portabel kalibreringslampe:
Brukes til absoluttkalibrering av kamera. Denne vil rutinemessig inter-kalibreres mot UNIS kalibreringslab, slik at vi har en felles standard for observasjoner fra Svalbard. UNIS kalibrerer mot internasjonal standard

Budsjett

Kostnadsplan (i 1000 kr)	**2012**	**2013**	**2014**	**Sum**
Anskaffelsesum	2.090			2.090
mva	0			0
Brutto anskaffelsesum	**2.090**			**2.090**

Finansieringsplan (i 1000 kr)	**2012**	**2013**	**2014**	**Sum**
Egne midler	50			50
NFR-midler	60			60
Andre offentlige midler				
Andre private midler				
Internasjonale midler	100			100
Søkes UiO (max 90%)	1.880			1.880
Totalsum	**2.090**			**2.090**
Merk: Totalsum for rubrikkene i kostnadsplan og finansieringsplan skal være like år for år.				

Vedleggsoversikt. Kryss av for vedlegg.			
X 1	**Prosjektbeskrivelse (maks 5 sider)**	**X 6**	**Veiledende/uforpliktende pristilbud fra aktuelle leverandører i NOK inkl. mva. (Ikke brosjyrer)**
X 2	**Beskrivelse av forskningsmiljøet (ca. 10-20 linjer)**		
X 3	**Samarbeidende miljøer, interne og eksterne, ev. rolle som kjernefasilitet**		
X 4	**Nødvendig utskifting av gammel infrastruktur (beskrivelse)**		**Vurdering av innpassing i fakultetets/enhetens og UiOs strategiske planer.**
X 5	**Teknisk avdeling IT/Bygg/Innkjøp** Egenmelding om avklaring og synliggjøring av ulike følgekostnader		

Fakultetets/museets/senterets prioritering nr. ________

Underskrifter:		
Dato:		
	Søker/Utstyrsansvarlig	**Fakultetsleder/Muesumsleder/Senterleder**

Fylles ut av fakultet/museum/senter	**Kommentarer**
Fakultetets/museumets/senterets prioriteringer	
UiO's vedtatte strategi	
Faglig kvalitet	
Sambruk med andre, internt og eksternt	
Nødvendig utskifting av gammelt utstyr	
Annet	

Vedleggsoversikt. Kryss av for vedlegg.			
X 1	Prosjektbeskrivelse (maks 5 sider)	X 6	Veiledende/uforpliktende pristilbud fra aktuelle leverandører i NOK inkl. mva. (Ikke brosjyrer)
X 2	Beskrivelse av forskningsmiljøet (ca. 10-20 linjer)		
X 3	Samarbeidende miljøer, interne og eksterne, ev. rolle som kjernefasilitet		
X 4	Nødvendig utskifting av gammel infrastruktur (beskrivelse)		Vurdering av innpassing i fakultetets/enhetens og UiOs strategiske planer.
X 5	Teknisk avdeling IT/Bygg/Innkjøp Egenmelding om avklaring og synliggjøring av ulike følgekostnader		

Fakultetets/museets/senterets prioritering nr. ________

Underskrifter:		
Dato:		
22/2/2012	Søker/Utstyrsansvarlig [signature]	Fakultetsleder/Muesumsleder/Senterleder

Fylles ut av fakultet/museum/senter	Kommentarer
Fakultetets/museumets/senterets prioriteringer	
UiO's vedtatte strategi	
Faglig kvalitet	
Sambruk med andre, internt og eksternt	
Nødvendig utskifting av gammelt utstyr	
Annet	

PROSJEKT tittel: HASI–Hyper sensitive All-Sky Imager
TYPE: Forskningsinfrastruktur
PROSJEKTLEDER: Jøran Moen

1. Innledning

Romfysikkgruppen ved UiO er internasjonalt kjent for sin innsats på studier av Dagnordlysfenomenet over Svalbard. Under symposiet ”Dayside Cusp and Polar Cap Ionosphere: Present knowledge and future planning” i Oslo 23-24. april 2009, markerte vi 30 år siden oppstarten av Dagnordlysprosjektet på Svalbard.

UiOs hovedbidrag har vært utvikling av fotometre og all-sky kamera for studier av romlige variasjoner i det lyssvake cusp nordlyset. 1988 var vi var de første med all-sky TV kamera for å studere den røde oksygenlinjen (630.0 nm). Med dette kameraet var vi i stand til å kartlegge forekomst, intensitetsvariasjoner og bevegelser i dagnordlyset (cusp-nordlys), men vi kunne ikke oppløse nordlysformer og strålestrukurer. I 1996 introduserte vi en ny generasjon CCD kamera, først i Longyearbyen, så i Ny-Ålesund (1997) og sist på Andøya (2002). Dette utstyret har en følsomhet ned mot 20 Rayleigh for eksponeringstider på 2 sekunder. Med dette kameraet har vi kunnet klassifisere diskrete former og strømsystemer i Dagnordlyset, noe som har vært nøkkelen til å avdekke magnetisk kobling mot solvinden (*magnetic reconnection*).

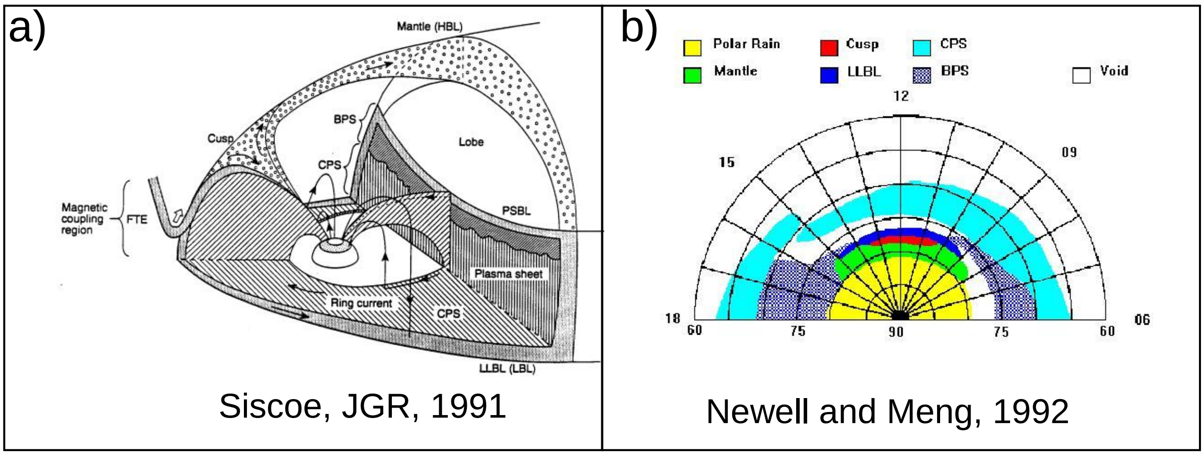
Vi har som mål at utviklingsmiljøet STAR skal utvikle seg til en senter for fremragende forskning, og vi har en SFFIII søknad inne (4DSpace). Gruppen fikk karakter 4-5 på NFR Fysikkevalueringen i 2010. Strategien er å utnytte våre fortrinn på Svalbard og Norges medlemskap i ESA. Vitenskapelig orienterer vi oss mot plasmabølger, instabiliteter og turbulens, som er svært relevante problemstillinger for romvær for GNSS og kommunikasjonstjenester i Nordområdene. Plasma instabiliteter drevet av solvinden i våre polområder skaper utfordringer for moderne, høypresisjons navigasjons og kommunikasjonssystemer. Dette gir oss mulighet til å koble romvær mot offshoreapplikasjoner. Det store situasjonsbildet for romværstudier kartlegges med radar og optikk fra bakke. Raketter og satellitter brukes for mikroskala målinger på bølger, instabiliteter og turbulens. I tillegg til vårt rakettprogram (ICI-serien) er vi involvert i tre satellittprosjekter som alle skal settes i bane rundt solar maximum i 2014; vår egen CubeSTAR, PICASSO (en Belgisk cubesat) og QB50 (et EU prosjekt). QB50 er et unikt prosjekt hvor vi skal instrumentere 20 satellitter som vil gå i bane rundt jorda som perler på ei snor. Det vil gi oss en første mulighet til å studere utvikling av romvær i jordatmosfæren i rom og tid. All-sky kamera blir svært viktig for det vitenskapelige utbyttet. For raketter er det helt avgjørende å identifisere hvilket fenomen vi skal skyte på og bestemme et gunstig skytetidspunkt. De nye kameraene vil uten anstrengelse kunne observere elektronskyer som drifter over polkalotten, som er et objekt for satellittstudiene.

Det er økende internasjonal satsning på forskningsinfrastruktur på Svalbard. Vi ønsker å befeste STAR/UiO som den mest attraktive samarbeidspartner på nordlysmorfologi og airglow studier, og ikke minst, vi trenger kameraene for maksimal faglig uttelling av ICI-serien raketter. Med gamle systemene kan vi ta seks bilder hvert minutt. Med en ny generasjon kan vi øke dette til 15-20 bilder i minuttet. Økt hastighet, bedre følsomhet og redusert støy er meget vesentlige forbedringer for utvikling av fagfeltet. HASI-systemet som Fysisk institutt finansierte i 2009 har allerede vært i to års drift.

2. Faglige problemstillinger

2.1 Optiske studier av magnetosfæreprosesser

Figur 1a viser inndelingen av magnetosfæreregioner på jordens dagside (CPS, LLBL, Cusp, og Mantle). Disse representerer et enormt volum og man kan forestille seg at noen 10-talls forskningssatellitter i bane rundt jorda for å overvåke disse kilderegionene ikke gir tilstrekkelig informasjon. Men når disse enorme plasmavolumene kobler ned til atmosfæren langs jordas magnetfelt, blir informasjonen konvergert inn mot en begrenset breddegradsutstrekning som vist i figur 2b. Pga av forskjellig energiinnhold og partikkelflusker kan vi differensiere mellom de forskjellige plasmakildene gjennom nordlysets farger og intensitet. Dette er svært nyttig når en skal studere fysiske mekanismer innen hver av disse plasmaregionene og hvordan de kobler og avsetter energi i atmosfæren. Grensen mellom lukkede magnetfeltlinjer og åpne magnetfeltlinjer som kobler mot solvinden er en kritisk grense for magnetosfærestudier. Dessverre har vi for dårlig følsomhet på våre gamle kamera til å avbilde denne grensen. Dersom vi kunne, ville vi kunnet måle plasmatransport over denne grenselinjen med radar, og vi kunne beregne helt nøyaktig hvor effektivt solvinden kobler seg mot jordas magnetfelt. Det store spørsmålet helt siden Dungey i 1961 foreslo magnetisk "reconnection" som prosess, er om prosessen er pulset av og på, eller om den pågår kontinuerlig men at den varierer i styrke. Svalbard er et av de få steder i verden hvor vi eventuelt kan verifisere dette, og benytte det i romværvarsel.

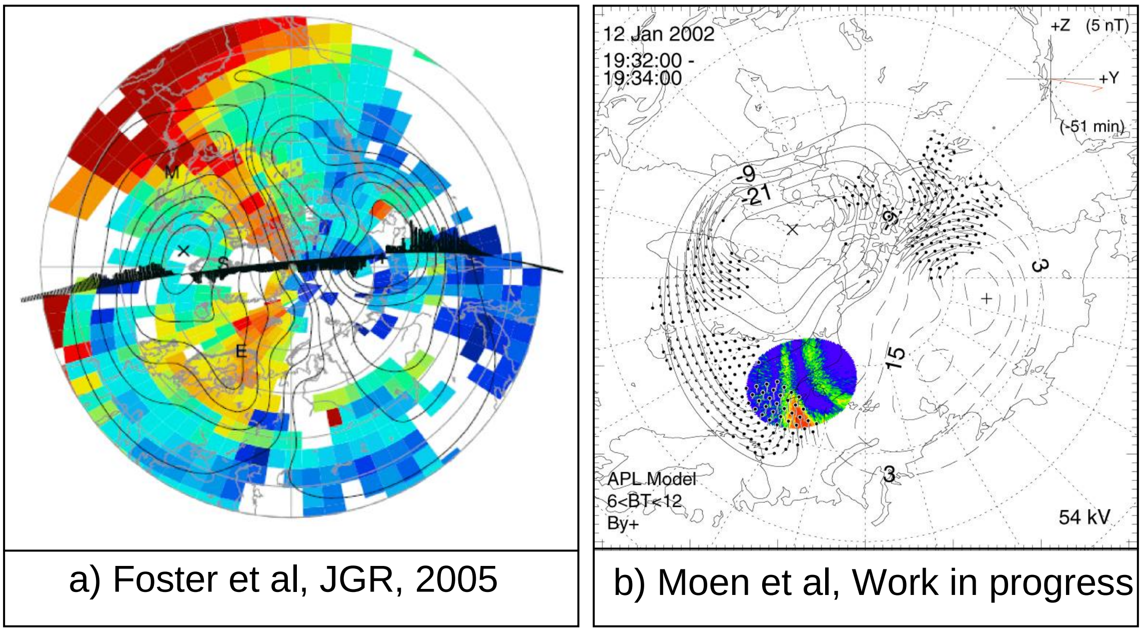


Figur 1: a) Illustrasjon av magnetiske grenselag mot solvinden på jordas dagside. Low Latitude Boundary Layer (LLBL) er den regionen hvor solvinden tilfører mest energi, og så har vi Cusp og Mantle med økende breddegrad. På lukkende magnetfeltlinjer har vi Central Plasma Sheet (CPS) og Boundary Plasma Sheet (BPS) som også mapper ned og grenser mot dagnordlyset. b) Viser et statistisk resultat av hvordan grenselagene i a) er identifisert i flere ti-tusen DMSP satellittpassasjer. Plottet er et magnetisk "polar cap dial"-diagram sentrert på den magnetiske polen, hvor magnetisk breddegrad er angitt på horisontalaksen og magnetisk lokal tid (MLT) er angitt på halvsirkelen.

Med ICI-2 raketten gjorde vi høyoppløselige målinger av elektron partikkelnedbør med et japansk elektron spektrometer. Vi oppdaget to forskjellige akselerasjons regioner, en bred region med kinetiske Alfvén bølger på nordsiden av en region med "inverted V" (dobbeltlag). Vårt kamera var ikke i stand til å skjelne mellom disse akselerasjonsregionene. Med et HASI kamera ville vi kunnet kartlegge utviklingen i rom og tid for hver av disse akselerasjonsregionene og eventuelt hvordan de henger sammen. Sammenhengen mellom Kinetiske Alfven bølger og dobbeltlag er et essensielt viktig spørsmål innen magnetosfære-ionosfærekobling som fremdeles står åpent i litteraturen. Raketter og satellitter gir viktig øyeblikksinformasjon, men kan ikke følge romlig utvikling over tid. Det er her bakkeinstrumentering har den største styrken.

2.2 Optiske studier av Airglow og plasma strukturer

Figur 2a viser en kombinasjon av GPS TEC målinger (Total Electron Content) og SuperDARN HF radar konveksjonskart. Rødt viser høye TEC verdier som er produsert av sollyset (ekstrem UV stråling) på dagtid (rødt). Høytetthetsplasma på dagsiden fanges opp av et solvinddrevet transportmønster fra dag til natt over polkalotten. Dette er observasjoner fra den kjente Halloween-stormen i november 2003, som skapte store problemer for GPS brukere også i Norge. Selv om TEC målingene har dårlig romlig oppløsning ser man noe struktur i "plasmatungen" over polkalotten. Figur 2b viser plasmaskyfenomen observert med all-sky kamera i Ny-Ålesund, riktignok fra en annen dag men med ekstremtettheter. Disse to skyene har blitt produsert i Nord-Amerika og de bruker normalt 2-5 timer på veien over polen. Plasmaskyene er ustabile og turbulente strukturer i elektronplasmaet kan blokkere GPS navigasjonssignaler. Skyene i Figur 2b består av ekstreme elektrontettheter og er intense nok til å kunne observeres med våre gamle kamera, men som regel har vi problemer pga av at signalet ligger rundt støyterskelen. Skyene trekkes etter hvert inn i nattnordlyset og brytes opp i enda mindre strukturer (*blobs*). Det er derfor av stor interesse for oss å ha identiske kamera på Svalbard og i Nord-Norge for å studere resultatet etter at de har vært i kontakt med nattnordlyset.



Figur 2: a) GPS TEC observasjoner (total elektrontetthet mellom satellitt og GPS mottaker) presentert sammen med radarobservasjoner av et 2-celle sirkulasjonsmønster over polkalotten målt med SuperDARN radar. Dataene er presentert i et såkalt "polar cap dial plott" tilsvarende Figure 1b), men også med kartreferanse.
Rødt viser ekstremtettheter som produseres på dagen og fraktes over mot nattsiden. b) Kombinasjon av SuperDARN konveksjonsdata og plasmaskyobservasjoner gjort med vårt all-sky kamera i Ny-Ålesund. Dataene er presentert i magnet over den nordlige halvkule sentrert på den magnetiske polar (Polar Cap Dial Plot).

Når vi er på dagsiden, formes tilsvarende skyer over Svalbard, som deretter drifter over polkalotten til Nord-Amerika. Svalbard er det eneste stedet i verden hvor man kan studere formasjon, instabiliteter og turbulens i slike skyer optisk, med radar og sonderaketter samtidig. ICI-2 fløy gjennom en slik nydannet sky, men den var for svak til at den kunne oppløses med vårt all-sky kamera. Med nye hyper-følsomme all-sky kamera vil vi maksimere uttellingen på ICI-serien raketter (*Investigation of Cusp Irregularities*). ICI-3 ble skutt i desember 2011, og ICI-4 vil gå i 2013. På grunn av at vi har lyktes med i å miniatyrisere et

Langmuirprobe system har vi tilgang på 22 satellittplattformer (Cubesats) som vi skal fly på i 2014/1015. Med HASI vil vi avbilde den 2dimensjonale utstrekningen på plasmaskyene som rakettene og satellittene skal fly gjennom (jf. figur 2b).

3. Relevans

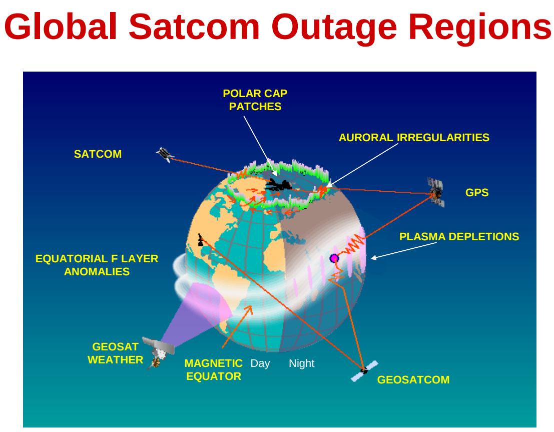
STAR-miljøets forskning med ICI-serien raketter, radar og optikk på Svalbard er et eksempel på grunnforskning med praktisk relevans. I stedet for å formulere dette selv, tillater jeg meg å klippe inn ekspertuttalelse som fremkom ved Norges Forskningsråds evaluering av prosjektsøknaden ”ICI 2009-2010”, som fikk rating ”exceptional” av en reviewer, og ”excellent” av den andre. Her er oppsummeringen fra den første:

Please provide an overall assessment of the elements evaluated in relation to the application. Indicate the most important strengths and weaknesses of the project proposal and provide any necessary supplementary comments.

It is quite seldom one meets this type of project where a completely new invention in the behavior of nature, having also a direct impact on every-day life, is attacked by theoretical tools together with in-situ and remote sensing observations. The PI and his team has to be congratulated of this new opening.

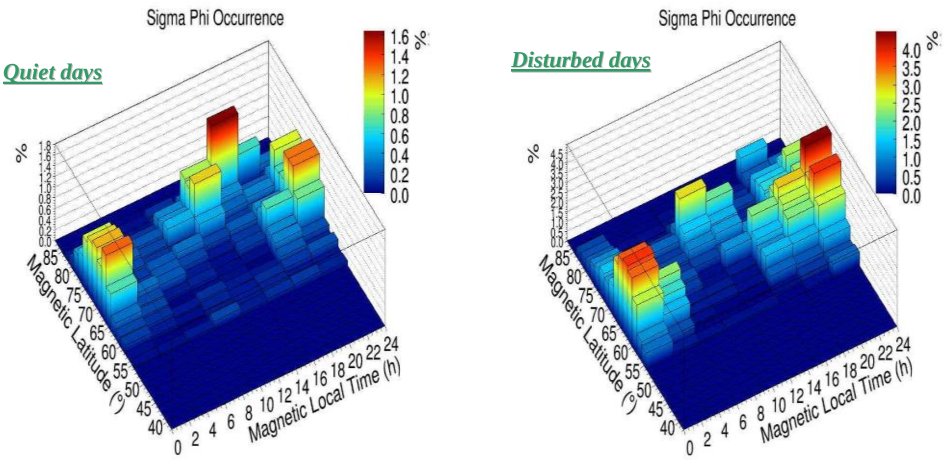
The project takes optimal advantage of all major infrastructure in Svalbard, including Svalrak, EISCAT and the optical observatories in Longyearbyen and Ny-Ålasund. The "Reversed flow channels" to be experimentally studied in the polar cusp by these tools were found quite recently. It is astonishing to hear that ESR observed these events in 40% of scans around magnetic noon and that they were quite stable lasting for about 18 min and extending over 100-200 km. One might wonder why they were not observed earlier and why Kelvin Helmholtz instability, being so common in nature, was not suspected earlier to be the main driver of plasma in the polar cusp. One answer might be the poor understanding of the HF backscatter in the F-region and, especially, in the polar cusp.

Hence, this is the right moment to carry out a thorough study of this new phenomenon. December 2010 is an ideal moment located around the solar maximum when the cusp disturbances are largest. Also extensive satellite support will still be available by this time. The reviewer wishes the project best success and expects some revolutionary new results that will help us to better understand the complicated plasma processes in the polar cusp.



Figur 3: Illustrasjon av problemområder for satellittbaserte navigasjon og kommunikasjonstjenester.

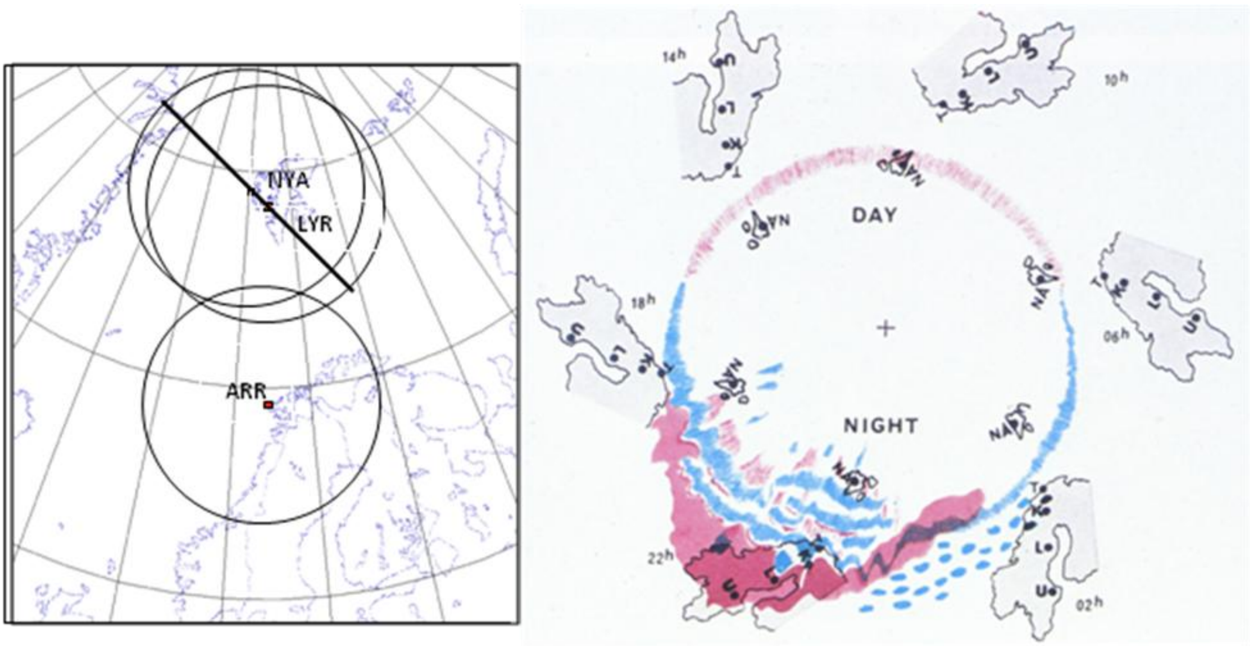
Figur 3 viser problemregioner for globalt satellittkommunikasjon. Det er rundt ekvator hvor instabiliteter oppstår ved at gravitasjonskraften står vertikalt på plasma tetthetgradienter, og i polområdene hvor solvinden utøver en kraft vertikalt på tetthetsgradienter. Dvs fenomenene vi forsøker å studere er ikke et regionalt problem for Svalbard, men er et globalt fenomen både ved ekvator og i polområdene som forventes å få økende oppmerksomhet etter hvert som vi gjør oss kritisk avhengig av infrastruktur i rommet. Det er grunn til å tro at *impact* faktoren på denne type forskning vil øke fremover. Offshore aktivitet nord for polarsirkelen vil bringe med seg mange kravstore brukere av kommunikasjons og navigasjonstjenester som vil møte store utfordringer ved solstormer. Figur 4 viser klimatologien for scintillasjonsforstyrrelser på GPS signal som funksjon av breddegrad og tid i den Skandinaviske sektoren. Forstyrrelsene kan forklares ut fra den transpolare plasmaskytransporten beskrevet over. En seriøs satsning på dette forskningsfeltet nå fremover, vil kunne koble romfysikk til anvendelser innenfor offshoresektoren i Norge.



Figur 4: Spogli et al., EGU, 2009. Viser klimatologien til scintillasjonsforstyrrelser på GPS satellitsignal. Longyearbyen ligger på 75 MLAT og Trømsø på 65 MLAT. Under rolige forhold er forstyrrelsene avgrenset til 22-02 MLT (20-24 UT) i Barentshavet. Forstyrrelsene på dagtid er pga plasmaskyer som produserer over eller syd for Svalbard.

4. Geografisk dekning

I dag opererer vi 3 all-sky kamerasystem, 2 på Svalbard (Ny-Ålesund og Longyearbyen) og et på Andøya. Disse har overlappende synsfelt som vist til venstre i Figur 5. Nordlysovalen vandrer mellom Svalbard på dagtid og Nord-Norge på nattid (høyre del av Figur 5) og forutsatt at værforholda er bra har vi kontinuerlig overvåkning av Nordlysovalen.



Figur 5: (Venstre) Geografisk dekningsområde med UiO's kamera. (Høyre) Nordlysets vandring gjennom døgnet.

Beskrivelse av forskningsmiljøet.

STAR – Space Technology and Research Development center

Leder: Prof. Jøran Moen

STAR er et av MNF's satsningsområder. Satsningen har hatt stor suksess med synergien mellom eksperimentell romfysikk og elektronikk-instrumentering. Det har bidratt til solid finansiering av drift gjennom Norsk Romsenter, Norges Forskningsråd og ESA Prodex. Vi har et langsiktig fokus på å koble denne virksomheten mot plasma teori, og vi har hatt en vellykket rekruttering med Postdoc Dr. Wojchiech Miloch. Han engasjerer seg i eksperimentelle problemstillinger.

Samarbeidet innenfor STAR er mulighetsdrevet og formes gjennom eksternt finansierte prosjektaktiviteter. Vi har etablert industrisamarbeid med EIDEL som åpner muligheter innen ESA SSA (romvær program) og ESA GSTP (teknologiprogram).

Foruten noen fellesaktiviteter blir den sosiale kontaktflaten i stor grad utviklet gjennom tverrfaglige prosjektkoblinger innenfor STAR.

Fellesaktiviteter: Lunsjforedrag. Mini-symposium med bevertning en gang hvert halvår. Plasma og romfysikkgruppen arrangerer STAR julebord.

Størrelse av satsingen/gruppa

Antall faste ansatte: 7 (4 FI/UiO + 1 IFI/UiO + 3 UNIS)

Antall postdoktorer: 3 (1 UiO + 1 UNIS)

Antall stipendiater: 7 (6 på heltid med finansiering og 1 på overtid/deltid).
STAR UNIS er i prosess med å ansette 2 nye og vi er bevilget 1 ny KD stipendiat til STRA UiO i 2012.

Vedlegg 3

Samarbeidende miljøer

Nasjonalt:

STAR er et samarbeide mellom romfysikk ved UNIS og UiO, og kamerane vil utgjøre en viktig basis for grunnforskningen ved begge institusjonene. Kameraene vil kalibreres i den optiske labben på UNIS. Univ. Tromsø har også en aktivitet på plasmaskystudier, og deltar i NFR prosjektet ICI 2011-2013 (ICI-4). Prof. Kjellmar Oksavik som har tiltrådt en stilling i ved Universitetet i Bergen har fått bevilgning fra NFR for investering i en 3 GPS mottakere som skal plasseres på Svalbard som blir komplementære med våre GPS mottakere i Ny-Ålesund og i Oslo (den siste vil vi trolig flytte til Midt-Norge). HASI-kameraene vil være vårt viktigste samarbeidsbidrag til Prof. Oksaviks romværprosjekt.

Internasjonalt:

Jøran Moen og Unni Pia Løvhaug (fra UiTø) sitter i Management Commite for COST0803 *"Developing space weather products and services in Europe"*. Norge er medlem av ESAs Space Situation Awareness program som er opprettet for å ivareta Galileo. Den foreslåtte nyinvestering på kamera vil gi oss økt potensial til å trekke inn eksterne midler fra ESA og EU-program. Data vil også brukes og tilgjengeliggjøres for NASAs og JAXAs rakettkampanjer, og som bakkestøtte for satellittprosjekter og optisk støtte for EISCAT prosjektet.

På et symposium i Oslo 23-24 april 2009, med ca 20 deltagere fra fra USA, Kanada, Italia, Frankrike, UK og Danamark etablerte, etablerte vi en internasjonal arbeidsgruppe PICCAP 24 (Polar Ionosphere Cusp CAP solar cycle 24) med Jøran Moen som leder (http://www.mn.uio.no/fysikk/english/research/projects/dayside-aurora/). PICCAP 24 er et initiativ for å koordinere ionosfæreobservasjoner i polkalotten gjennom solflekksyklus 24 for å sikre gode datasett for grunnforskning på romvær.

Nødvendig utskiftning av gammel infrastruktur:

Denne søknaden gjelder erstatning av de to eksisterende all-sky kamerasystem på Svalbard (Ny-Ålesund og Longyearbyen) som er 15-16 år gamle. Disse har ikke tilstrekkelig følsomhet til våre forskningsformål. Dessuten er de allerede langt over nominell levetid og det er bare et tidsspørsmål før de bryter sammen.

UNIVERSITETET I OSLO
Forskningsadministrativ avdeling

Vedlegg til søknad om vitenskapelig utstyr over 1 mill kr Egenerklæring

Gjelder innkjøp av
2 hyperfølsomme all-sky kamera
Instrumentene legges inn under Plasma og romfysikk.
Plasseres i ved optiske stasjoner i Ny-Ålesund og Longyearbyen.

Behov for IT-støtte

X Utstyrenhetenes IT-behov passer inn i universitetets IT-infrastruktur

¤ Utstyrsenhetens IT-behov passer ikke inn i universitetets IT-infrastruktur
  ¤ Utstyrsenhetens IT-behov er avklart med USIT
  ¤ Kostnader i forbindelse med tilpasning av infrastruktur NOK...........

Behov for laboratorieinvesteringer

X Utstyrsenheten vil ikke innbære vesentlige endringer med hensyn til arealdisponering

¤ Utstyrsenheten vil innebære vesentlige endringer i arealdisponering, og dette er avklart med Teknisk Avdeling

X Utstyrsenheten vil ikke innebære omkostninger til ombygging av lokaler, bygningstekniske-, vvs- eller elektroniske arbeider

¤ Utstyrsenheten vil innebære omkostninger til ombygging av lokaler, bygningstekniske-, vvs- eller elektroniske arbeider
  ¤ Ombygging er avklart med Teknisk avdeling
  ¤ Kostnader i forbindelse med laboratorieombygging osv er ca NOK...........

Driftskostnader

X Det vil ikke påløpe vesentlige driftskostnader ved utstyret

¤ Det vil påløpe driftskostnader ved utstyret årlig tilsvarende ca NOK.............

Prosedyrer og retningslinjer for anbud og kjøp

X Instituttet er kjent med universitetets retningslinjer for anbud og innkjøp

¤ Instituttet har hatt kontakt med innkjøpsseksjonen for avklaring av retningslinjer for anbud og innkjøp

Underskrift

....
Prosjektleder Administrativt ansvarlig

Vedlegg 6

Tilbudet omfatter 2 x kamera	: USD 326.783
+ kalibreringsenhet	: USD 24.330
SUM	: USD 351.113
SUM 1 USD = NOK 5.95	**: NOK 2.090.000**

Keo Scientific Ltd.
404, 1300 – 8th St. SW
Calgary, AB Canada T2R 1B2
www.keoscientific.com
Tel 1.403.452.7222
Fax 1.403.206.7680

QUOTATION

Quote #	QT-0427
Date	2/9/2012
Pricing Firm Until	4/9/2012

Billing Address
University of Oslo (Moen)
Department of Physics
Postboks 1048 Blindern
Oslo
Norway

Shipping Address
University of Oslo (Moen)
Stasjonsleder
Norsk Polarinstitutt
Ny-Ålesund
Norway

Contact: Joran Moen
Phone: +47 22855666
Fax: +47 22855671

Customer Reference	Lead Time	Payment Terms
-	5 months ARO	Net 30

LINE	DESCRIPTION	QTY.	UNIT PRICE	EXTENSION
1	Keo Sentry 4" Scientific Imager - 4-inch telecentric allsky optics - 6-position thermally stabilized FilterWheel - CCD Camera: Pixis 2048B_eXcelon, featuring: - Permanent vacuum guarantee - Princeton Instruments proprietary AIMO CCD, scientific grade 1, back-illuminated, 2048 x 2048 pixels, eXcelon enabled, Keo-grade quality - 13.5 x 13.5 M pixels (27.65mm x 27.65mm image area) - Thermoelectric Peltier cooled with air. - Dual speed read out, 2 MHz and 100 kHz 16 bit - USB 2.0 interface with 5 meter USB cable - Keo nose-cone - f/1.2 imaging onto CCD - High-reliability shutter - 25 mm image diameter - Standard Keo computer control interface electronics - Assembly, testing, documentation	2 ea.	$132,668.00	$265,336.00
2	Filter - 4" dia., CWL 630.0 nm, FWHM 2.0 nm	2	$6,990.00	$13,980.00
3	Filter - 4" dia., CWL 777.4 nm, FWHM 2.0 nm	2	$6,990.00	$13,980.00
4	Filter - 4" dia., CWL 427.8 nm, FWHM 2.0 nm	2	$6,990.00	$13,980.00
5	Filter - 4" dia., CWL 557.7 nm, FWHM 2.0 nm	2	$6,990.00	$13,980.00
6	Software: Keo Synopticx/32	2	$1,495.00	$2,990.00

Remarks

Terms of Sale:

Delivery to Oslo Airport is included in the pricing quoted. This includes packing, export preparation plus any associated fees, airfreight and insurance. University of Oslo is responsible for any Oslo Airport fees, customs clearance and local delivery. Risk transfers from Keo to University of Oslo immediately prior to the goods being unloaded at the terminal.

Keo will commence work on the order when the Purchase Order.

Sub-Total	USD $324,246.00
Freight	USD $2,537.00
Tax	USD $0.00
Total	**USD $326,783.00**

Keo Scientific Ltd.
404, 1300 – 8th St. SW
Calgary, AB Canada T2R 1B2
www.keoscientific.com
Tel 1.403.452.7222
Fax 1.403.206.7680

QUOTATION

Quote #	QT-0428
Date	2/9/2012
Pricing Firm Until	4/9/2012

Billing Address
University of Oslo (Moen)
Department of Physics
Postboks 1048 Blindern
Oslo
Norway

Shipping Address
University of Oslo (Moen)
Stasjonsleder
Norsk Polarinstitutt
Ny-Ålesund
Norway

Contact: Joran Moen
Phone: +47 22855666
Fax: +47 22855671

Customer Reference	Lead Time	Payment Terms
-	5 months ARO	Net 30

LINE	DESCRIPTION	QTY.	UNIT PRICE	EXTENSION
1	Keo Alcor-RC - Calibrated, Remote Controlled Low Brightness Source	1	$23,750.00	$23,750.00

Remarks

Terms of Sale:

Delivery to Oslo Airport is included in the pricing quoted. This includes packing, export preparation plus any associated fees, airfreight and insurance. University of Oslo is responsible for any Oslo Airport fees, customs clearance and local delivery. Risk transfers from Keo to University of Oslo immediately prior to the goods being unloaded at the terminal.

Keo will commence work on the order when the Purchase Order.

Sub-Total	USD $23,750.00
Freight	USD $580.00
Tax	USD $0.00
Total	**USD $24,330.00**

Søknad om midler til forskningsinfrastruktur 2012 (over 1 mill kroner)

Prosjekttittel:
High Power Impulse Magnetron Sputtering system (HiPIMS)

Søker	Utstyrsansvarlig/ prosjektansvar	Administrativt ansvar
Navn	E. Monakhov	
Stilling & Akademisk grad	Professor	
Divisjon/Avdeling	LENS/Fysikalsk Elektronikk	
Fakultet/Enhet	Fysisk Institutt/Mat-Nat	
Postadresse	PB 1048 Blinder, 0316 Oslo	
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Telefon	552 40935	
Forskningsgruppe som skal drifte utstyret	LENS, MiNa-lab	

Prosjektsammendrag (maks. 200 ord):

This project is aimed at strengthening UiO's position at the leading front in the field "Materials for Energy Technologies" through the purchase a state-of-the-art system for High Power Impulse Magnetron Sputtering of metal-oxides.

Metal-oxides are a key element in environmentally friendly energy technologies. The specific applications for metal-oxides are (i) transparent electrodes and absorbers for solar cells, (ii) light emitting diodes for energy saving lighting, and (iii) proton and mixed conductors for fuel cells. The proposed system is intended to enhance our capabilities and increase the probability of success on the critical scientific and technological issues:
1) growth of high quality crystalline metal-oxide films, 2) p- and n-type electronic doping of metal-oxides, and 3) band gap engineering of semiconducting metal-oxides.

Type utstyr (kort beskrivelse av infrastrukturen og hva det skal brukes til):

High Power Impulse Magnetron Sputtering system will be used for deposition of metal-oxide films relevant for energy applications. This method represents the forefront of modern deposition techniques. The system features ultra-high vacuum chamber and a flexible design well-suited for research purposes.

Budsjett

Kostnadsplan (i 1000 kr)	**2012**	**2013**	**2014**	**Sum**
Anskaffelsessum	765	985		1750
mva	191	246		437
Brutto anskaffelsesum	956	1231		2187

Finansieringsplan (i 1000 kr)	**2012**	**2013**	**2014**	**Sum**
Egne midler	96	123		218
NFR-midler				
Andre offentlige midler				
Andre private midler				
Internasjonale midler				
Søkes UiO (max 90%)	860	1108		1969
Totalsum	956	1231		2187

Merk: Totalsum for rubrikkene i kostnadsplan og finansieringsplan skal være like år for år.

Vedleggsoversikt. Kryss av for vedlegg.

X	**Prosjektbeskrivelse (maks 5 sider)**	X	**Veiledende/uforpliktende pristilbud fra aktuelle leverandører i NOK inkl. mva. (Ikke brosjyrer)**
	Beskrivelse av forskningsmiljøet (ca. 10-20 linjer)		
	Samarbeidende miljøer, interne og eksterne, ev. rolle som kjernefasilitet		
	Nødvendig utskifting av gammel infrastruktur (beskrivelse)		**Vurdering av innpassing i fakultetets/enhetens og UiOs strategiske planer.**
	<u>Teknisk avdeling IT/Bygg/Innkjøp</u> Egenmelding om avklaring og synliggjøring av ulike følgekostnader		

Fakultetets/museets/senterets prioritering nr. ________

Underskrifter:

Dato:		
27.02.2012	**Søker/Utstyrsansvarlig** E. Monakhov	**Fakultetsleder/Muesumsleder/Senterleder**

Fylles ut av fakultet/museum/senter	**Kommentarer**
Fakultetets/museumets/senterets prioriteringer	
UiO's vedtatte strategi	
Faglig kvalitet	
Sambruk med andre, internt og eksternt	
Nødvendig utskifting av gammelt utstyr	
Annet	

High Power Impulse Magnetron Sputtering system for metal-oxide synthesis (HiPIMS)

E. Monakhov, Fysikalsk Elektronikk/LENS, UiO

Proposal to "UiOs midler til forskningsinfrastruktur 2012"

I. Overall objective

This project is aimed at strengthening UiO’s position at the leading front in the field "Materials for Energy Technologies" through the purchase a state-of-the-art system for High Power Impulse Magnetron Sputtering of metal-oxides.

II. Specific applications

Metal-oxides are a key element in environmentally friendly energy technologies. The specific applications for metal-oxides are (i) transparent electrodes and absorbers for solar cells, (ii) light emitting diodes for energy saving lighting, and (iii) proton and mixed conductors for fuel cells. The proposed system is intended to enhance our capabilities and increase the probability of success on the critical scientific and technological issues:

1) growth of high quality crystalline metal-oxide films,

2) p- and n-type electronic doping of metal-oxides,

3) band gap engineering of semiconducting metal-oxides.

III. Scientific background and state-of-the-art

III.1. Conventional deposition techniques

A number of different deposition techniques have been tested and reported over the years for growth of metal-oxide layers. These techniques include both chemical and physical vapor depositions: CVD and PVD, respectively. It is realized now that CVD-type deposition techniques are particularly useful in the applications where the quality of the interface between the oxide and non-oxide materials is of highest importance. For instance, atomic layer deposition (ALD) has a tremendous success in deposition of high-k dielectric oxides for modern MOSFETs. ALD is also considered now for deposition of passivating Al_2O_3 layers in Si-based solar cells. The CVD methods are, however, less successful in the applications where dense crystalline oxide films with good control over the doping and microstructure are needed.

One PVD-type deposition technique that stands out in terms of synthesis of high quality metal-oxide layers is pulsed laser deposition (PLD). Already in the 1980's, PLD has been successfully used for deposition of high-quality complex perovskite high-T superconducting oxides. Until now, PLD is the only deposition technique that has been reported to provide synthesis of macroscopic-size p-type ZnO and ZnO-based LEDs. As an evidence for the recognition, a PLD system has been recently purchased by T. Norby's group (UiO/KI/SMN) for metal-oxide depositions. Despite the success, however, PLD has never been seriously considered as a technologically viable technique due to the inability for scaling.

III.2. Beyond state-of-the-art

Today we are witnessing development of High Power Impulse Magnetron Sputtering (HiPIMS), a technique that can match and potentially surpass the quality obtained with PLD. Indeed, during PLD the emitted atoms have extremely high kinetic energies of up to 100 eV, and in some cases up to 500 eV. These high energies are believed to be the main factor for the high crystal quality of the PLD-deposited layers. HiPIMS operates at such powers that the sputtered atoms can have kinetic energies in the same range up to 100 eV and higher. At the same time HiPIMS, as a magnetron sputtering technique, is readily scalable and applicable for industrial purposes.

QPrep500 from Mantis Deposition, Ltd. This or similar system will be used for HiPIMS. Note the UHV design of the chamber with multiple flanges that allow future upgrades and re-configurations.

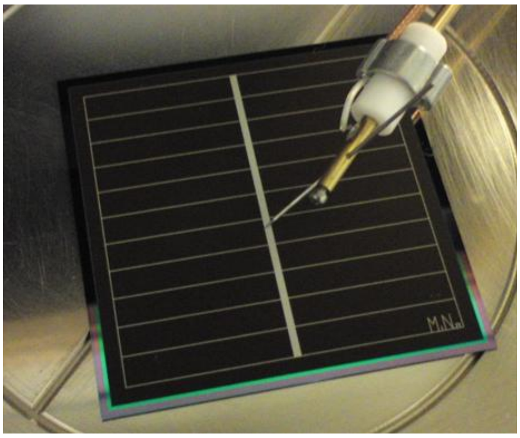
It is already demonstrated experimentally that HiPIMS results in metal-oxide films of excellent quality. As an indicator of the growing interest, at the latest conference "Magnetrons, Ion beam processing & Arc Technologies European Conference" MIATEC 2011 almost 30% of contributions have been dedicated to HiPIMS. The installation of HiPIMS will advance UiO’s position at the forefront of functional materials research.

One can also notice that the system under consideration (see figure) has extremely flexible design that allows relatively easy upgrade and reconfiguration. Due to the multiple flanges, a number of other deposition or analysis options can be added. The system is ultra-high vacuum (UHV) compatible and very well-suited for research purposes.

IV. Metal-oxide applications and challenges

IV.1. Solar cells

The use of transparent conductive metal-oxides (TCO) in solar cells has been proposed already several decades ago. Different concepts have been put forward and developed. Probably the most successful application of TCO can be found in the HIT (Heterojunction with Intrinsic Thin layer) solar cells, commercially produced nowadays by Sanyo. These solar cells hold the record efficiency among commercially produced Si-based cells. Besides the traditional Si-based cells, TCOs are presently widely used in the second generation thin-film concepts. For future third generation solar cells, TCOs are considered as an integral part in most of the concepts. Presently the most used TCO is indium-tin-oxide (ITO). The huge demand for In has resulted in a considerable price increase: by a factor of 3-4 for the last 10 years. To avoid the problem with In shortage, researcher are looking for a material that can substitute ITO.



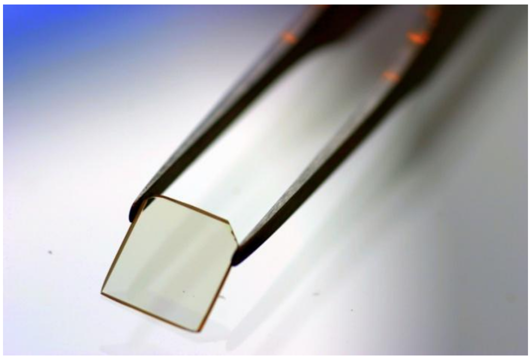
A solar cell fabricated at MiNa-lab with an ITO layer on the front-side. ITO has to be substituted by ZnO.

Recently, a concept of oxide-based tandem cells has been developed, where metal-oxides act as an active light absorber. In this more advanced approach, one can use a range of metal-oxides: from native n-type ZnO to native p-type Cu_2O. This approach requires a higher degree of control over the crystal quality and dopants, and, in some cases, an ability for band-gap engineering. The researchers at LENS and international partners have already made some progress on resolving these problems but major challenges remain, both with respect to novel TCOs and the oxide based tandem cells.

IV.2. LED lighting

Light emitting diodes (LED) as a lighting source are becoming increasingly attractive. This is due to the extremely efficient power consumption and a long lifespan. For instance, an LED lamp of just 9 W is equivalent to an incandescent bulb of 60 W. Moreover, LED lamps, in contrast to the fluorescent ones, do not contain such toxic elements as mercury, while being up to 50% more efficient. The two main obstacles for a wider spread of LED lighting are (i) high purchase prices and (ii) absence of high-luminosity lamps. These two problems have scientific and technological reasons. Presently, the most of white LEDs are based on Ga-Al-N compounds. The disadvantage in using Ga-Al-N is the absence of native wafers/substrates for epitaxial crystal synthesis. Thus, another material with a different crystal structure and/or lattice constant has to be used as a substrate, such as expensive SiC. This results in the Ga-Al-N layers with a relatively high concentration of crystal defects that are detrimental to the conversion of current to light.

It is expected, however, that LEDs based on ZnO can be more efficient due to a very high exciton binding energy of 60 meV. Besides, ZnO has a technological advantage: ZnO wafers/substrates of up to 3"-diameter are commercially available. This opens a feasibility of almost defect-free epitaxial growth of LED structures. The above considerations show a theoretical possibility for cheap and high-luminosity LEDs. The main challenges for ZnO-based LED, such as reliable p-type doping and band-gap engineering, are still not fully overcome, despite a considerable progress over the last years (see, for instance, our review on ZnO and references therein).[1]



A single-crystal ZnO wafer under investigation in MiNa-lab. It can be used as a native substrate for epitaxial growth.

IV.3. Proton and mixed conductors for fuel cells

The existence of protonic defects and the corresponding proton transport in wide-bad-gap metal-oxides has been established already in the late 1960's. This paved way to development of solid oxide fuel cells (SOFC). Presently the most common proton and mixed conductors are oxides with perovskite-type structures (ABO_3) with cubic or slightly reduced symmetry. Besides the established proton conductors with the ABO_3 structure, the search for other proton conducting oxide continues. For instance, recently $RENbO_4$ and $RETaO_4$, where RE is rare earth elements, have been proposed by Haugsrud and Norby.[2]

[1] Monakhov et al., *J. Phys. D: Appl. Phys*. **42**, 153001 (2009)
[2] Haugsrud and Norby, *Nature Materials* **5**, 193 (2006)

In order to enhance the proton transport, the oxides are normally doped with acceptors. In addition, a considerable attention should be paid to the quality of the polycrystalline microstructure of the oxides, since the grain boundaries can have a considerable detrimental effect on the proton conducting properties. Thus, the challenges related to the efficient acceptor doping and improved crystal quality are also crucial for fuel cell applications.

V. Research environment and existing infrastructure

UiO-MiNaLab houses today about 35 people on a daily basis from the LENS group and comprises a separate clean room floor (~440 m^2 in size) with novel equipment for growth and processing of semiconductor materials and device structures, e.g., systems for Magnetron sputtering, Metal Organic Chemical Vapor Epitaxy (MOVPE) and atomic layer (ALD) deposition of semiconducting oxides. Installation of HiPIMS will support ongoing and recently awarded projects, such as Solar FME and Heterosolar (RENERGI).

Here, we would like to stress that our ambition is to be a leading group at the international level regarding modification, processing, and nanostructuring of novel semiconductors, as also recently acknowledged by international evaluators of the Physics research in Norway, providing a stimulating research environment to promote training/education of students and international exchange of scientists.

VI. Budget

The tentative price for delivery and installation is around 189 000 GBP (see attached quotation from Mantis Deposition, Ltd.). Assuming the exchange rate of 9 GBPNOK, the budget will amount to 1.7 MNOK, ex. VAT. The costs for pre-installation work (el power, cooilng water, gases) at MiNa are estimated as 50 kNOK.

Taking into account the duration of the proposal evaluation and the tender, the purchase order is expected to be placed in Autumn 2012. Delivery and installation is expected in Spring 2013. According to the quotation, 45% of the order amount should be paid in 2012 upon order placement.

Budget over years 2012-2013, kNOK, ex. VAT:

	2012	2013	Total
Purchase and installation, ex VAT	765	935	1700
Pre-installation	-	50	50
Total	**765**	**985**	**1750**

Quotation Number: NW120101a

Customer: Esben Lund, University of Oslo, Norway

Date: 22nd February 2012

Suggested configuration:

Item	Description	Qty	Price
QPrep500-4i-BASE	SS304 cylindrical chamber with hemi-spherical base pumped by 700ls-1 turbo pump (Pfeiffer HiPace700) and backed up by dry pump (Pfeiffer ACP15)	1	£55,880
QPrep500-4i-SMPL	Substrate table suitable for 4" samples	1	£3,960
QPrep500-4i-SMPL-ROT	Rotation option for substrate table	1	£8,250
QPrep500-4i-SMPL-800H	800C heating option for substrate table	1	£8,250
QPrep500-4i-SMPL-RF/DC	Provision for DC/RF bias of substrate table. Suitable for DC bias up to 500V. Power supplies are not included.	1	£2,640
QPrep500-LL-4i	Load-lock chamber and sample transfer system for 4" samples	1	£23,375
CUSP-3iU	3" magnetron sputter source with integral gas hood	3	£13,760
CUSP-3i-ASH	Integral automatic shutter for CUSP-3iU	3	£3,960
CUSP-3i-DCP	720W DC power supply for CUSP-3iU (TDK Lambda)	2	£6,380
CUSP-3i-HIPIMS	HIPIMS power supply for CUSP-3i (Ionautics)	1	£41,700
MFU	Mass flow unit for Ar (MKS) and O2 (MKS)	2	£3,190
MFU-4CC	Four channel controller for MFU units	1	£2,090
QP-AUSYS	Full system automation with recipe-driven process	1	£10,450
Installation and training	Includes 3 days training	1	£3,200
Delivery	DAP	1	£2,300
TOTAL			**£189,385**

Options:

Item	Description	Qty	Price
QP-QCM	Quartz crystal thin film deposition monitor (Inficon)	1	£4,730

Mantis Deposition, Ltd. 2 Goodson Industrial Mews Wellington St. Thame Oxfordshire OX9 3BX UK
Tel: +44-1844-260160 Fax: +44-1844-260421
www.mantisdeposition.com Email: sales@mantisdeposition.com

UNIVERSITETET I OSLO
Forskningsadministrativ avdeling

Egenerklæring

Vedlegg til søknad om vitenskapelig utstyr over 1 mill kr

Gjelder innkjøp av High Power Impulse Magnetron Sputtering system (Navn på utstyret)

MiNa-lab, UiO (Angi utstyrsenhet)

LENS, Fysisk Institutt (Enhet utstyret skal plasseres ved)

Behov for IT-støtte

X Utstyrenhetenes IT-behov passer inn i universitetets IT-infrastruktur

¤ Utstyrsenhetens IT-behov passer ikke inn i universitetets IT-infrastruktur
- ¤ Utstyrsenhetens IT-behov er avklart med USIT
- ¤ Kostnader i forbindelse med tilpasning av infrastruktur NOK....................

Behov for laboratorieinvesteringer

X Utstyrsenheten vil ikke innbære vesentlige endringer med hensyn til arealdisponering

¤ Utstyrsenheten vil innebære vesentlige endringer i arealdisponering, og dette er avklart med Teknisk Avdeling

¤ Utstyrsenheten vil ikke innebære omkostninger til ombygging av lokaler, bygningstekniske-, vvs- eller elektroniske arbeider

X¤ Utstyrsenheten vil innebære omkostninger til ombygging av lokaler, bygningstekniske-, vvs- eller elektroniske arbeider
- ¤ Ombygging er avklart med Teknisk avdeling
- X Kostnader i forbindelse med laboratorieombygging osv er ca NOK 50 000.-

Driftskostnader

X Det vil ikke påløpe vesentlige driftskostnader ved utstyret
¤ Det vil påløpe driftskostnader ved utstyret årlig tilsvarende ca NOK...................

Prosedyrer og retningslinjer for anbud og kjøp

X Instituttet er kjent med universitetets retningslinjer for anbud og innkjøp
¤ Instituttet har hatt kontakt med innkjøpsseksjonen for avklaring av retningslinjer for anbud og innkjøp

Underskrift

E. Monakhov
....
Prosjektleder

....
Administrativt ansvarlig