NOTAT_1 til Styremøtet Fysisk institutt 23. februar 2012.

Til ***Styret ved Fysisk institutt***
Fra ***Instituttleder***

Ad. Vedtakssak, sak 09/12

I kjølvannet av Forskningsrådets internasjonale evaluering av fysikk grunnforskning i Norge samt Oppfølgingsutvalgets innstilling, lyste forskningsrådet ut et 'Institusjonsbasert Strategisk Program' (ISP) for fysikk som hadde som målsetning å følge opp anbefalinger som var blitt gitt. Programmet hadde en finansieringsramme på 25,5 MNOK fordelt over tre år. Dokumentene og utlysningen finnes på linken http://www.forskningsradet.no/no/Artikkel/Evaluering_av_grunnleggende_forskning_i_fysikk/1235469194096?lang=no

Fysisk institutt besluttet å sende inn tre søknader til dette programmet og inviterte gruppene til å sende inn skisser til søknader. Etter en behandling i GruppelederForum i august 2011 ble det besluttet å sende inn fulle søknader fra AMKS-gruppa, Teorigruppa og EPF-gruppa. Søknadene skulle beskrive tiltak for å styrke viktige eksisterende eller nye virksomheter i gruppene i henhold til anbefalinger gitt i de overnevnte utredningene, og etter avtale med Instituttledelsen skulle det søkes om tre-årig finansiering av en eller flere 1.amanuensis og/eller post dok.-stillinger samt eventuelle driftsmidler. Instituttet skulle på sin side matche dette med en (eller flere) stipendiatstillinger samt egeninnsats. Instituttet forpliktet seg likeledes til å videreføre 1.amanuensisstillingen(e) etter utløpet av de tre årene med finansiering fra Forskningsrådet.

I tillegg ble det sendt en søknad om opprettelse av et nasjonalt beregningsbasert fysikk-senter ifra NTNU, der UMB og UiO var likeverdige partnere med NTNU. Her gjorde ikke instituttet noen bindende forpliktelser idet søknaden ble sendt uten at den på forhånd var blitt diskutert med Instituttledelsen eller inkludert i GruppelederForum's behandling av saken.

I brev fra Forskningsrådet datert 4. januar 2012 ble det informert om at søknaden fra EPF gruppen, med tittelen *Accelerator physics research for the next generation of high-energy physics experiments*, var blitt innvilget med tre-årige lønnsmidler for en post dok. samt 243 kNOK til drift over tre år, totalt 3 MNOK over tre år - noe som var en betydelig avkortning av det opprinnelige søknadsbeløpet på 5.5 MNOK. De andre to søknadene ble avslått. Den overnevnte søknaden fra NTNU ble innvilget med en post dok. på hver node samt noe driftsmidler. Denne søknaden omtales ikke ytterligere i dette notatet.

I alt ble 5 ut av 12 innsendte søknader innvilget .

Formålet med EPF-gruppens søknad er som følger:

> *The objective of the proposed project is to establish a high quality accelerator physics activity at the Department of Physics, University of Oslo, by building on the work within the international CLIC collaboration for a future linear collider at CERN, increasing the cooperation with Nordic partners in the NorduCLIC framework, and participating in the European Spallation Source project in Lund. It will give the Univ. of Oslo stronger contact*

with cutting edge international research projects in accelerator physics and give the Experimental Particle Physics group and the Department of Physics a new research dimension linked to participation in the build-up phase of future modern accelerator-based research infrastructures.

The Experimental Particle Physics group currently has activities in physics studies at LHC (ATLAS), data analysis methods and tools (e.g. GRID computing), detector instrumentation for physics experiment as well as medical systems, and the CLIC accelerator project. The group got top rating in the NFR evaluation of the Basic Physics Research in Norway in 2009. ***The evaluation specifically encourages the group to expand activities in accelerator physics.***

The central part of this initiative is to increase the national competence level in accelerator physics. This field is of increasing importance in physics research as well as in society, due to the many accelerator applications in science, industry and medicine. Because accelerator physics is a coherent field of physics, competence gained with one type of accelerators, e.g. linear colliders, is directly applicable to other accelerator projects. It also opens doors to Norwegian participation in the development of future European infrastructures, where accelerator technology is the key scientific discipline in a range of emerging projects in particle physics and nuclear physics, in material science and energy research.

In combination with other existing funding sources, in particular the CERN/related physics programmes and CERN's technical student programme, the applied funding will enable full financing of several Ph.D and master students directly integrated in the aforementioned projects.

Den fulle prosjektbeskrivelsen er vedlagt dette notatet.

Etter samtale med Forskningsrådet ble det klart at Fysisk institutt kunne lyse ut en 1.amanuensis-stilling i tråd med denne prosjektbeskrivelsen for tiltredelse *ca 1. mars 2013*. En eventuelt kostnadsdifferanse mellom post.dok.-lønnsbevilgningen fra Forskningsrådet og lønnen til en 1.amanuensis måtte da dekkes av instituttet selv. Det ble forventet at instituttet som egenandel stilte opp med minst en stipendiat-stilling (startpakke-stipendiat), andre prosjektdeltakeres (Read, Ould-Saada, Raklev, Stapnes) medvirkning i prosjektet og videre at instituttet har som uttalt mål å overta finansieringen av denne stillingen etter tre år.

Instituttledelsen er av den oppfatning at søknaden fra EPF gruppen er solid forankret i fagmiljøet, i evaluerings- og oppfølgingsrapportene og i instituttets ledergruppe (GruppelederForum). Søknaden ble utformet i tett samråd med Instituttledelsen som også tok initiativ til avklaringsmøtet med Forskningsrådet.

I tråd med overnevnte, bes Styret om å vedta at det lyses ut en 1.amanuensis-stilling innen akseleratorteknologi med tiltredelse ca 1. mars 2013.

Forslag til vedtak:

Styret vedtar at det lyses ut en 1.amanuensis-stilling innen eksperimentell partikkelfysikk/akseleratorteknologi. Styret gir videre Instituttledelsen mandat til å utforme en betenkning for denne 1. amanuensis- stillingen i tråd med formålet for stillingen som beskrevet i søknaden til Forskningsrådet.

Application for funding of a Research Institution-based Strategic Project in Accelerator Physics at the Department of Physics, University of Oslo

1. Introduction

The objective of the proposed project is to establish a high quality accelerator physics activity at the Department of Physics, University of Oslo, by building on the work within the international CLIC collaboration for a future linear collider at CERN, increasing the cooperation with Nordic partners in the NorduCLIC framework, and participating in the European Spallation Source project in Lund. It will give the Univ. of Oslo stronger contact with cutting edge international research projects in accelerator physics and give the Experimental Particle Physics group and the Department of Physics a new research dimension linked to participation in the build-up phase of future modern accelerator-based research infrastructures.

The Experimental Particle Physics group currently has activities in physics studies at LHC (ATLAS), data analysis methods and tools (e.g. GRID computing), detector instrumentation for physics experiment as well as medical systems, and the CLIC accelerator project. The group got top rating in the NFR evaluation of the Basic Physics Research in Norway in 2009 [1]. The evaluation specifically encourages the group to expand activities in accelerator physics.

The central part of this initiative is to increase the national competence level in accelerator physics. This field is of increasing importance in physics research as well as in society, due to the many accelerator applications in science, industry and medicine. Because accelerator physics is a coherent field of physics, competence gained with one type of accelerators, e.g. linear colliders, is directly applicable to other accelerator projects. It also opens doors to Norwegian participation in the development of future European infrastructures, where accelerator technology is the key scientific discipline in a range of emerging projects in particle physics and nuclear physics, in material science and energy research.

We apply for funding for one project leader/researcher for the period mid-2012 to mid-2015, as well as partial funding for Ph.D students under the CERN technical student program, supervised from the Univ. of Oslo, plus travel expenses. In total 1.8-1.9 MNOK per year over 3 years, or 5.5 MNOK. In combination with other existing funding sources, in particular the CERN/related physics programmes and CERN's technical student programme, this will enable full financing of several Ph.D and master students directly integrated in the aforementioned projects.

[1] Basic Physics Research in Norway – An evaluation, The Research Council of Norway, 2009

2. Scientific case

The advancement of particle accelerators has been driven by particle physics research, and the establishment of the very successful Standard Model of particle physics is the result of particle accelerator-based research during the last ~100 years. Likewise, the advances in nuclear physics the last century are heavily based on particle accelerators. The development of novel particle accelerators with capabilities of reaching higher collision energy, higher beam power and higher luminosity has required substantial and systematic research in the behavior of charged particle beams – in other words accelerator physics. The use of accelerators has furthermore spread to a wide range of areas, including synchrotron radiation research with electron storage rings and free electron lasers, cancer radiotherapy and more recently proton and ion therapy for cancer patients plus a number of industrial applications. Today 30,000 accelerators are at work worldwide in areas ranging from high-energy proton collisions at the LHC, diagnosing and treating disease to powering industrial processes [1]. 24 Nobel Prizes in Physics have had direct contributions from accelerators, and 4 Nobel Prize winners were dedicated accelerator physicists, including the 1984 Nobel Prize winner Simon van der Meer. It is probable that many advances in these fields could not have taken place without dedicated research in accelerator physics and technology.

In high-energy physics (HEP) the LHC [2] is currently studying proton-proton collision at the Teraelectronvolt scale (7 TeV center of mass energy in 2011-2012, to be increased in 2014). A lepton collider will allow important complementary studies of the physics discovered at LHC, and is considered by the HEP community to be an important next step in order to advance particle physics [3]. However, the basic parameters of this collider can not be set until there are results from the LHC which indicate whether or not a light Higgs boson exists and what its mass is if it does exist, whether there are new physics signals (supersymmetry, extra spacetime dimensions, new gauge symmetries, etc) and what the mass or energy scale of this new physics is. The EPF group contributes actively to several of these experimental studies in the ATLAS experiment. With 1-2 fb^{-1} of data analysed there is not yet evidence for Higgs production, although a large part of the allowed mass region is now excluded by the data, and the many negative results of searches for new physics indicate that the scale of the new physics can not be very light [8].

Today there exists no established technology that allows for achieving lepton collisions at high luminosity in the multi/TeV range. The compact linear collider study at CERN aims to develop the technology for an electron-positron linear collider with a center-of-mass beam collision energy in the multi-TeV range. The CLIC concept is based on an innovative Two-Beam Acceleration concept, where the main electron and positron beams will be accelerated by energy extracted from electron drive beams instead of pulsed power klystrons. In this process the drive beam will lose up to 90% of its initial energy. The CLIC concept is described further in [4]. At CERN, the key concepts of CLIC are tested in the CLIC Test Facility (CTF3) [5]. The CLIC study aims at proving feasibility of the CLIC concept by the middle of 2012. The project will then enter a project implementation preparatory phase, taking into account input from the first LHC results. Recently detector/specific R&D for CLIC has been added to the collaborative effort. The Norwegian CLIC effort is regulated through a Memorandum of Understanding and the University of Oslo is an official member of the CFT3/CLIC-collaboration, and a partner in the Nordic CLIC collaboration "NorduCLIC" [6]. During the last 5 years the CLIC effort has grown from one Ph.D. student to one professor (currently 10% level), one post.doc, two Ph.D. students and technical students. In addition 4 other students at the University of Oslo have started Ph.D. studies in accelerator

physics: in LHC machine background and operation studies, Neutrino factory studies and high-power proton drivers.

Furthermore, the Norwegian CERN activities related to accelerator science have been asked to formulate an activity related to accelerator development at the European Spallation Source, ESS [7] and this could open another important avenue for this project in the coming period.

In summary, the Norwegian accelerator activities have developed substantially during the recent 5 years: It is important to maintain this momentum and establish a sustainable academic environment to increase Norwegian competence in accelerator physics and technology. A successful application to the ISP program, combined with the use of the CERN technical and doctoral student programs can do that.

As an example of the impact of strong accelerators expertise in a country, both within research as well as for broader interests, we list some Swedish accelerator activities:

- the decision to construct the new European Spallation Source at Lund, Sweden
- a successful history in construction, operation and application of Synchrotron Light Sources (Max I-III). Recent go-ahead for a new major accelerator facility, Max IV (Lund, Sweden)
- the available of proton therapy of cancer treatment in Sweden (Uppsala, Sweden)

It is likely that none of these projects would have been carried through without national expertise in particle accelerator physics and technology. Likewise, it is likely that increased national focus on accelerator research in Norway would put Norway to in a position to be a full partner in Nordic, European and International projects involving large-scale accelerator infrastructure. A strong national activity can also be used to increase the interest and competence of Norwegian industry to be able to deliver components and systems during the construction phase of these large projects.

[1] Accelerators for America's Future, U.S. Department of Energy, 2010
[2] LHC Design Report, CERN-2004-003 (2004)
[3] The CERN Council Strategy Group: http://council-strategygroup.web. cern.ch/
[4] The CLIC Study Team, A 3 TeV e+e- Linear Collider Based on CLIC Technology (2000)
[5] G. Geschonke and A. Ghigo (eds.), CTF3 Design Report", CERN CTF3 Note 047 (2002)
[6] Statues of the Nordic CLIC Consortium NorduCLIC
[7] http://ess-scandinavia.eu/
[8] http://eps-hep2011.eu/, http://www.tifr.res.in/~lp11/.

3. Scientific goals

The main scientific goal for the accelerator physics program is linked to the participation in the CLIC collaboration together with Nordic partners in the NorduCLIC program, profiting maximally from the experimental test facilities at CERN and interaction with the CERN technical student programs for additional training in accelerator physics. We also foresee to have a limited activity towards the LHC upgrade program at CERN.

A secondary goal for the accelerator physics program is studies of superconducting radiofrequency (RF) technology and RF generation for the proton driver for the European Spallation Source, also in cooperation with Nordic Partners. The collaboration with ESS will

as well profit from advanced accelerator test facilities in Uppsala and Lund, and student training placements.

For the long term we also plan a small activity towards future projects, taking profit from future accelerator R&D within the TIARA Network. As example, the group currently has a Ph.D. student at CERN involved in neutrino factory studies.

3.1 Main scientific goal : CLIC and NorduCLIC

NorduCLIC is a collaboration formed by the EPF group at the University of Oslo (Norway), Uppsala University (Sweden), Helsinki Institute of Physics Group (Finland) and Aarhus University (Denmark). A core NorduCLIC program has been established that focuses on the design, construction and experimental tests of high-gradient accelerating structures for CLIC [1], as well as detailed studies of the CLIC two-beam acceleration scheme, by both theory, simulation and experimental means. Figure 1 shows a cartoon of the two-beam acceleration scheme.

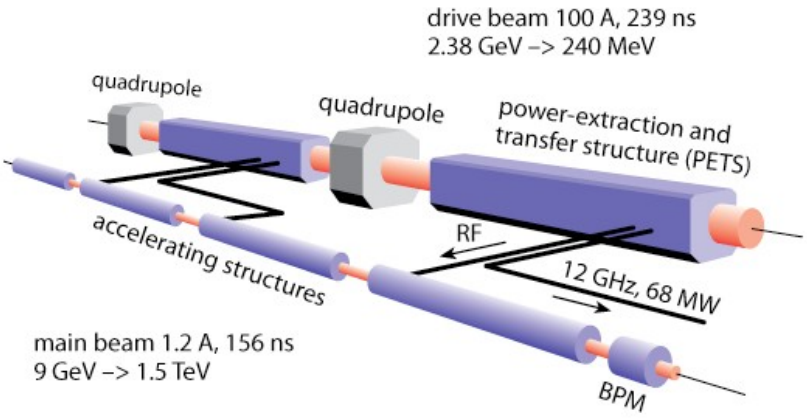

Figure 1: The novel two-beam acceleration concept being developed for CLIC. Specially designed power extraction structures extract energy from an electron drive beam in form of rf power. This rf power is used to accelerate electron and positron beams up to TeV energies.

The EPF group is currently involved in the above activities through one professor at 10% level (currently 90% at CERN), one Post. Doc. researcher and two Ph.D. students. As an example of the current NorduCLIC activites, Ref. [2] describes important scientific results for proving the feasibility of CLIC. The specific work of the EPF group within NorduCLIC during the funding period 2012-2015 is planned to include :

1. Two-beam acceleration experiments in the CLIC Test Facility Two Beam Test Stand. The test stand programme will be significantly expanded in the coming period to test all aspects of the two-beam acceleration scheme, including break-down studies and experimental tests of full-size CLIC modules [3].
2. CLIC structure RF designs. This research include 1) accelerator structure RF design and optimization, including higher order mode studies, 2) beam dynamics studies of the CLIC main linacs [4]
3. Studying dark current behavior in CLIC structures. This research includes 1) FEM-simulations of tracking of field emitted electrons in CLIC structures, 2) benchmarking against measured electron spectra at the 12 GHz test stand at CERN and/or the

planned 12 GHz test stand in Uppsala 3) and beam dynamic studies of dark current in the CLIC main linac [4]

4. Beam physics studies of a heavily decelerated electron beam. This research includes 1) simulation of intense electron drive beams, 2) accelerator collective effects code development 3) experimental tests in the Decelerator Test Beam Line in the CLIC Test Facility [5]

This program will position the group to be a leading CLIC collaboration partner focusing on the core of the CLIC technology, the two-beam acceleration linac scheme. In addition to the core research activities outline above, the EPF group will participate in seminars and workshops on physics at the next linear collider. On a medium time-scale the participation in the CLIC study will put the group in a good position to contribute to the preparation of detector, computing and physics analysis tools needed for the generation of experiments after the LHC. This is important for the group, since on the long term the focus of the groups activities will necessarily be weighted more towards future HEP projects.

3.3 Secondary goal: participation in ESS

The proton driver of the European Spallation Source (ESS) is a superconducting high power proton linac, with 5 MW average beam power and a beam energy of 2.5 GeV [6]. This type of accelerator has not been conceived in Europe previously, and a large amount of accelerator R&D is foreseen for the ESS. Norway joined ESS in 2010, agreeing to a contribution of 2.5% of the construction cost (~40 MEUR). As part of this, the Norwegian CERN activities related to accelerator science has been asked to formulate an activity at ESS related to accelerator development. There are many synergies in the competences required for linear collider R&D and the ESS development work, and the accelerator project aims to take profit of this. The EPF group has started a collaboration with Uppsala University (one of the NorduCLIC partners) in order to participate in the design, construction and test a low-level RF control and monitor system for superconducting elliptical cavities. This includes experimental work in the ESS cryogenic super conducting RF test stands planned for construction in Uppsala (with completion planned for 2013). In particular, the University of Oslo will make use of existing expertise in RF cavity simulations and beam dynamics to study the behavior of ESS super conducting RF cavities loaded with RF power and beam [7]. Figure 2 shows a cartoon of the proposed Uppsala Superconducting RF Test Facility [8], the experimental facility for these studies.

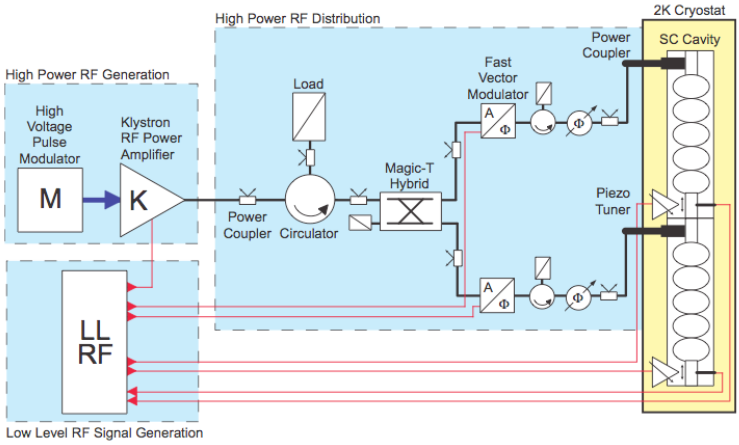

Figure 2: Uppsala Superconducting RF Test Facility

Super conducting RF technology is today considered a good option for a number of particle accelerator applications, including the European X-ray free electron lasers [9] and accelerator/driven fission power [10, 11]. The planned participation in ESS will provide the Norwegian physics community with valuable expertise within the field of superconducting RF systems.

[1] T. Ekeloef et al., Application for funding of a common Nordic research project "NorduCLIC" within the International Compact Linear Collider development program (2009)
[2] E. Adli (University of Oslo), R. Ruber and V. Ziemann (Uppsala University) et al., "X-band rf power production and deceleration in the two-beam test stand of the Compact Linear Collider test facility", Phys. Rev. ST Accel. Beams, 14, 081001 (2011)
[3] R. Corsini, CLIC TDR plans, International Workshop on Linear Colliders 2010
[4] E. Adli, Proposal for rf design and simulation tasks within the NorduCLIC framework, Technical note, 2010
[5] E. Adli et al., Experimental Program for the CLIC Test Facility 3 Test Beam Line, Presented at the 1st International Particle Accelerator Conference, IPAC'10 (2010)
[6] M. Lindroos et al., The ESS Superconducting Linear Accelerator, SFR (2009)
[7] R. Ruber, V. Ziemann and T. Ekeloef, RF Development for ESS (2009)
[8] R. Ruber, V. Ziemann and T. Ekelöf, FREIA: Facility for Research Instrumentation and Accelerator Development, Uppsala University (2010)
[9] http://xfel.eu/
[10] http://myrrha.sckcen.be/en/Engineering/Accelerator
[11] Thorium as an Energy Source - Opportunities for Norway, The Research Council of Norway (2008)

4. Strategic significance for the Department of Physics

This research proposal addressing advanced accelerator research is tightly integrated to the recent reviews addressing the need for increased accelerator expertise in Norway. The evaluation "*Basic Physics Research in Norway. An evaluation*", The Research Council of Norway (2010) supports an increase in accelerator activities at the Department of Physics at the University in Oslo. Furthermore, international reviews of the Norwegian CERN activities have given the same message: Increased focus on accelerator physics in the future is needed, and must be a prioritized area in the coming decade of particle physics project planning.

This accelerator physics ISP project addresses these priorities by sustaining a substantial Norwegian accelerator physics activity, ensuring continuing recruitment and supervision of master and Ph.D. students and allowing for Norwegian activities to be more strongly linked to international expertise on accelerator science, with a strong focus on linear colliders. This is relevant for Norwegian participation in a number of future research projects in Europe as outlined above, with a much wider scope than particle physics alone. Univ. of Oslo has both the initial expertize, and European ambition to be able to participate and contribute to several of these project in the future, with important benefits to a wide range of research activities at the Institute and Faculty. This expertise covers first and foremost the scientific programmes of these facilities(i.e. the scientific user communities), but also specific expertise in modern accelerator science, and finally electronic and mechanical workshops that can contribute to instrumentation in these projects in a similar way as they today contribute to detector development and construction.

4.1 Development of competences

The current EPF group involvement in accelerator activities involves one professor at 10% level (currently 90% at CERN), one full time post.doc researcher, supervision of six Ph.D. students (five paid mainly by the CERN technical student programmed) and several CERN technical master students. Future recruitment will allow a continuity of student flow and project knowledge at the Dept. of Physics.

A vital part of increasing the accelerator science competence in Norway is to introduce courses in accelerator science and accelerator physics. Two different kind of courses, one at bachelor level and one at M.Sc. / Ph.D. level are envisioned :

"Introduction to particle accelerators for High-Energy Physics" [Bachelor level]
- Basic accelerator physics
- Accelerators for high-energy physics
- Future linear colliders
- Other accelerator applications; including medical applications

A small part of this curriculum is today included in FYS4550.

"Accelerator Physics" (theoretical curriculum, electrodynamics) [M.Sc. / Ph.D. level]
- Collective electrodynamics effects in charged particle beams
- Synchrotron radiation
- Microwave techniques for accelerators
- Plasma acceleration and novel acceleration principles

In addition, students working in the field of accelerator physics will be encouraged to participate in European and International master classes on accelerator physics, like the CERN Accelerator School and the US Particle Accelerator School.

In general, one of the goals of the project is to raise the competence for accelerator research and development to the level where it becomes natural in the future for the Department of Physics to play a key role in large national accelerator initiatives such as the development and construction of a national center for proton or ion therapy.

5. National and International collaboration

5.1 National collaboration

University of Oslo: The planned contribution to CLIC will in general allow the Experimental Particle Physics group to be a partner in future particle physics projects at the Energy Frontier. In the coming period, cooperation with the Theory Group (Assoc. Prof. Are Raklev) on studies of the physics case and the optimal parameter range for a future linear collider is of considerable interest. Furthermore, accelerator physics is heavily dependent on computer simulations of electrodynamic effects, ranging from full 3D particle in cell simulations to codes tracking up to ~10^7 through complex beam lines. The EPF group is already involved in FEM simulations of accelerator structures and collaboration with the Computational Physics group at the Dept. of Physics (Prof. Morten Hjort Jensen), will be fruitful in order to extend the current work. Lastly, the Department of Physics is currently involved in technology development for cryomodules based on ESS superconducting technology, for use at HIE-

ISOLDE, a project to upgrade the intensity and energy of the radioactive beams in the ISOLDE facility at CERN. The ESS development proposed for the accelerator project (involving simulation of superconducting rf structures) might benefit from a cooperation with the on-going involvement in ESS research and vice versa.

University of Bergen: At the Univ. of Bergen Prof. Gerald Eigen is involved in CLIC/ILC detector studies in particular related to calorimeter systems, linked to the CALICE collaboration (calorimeter R&D), the Norwegian CLIC project and the AIDA FP7 Integrating Activity project. Also on the theory side there have been studies of the linear collider physics potential. An accelerator physics project at the Univ. of Oslo, focusing on linear collider activities, will collaborate with and complement the Bergen linear collider activities, and seek to streamline the total Norwegian contribution to future linear collider projects.

5.2 International collaboration

The main focus on the accelerator physics project is as collaborator in the international CLIC collaboration, which currently has 41 member institutes from 21 countries, including CERN. The project will therefore profit from important synergies from the CERN-related research funding, which increases the robustness of this project and provides a long-term perspective for research activities and funding opportunities. Further collaboration with the Nordic partners in NorduCLIC and ESS development (as discussed above) also helps to ensure the robustness, impact and quality of this project. At a later stage other accelerator projects might become of interest but we believe that these two already require a wide range of accelerator expertise and stand out as natural initial focus points.

Furthermore, Norway works with seven other Nordic Groups in the NorduCLIC collaboration, and participate in the TIARA Preparatory Phase project for European Accelerator R&D facilities. TIARA, "*Test Infrastructure and Accelerator Research Area*", is a EU FP7 Preparatory Project defined by the CERN Council, with the aim of identifying and building up European distributed research infrastructures in accelerator science and coordinate R&D activities taking place at these infrastructures. Together with our Nordic Partners in TIARA we consider this an opportunity to build up local infrastructures and participate in coordinated European R&D effort at these and other infrastructures for future accelerator projects. For Norwegian students and researchers this can open an additional avenue for participation in future European research projects, even with our limited national resources compared to other European nations.

Attachments

- **CV Prof. Alex Read**
- **CV Prof. Steinar Stapnes**
- **Collaboration Letter, CERN/CLIC (Spokesperson Roberto Corsini, CERN)**
- **Collaboration Letter, NorduCLIC (Prof. Tord Ekelof, Chair in Elementary Particle Physics, Uppsala University)**