Accelerator issues – discussion points

Erik Adli, Steinar Stapnes

- Two aspects addressed:
  - One: What accelerators are being prepared (world-wide) where the Norwegian community is or could be involved (Steinar) ?
    - How are they/can they be related to the European Strategy and “our” national CERN programme ?
  - Two: What are the natural next goals for the thriving Norwegian accelerator activities (Erik) ?
    - Are there links to potential Norwegian installations in the coming decade ?
- In red – points worth mentioning in a Norwegian European Strategy Update (ESU) document (for discussion)

The CERN complex/programme is well defined for the coming ~decade

LHC running, HiLumi is being constructed -> perspective for physics ~2035 (at least)
Fixed target, AD, ISOLDE, etc -> we are in ISOLDE and AEGIS
Several R&D opportunities for e+e- machine studies in CLEAR, AWAKE, etc -> we are in both – some uncertainty on how these evolve but likely to remain for quite some years
Our current Norwegian programme is well anchored in these facilities (make a sub-point about value of small acc. facilities for R&D)

Studies for new facilities, what is new since last Strategy Update:

- With no BSM guidance not obvious choice – a tendency to wait for more LHC and HiLumi data for big decisions ?
- Is BSM physics necessarily best accessed at the Energy Frontier (is higher energy our highest or only priority) – a tendency towards e+e- for detailed SM and “creative” lower energy precision measurements and searches (neutrino and flavour physics already pursuing this avenue)
- Competing projects in Japan and China (SM with e+e-) that can be implemented faster than CERN can (more slide 4)

CLIC and High Energy LHC possible as next machine, FCC maybe later (costs very high and timescales very long) – other ideas also on table (LHeC, plasma (beyond AWAKE), muons, etc) – not so clear how to organise future studies given the uncertainty on what the next machine should be.

- At least four critical areas for R&D (RF, HF magnets, luminosity performance (very wide technical scope), physics&detectors) plus parameter studies for possible machines
- Maybe worth thinking about organizing along such topics being flexible on machine implementations, instead of along less flexible machine collaborations ?
- To what extend should these directions extend R&D scope beyond CERN sited projects ?
- In any organisatinal form we (Norwegian scientists) can participate on the accelerator side and detector/physics side, which form do we prefer ?

Physics Beyond Collider ideas, increased momentum for these – do we have a view about importance ?

Beam Dump Facility	87 events
Conventional beams	9 events
EDM storage ring	14 events
LHC fixed target	11 events
nuSTORM	5 events
Technology	8 events
Physics with e-beams (AWAKE)	empty
Physics with e-beams (SPS)	8 events
Physics - BSM	15 events
Physics - QCD	3 events
FASER	3 events

Outside CERN long baseline programme and SuperKEKb interesting physics opportunities
The neutrino platform at CERN provides a possible access to the former, Belle II would require direct involvement with collaboration – many European groups do this.
A question more to our community than to the ESU.

250 GeV e+e- colliders being pursued in Japan (ILC) – upgradable to at least 500 GeV and CEPC in China – "upgradable" to a pp machine

- Obviously interesting for Norway (I think), both accelerator, detector and physics – we would benefit from CERN providing "access" and European coordination both on accelerator and detector side.
- A challenge for CERN – but can we imagine CERN not taking on this ?

Concerning nuclear physics it is unlikely that the European Strategy will overlap/interfere much with NUPECC long range plan (http://nupecc.org/lrp2016/Documents/lrp2017.pdf) - and certainly not contradict it.
Overlap related to ALICE (secured with LHC), some fix target experiments at CERN and some mentioning of LHeC (do we comment on this in our document?)

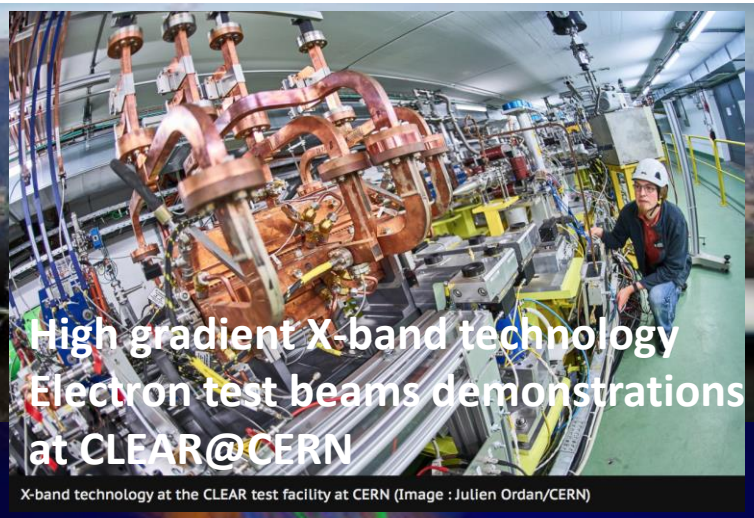
Participation in facilities in Europe as FAIR, the US (e.g. JLAB, new e-ion) and JAPAN will fall into "bi-lateral" categories, i.e. directly without CERN in the mix

We could also make a comment that participation EU projects with CERN is important for us (isn't it?) in the areas of accelerator, detectors and various spin-off technologies/projects. Mention also EuPRAXIA ?

Oslo accelerator contributions

Compact Linear Collider

(Option for Multi-TeV electron positron collider)

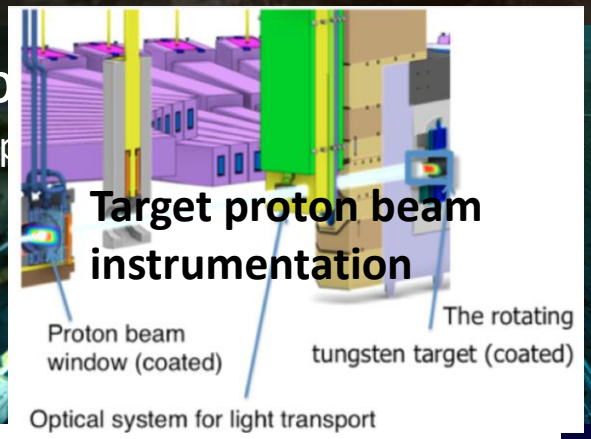


High gradient X-band technology Electron test beams demonstrations at CLEAR@CERN

X-band technology at the CLEAR test facility at CERN (Image : Julien Ordan/CERN)

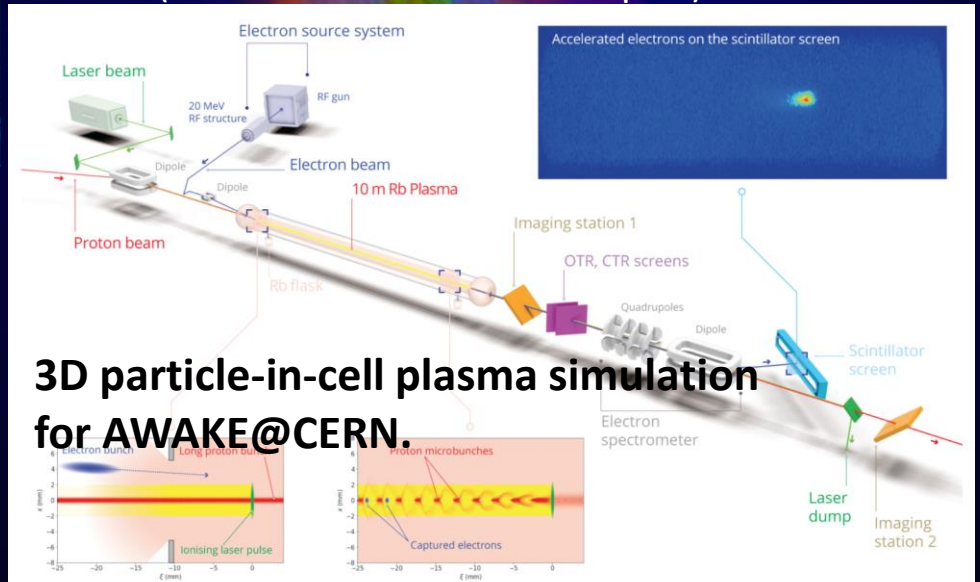
European Sp

(The world's most p



Plasma wakefield acceleration

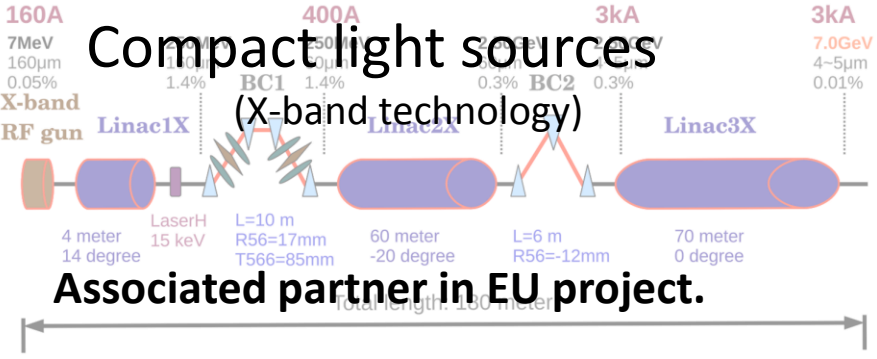
(Novel acceleration techniques)



3D particle-in-cell plasma simulation for AWAKE@CERN.

Compact light sources

(X-band technology)



Associated partner in EU project.

Oslo local capabilities

Local capabilities built up in Oslo through CERN and ESS collaborations.

- **experimental, cross-disciplinary,** linking the HEP group with many parts of the Physics Department as well as the Chemistry Department.

Accelerator instrumentation: Utilizing a **broad spectrum of mostly permanent Oslo resources**. Increasing Oslo competence for future participation in accelerator projects.

The Electronics laboratory

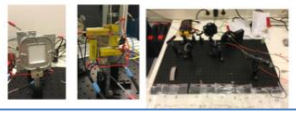
Elektronikklaboratoriet er en fellestjeneste for hele instituttet, og har kompetanse på blant annet utlegg og bestykning av komponentbærere og bruk av avanserte DAK-verktøy og kretskortdesign. Ved laboratoriet jobber vi blant annet med instrumentering av vitenskapelige raketter og satellitter, og vi har lang erfaring som leverandør av produkter og tjenester til CERN.

Røhne, Ole Myren
Forsker
(Part of the high-energy physics section)

Co-manager for the electronics and software part of the project.

Supports us for :

- Electronics architecture
- Software development
- FPGA developments
- Coating tests hardware



Dorholt, Ole
Senioringeniør

Bang, David Michael
Head Engineer

We run accelerator and plasma simulations on **Norwegian HPC-resources**

The Abel computer cluster

- A powerful computing cluster boasting over 650 computers and over 10000 cores (CPUs). Designed to handle many simultaeous jobs and users with varying neeeds.

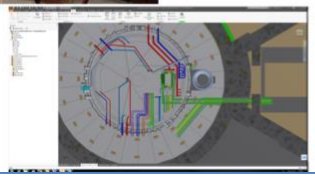
Routinely allocations ~ **1M CPU-hours/year, free**. National advantage!

The Instrument Workshop

Verkstedet samarbeider med alle de vitenskapelige gruppene ved instituttet. Instrumentmakerne lager blant annet utstyr som benyttes i raketter og satellitter, og er underleverandør til flere eksperimenter ved det europeiske forskningssenteret CERN.

Supports us for :

- Tooling and machining
- Optical prototype
- Opto-mechanical components
- CAD



Borg, Hans
Avdelingsleder

Ringnes, Jonas
Avdelingsinger

Lithun, Mar
Charlotte
Overingeni

The Oslo XRD laboratory

Wragg, David
Senioringeniør
Laboratory Manager
Norwegian National Centre for X-ray Diffraction and Scattering

X-rad diffraction performed on different coatings (before and after irradiation), in order to examine crystal structure.

Instruments at the XRD lab

APEX

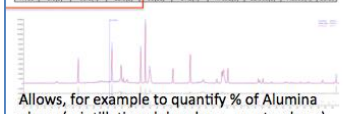
D500

DIFF 1

DIFF 2

DIFF 3

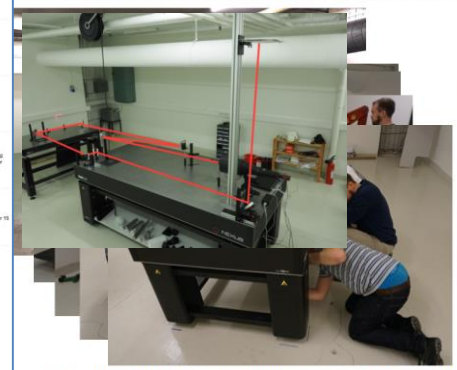
Huber



Allows, for example to quantify % of Alumina phase (scintillating alpha phase, vs. eta-phase)

New accelerator development lab. infrastructure

Will be used for Optical system prototype, laser tests and, in future, other accelerator development.



Danielsen, Kjell Martin
Senior Engineer
Purchasing.

Loose, Dag Magnus
Principal Engineer
Room manager.

- **Room and refurbishment contribution to the project from the Department of Physics**
- **Thanks to everyone who worked hard to get the new lab in good shape for the ESS visit!**

The Oslo Cyclotron Laboratory (OCL)

- OCL houses the only rese archaccelerator in Norway, a MC-35 Cyclotron (p, d, ^{3}He, ^{4}He, up to 35 MeV p). The laboratory serves as an experimental center for various fields of research and applications
- OCL has been very welcoming to our project, very good collaboration!
- Proton test beams available during proton runs (parts of the year).

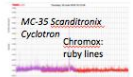
Görgen, Andreas
Professor

Semchenkov, Andrey
Senior Engineer - Nuclear and Energy Physics

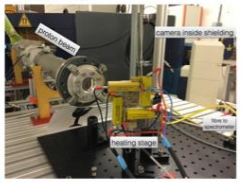
Siem, Sunniva
Professor

Müller, Jan Christian
Senior Engineer

Sobas, Pawel Andrzej
Head Engineer



OCL Beam set-up



- ***Successful testing campaign completed May-June 2016***
- ***Hoping for more beam***

Capabilities puts us **in position to contribute** to any new CERN project

Outlook

Important to be present in CERN accelerator R&D developments the coming years, in order for us to **participate in the scientific discussions** and strategies about the next machine, and **to contribute to the next machine** (ensuring student opportunities, industrial return)

Oslo plans to **continue involvement** of future accelerator projects :

- Participation in linear colliders (CLIC, ILC), future technology (AWAKE), also LHC(->FCC)
- Continued ESS collaboration, ensuring experience with commissioning and operation
- Follow compact light source developments, link to life science initatives, look into proton therapy technology

While using **CERN as a focal point** allows to leverage some resources through CERN student programs, a continuous base activity at Oslo is needed to keep momentum and base accelerator competence. At least on the level of a couple of researchers, plus students.

Most of current funding ends 2018 (free projects**).** While we continue apply for free NFR and EU funding, outcomes are very uncertain, and stable national funding would be required to guarantee a continuous activity

Expertise needed to, on the medium term, establish compact **research accelerators in Norway.** For example inverse Compton scattering light sources, linked to life sciences activities.