

Acceleratorutveckling för framtida forskning:

ESS, CLIC och frielektronlaser

Rapport vid VRs besök vid Uppsala universitet

2011-09-28

Tord Ekelöf

Uppsala universitet

Användning av acceleratorer

The development of state of the art accelerators is essential for many fields in research, medicine industry

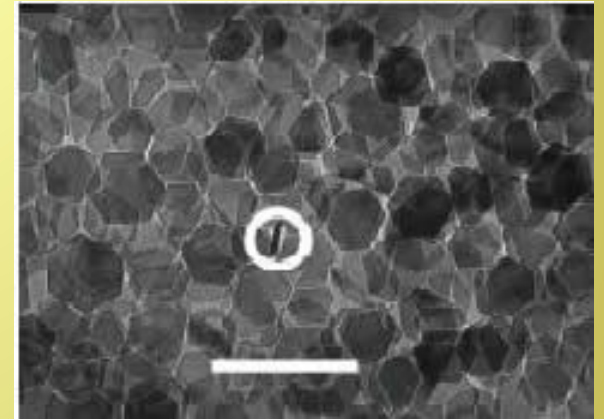
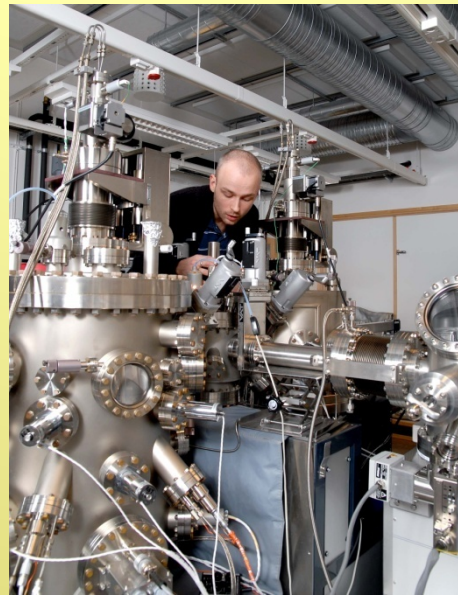
★ In past 50 years, about 1/3 of Physics Nobel Prizes are rewarding work based on or carried out with accelerators

Type of *research* accelerators and projects at Uppsala University

- Spallation neutron research (material sciences, biology...)
 1. European Spallation Source ESS
- Particle Physics
 2. Compact Linear Collider CLIC
- Nuclear Physics
- Synchrotron radiation research (condensed matter, biology, geophysics, human sciences...)
 3. Superconducting Free Electron Laser
- Fusion research
- Transmutation research

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1. European Spallation Source ESS

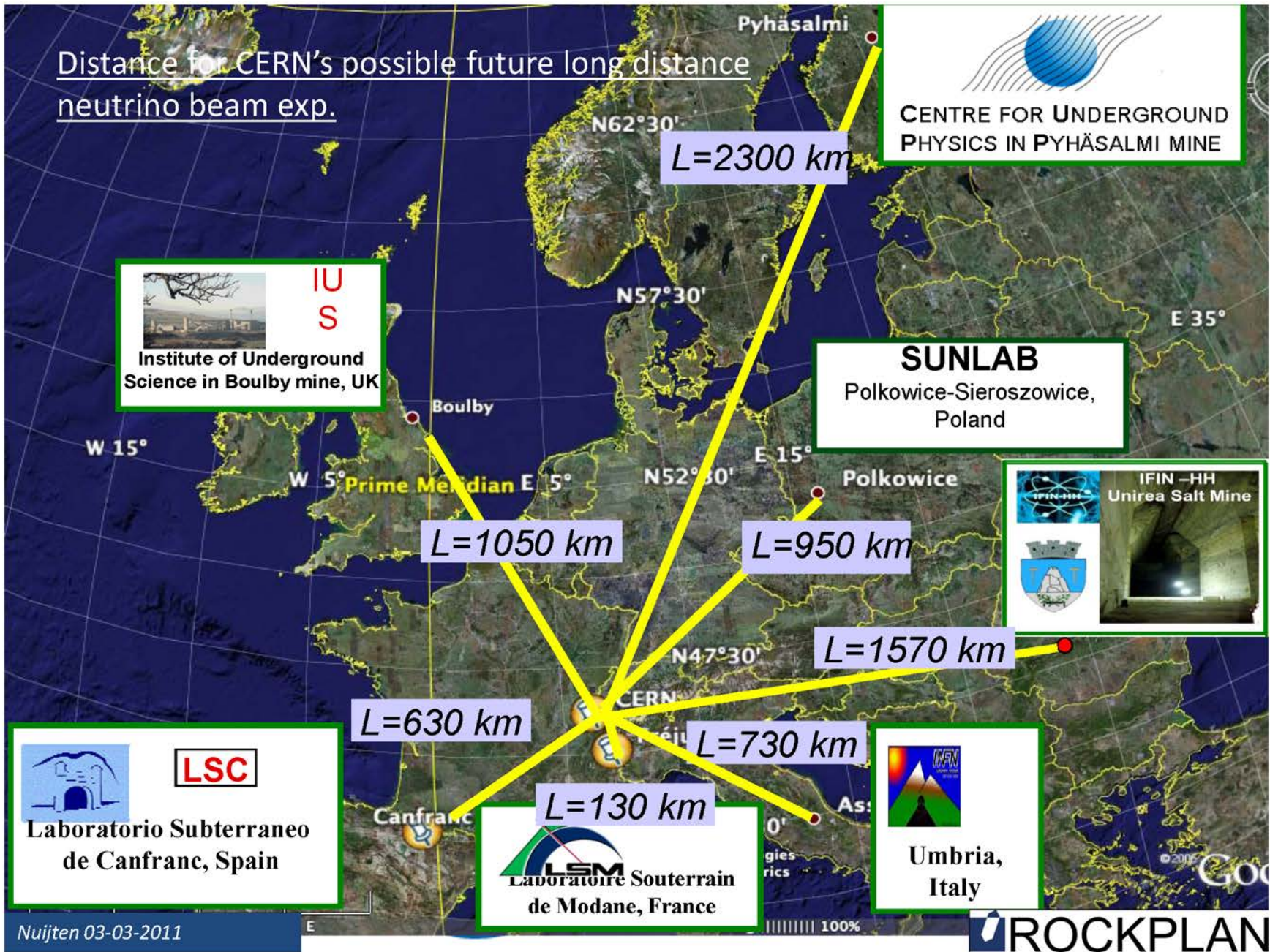


Användning

Vi har just hört en presentation av Adrian Rennie om hur den mycket kraftfulla spallationskällan, som ESS kommer att utgöra, kan användas för forskning inom **materialfysik, biologi, kemi** m.m.

ESS protonlinjäraccelerator på 5 MW 2.4 GeV kommer att vara världsunik - den kommer även att utgöra Europas och världens mest intensiva **högenerginetrinokälla** av stort intresse för aktuella frågor inom partikelfysiken.

Distance for CERN's possible future long distance neutrino beam exp.

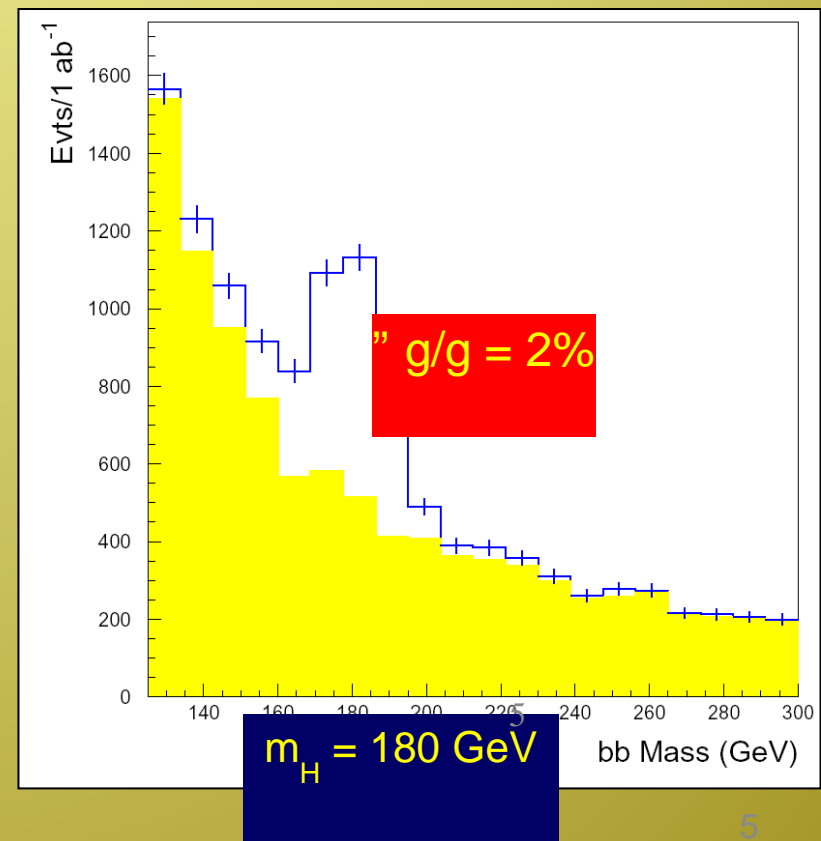
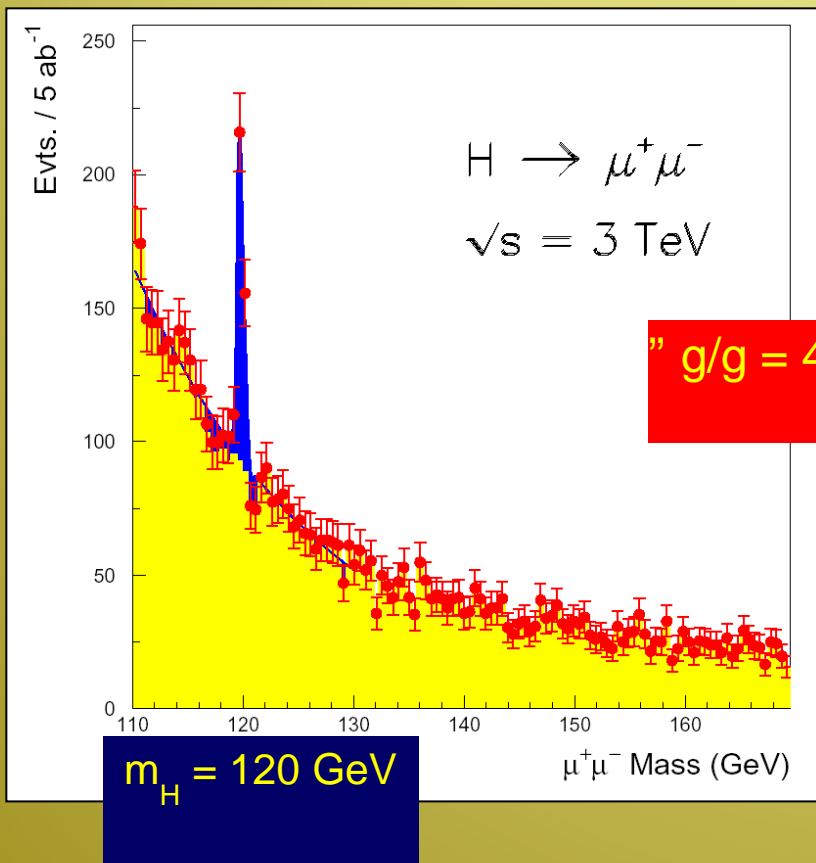
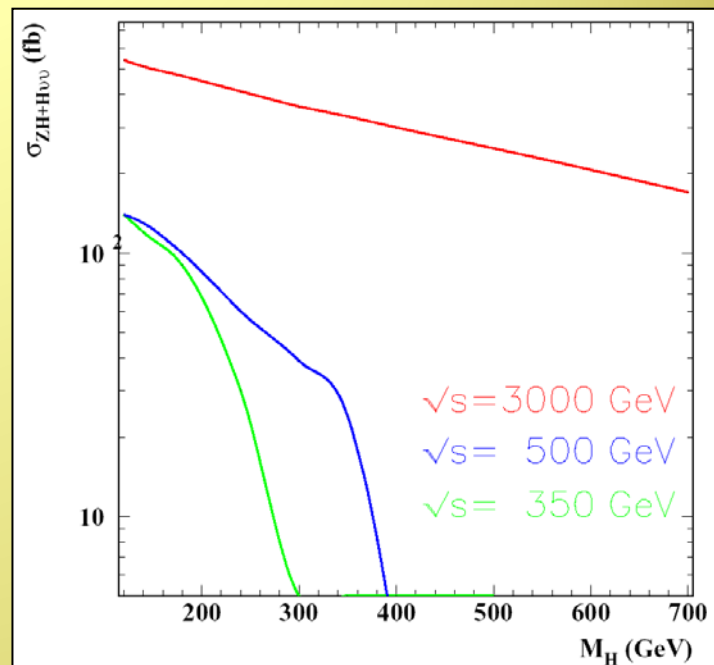


Nuijten 03-03-2011

2. Compact Linear Collider CLIC

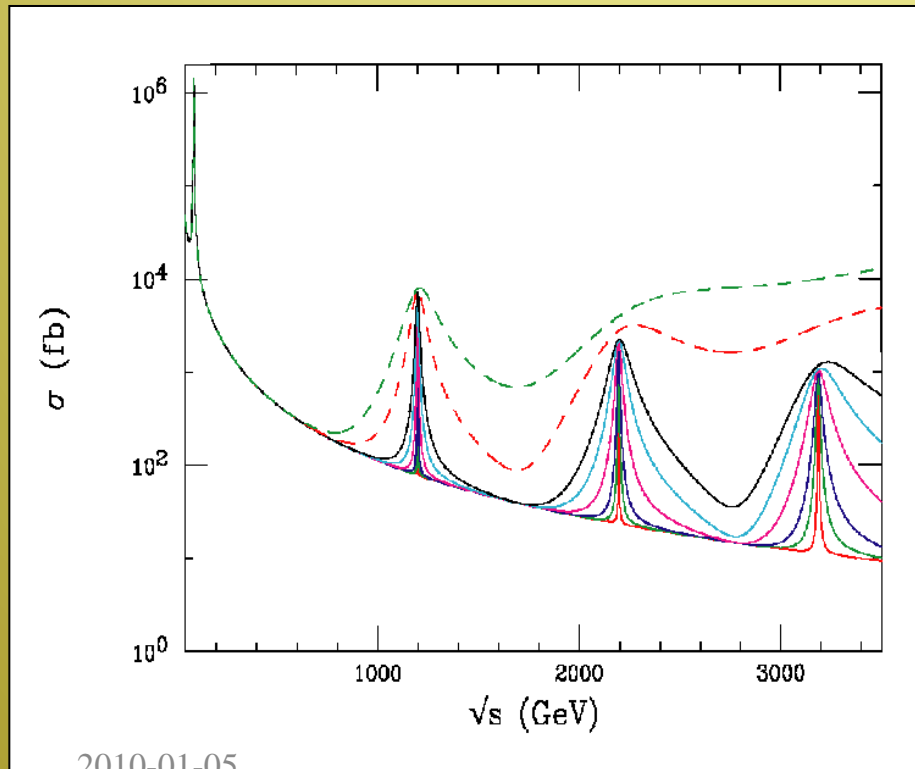
Large Higgs Cross Section @ CLIC → 2.

Can measure rare decay modes ...

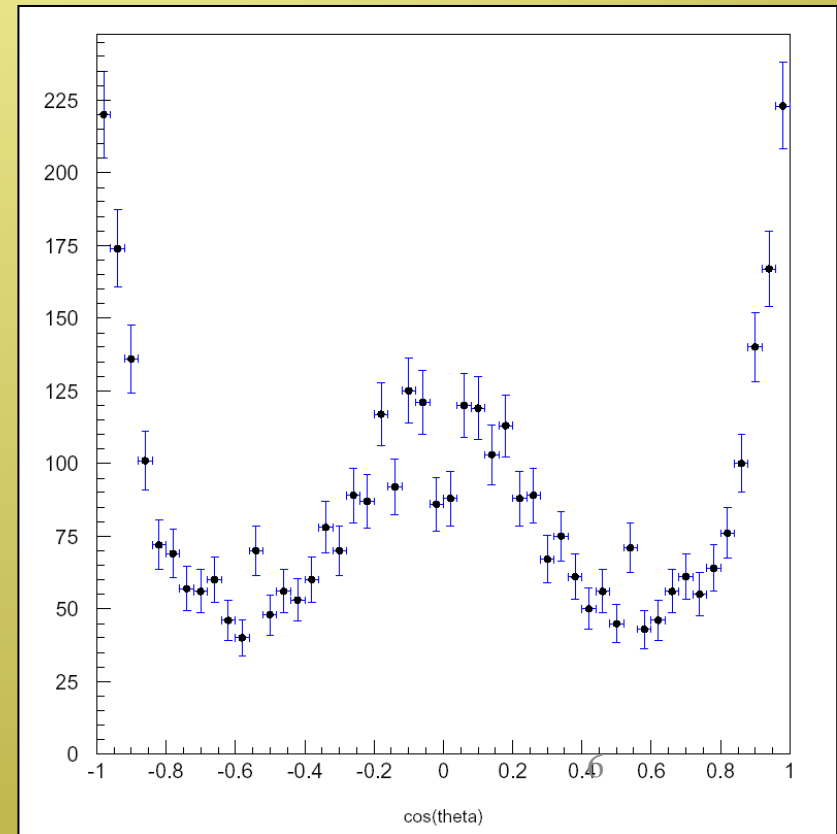


CLIC could measure Kaluza-Klein excitations

Direct-channel resonances

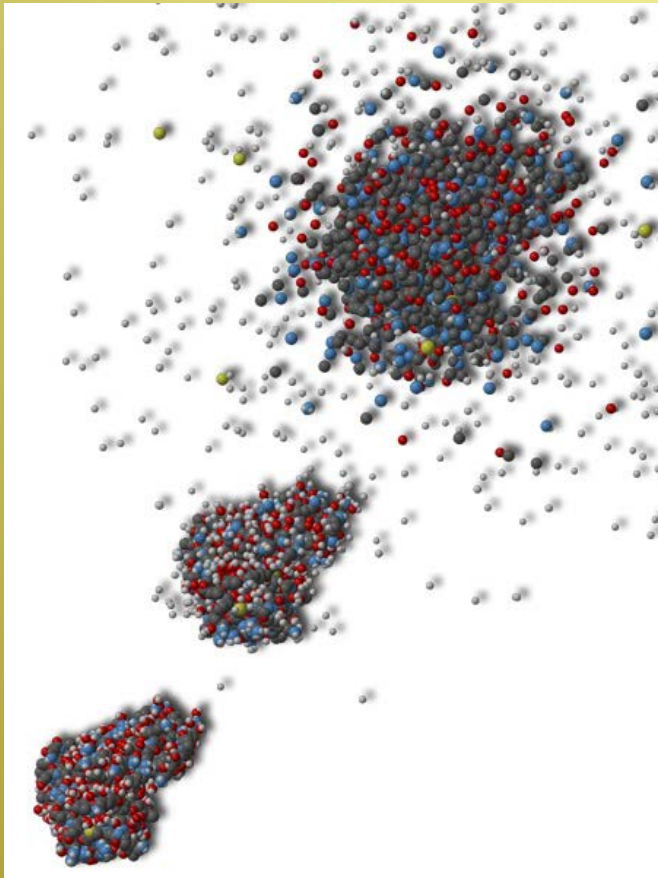


Angular distribution in graviton decay



3. Supraleedande frielektronlaser

Forskning med 1 MHz femtosekund pulser med 10^{13} - 10^{14} fotoner



Makromolekylers struktur
Janos Hajdu

Raimund Feifel



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1. ESS and Uppsala



- European (5 MW Neutron) Spallation Source will be built in Lund
- Finance volume: ~13 GSEK, 1 GSeK/y
- 3-4 y design + 5 y construction
- First beams ~2019
- Uppsala University has taken responsibility for the development of the radio-frequency distribution system of the ESS - project cost 177 MSEK
 - FREIA Department Board: T. Ekelöf, R. Ruber, A. Rydberg, V. Ziemann
- Contract signed by UU and ESS managements 10 June 2011





EUROPEAN SPALLATION SOURCE



UPPSALA UNIVERSITET

Contract Agreement
for
Design and Development Services

European Spallation Source ESS AB

Uppsala University

10th June 2011
Date

May 4, 2011
Date

[Signature]
Signature

[Signature]
Signature

Colin CARLIE
Name (in block letters)

ANDERS HALLBERG
Name (in block letters)

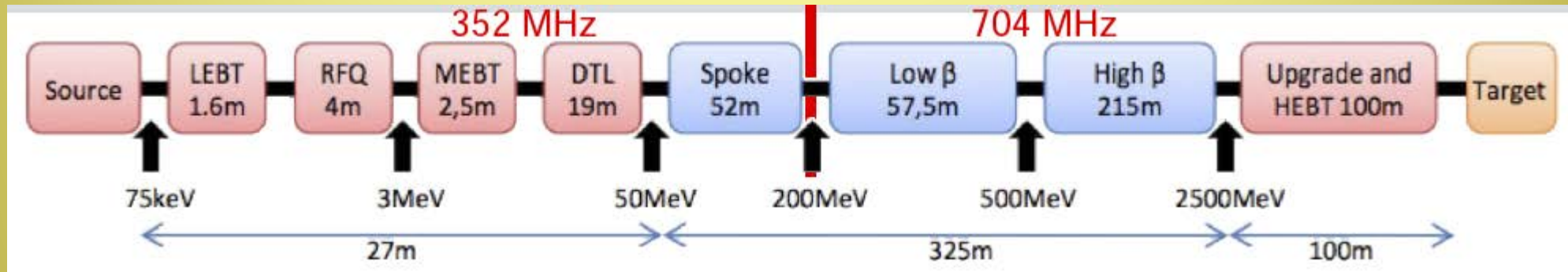
CEO
Position

Vice-Chancellor
Position

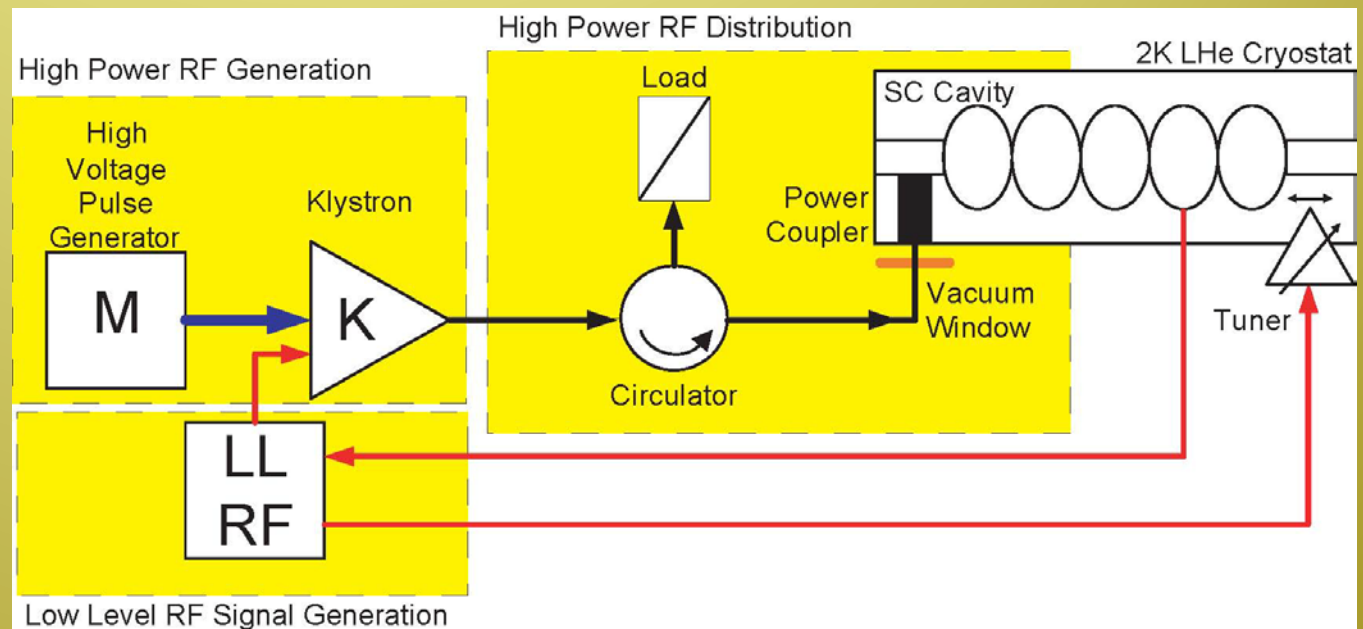
Tord Ekelof
Uppsala universitet



ESS RF distribution system

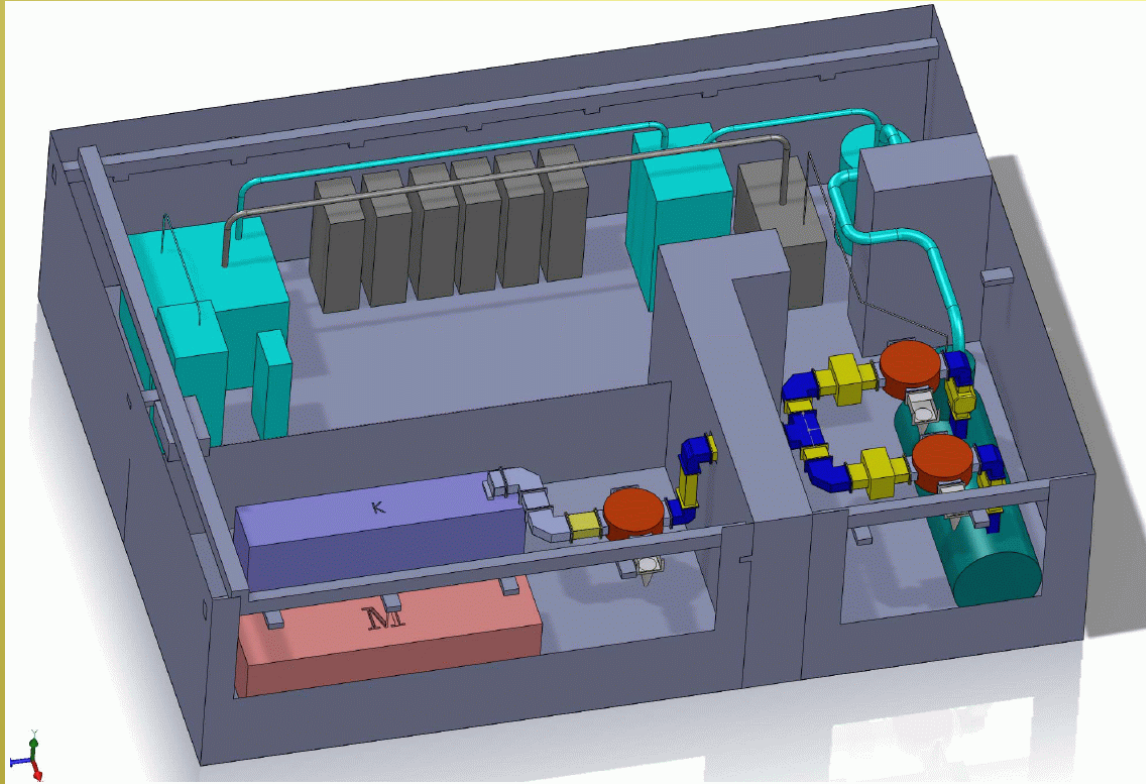


- About 200 s.c. acceleration cavities (352 + 704 Mhz)
- Modulators
- Klystrons
- LLRF system
- Efficiency
- Test stand





FREIA: Uppsala RF-teststand

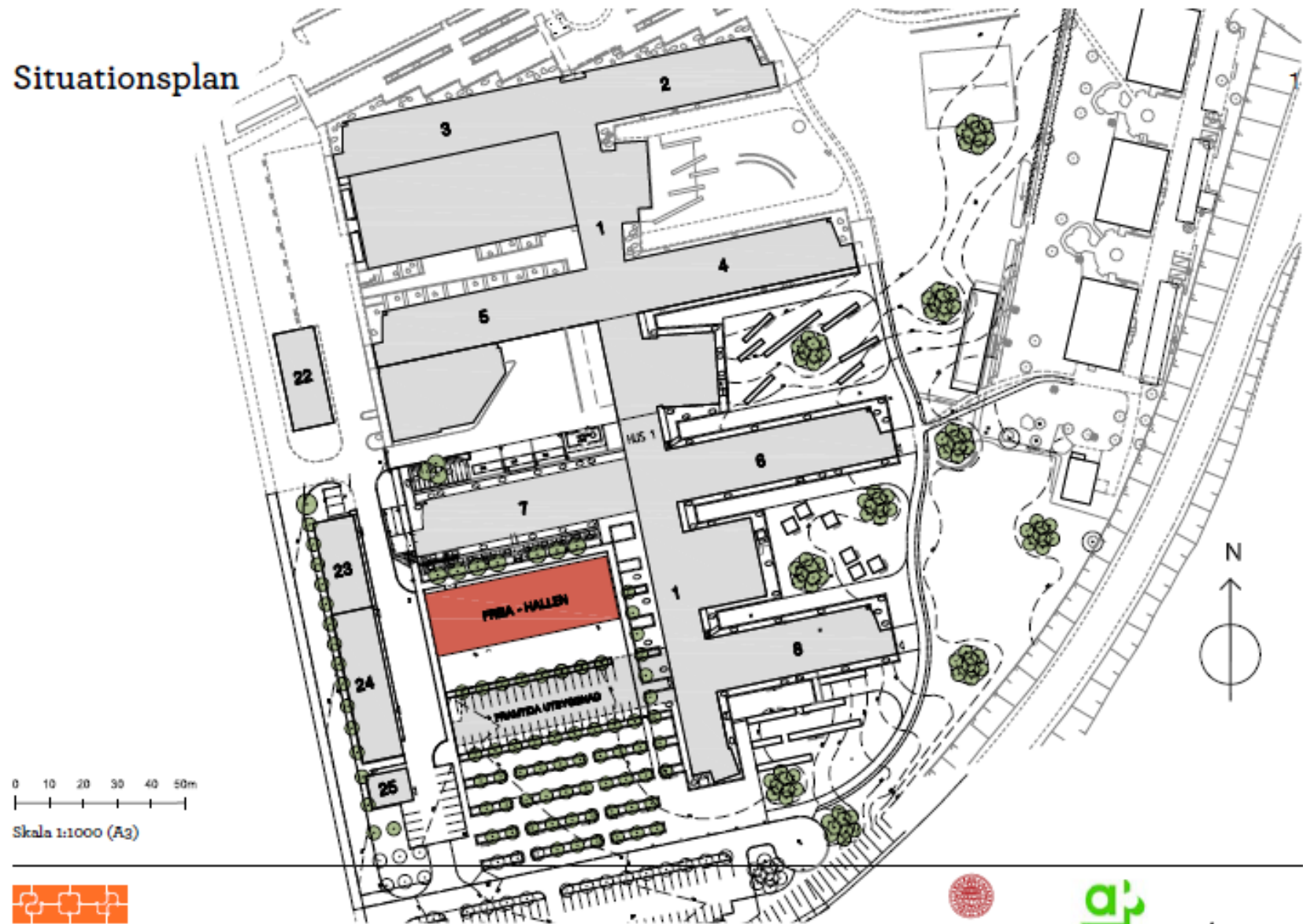


- LHe refrigerator (140 l/h) [KAW]
- 2 cavities in horizontal cryostat
- 6 MW pulse modulator
- 3 MW klystron

- 4 years development phase
- Volume 177 MSeK (1.4%)
- ~20 positions + hardware
- 2011-2012: buildup, design update and TDR writing
- 2013-2014: R&D, Two cavities/klystron concept, testing components, system integration
- 2015-beyond: components testing energy efficiency
- Towards an UU FEL

Experimenthallen för FREIA - läge

Situationsplan



0 10 20 30 40 50m

Skala 1:1000 (A3)



Ångströmlaboratoriet | FREIA-Hallen, skissutredning | Uppsala | Tema arkitekter 2011-09-20 | www.temagruppen.se



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AKADEMISKA HUS

tema:

Experimenthallen för FREIA - layout, golvyta ~1000 m²

FREIA, floor plan
Uppsala University

DRAFT 7
2011-09-13

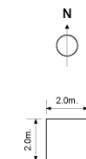
TOTAL AREA: 1242 m²
Ground floor: 18 x 54 m = 972 m²
1st Floor: 5 x 54 m = 270 m²

Overhead crane:
Max. load = 5 ton
Height floor to crane = 7.0 m

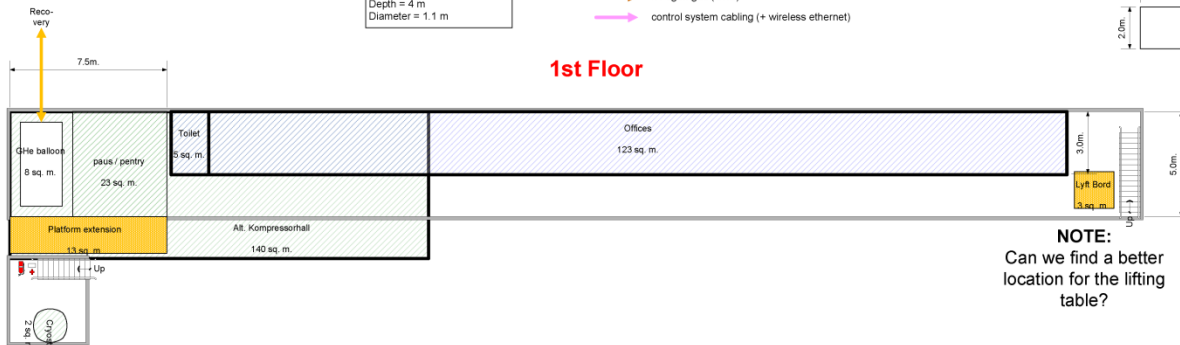
Bunkers:
Wall thickness = 0.8 m
Internal height = 5 m

Hole vertical cryostat:
Depth = 4 m
Diameter = 1.1 m

- electricity (3 phase)
- RF waveguide
- helium gas: high (HP), medium (MP), low pressure (LP), recovery
- helium cryogenic transfer line; nitrogen cryogenic transfer line (LN2)
- cooling water
- nitrogen gas (GN2)
- control system cabling (+ wireless ethernet)

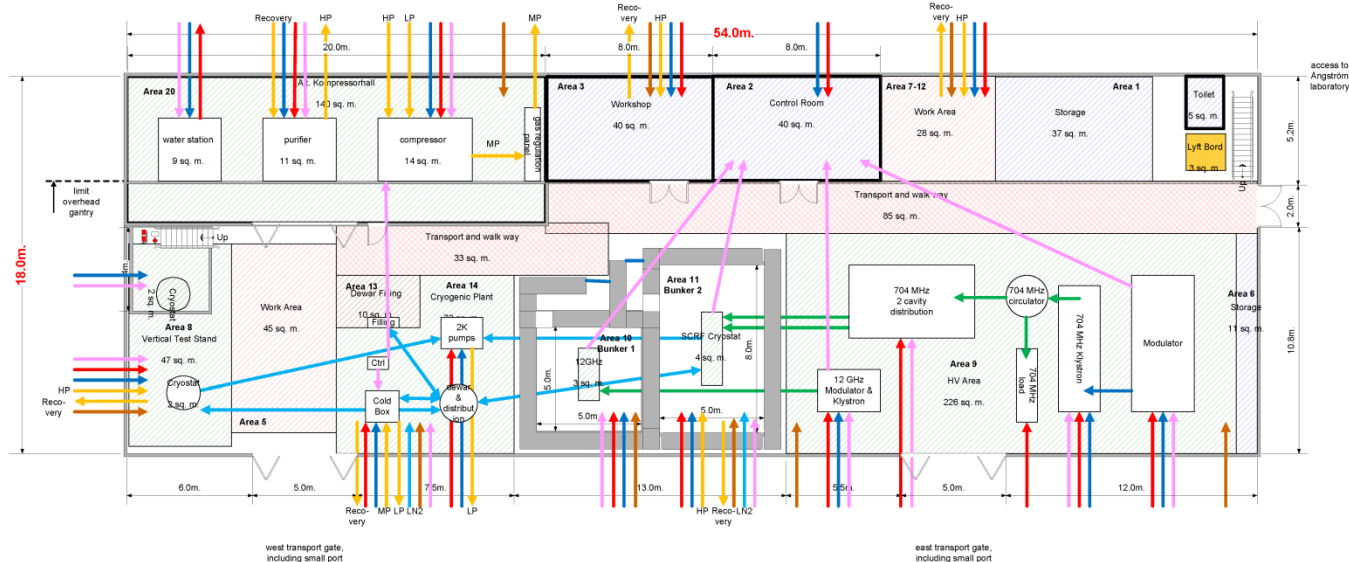


NOTE:
Could the GHe balloon
go outside, above the
high pressure gas
storage?



NOTE:
Can we find a better
location for the lifting
table?

Ground Floor

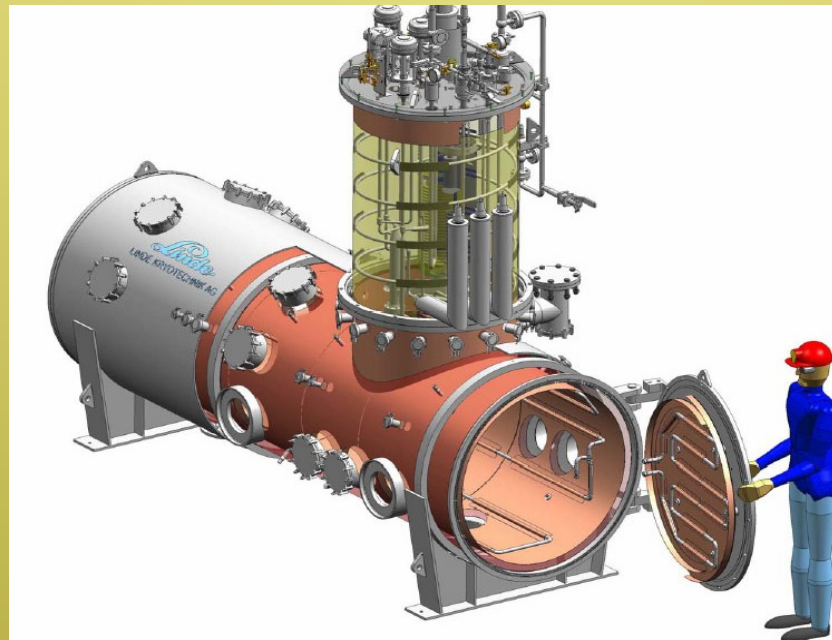


Ansökan till VR/RFI om 13 700 kSEK

Huvudsökande: Roger Ruber

A Cryogenic Test Facility (FREIA) at Uppsala University

Funding in kSEK	2012	2013	2014
design update and integration	1'125		
test cryostat	3'500	3'575	
instrumentation, controls and vacuum	750	1'250	600

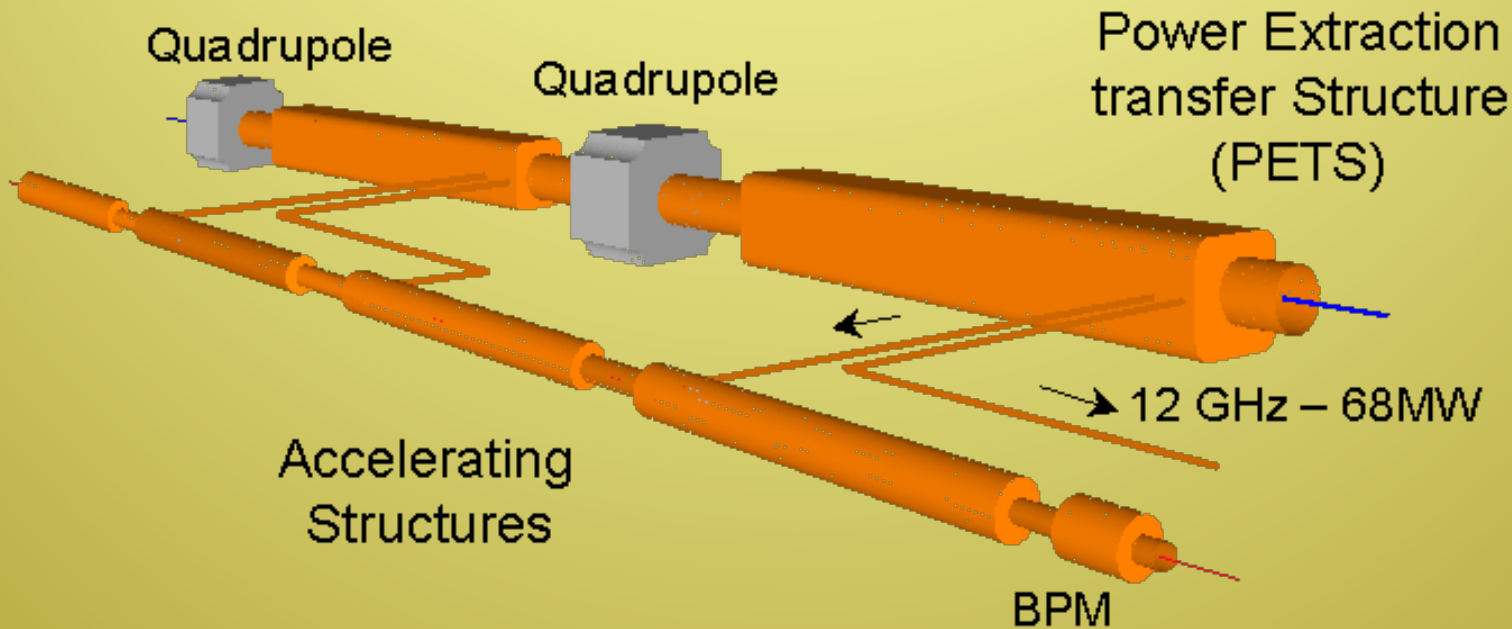


Layout of the HoBiCaT cryostat. The vertical feedbox includes a liquid helium reservoir and 2 K cold box.

2. CLIC och Uppsala

The CLIC Two Beam Scheme

Drive beam – 100 A, 240 ns
from 2.4 GeV to 240 MeV



Main beam – 1.2 A, 156 ns
from 9 GeV to 1.5 TeV

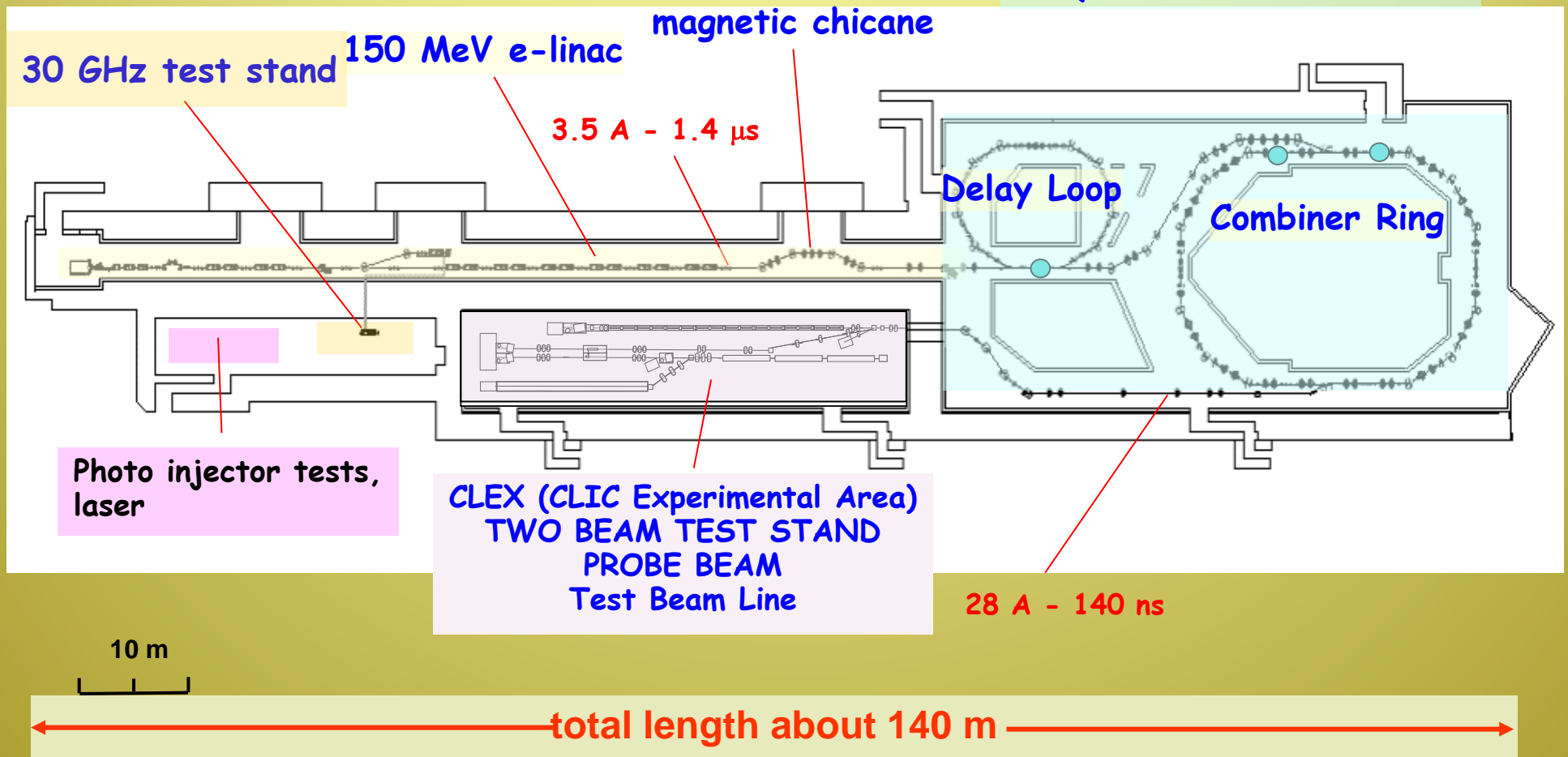
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CLIC Test Facility at CERN

CTF3 building blocks

Infrastructure from LEP

PULSE COMPRESSION
FREQUENCY MULTIPLICATION

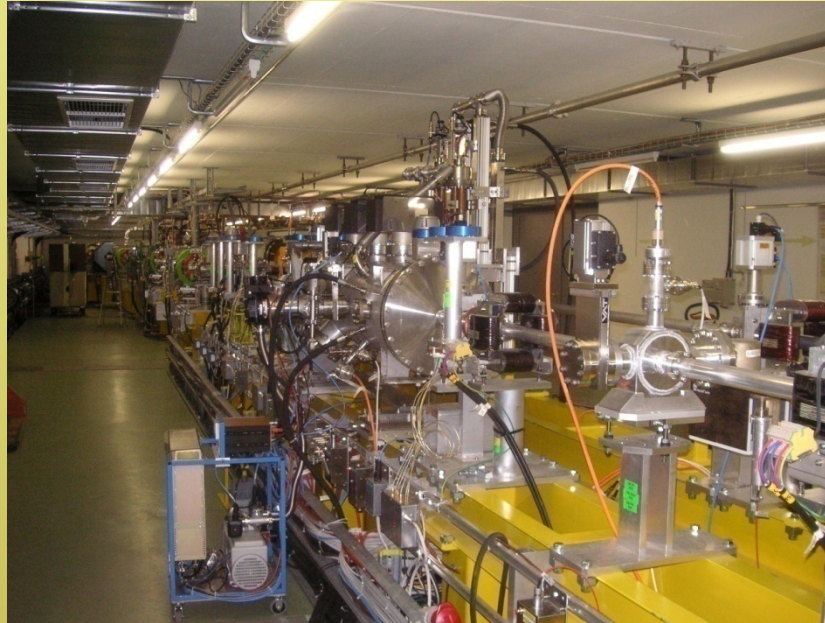


201001-05

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NorduCLIC

Helsinki-Oslo-Uppsala Nordic CLIC Consortium created in April 2009
Funding granted by the three Nordic Research Councils in December 2009
(~1.2 Meuro in addition to funding of ongoing Nordic national CLIC programs)



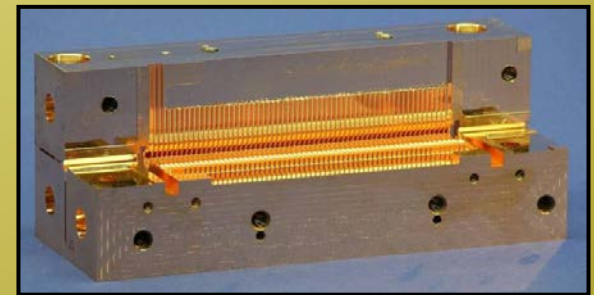
Two Beam
acceleration in
CLIC Test
Facility

The CTF3 Two Beam
Test Stand



Accelerating structure

Power Extraction and Transfer Structure



2006 anslag VR 6.3 MSEK och KAW 9.2 MSEK för uppbyggnaden och driften av Uppsalas Two Beam Test Stand i CERNs CLIC Test Facility 2007-2011

Ansökan till VR/KFI om 6370 kSEK i driftanslag 2012-2015
Huvudsökande: Volker Ziemann

Operating Grant for the Two-beam test stand of CTF at CERN

	2012	2013	2014	2015
Technical coordinator	756	774	792	810
Travel and subsistence	402	402	402	402
Maintenance	350	350	350	350
User support	60	60	60	60
Total (kSEK):	1568	1586	1604	1622

CERN Klystron Based Test Stand



02/09/2011

CLIC Project meeting - Update on RF testing facilities

Tord Ekelöf
Uppsala universitet

CLIC Klystron Based Test Stands

- It will be decisive to set up several new RF test facilities are very important for the CLIC structure testing programme!
- They should allow extension to a reasonable number of test slots (initially 2, later 16 or so), including the ("combined medium-power klystrons" option)
- Could it be combined with a test stand for 704 MHz (SPL, ESS, LHeC, ...)?

Ansökan till VR om 200 kSEK i planeringsbidrag
Huvudsökande: Tord Ekelöf

A 12 GHz Klystron Based Test Stand for CLIC in Uppsala

Kostnader för den första Klystron Based Power Test Stand på CERN

Klystron 740 kCHF
Modulator 540 kCHF
Low-level RF 170 kCHF
Pulse compressor 90 kCHF
RF network/components 300 kCHF
Diagnostics/control 200 kCHF
Vacuum/cooling 290 kCHF

Total about 2.3 MCHF

CERN erbjuder sig att betala klystronen för
uppställningen i Uppsala

**COLLABORATION FRAMEWORK AGREEMENT
KN 1914/DG**

between

UPPSALA UNIVERSITY

and

**THE EUROPEAN ORGANIZATION
FOR NUCLEAR RESEARCH (CERN)**

concerning

**COLLABORATION IN THE BUILD-UP AND USE
OF A NEW UPPSALA ACCELERATOR TEST
FACILITY ENTITLED "FREIA"**

2011

3. Supraledande frielektronlaser

Projekt som drivs av Centrum för frielektronlaserforskning, vars nuvarande utvecklingsprojekt gäller XFEL på DESY:

- Femtosecond replica transformer for VUV-FEL and XFEL
kontaktpersoner: Volker Ziemann UU och Peter van der Meulen, SU
 - Magnets for TESLA X-FEL electron linac
kontaktperson: Håkan Danared SU
 - Wake fields and particle free UHV components
kontaktpersoner: Ulf Karlsson KTH och Lars Westerberg
- Nyligen har även samarbetsprojekt med SwissFEL diskuterats (laser heater och seeding) men det är oklart hur dessa skall finansieras

Avsikten är vidare att starta ett utvecklingsprogram för design och på längre sikt uppförande av en supraledande frielektronlaser för uppförande i Uppsala

En supraleddande frielektronlaser skiljer sig från XFEL i Hamburg, SwissFEL i Zurich och MAX IV-FEL i det att acceleratorkaviteterna är supraleddande och därför utan Ohmska värmeförluster.

En sådan laser kan därför köras med en mycket högre repetitionsfrekvens, ca 1 MHz i stället för ca 1 kHz. Fotonflödet blir därmed en faktor ~ 1000 högre vilket möjliggör helt nya typer av experiment. Genom att switcha mellan pulserna kan också flera olika experiment köras samtidigt. En sådan laser borde i övrigt kunna nå samma korta pulslängder (ner till 1 nm), fotonenergi 400-2000 eV och antal fotoner per puls (10^{13} - 10^{14}) som en normalledande laser.

Utvecklingen av en sådan supraleddande frielektronlaser skulle kunna påbörjas i FREIA-hallen när utvecklingsprojektet för ESS slutförts 2015.

Ansökan till VR om 1750 kSEK i planeringsbidrag 2012-2013
Huvudsökande: Mats Larsson

Planing grant for a Swedish free electron laser



Creation of a coordinated panEuropean multi-purpose distributed Test Infrastructure



Monitoring and coordinating the use and the development of the European test infrastructures for accelerator R&D



Monitoring accesses, including industry involvement



Identifying weaknesses and needed upgrades/investments and assessing their costs



Making recommendations and contributing to upgrade and/or construction of new R&D Infrastructures as well as their corresponding R&D programs

TIARA and Nordic TIARA

EU Preparatory Phase Projectt 2011-2013

Partners

CERN

England - STFC

France- CEA and CNRS

Germany - DESY and GSI

Eastern European countries through Poland -

IFJ PAN (contractor)

Spain - CIEMAT

Nordic countries through Sweden - Uppsala
(contractor), Aarhus, Helsinki, Jyväskylä, Lund,
Oslo, Stockholm

Switzerland - PSI

Sammanfattning

Acceleratorer spelar en allt större roll inom naturvetenskap, industri och medicin

Uppsala universitets engagemang i utvecklingen av ESS' supraleddande linjäraccelerator har lett till utmanande och mycket lovande möjligheter att utveckla flera ledande framtida accelerator projekt:

European Spallation Source ESS
Compact Linear Collider CLIC
Superconducting Free Electron Laser

Det laboratorium FREIA som vi nu har börjat bygga upp på Ångströmlaboratoriet och som skall vara klart i januari 2013 kommer att kunna utgöra en viktig svensk och nordisk nod i det Europeiska nätverket TIARA för den framtida internationella acceleratorutvecklingen