

FREIA Laboratory for Accelerator and Instrumentation Development at Uppsala University

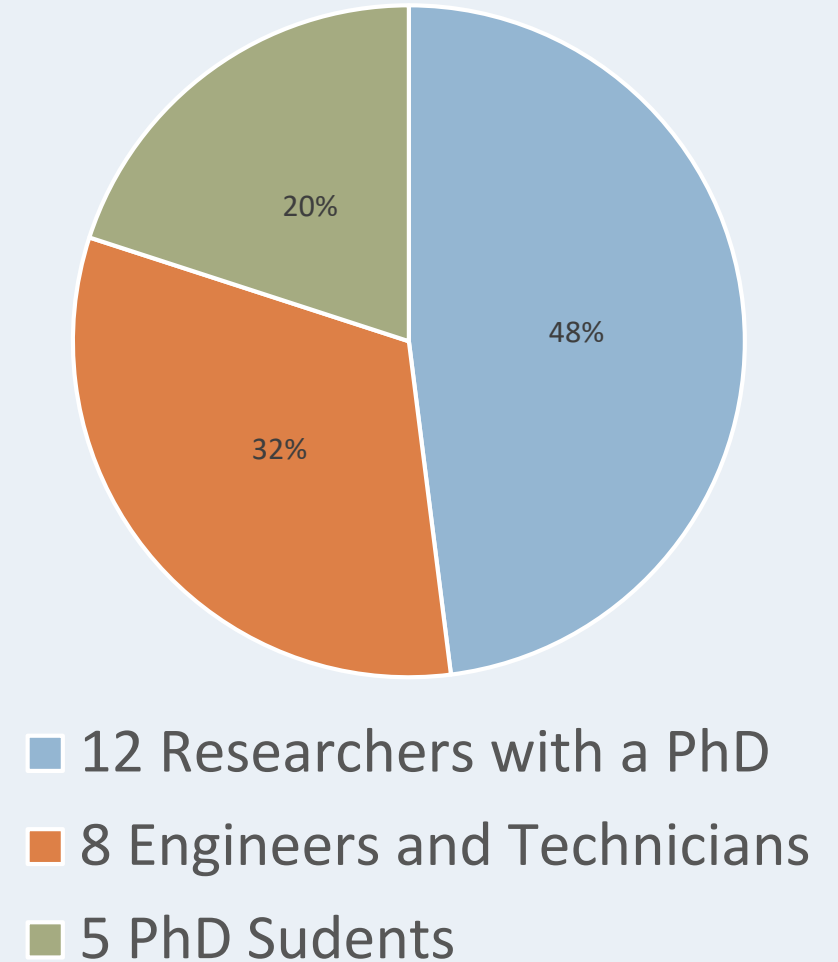
Brief presentation of the FREIA Laboratory at the UU-CERN-
RFR meeting for the DFH collaboration project for HL-LHC
Wednesday 20 June 2018

Personnel

- 8 senior staff have been recruited from the former National Uppsala Accelerator Laboratory TSL.
- New recruitments of mostly younger members of the personnel have been made through wide international announcements.
- Two out of the currently three recruitments made from outside Sweden (from China, Spain and Ukraine) are women.





25 employees



Infrastructure

- Major high-tech infrastructure for accelerator and instrumentation development and tests.
- The nearby Ångström Mechanical Workshop with its highly qualified workshop personnel and large set-up of modern numerical workshop machines is a significant asset for FREIA.
- The FREIA laboratory will have to continuously develop and complement its infrastructure when collaborations on new projects will be added to the current activities.
- Funding will be needed in future not only to cover the operational costs but also for investments in new infrastructure.

2020-06-20

miCi FREIA Laboratory - Uppsala (Sweden)  

FREIA stands for "Facility for Research Instrumentation and Accelerator Development". The FREIA Laboratory was established in 2011 within the department of Physics and Astronomy at Uppsala University, to develop and test new particle accelerator and detector instrumentation. Freia is located at the Ångström Laboratory campus and was inaugurated in 2013.

The Freia Hall

The Hall
1000 m² large, 10 m high. Has a 6.3-ton movable crane and other mechanical equipment, office space for ~15 people, small workshops for mechanics and electronics and 50 m² control room.

Bunkers
Three concrete bunkers for equipment producing ionizing radiation.
1 bunker, 10.4 m x 4.0 m x 4.8 m high, with cryostat
2 bunkers, dimension 4.0 m x 2.8 m x 2.4 m high
Monitoring systems for ionizing radiation and oxygen deficiency

Radiation Safety
Interlock system prevents entry into the experimental bunker
Area monitoring detectors outside and inside the bunker

Cryo Plant

Cryogen Distribution
The cryogenic facility produces and distributes liquid helium and provides liquid nitrogen to the test cryostats in the FREIA Laboratory
In addition it provides these cryogens to all other research departments at the University.

Helium Liquefier

- Helium liquefier 140 l/h at 1.15 bar.
- Liquid helium storage dewar 2'000 l
- Liquid nitrogen storage dewar 20'000 l at 3 bar.
- High pressure helium gas storage, 11 m³ at 200 bar.
- High pressure helium gas recovery compressor station, 75 m³/h at 200 bar.
- Impure helium recovery gas storage balloon 100 m³.
- Helium gas sub-atmospheric pumping system, 3 g/s at 10 mbar

Test Cryostats

Horizontal Cryostat
A versatile horizontal cryostat system for testing superconducting cavities.

- Inner measures 3.2 m length and 1.19 m diameter
- Range of operation: 1.8 to 4.5 K, 16 to 1250 mbar.
- Pressure stability at 16 mbar: +/- 0.1 mbar.
- Cooling power at 1.8 K: 90 W.
- Internal warm magnetic shielding: mu-metal, 1 mm.

The facility allows users to characterize 1-2 superconducting cavities at a time at either low or high RF power. Each cavity must be equipped with a helium tank.

Vertical Cryostat (Under development)
Availability: ~Begin ng of 2018

A versatile vertical cryostat system for testing superconducting devices such as accelerating cavities and magnets, either in saturated or sub-atmospheric liquid helium baths.

- Dimensions: 1.1 m diameter, 2.8 m height
- Range of operation: 1.8 to 4.5 K, 16 to 1250 mbar.
- Pressure stability at 16 mbar: +/- 0.1 mbar.
- Cooling power at 1.8 K: 90 W.
- Superconducting magnets
 - maximum allowed stored energy up to 500 kJ,
 - maximum allowed weight up to 5 ton,
 - 2x 2'000 A four quadrant power converters.
- Superconducting cavities
 - 1 kW RF power in a self-excited loop.

Control and Measurement

RF controls
Self-excited loop, 352 MHz, 1 kW CW.
LLRF controls and RF power measurement

Standard Measurement Equipment
E.g. vector network analyser, frequency generators and oscilloscopes

Epics Control System
The overall control system is based on EPICS. It provides

- Uniform operator's interface to most equipment in the control room
- Common services like data logging, alarm manager, electronic logbooks
- Remote access

RF Amplifiers

High Power RF Facility
For research and development of RF power generation, distribution and control for superconducting and normal conducting accelerating cavities for future accelerators

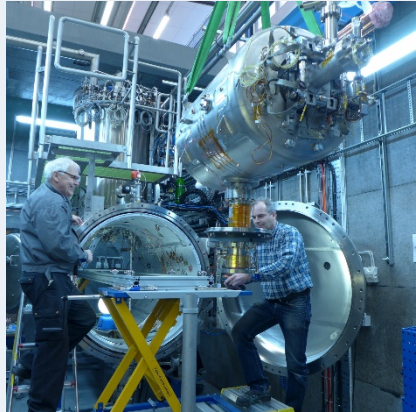
Tetrode based amplifiers

- 2x high power RF amplifier, 352 MHz, 400 kW pulsed, 5% duty factor.
- 1x high power RF amplifier, 352 MHz, 50 kW CW.

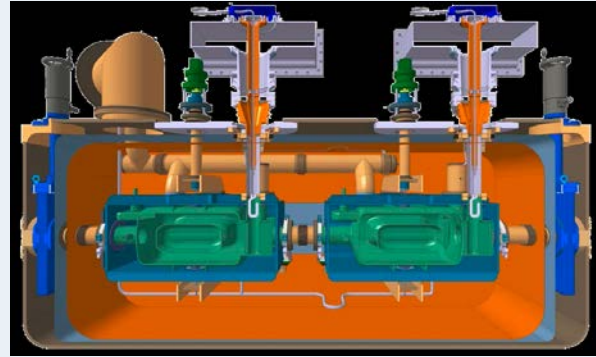
To be complemented with a 704 MHz, 5% duty factor modulator and klystron

Freia Solid State Amplifier Development
A high efficiency solid state amplifier, 352 MHz, 10 kW.
A high efficient and compact power combiners, 10 kW and 100 kW class.

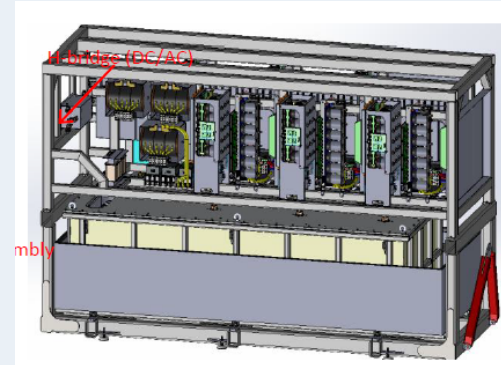
Research profiles



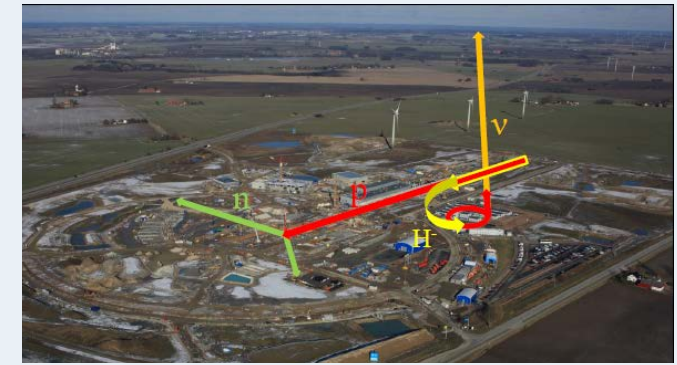
Characterization of superconducting cavities for the ESS Linear Accelerator



Test and development of Crab cavities for the CERN LHC Luminosity Upgrade



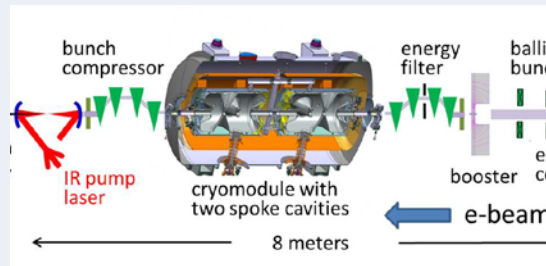
Development of Control system for ESS modulators



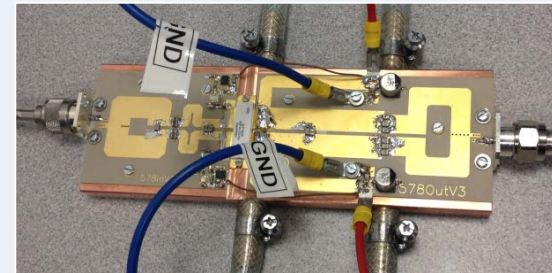
Doubling of the linac power and compression of the proton pulse for the ESS Neutrino Super-Beam (ESSnuSB) project



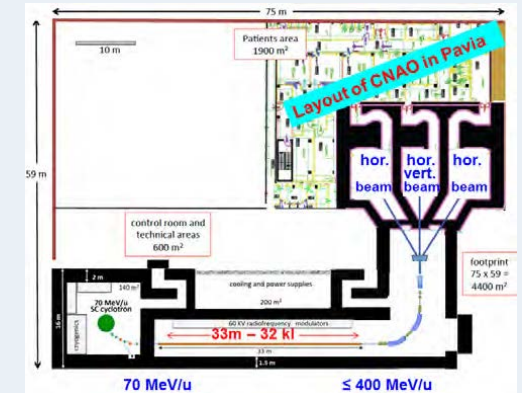
Commission the Laser Heater for X-FEL



Enabling technology of generation of single-cycle light-beams



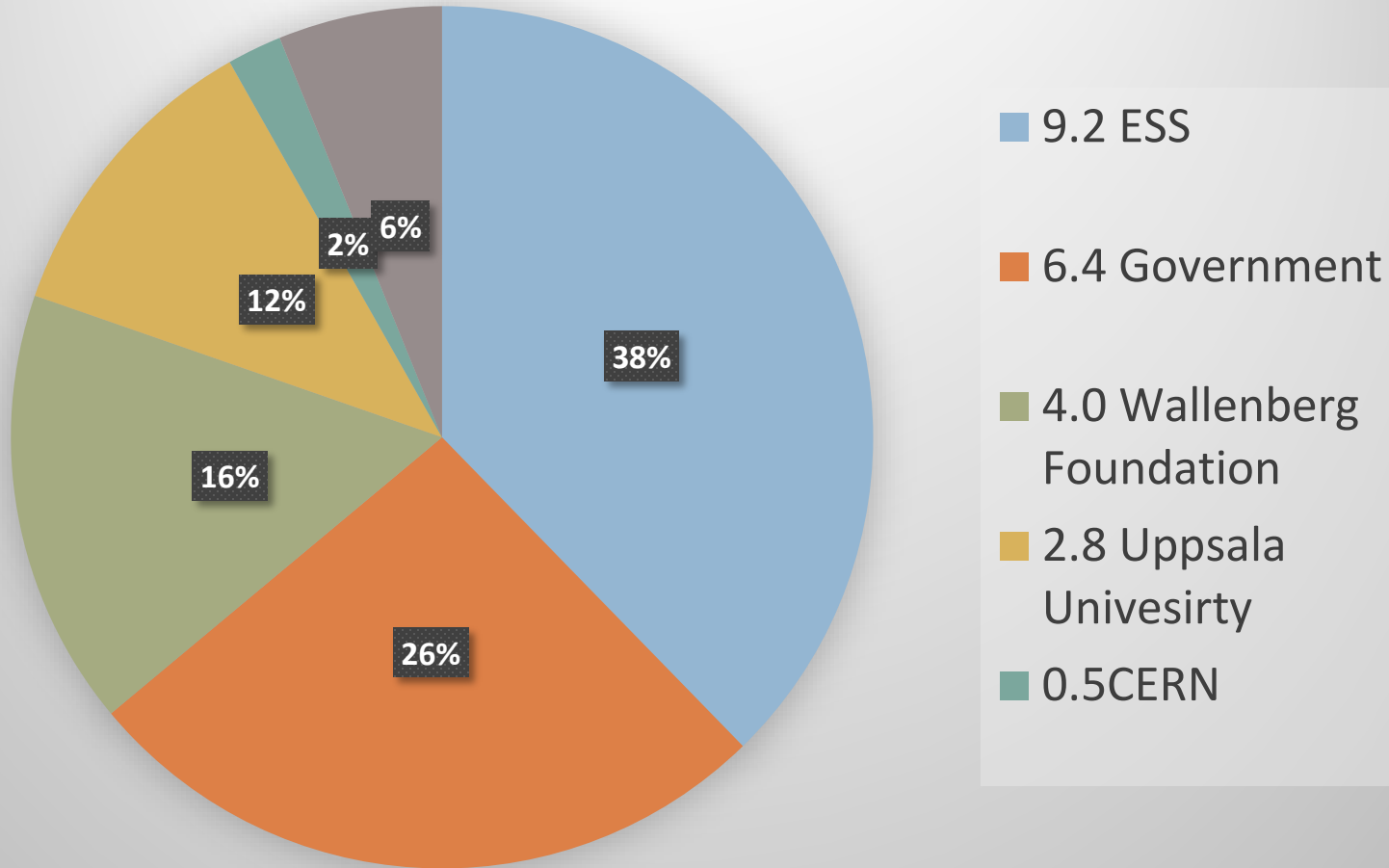
High-power microwave sources for scientific and industrial accelerators



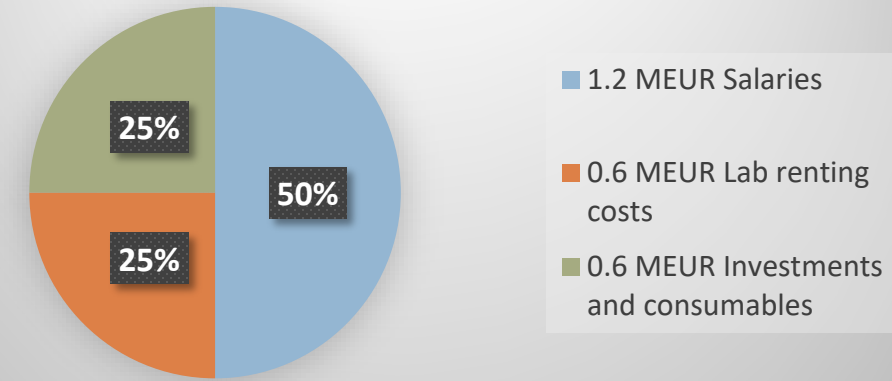
Superconducting Light Ion Haron Therapy Cyclinac

Finances

Contribution to total income 24.4 MEURO, period 2013-2020



Operation cost 2.4 MEUR per year



There are also contributions coming from several EU-projects in which FREIA is a partner:

- EUCARD2 40 KEURO,
- ARIES 337 KEURO,
- EuroNuNet 16 KEURO and
- AMICI 100 KEURO.

§

The regular operations budget from the Faculty to FREIA is 0.1 MEUR/year.

Academic culture

- The FREIA research and development results are presented by FREIA scientists at **seminars and international conferences** and published in refereed journals, conference proceedings and internal reports.
- FREIA staff are contributing to the **teaching** to a variety of undergraduate and graduate courses at the University
- FREIA is **inviting external scientists to give seminars** at the Department of Physics and Astronomy (Carlo Rubbia of CERN, Ken Long of Imperial College and John Womersley of ESS are examples of renowned scientists recently invited to give FREIA seminars).
- The FREIA activities regularly reviewed at the **weekly meetings** of the FREIA Division.

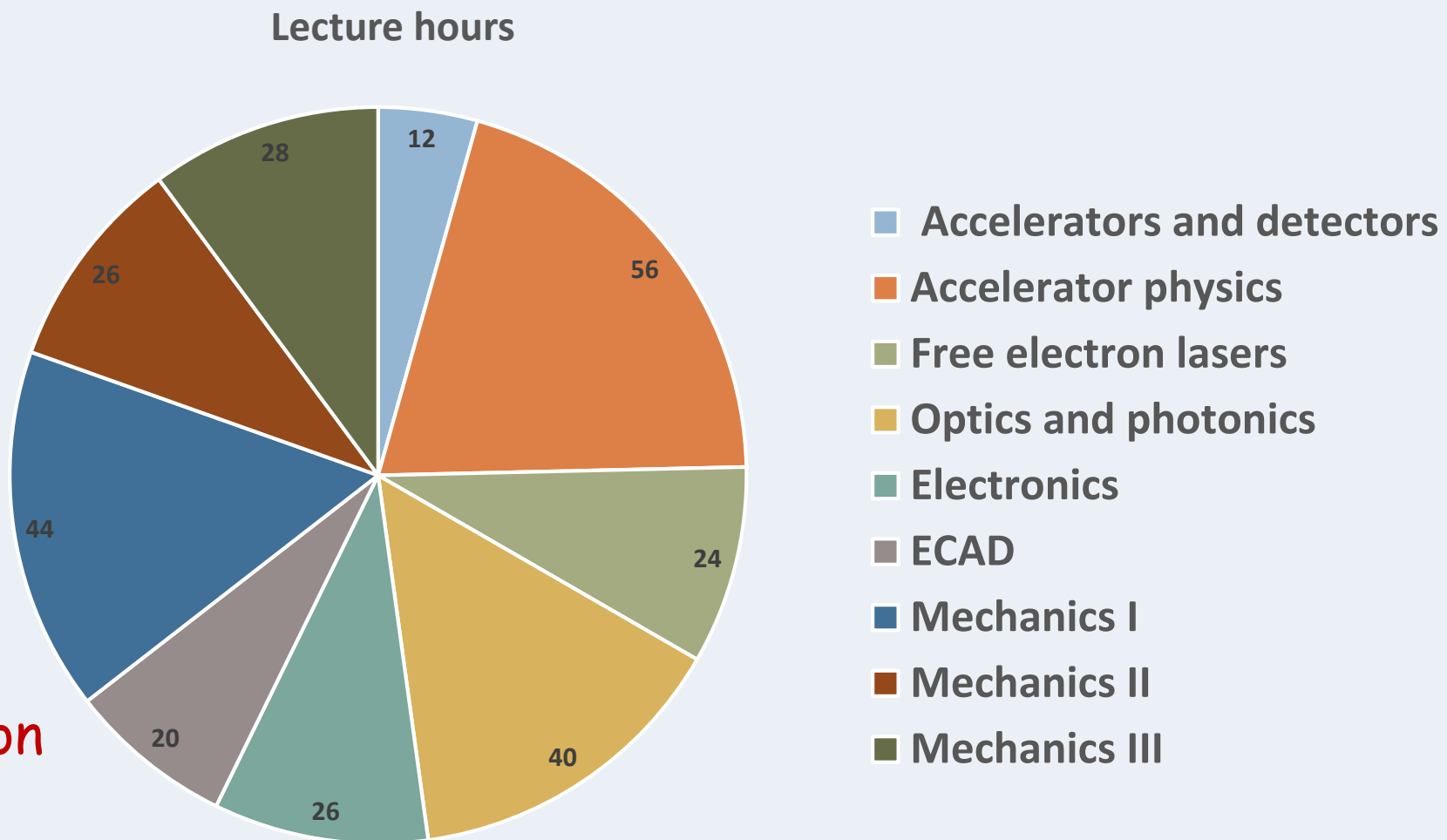
Teaching

8 FREIA lecturers
giving

304 lecture hours

and

158 laboratory instruction
hours



FREIA Vision

Pursue physics research and development on the national and international level in collaboration with large research infrastructure and industry of accelerators and instrumentation for the development of new research instruments for Neutron Physics, Particle Physics, Synchrotron Radiation Physics, Medical Physics, Nuclear physics, Fusion Physics, Astronomy and Space Physics.