FREIA Laboratory

Facility for Research Instrumentation and Accelerator Development

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24 mars 2014, Uppsala
Facility for Research Instrumentation and Accelerator Development

State-of-the-art Equipment
- cryogenics
  - liquid helium
  - liquid nitrogen
- control room
  - equipment controls
  - data acquisition

Competent and motivated staff
- collaboration with HEP & NP (IFA), solid-state electronics (Teknikum), Ångström workshop and TSL

Funded by KAWS, Government, Uppsala Univ.

RF power sources
- horizontal cryostat
- vertical cryostat
- 3 bunkers with test stands

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The New FREIA Laboratory

Inaugurated
18 June 2013

First Liquid Helium
14 March 2014
Ongoing Projects (UU-ESS Contract)

High-power Spoke Linac Testing

UU-ESS-IPNO-CERN Collaboration

- high power soak testing of power source, controls, amplitude and phase stability with accelerating cavity
- test cavity tuning system, dynamic load, electron emission and multipactoring

Peak fields @ 8 MV/m
- \( E_{\text{surf}} = 35 \text{ MV/m} \)
- \( B_{\text{surf}} = 56 \text{ mT} \)
- Deformation 0.25 mm
- Cryo loss = 15 W

RF Source Development

UU-Industry Collaboration

- vacuum tube amplifier (Thales, Electrosys)
- solid-state amplifier (Siemens)
- SSA module & combiner optimization (NXP, ESRF, CERN)
Future Projects (New UU-ESS Contract)

Spoke Linac Cryomodules (13#)
UU-ESS-IPNO Collaboration
- continue prototype testing (2016)
- acceptance testing of spoke linac cryostat with 2 cavities each
- requires high throughput and planning (6 weeks per cryomodule)

Warm Linac Units (45#)
UU-ESS-Industry Collaboration
- warm units connecting the cryostats with SRF cavities
- assembly, alignment and test
- vacuum beam line, magnets, diagnostics
- parts by industry or institutional partners

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SIGURD  Set-up and Instrumentation for GHz Research and Development

High Energy/Accelerator Physics

High Gradient RF research

• compact high gradient accelerators (medical, FEL, particle collider)
• vacuum breakdown pattern, rate, relation to gradient, memory effects
• pulse heating, plasma formation, dark currents, breakdown currents
• post-mortem analysis of structures in SEM at Microstructure Lab
• link to theory developments (Helsinki University)

KAWS application decision expected May’14

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Neutron Generator

Applied Nuclear Physics
- neutron tomography and detector tests
- student exercises and projects
- physics experiments in combination with solid-state based gamma-detector
  - nuclear fission
  - activation analysis

THz FEL
Stockholm-Uppsala FEL Centre
Material Physics, Chemistry, Biophysics
- THz radiation non-ionizing, strongly absorbed by water
- imaging & spectroscopy for
  - solid-state physics: semiconductors, superconductivity
  - matter in gas state
  - biophysics: biological tissues, proteins, molecular science

AForsk application to be submitted 31 March’14
Planning grant to be submitted 26 March’14
Projects under Study

ESS neutrino Super Beam

High Energy Physics
• study neutrino oscillations & CP-violation
• design study
  – ESS accelerator upgrade,
  – accumulator ring, beam lines
  – pion capture & focusing system,
  – underground detector in Swedish mine

Assembly Reactivity Control (ARC)

Applied Nuclear Physics
• 4th generation nuclear power
  – inherent safety
  – passive safety features
• ARC is a new safety system that
  – does not require (human) interference
  – passively provides negative reactivity feedback in fast reactors
• collaboration with US/EU institutes
  – to construct a test set-up

Horizon 2020 applications 2014

Preliminary layout

Neutron spallation target
Accumulator
Beam-line for energy upgrade
ESS linac
Target station
Neutrino beam
Possible FREIA Contributions

Accelerators & Instrumentation

- **MAXlab XFEL extension**
  - X-band technology opens new possibilities
    - higher rep-rate, shorter linac
  - link to SIGURD application
  - link to TBTS R&D at CERN (KAWS/VR)
  - link to CLIC-FEL development

- **MYRRHA: hybrid research reactor (B)**
  - “accelerator driven system”
  - spoke linac development (60 cavities)
  - solid-state RF sources

- **CERN medical accelerator**
  - development of optimized accelerator for proton therapy and isotope production
  - solid-state RF sources
Spin-off from Uppsala Accelerator R&D

- **Scanditronix**
  - major supplier
    - cyclotrons 1970-80’s
    - PETs 1980’s

- **GE Medical Systems**
  PET and cyclotrons
  - former Scanditronix

- **IBA Dosimetry**
  - former Scanditronix Wellhöfer

- **Scanditronix Magnets**
  - magnets

- **ScandiNova**
  - high voltage pulse modulators

- **Gammadata**
  - physics tools education, research, industry

- **Scandion Kliniken**
  - proton therapy centre

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Summary

• FREIA is building a bridge
  – between physics, engineering and industry

• FREIA laboratory enables
  – accelerator R&D for medical and research purposes,
  – development of large infrastructures and instrumentation,

• FREIA opens new opportunities
  for unique scientific projects in Uppsala