



UPPSALA
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EUROPEAN
SPALLATION
SOURCE

FREIA

Facility for Research Instrumentation and Accelerator Development

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Uppsala University

ESS/SPL Collaboration Meeting

1 July 2011



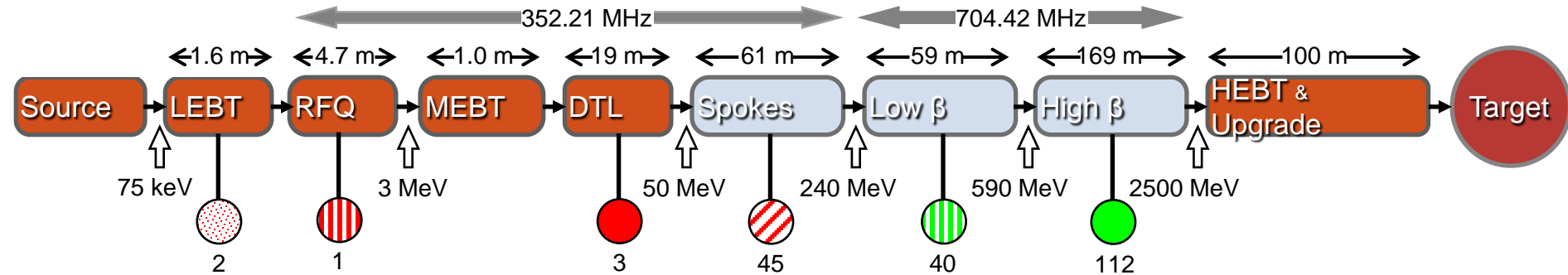
Concentrating on RF and instrumentation ...

- Cyclotron (since 1948)
- CELSIUS ring (1984 – 2006)
- CTF3 / CLIC
 - Two-beam Test Stand & RF breakdown issues
 - FP6-EuroTeV, FP7-EuCARD
 - NorduCLIC
- FEL
 - FLASH Optical Replica Synthesizer,
 - XFEL Laser Heater
 - Stockholm-Uppsala FEL Centrum
- ESS
 - RF systems



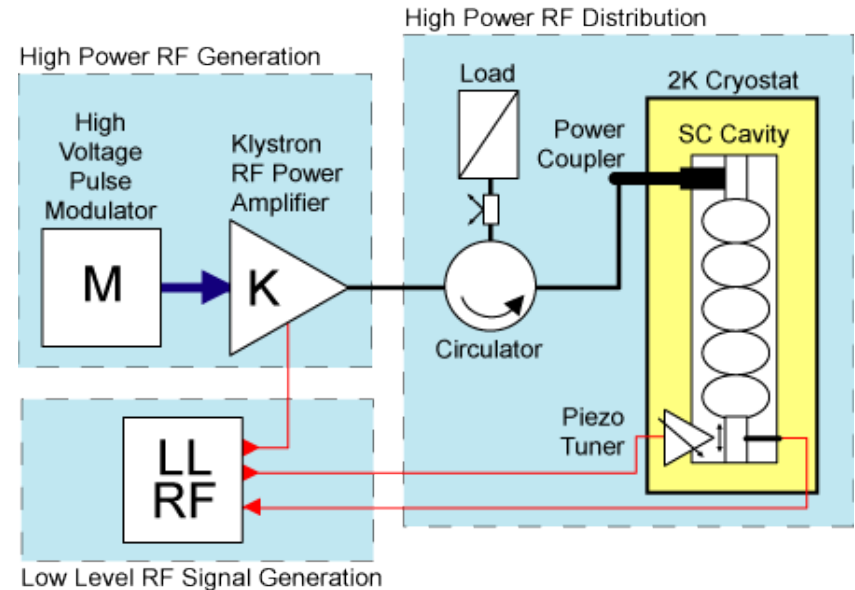
ESS has need for RF development & test stand, but

- ESS is a (very) green site
 - small core staff group, overloaded
 - no building work to start until a couple of years
- existing test stands are fully occupied and/or not yet equipped for 704 MHz
- ESS and Uppsala discussed and agreed to
 - build & operate test facility in Uppsala,
 - perform RF system R&D in Uppsala
 - write TDR RF system part by Uppsala



• 200 cavities (352 + 704 MHz)

- one-klystron-per-cavity baseline
- 200 RF systems: modulator, klystron, distribution, controls
- minor fault might create major risk or down time
- ensure low beam loss operation
- large part of construction budget
- expensive operation, requires efficiency enhancements
- 5 MW beam \rightarrow 20 MW RF (losses and LLRF overhead)



Objectives

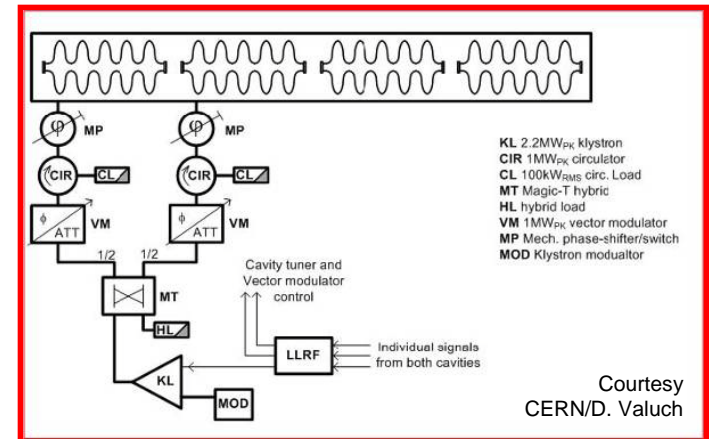
- soak testing of RF systems
- energy efficiency and operational costs reductions
 - two-cavities-per-klystron concept
 - solid state technology
 - high efficiency components and energy recovery
- investigate technical alternatives to the baseline
- produce technical design, with cost estimate, to start tendering
- training of personnel and students

Parasitic

- RF breakdown, multipactoring

Tool

- prototype RF system & 2 SRF cavities

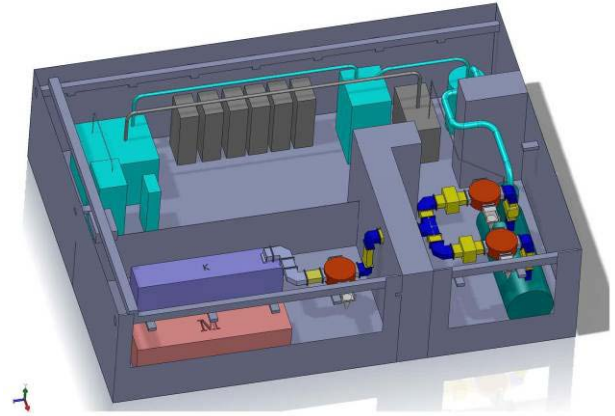


- **Test Facility at Uppsala University**

- prototyping of LLRF and HLRF solutions
- training of students and staff

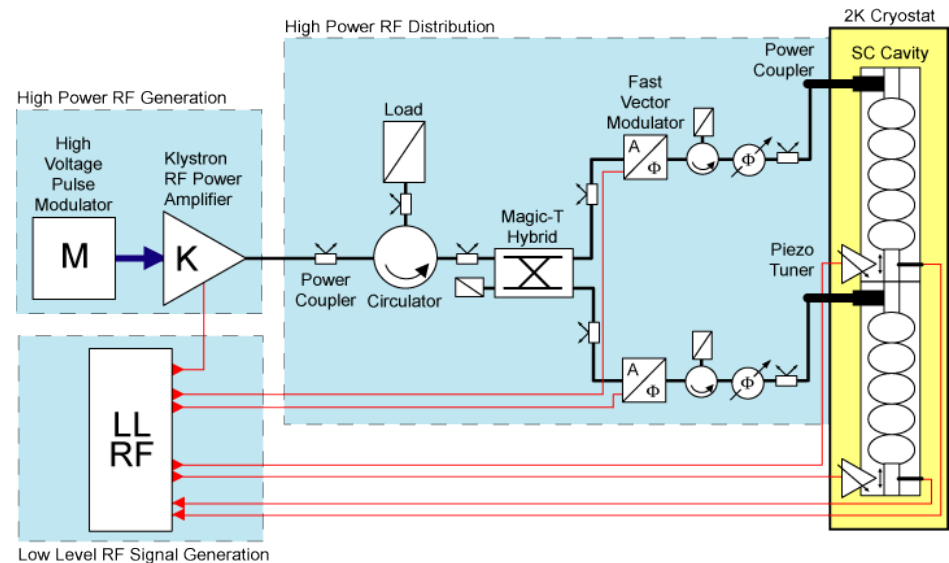
- 4 Years development phase

- 2011 – 2012: design, tendering
- 2013 – 2014: commissioning, R&D RF systems (components & concepts)
- 2015 and beyond: energy efficiency, component testing



- **Hardware:**

- RF power source, 704 MHz
- RF distribution system
- LLRF system
- 2 SRF elliptical cavities
- helium liquefier

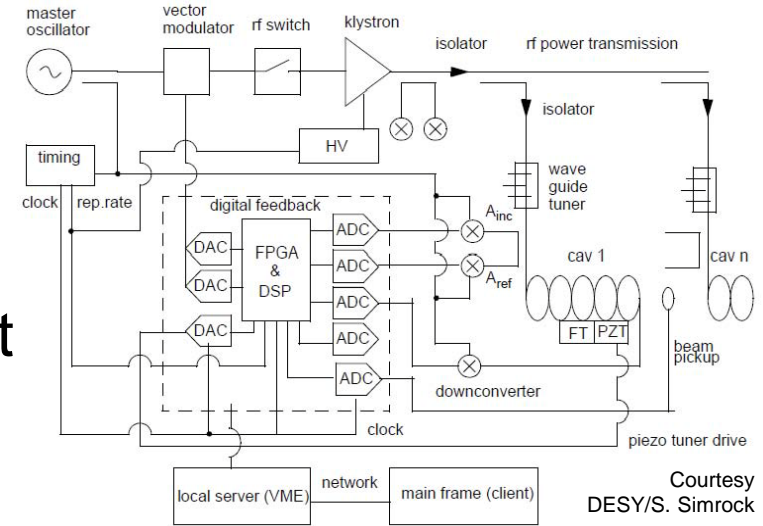


Baseline prototype for high beta elliptical cavities

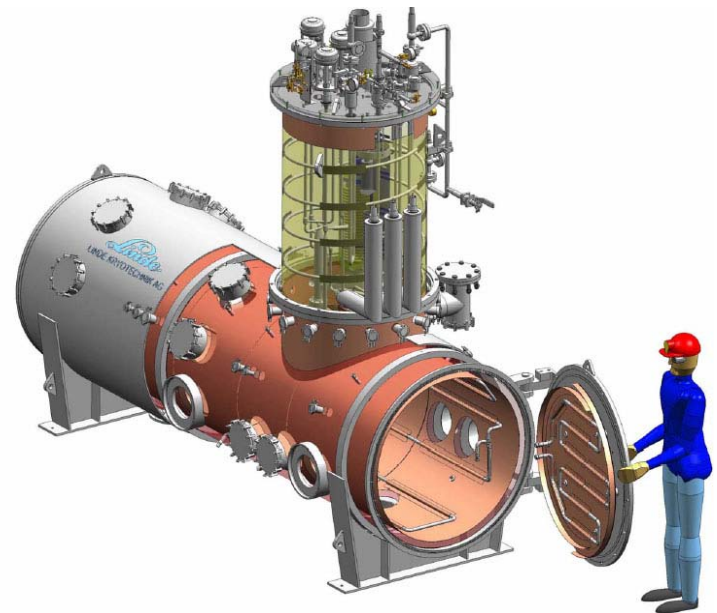
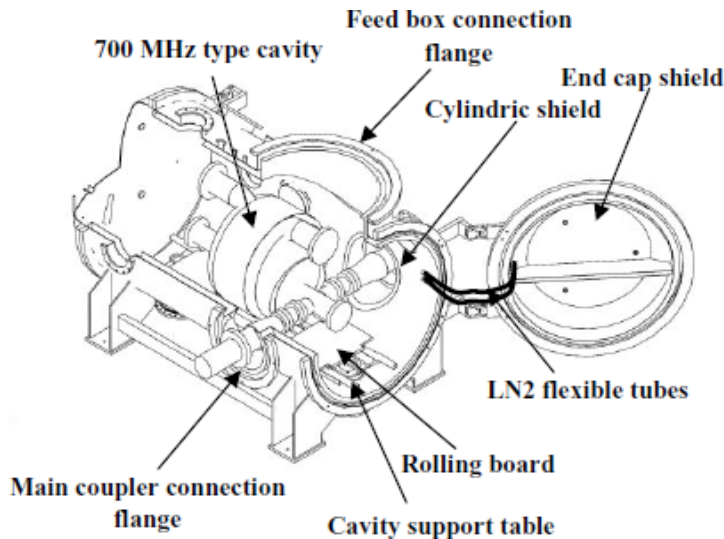
- 14 Hz repetition rate with 4% duty cycle
- 704.42 MHz Klystron
 - 3.3 ms RF pulse
 - 2.86 ms beam pulse, 0.1 ms LLRF, + cavity fill time
 - 1.5 MW RF output, 65% efficiency
 - 900 kW cavity input, LLRF overhead, losses
- HV pulse modulator
 - 3.5 ms, 1.8 MW: 113 kV, 21 A, droop <2% (tbd)
- ESS klystron gallery
 - 1.6 m average distance b/w cavities → space is critical

To be developed by LTH/A. Johansson

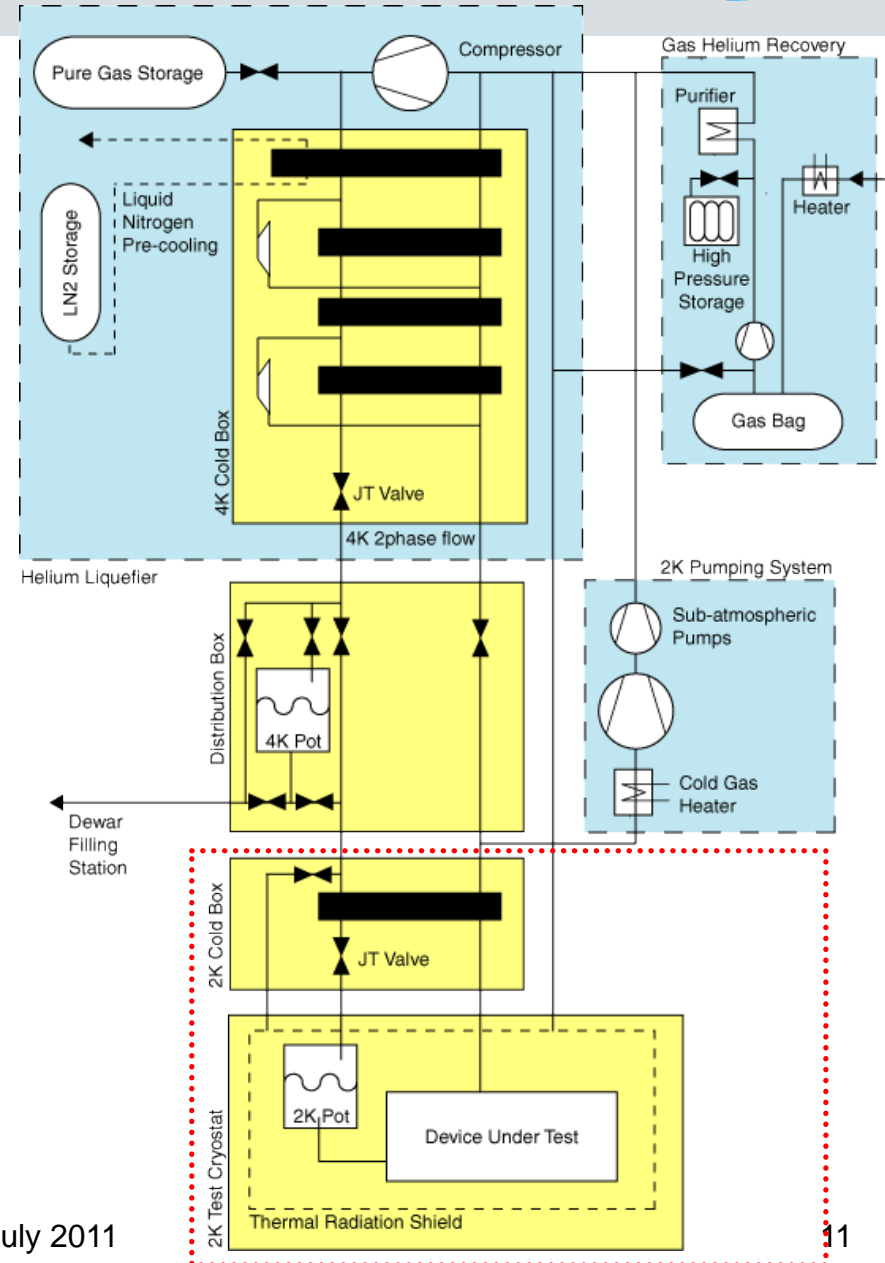
- for
 - power source testing,
 - baseline system,
 - two-cavities-per-klystron concept
- investigate energy efficiency
 - klystron and cavity model,
inside hardware it could be used for commissioning w/o
beam & power
 - investigate feasibility of klystron linearization, to run at
higher efficiency



- internal volume for 2x 704 MHz cavities (3.5 m x Φ 1.1 m)
–to test two-cavities-per-klystron concept
 - operation temperature range 1.5 – 2.2 and 4.2 – 4.6 K
- Base on existing designs: CHECHIA, CryoHoLab, HoBiCat
or prototype hybrid cryostat design?



- commercial helium liquefier
 - 140 l/h at 4.5 K, LN₂ pre-cooling
 - 14 bar compressor
- 4K distribution box
 - 2000 l storage & buffer tank
 - to dewars or test cryostat(s)
- 2K cold box & pumping system
 - heat exchanger + JT expansion
 - 1.8 K \equiv 16 mbar; 2 K \equiv 31 mbar
- 2K test cryostat
 - 50 l LHe storage
 - 3.5 m x Φ 1.1 m (internal)
- gas helium recovery
 - purifier and storage
 - recovery compressor



- Uppsala to construct test facility for HPA RF systems within ESS collaboration (and help from others) for
 - prototyping and soak testing,
 - R&D for baseline alternatives, (solid state, 2cav/kly, ...)
 - training of staff and students.
- Planned RF workshops
 - 22 – 23 September, Lund
 - 12 – 16 December, Uppsala
- **Job openings: www.uu.se/jobb**

**Thanks to all colleagues,
in- & outside ESS & SPL collaboration**

