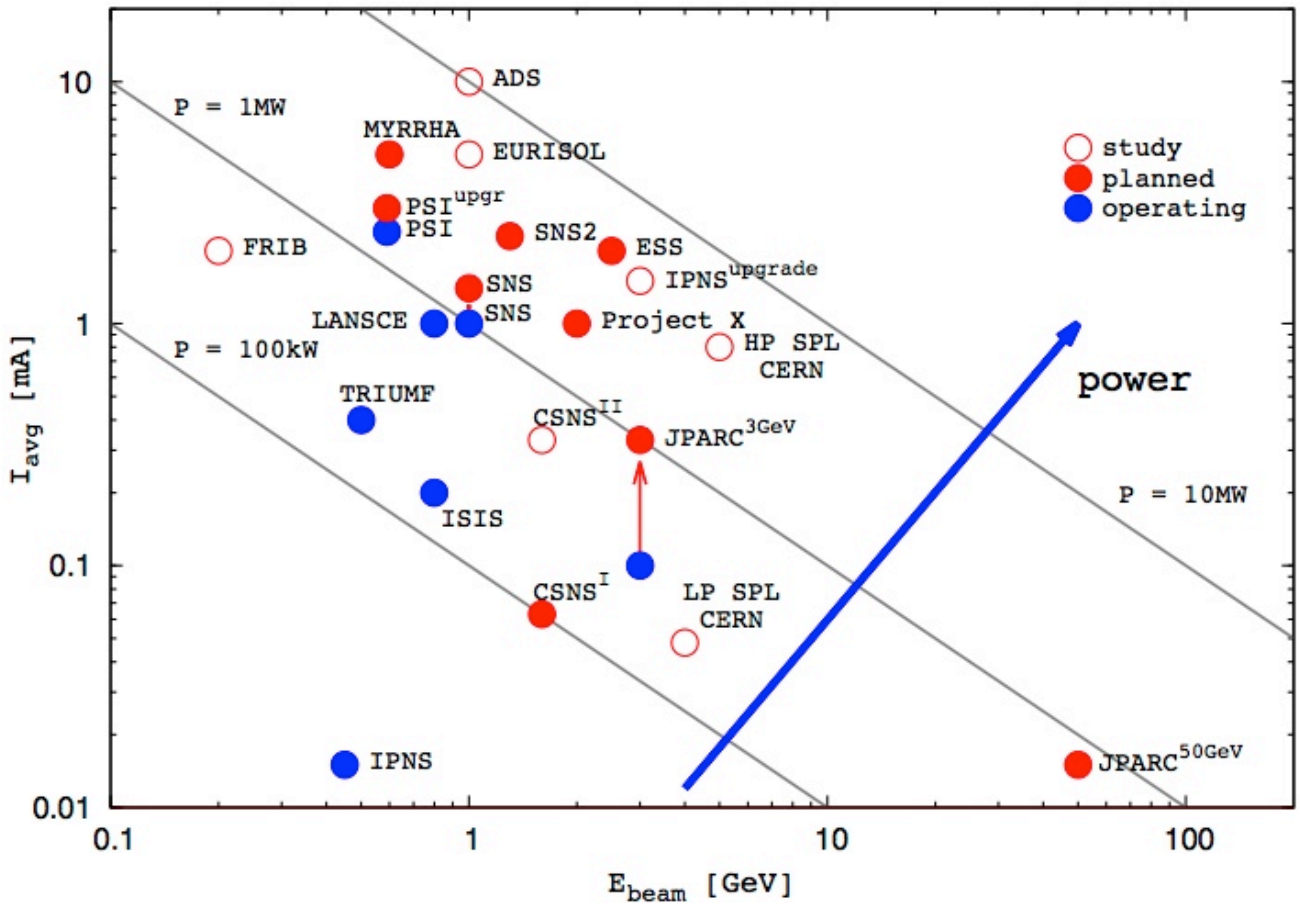
EUROPEAN
SPALLATION
SOURCE

The ESS Accelerator

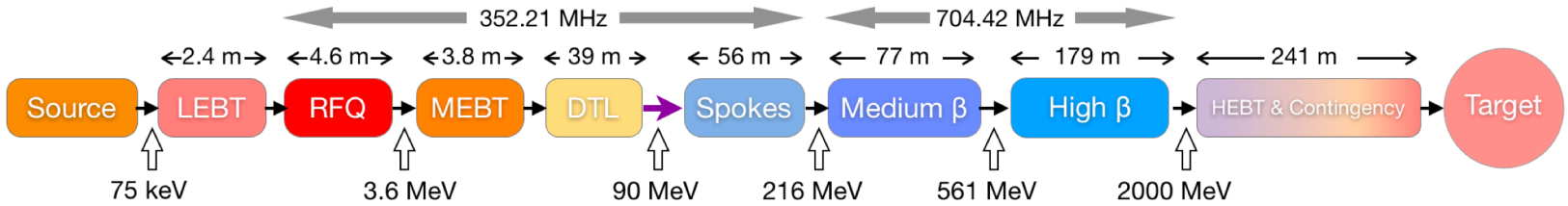
Krakow, 25 March 2014

Håkan Danared
Deputy Head Accelerator Division

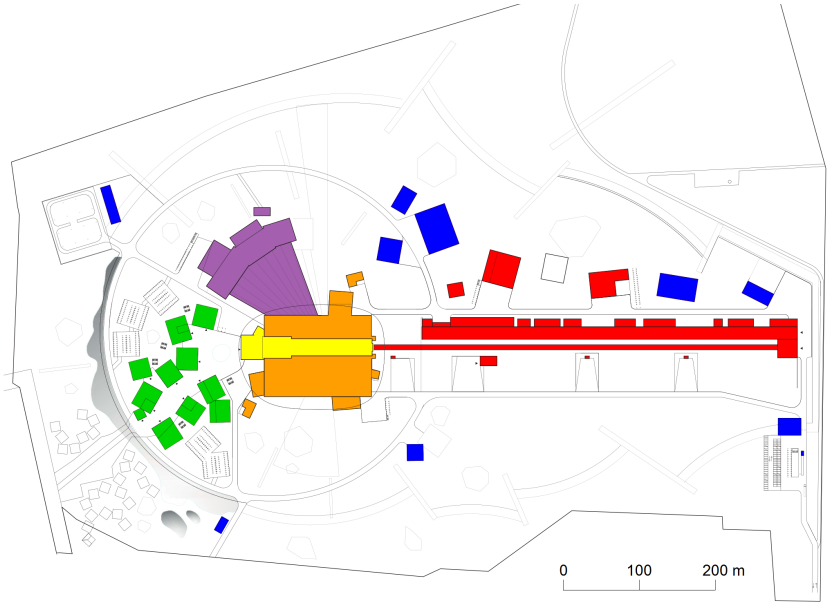
The Hadron Intensity Frontier



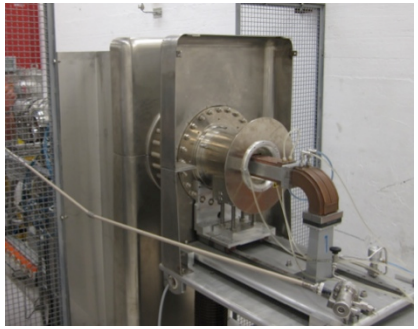
ESS Linac Parameters



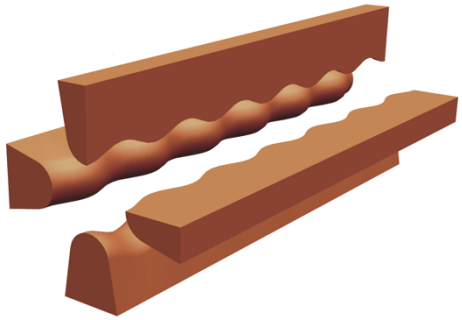
Particle species	p
Energy	2.0 GeV
Current	62.5 mA
Average power	5 MW
Peak power	125 MW
Pulse length	2.86 ms
Rep rate	14 Hz
Max cavity surface field	45 MV/m
Operating time	5200 h/year
Reliability (all facility)	95%



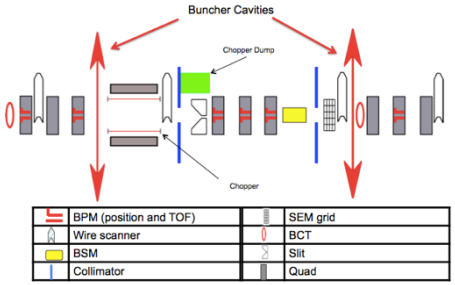
Ion Source and Normal-Conducting Linac



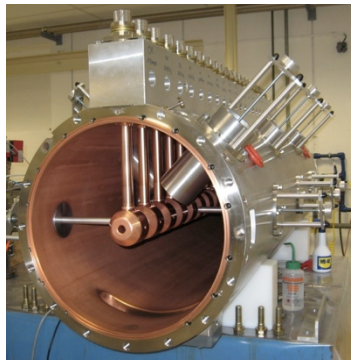
Prototype proton source operational, and under further development, in Catania. Output energy 75 keV.



Design exists for ESS RFQ similar to 5 m long IPHI RFQ at Saclay. Energy 75 keV->3.6 MeV.



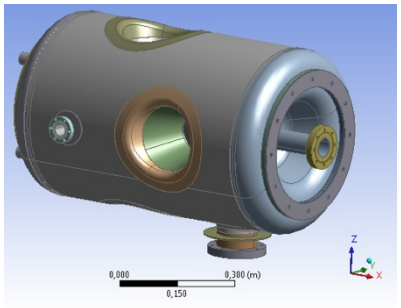
Design work at ESS Bilbao for MEBT with instrumentation, chopping and collimation.



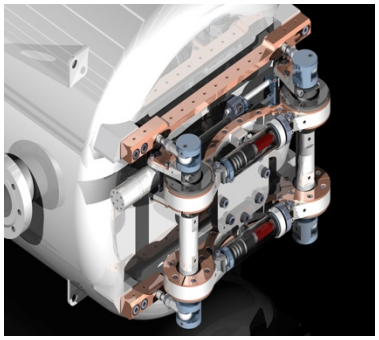
DTL design work at ESS and in Legnaro, 3.6 ->90 MeV.

Picture from CERN Linac4 DTL.

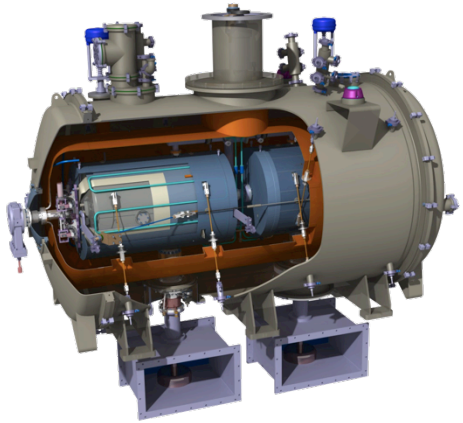
Spoke Cavities and Cryomodules



Superconducting double-spoke accelerating cavity, for particles with beta = 0.5, energy 90->216 MeV.



Cold tuner, to mechanically fine-tune the 352 MHz resonance frequency.



Cryomodule, holding two cavities at 2 K with superfluid helium. Length 2.9 m, diameter 1.3 m.

Power coupler, the antenna feeding up to 300 kW RF power to the cavities.

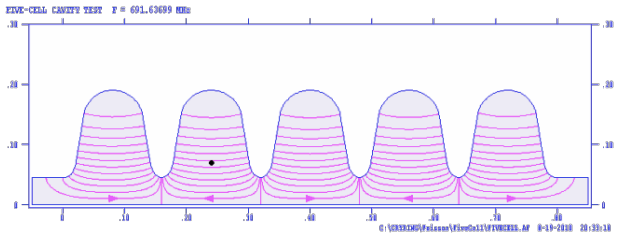
Single-spoke prototype for EURISOL

Cavity design done at IPN, Orsay. Prototype cavities are being manufactured.

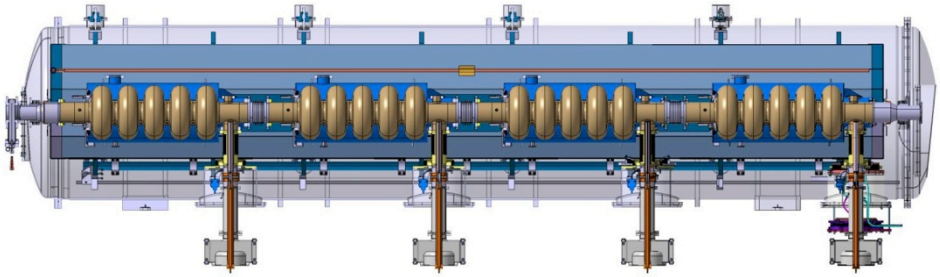
Cryomodule design highly advanced but not fully complete.

Elliptical Cavities and Cryomodules

Two families of superconducting elliptical cavities, for beta = 0.67, energy 216->561 MeV and beta = 0.86, energy 561->2000 MeV. First high-beta protoype shown.



Electrical field lines in ESS-like 5-cell cavity, 704 MHz, with cross section constructed from ellipses and straight lines.

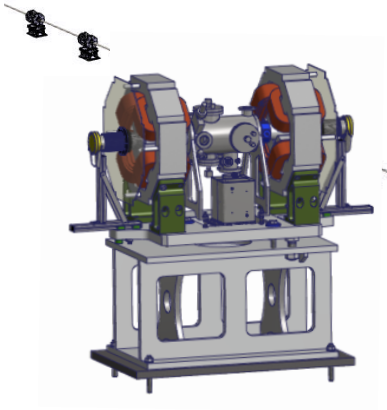


ESS elliptical cryomodule (not final) with 4 5-cell cavities and 4 power couplers for up to 1.1 MW peak RF power.

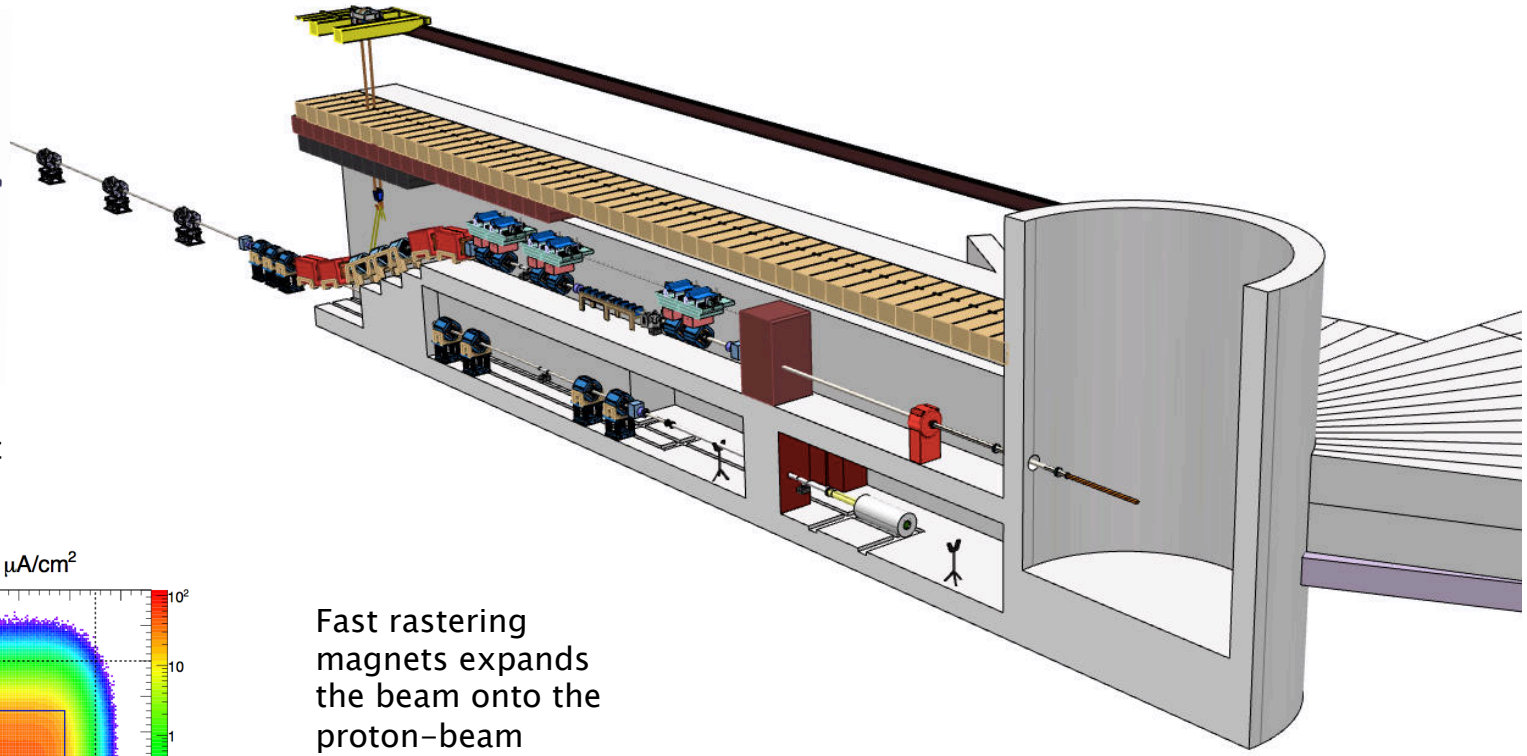
First cavity prototype delivered to Saclay, Cryomodule design well advanced at Orsay and Saclay.

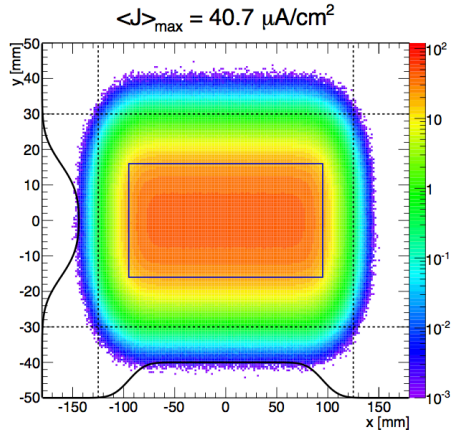
Elliptical Cavities Cryomodule Technology Demonstrator, ECCTD, to be ready 2015.

High-Energy Beam Transport



Quadrupole doublet for linac and HEBT





Fast rastering magnets expands the beam onto the proton-beam window and the 250 mm × 60 mm beam entrance window on the target wheel

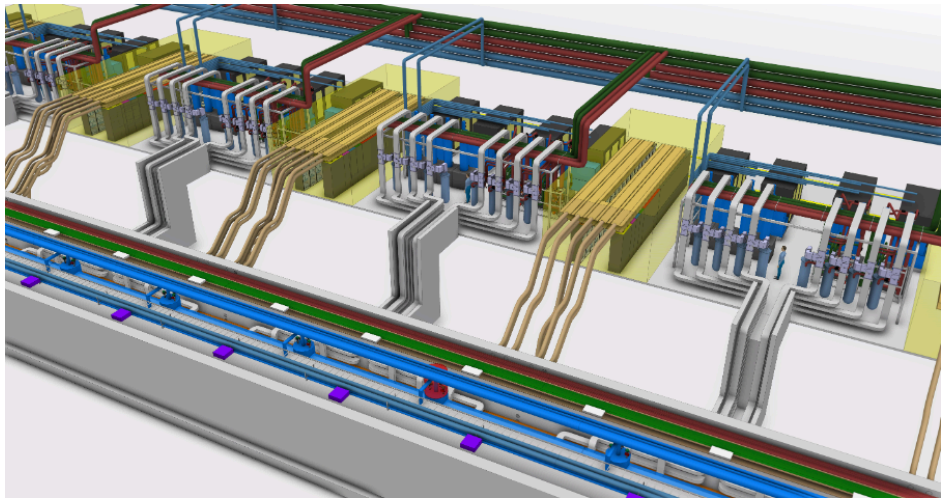
The HEBT design is a contribution from ISA, Århus.

RF Systems

SNS klystron gallery

Main features:
- One RF power source (klystron, IOT, ...) per resonator
- Two klystrons per modulator for ellipticals
- Pulsed-cathode klystrons for RFQ, DTL
- Gridded tubes (tetrodes or IOTs) for spokes
- Klystrons for medium-beta ellipticals, and as backup for high-beta
- Developments with industry for high-power IOTs

	Frequency (MHz)	No. of couplers	Max power (kW)
RFQ	352.21	1	900
DTL	352.21	5	2150
Spokes	352.21	26	350
Medium betas	704.42	32	900
High betas	704.42	88	1100



Layout of ESS linac tunnel and klystron gallery

Cryogenics

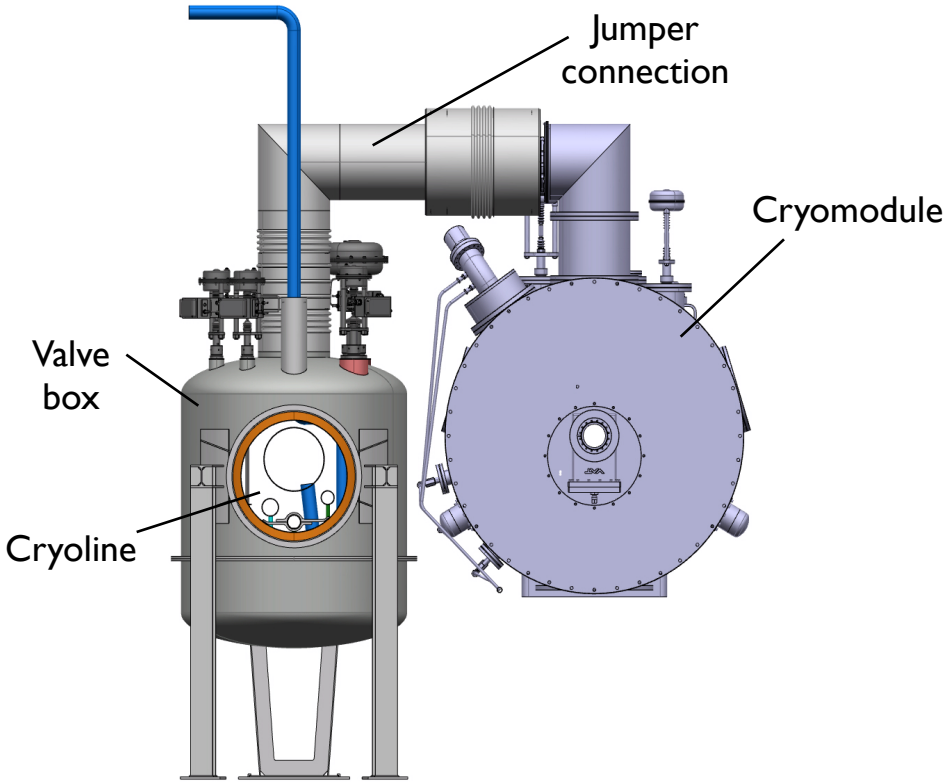
Three cryogenic plants

- Accelerator: 3.1 kW @ 2K, 12.8 kW @40 – 50 K plus 8 g/s helium liquefaction
- Target: ~ 20 kW @ 16K
- Test & Instruments ~ 250 W@ 4.5 K and 200 W @ 40K

Distribution system

- Permits independent cool down & warm up of cryomodules, likely IKC

Cryoplant orders to be placed in 2015 with operations starting in 2017 – 2018

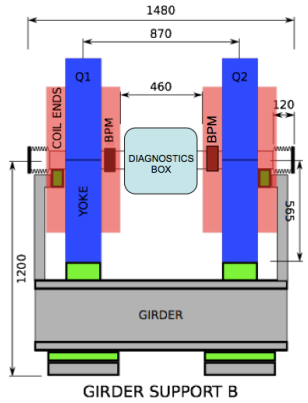


Further Components and Challenges…

… not mentioned for lack of time

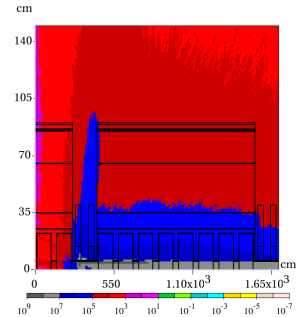
- *Beam instrumentation*
- Control system (ICS)
- Machine protection
- Personnel protection
- Vacuum
- Cryogenics
- Test stands
- Cooling, electricity
- Installation
- Logistics
- Safety
- Reliability
- System engineering
- In-kind
- Time schedule
- Budget

Control-box prototype

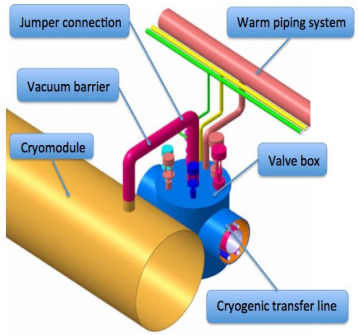


GIRDER SUPPORT B

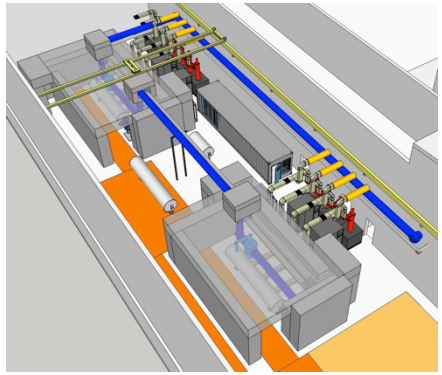
Quadrupole doublet on girder with BPMs and diagnostics box



Beam-loss simulations



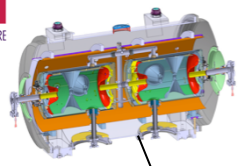
Cryogenic distribution

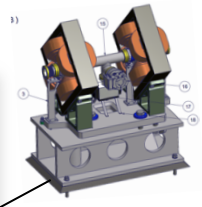


Cryomodule test stand

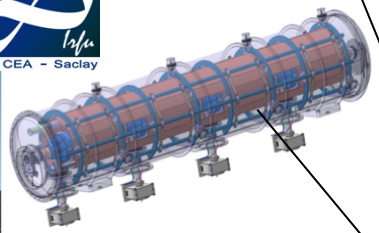
Collaboration During Pre-Construction

Sebastien Bousson

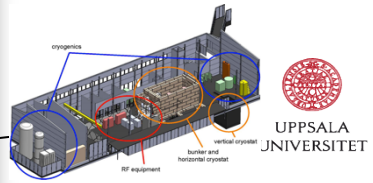




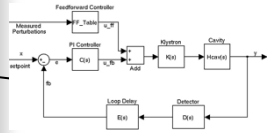
Søren Pape Møller



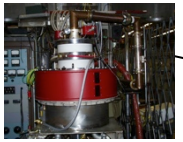
Pierre Bosland



Roger Ruber



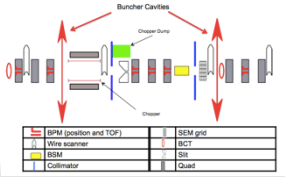
Anders J Johansson



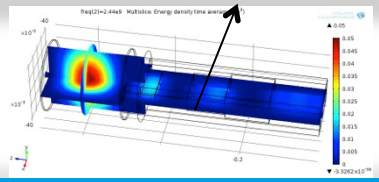
CERN

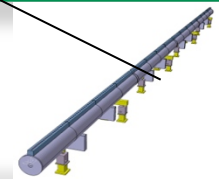
Roger Barlow

The National Center for Nuclear Research, Swierk



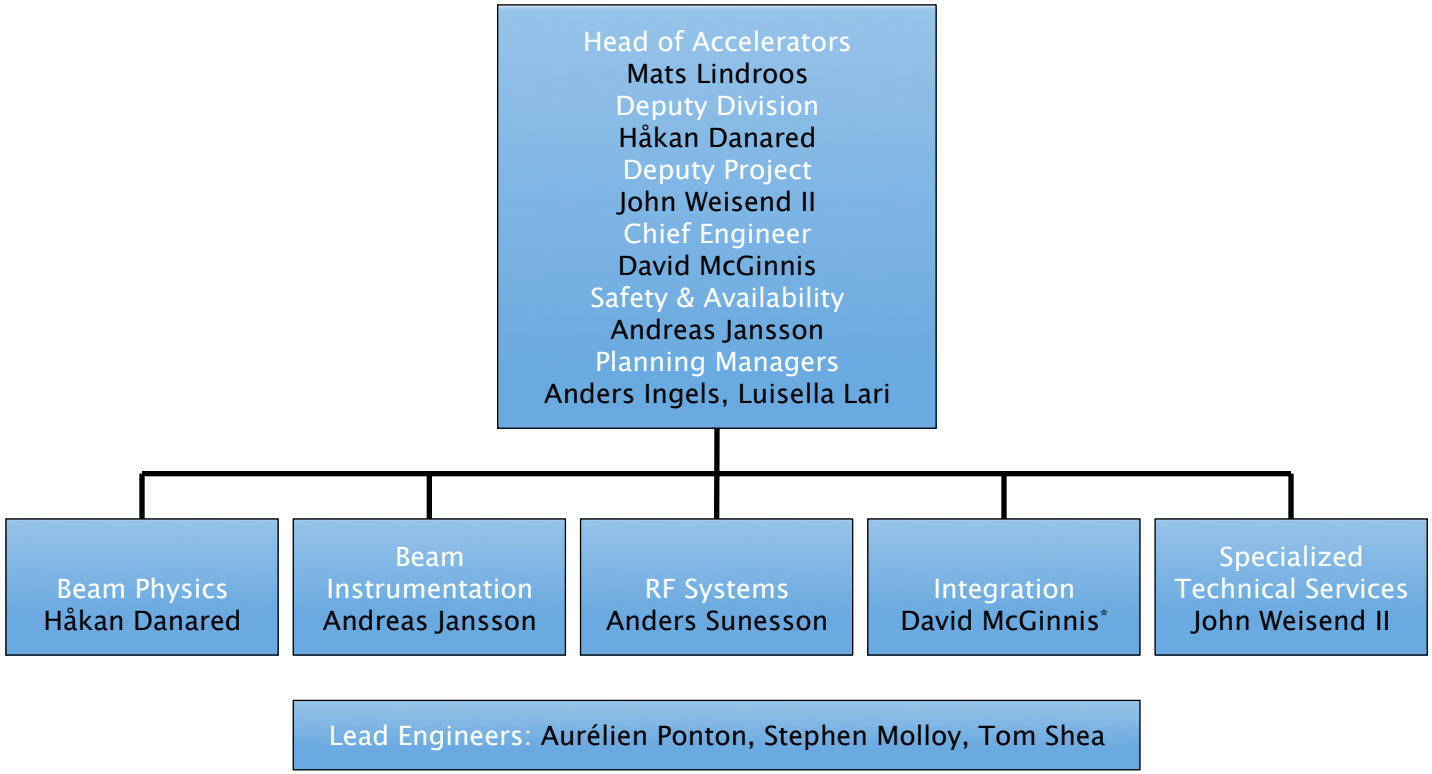
Ibon Bustinduy





Santo Gammino

Organization and Work Packages



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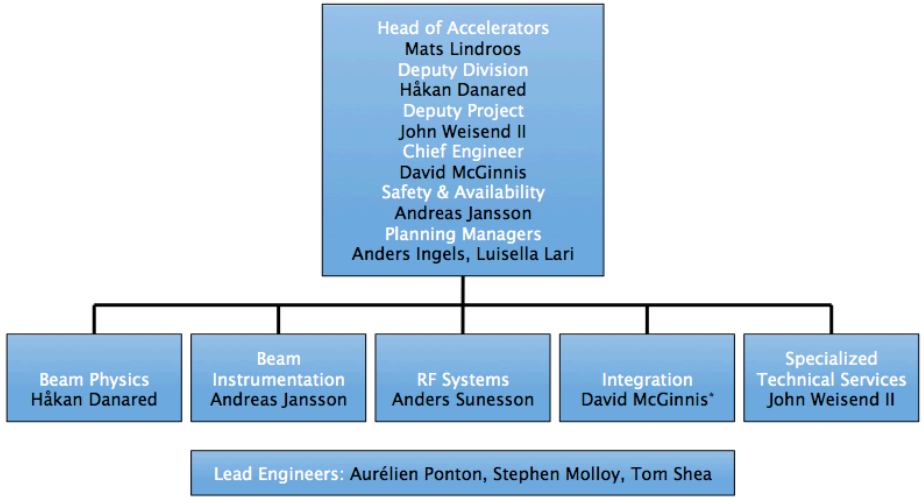
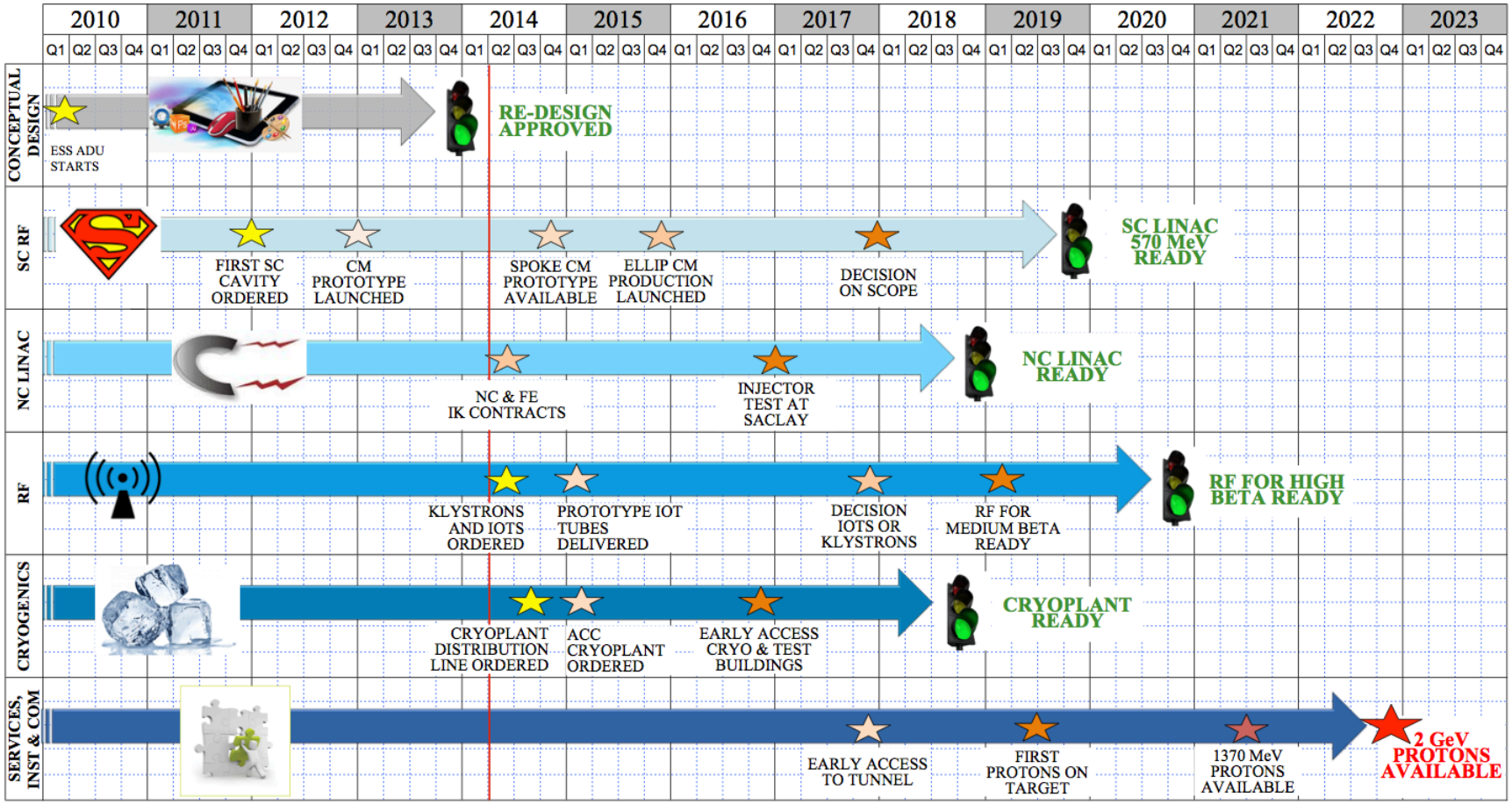


WP#	WP TITLE	WP LEADER	EXTERNAL WP?	LIASON FOR EXTERNAL WP
1	MANAGEMENT	J.G. WEISEND II	NO	
2	ACCELERATOR PHYSICS	M. ESHRAQI	NO	
3	NORMAL CONDUCTING FRONT END	S. GAMMINO	YES	A. PONTON
4	SPOKE CRYOMODULES	S. BOUSSON	YES	S. MOLLOY
5	ELLIPTICAL CRYOMODULES	P. BOSLAND	YES	C. DARVE
6	HEBT & MAGNETS	S. MØLLER	YES	P. LADD
7	BEAM DIAGNOSTICS	A. JANSSON	NO	
8	RF SYSTEMS	A. SUNESSON	NO	
9	ACCEL INFRASTRUCTURE & INSTALLATION	G. LANFRANCO	NO	
10	TEST STANDS	W. HEES	MIXED	W. HEES
11	CRYOGENICS	P. ARNOLD	NO	
12	VACUUM	P. LADD	NO	
13	SAFETY & RELIABILITY	A. JANSSON	NO	
14	REDESIGN EFFORT	D. McGINNIS	NO	
15	COOLING & ELECTRICAL SUPPORT	F. JENSEN	NO	

ACCSYS Project Governance and Review Structure

- Technical Board (all WP leaders and representatives of contracted partners) and project-level CCB, 6 meetings/year
- Collaboration board with directors of contracted laboratories/universities, as oversight committee
- Annual audits of every work package
- Reviews: Conceptual, Design, Ready-to-Build of major components

Time Schedule



Collaborations for Construction

- Partners from Accelerator Pre-Construction expected to continue through Construction
- Need for many additional partners in Construction
- Expressions of Interest for accelerator received from 17 organizations and 41 companies
- Detailed discussions are going on with a dozen organizations, including 4 in Poland
- Polish universities and laboratories have an extensive experience of working in European accelerator projects, and ESS wants to benefit from Polish expertise and Polish industry

Thank you.