

Status of the ESS linac

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RF group leader

www.europeanspallationsource.se

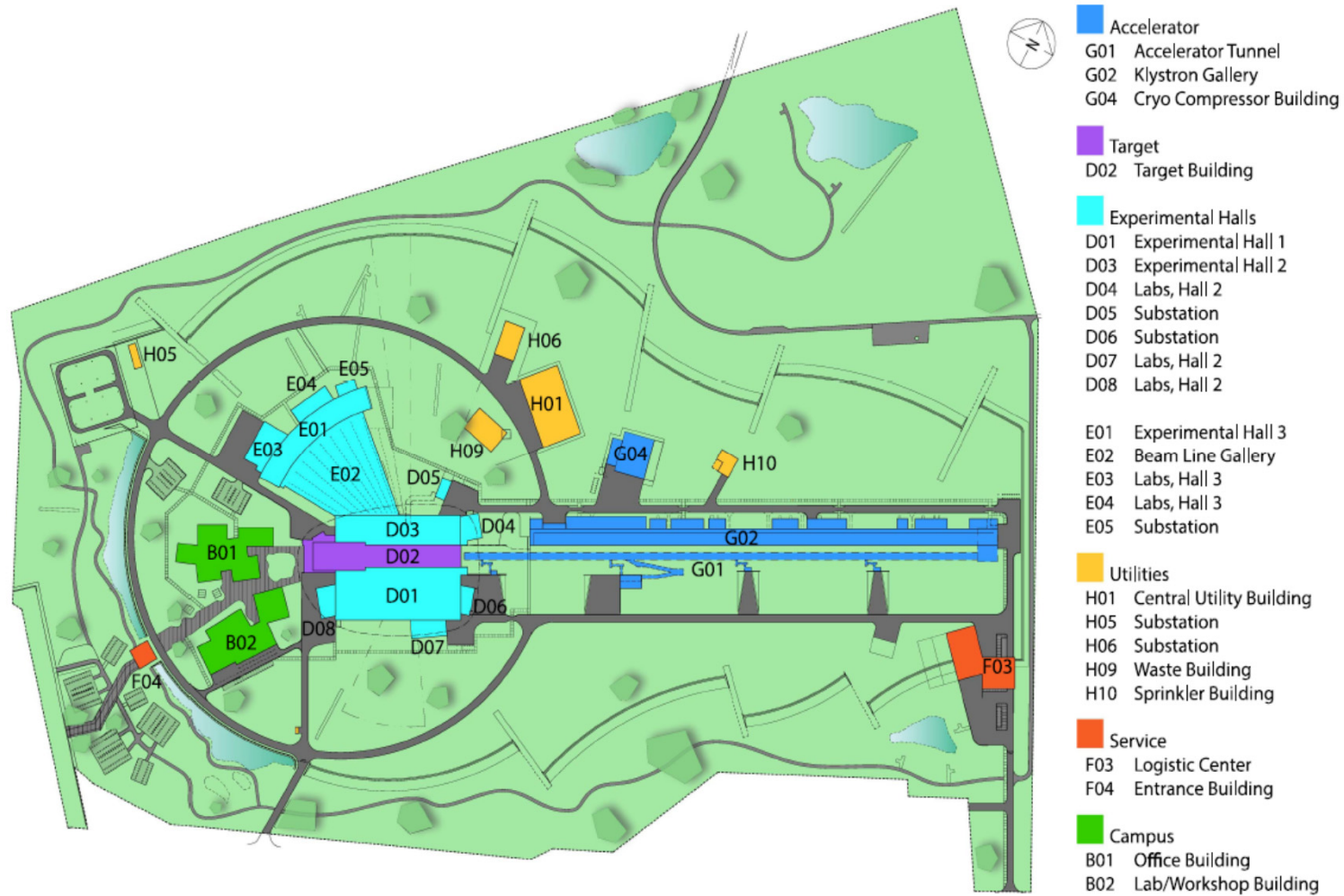
Beijing, linac2018, Sept 17, 2018

Overview



- ESS
- ESS Linac status
 - Overview, schedule
 - Cavities
 - RF systems
 - Power Converters
 - Beam instrumentation
 - Cryo system
 - ICS/MPS/PSS
 - Installation
- Q/A

ESS Site



ESS Site



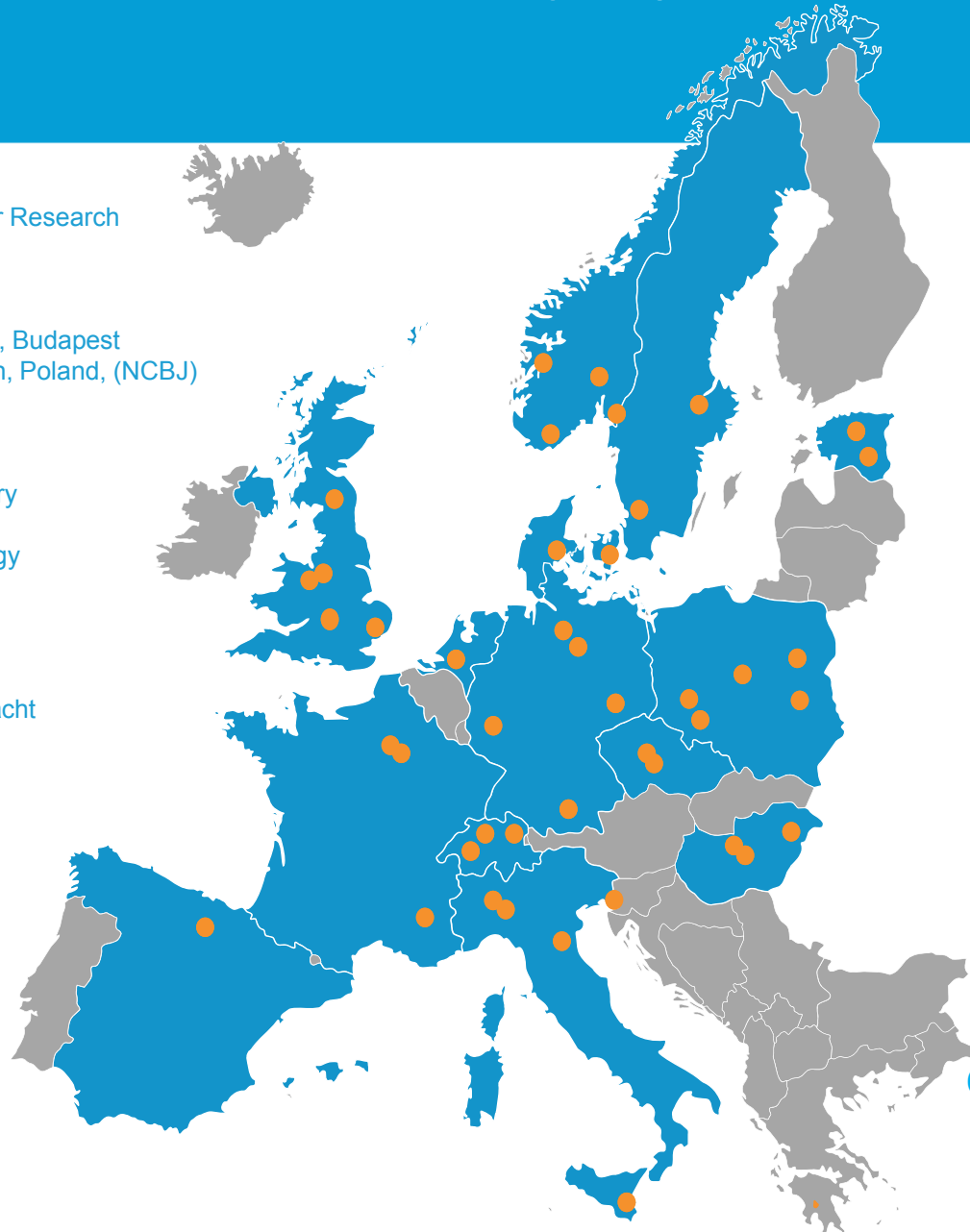
ESS Site



A European collaboration project



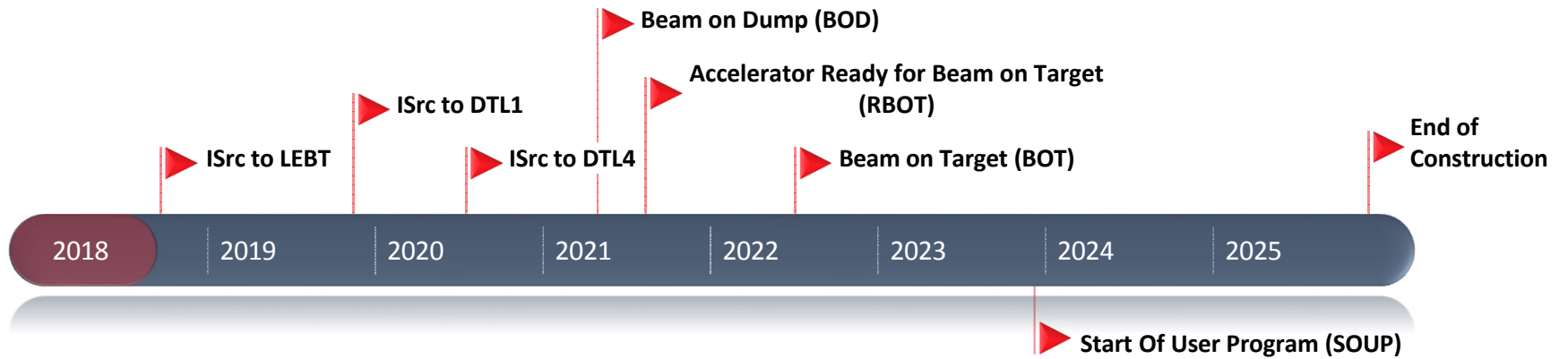
Aarhus University
Atomki - Institute for Nuclear Research
Agder University
Bergen University
CEA Saclay, Paris
Centre for Energy Research, Budapest
Centre for Nuclear Research, Poland, (NCBJ)
CERN, Geneva
CNR, Rome
CNRS Orsay, Paris
Cockcroft Institute, Daresbury
DESY, Hamburg
Delft University of Technology
Edinburgh University
Elettra – Sincrotrone Trieste
ESS Bilbao
Forschungszentrum Jülich
Helmholtz-Zentrum Geesthacht
Huddersfield University
IFJ PAN, Krakow
INFN, Catania
INFN, Legnaro
INFN, Milan



Institute for Energy Research (IFE)
Institut Laue-Langevin (ILL)
Rutherford-Appleton Laboratory, Oxford (ISIS)
Kopenhagen University
Laboratoire Léon Brillouin (LLB)
Lodz University of Technology
Lund University
Nuclear Physics Institute of the ASCR
Oslo University
Paul Sherrer Institute
Roskilde University
Tallinn Technical University
Technical University of Chemnitz
Technical University of Denmark
Technical University Munich
Science and Technology Facilities Council (STFC)
University of Tartu
Uppsala University
WIGNER Research Centre for Physics
Wroclaw University of technology
Warsaw University of Technology
Zurich University of Applied Sciences (ZHAW)

~ 100
Collaborating Institutions

Top-level Schedule

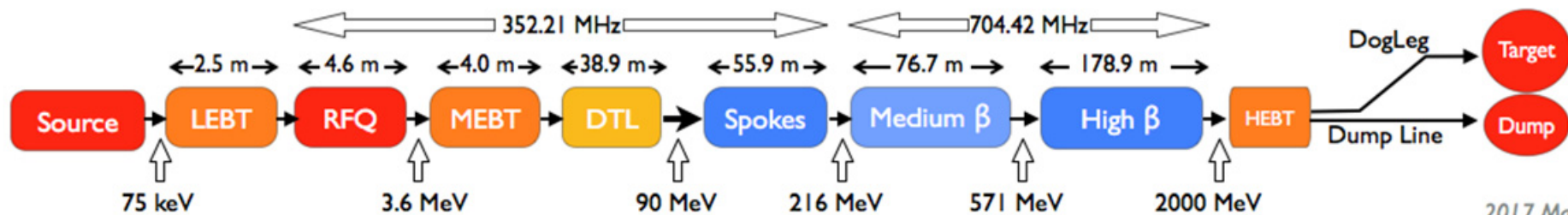


Linac top level design parameters



Parameter	Unit	Value
Energy	GeV	2.0
Current	mA	62.5
Pulse length	ms	2.86
Pulse repetition rate	Hz	14
Average beam power	MW	5
Power during pulse	MW	125
Beam emittance at target, ϵ_x	π mm mrad	0.34
Beam emittance at target, ϵ_y	π mm mrad	0.36

Linac Lattice and power levels



2017 March

	Energy (MeV)	Frequency /MHz	No. of Cavities	Temp / K	RF power required /kW	RF source	RF power specified /kW
Source	0.075	-	0	~300	-		
LEBT	0.075	-	0	~300	-		
RFQ	3.6	352.21	1	~300	1600	Klystron	3000
MEBT	3.6	352.21	3	~300	20	SSPA	35
DTL	90	352.21	5	~300	2200	Klystron	3000
Spoke	220	352.21	26 (2/CM)	~2	330	Tetrode	450
Medium β	570	704.42	36 (4/CM)	~2	870	Klystron	1500
High β	2000	704.42	84 (4/CM)	~2	1100	Klystron/IOT	1500/1200
HEBT	2000	-	0	~300	-		7

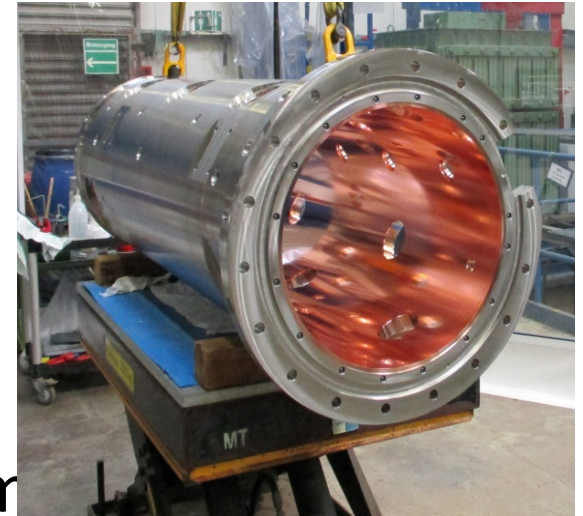
Cavities



- RFQ under machining
- DTL parts under fabrication
- DTLs will be assembled on-site
- Spoke cavities testing to start
- Elliptical test cryomodule under assembly
- Medium beta, high beta prototypes tested

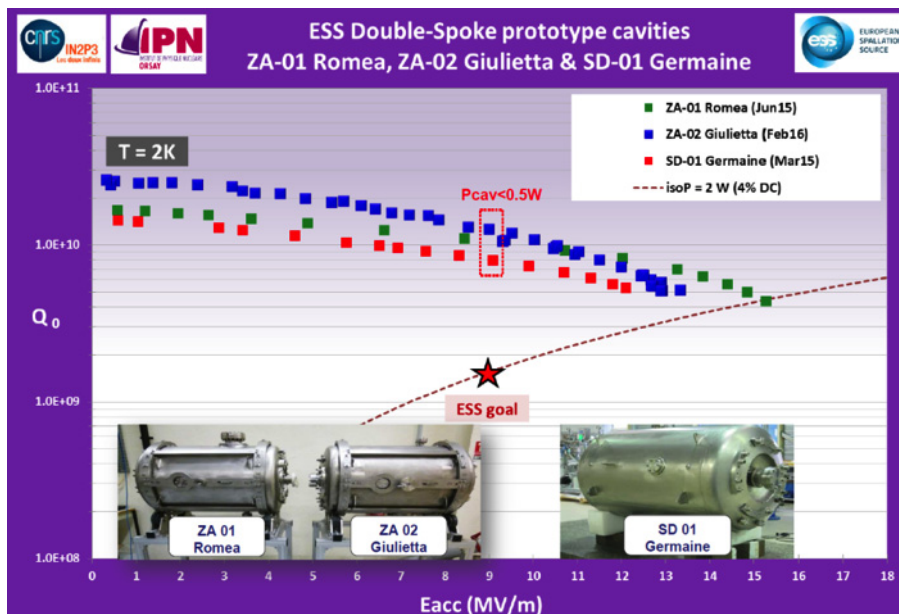
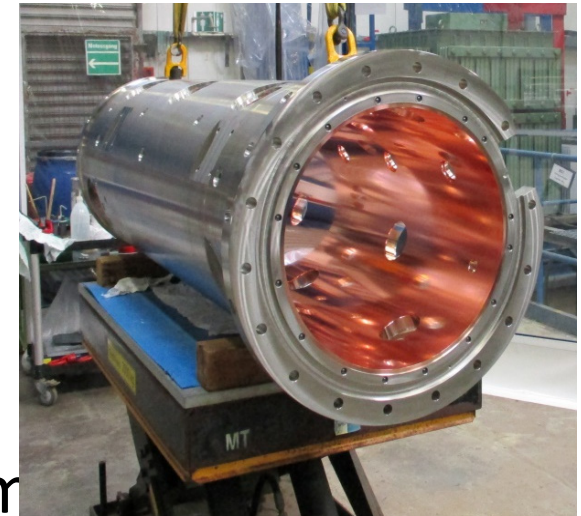
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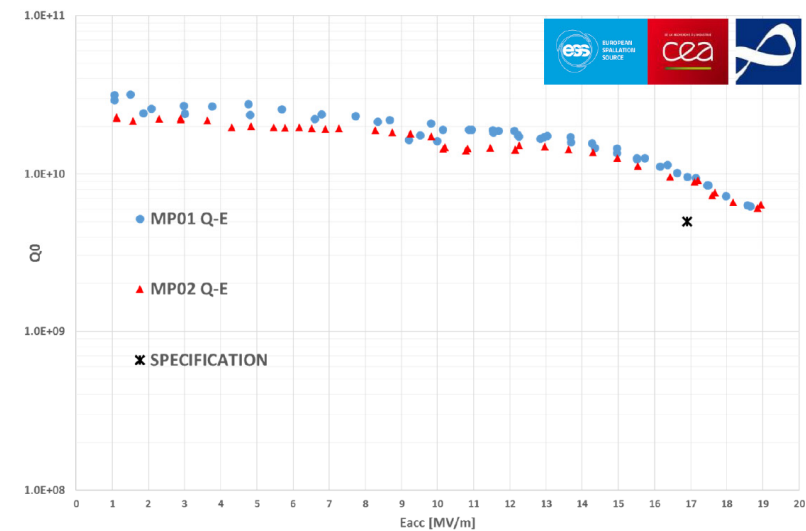
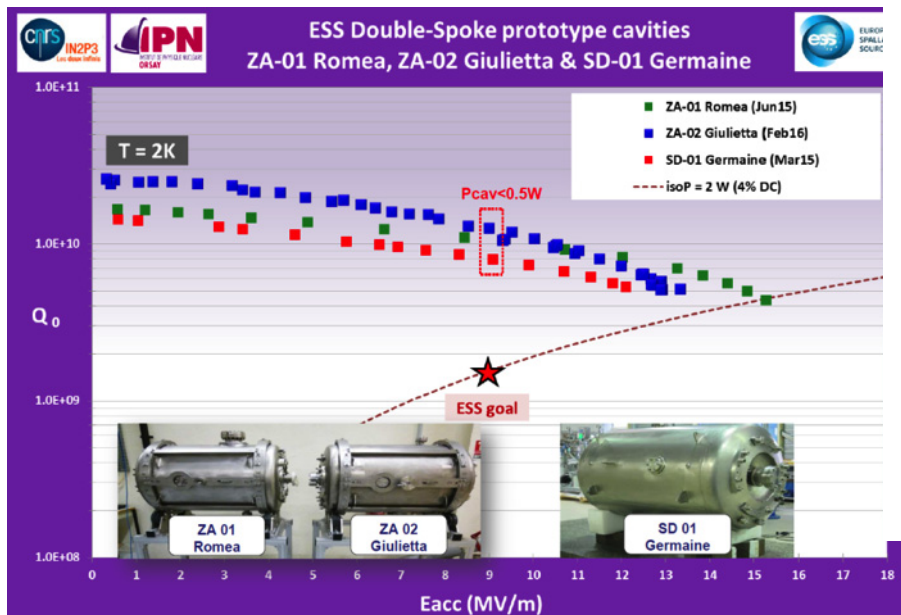
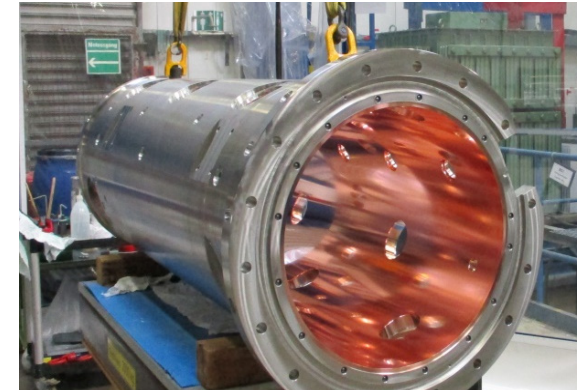
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under assembly
prototypes tested

Cavities

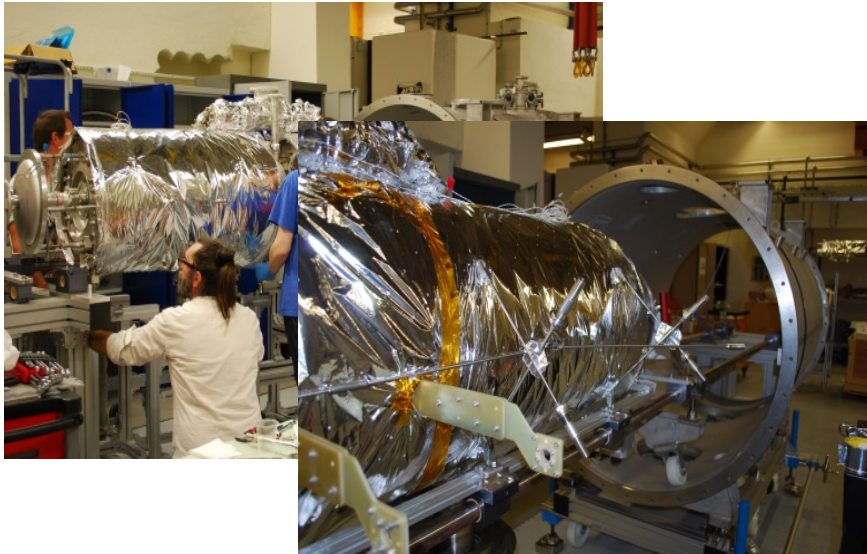
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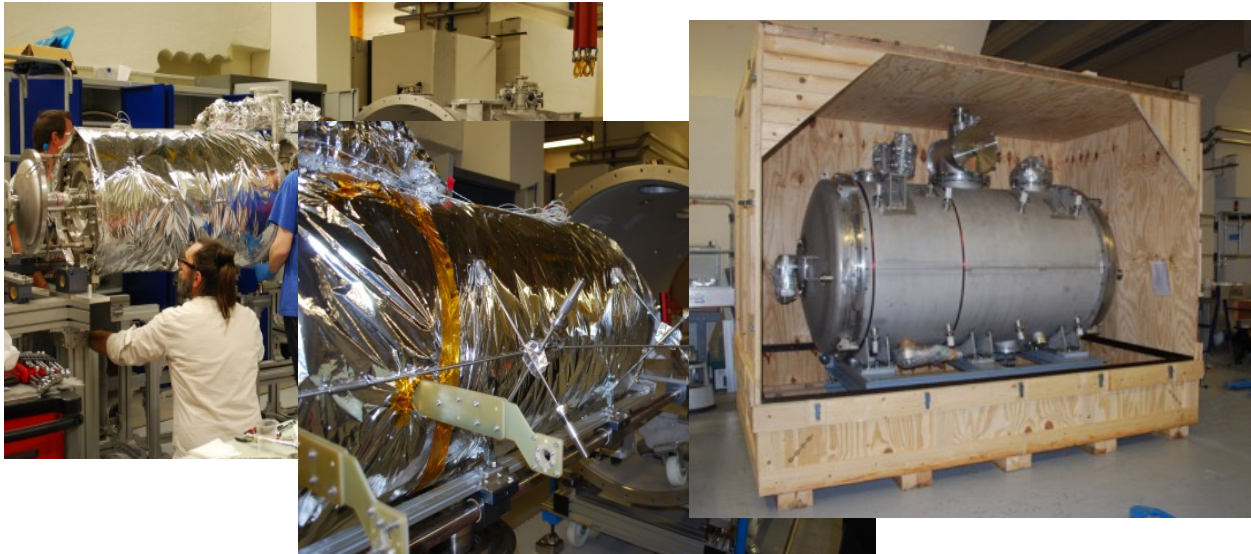
Cavities and cryomodules



Cavities and cryomodules



Cavities and cryomodules



Cavities and cryomodules



Cavities and cryomodules



RF systems

- Klystrons for RFQ/DTL
- Tetrode stations Spoke
- Klystrons medium beta
- Development project MB-IOT
- LLRF based on MTCA-4
- Interlock PLC + FPGA
- Waveguide systems



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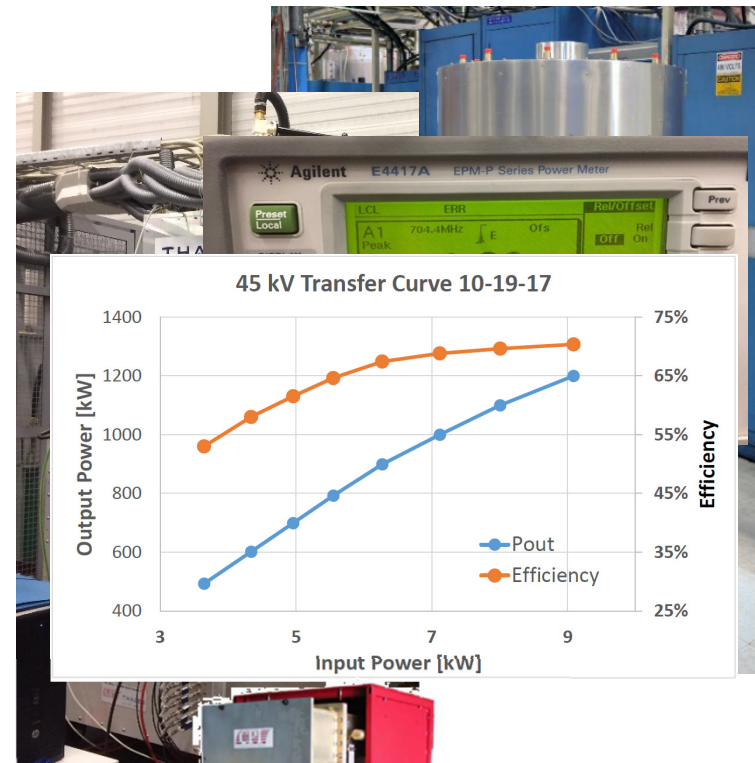
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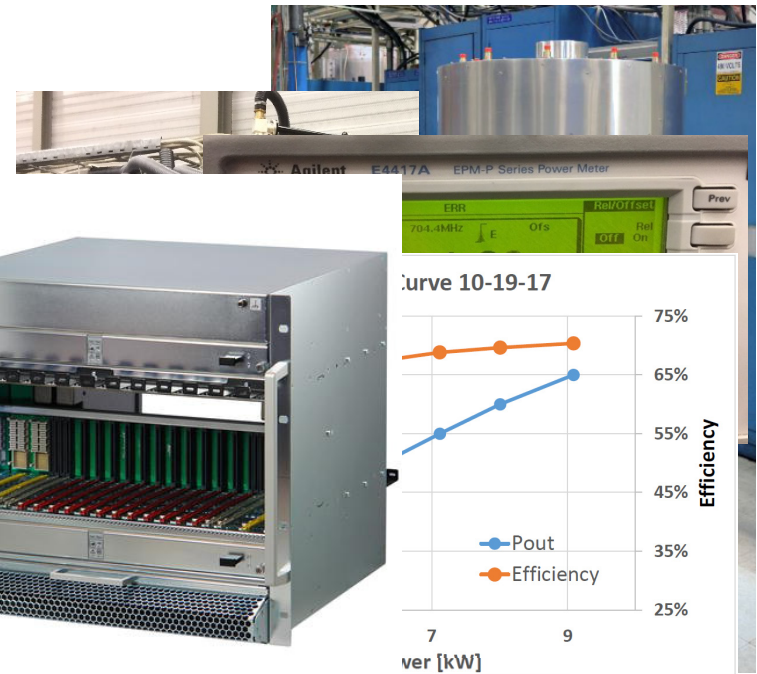
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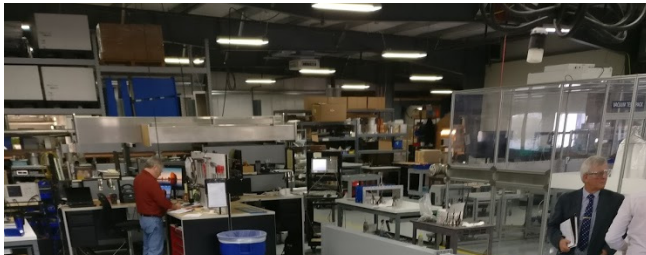
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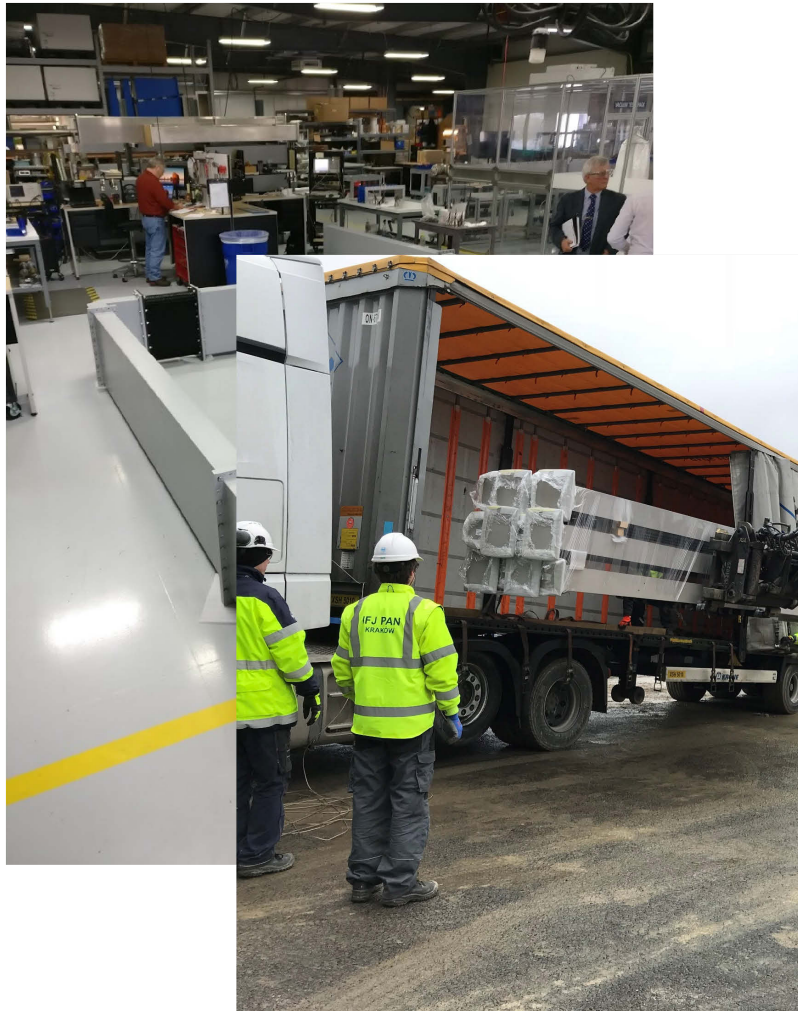
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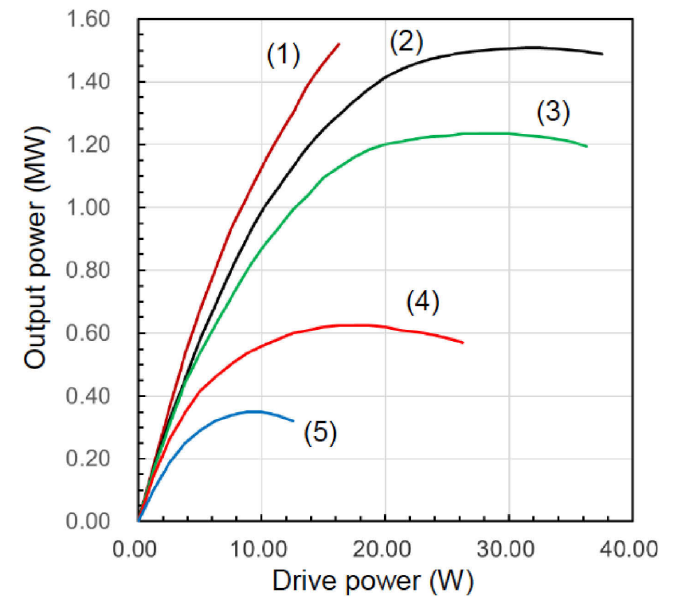
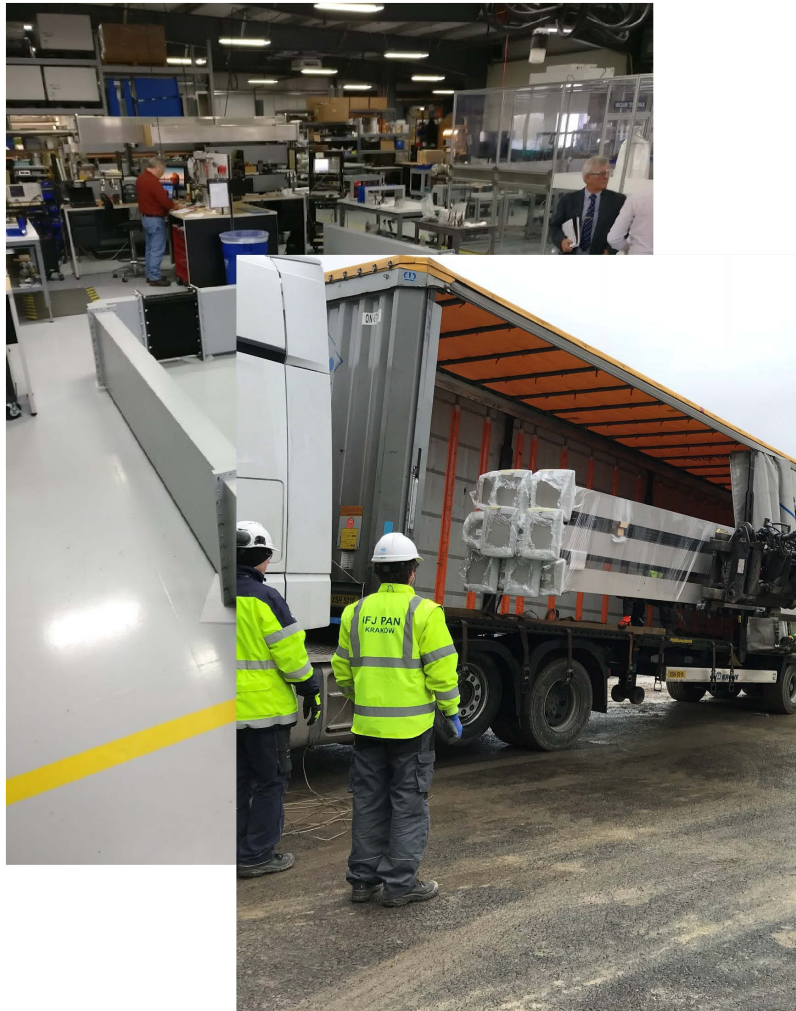
RF systems



RF systems



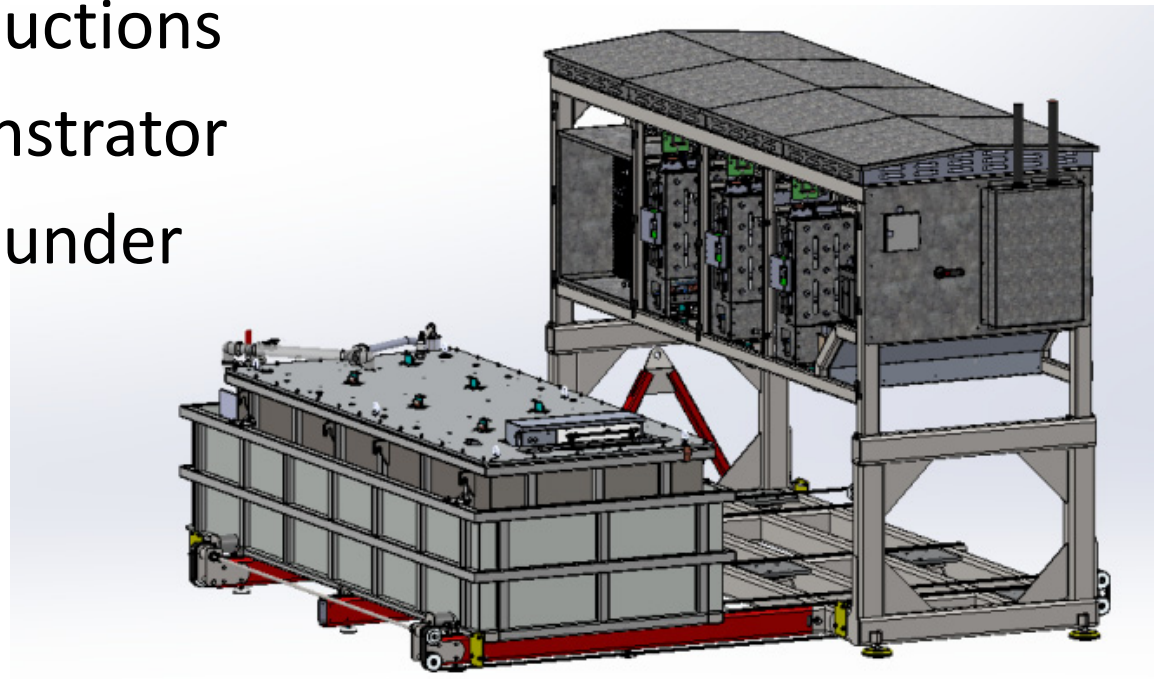
RF systems



No.	Beam voltage (kV)	Beam current (A)	Solenoid current		RF power (MW)	Iris
			1	2		
1	115.0	23.6	10.0	10.0	1.51	
2	106.4	21.2	10.0	10.0	1.52	
3	98.0	18.7	9.0	8.5	1.23	
4	75.0	12.7	7.0	8.0	0.625	Iris 1
5	61.2	9.4	5.5	7.0	0.350	Iris 2

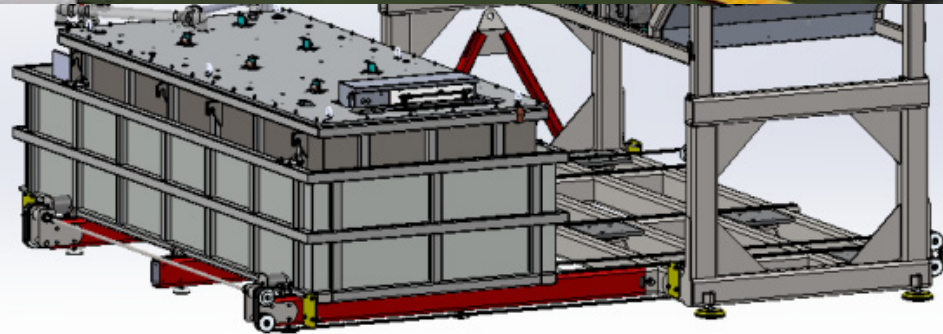
Power converters

- New concept for HV modulators, Stacked Multi Level, SML
- Cost and size reductions
- Prototype demonstrator
- First serial items under construction
- Magnet power



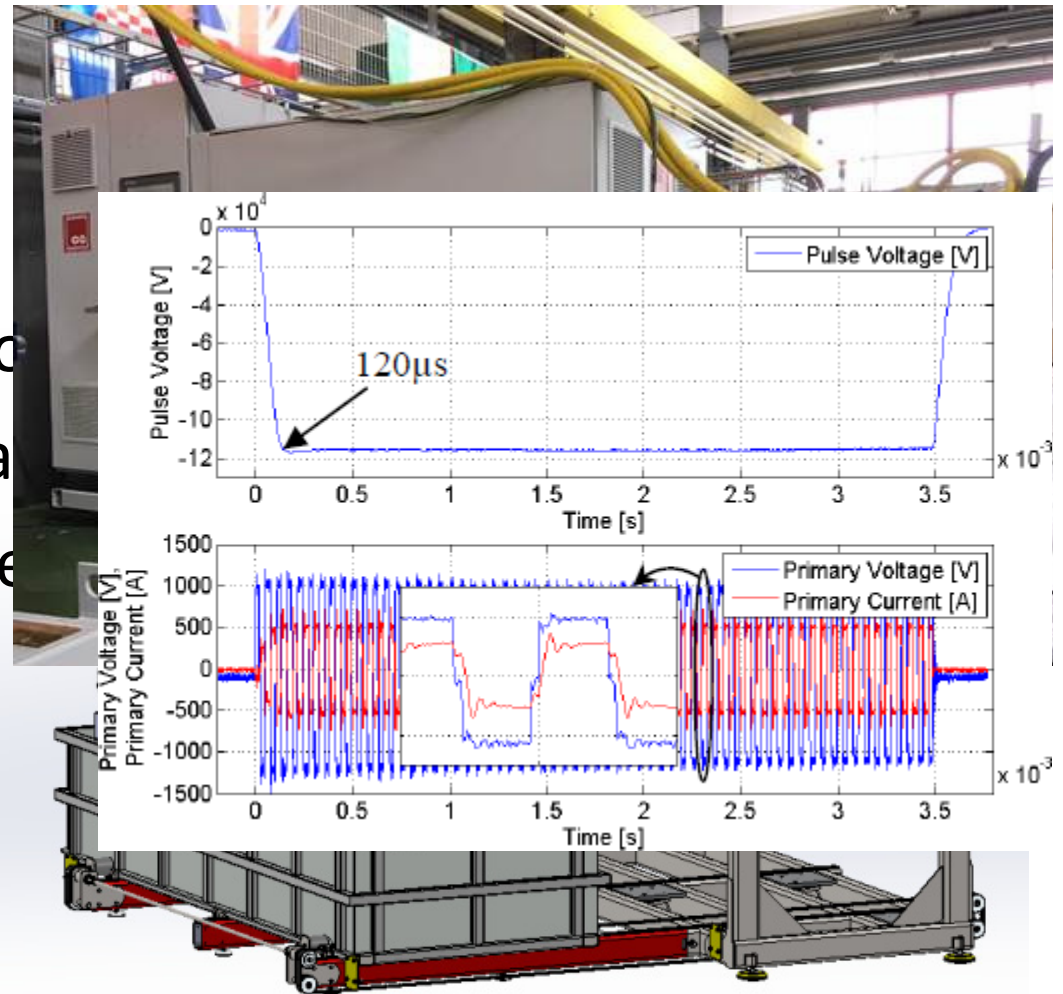
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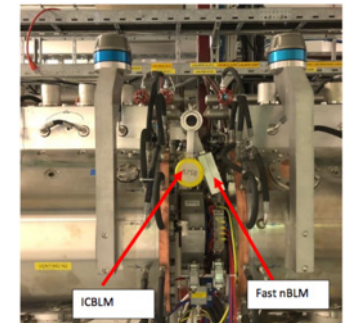
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Beam instrumentation

- Extensive collaboration
- Several categories of systems

Category	System
Beam Accounting	Doppler System
	Beam Current Monitors
	Faraday Cups
	Beam Loss Monitors (ionization, neutron)
	Aperture monitors
Centroid	Beam Position Monitors
Distribution	Emittance Measurements
	Bunch Shape Monitors
	Wire Scanners
	Beam Induced Fluorescence
	Imaging



Cryogenics



- Three cryoplants
- Two under commissioning (test stand and accelerator)
- Liquid helium production started

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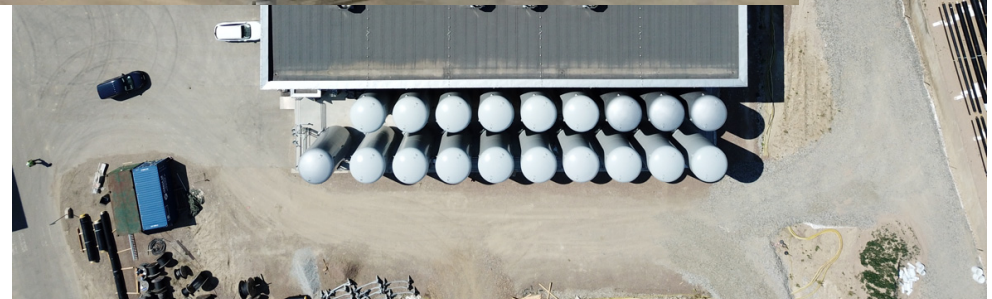
Cryogenics

- Three cryoplant
- Two under construction (accelerator)
- Liquid helium plant

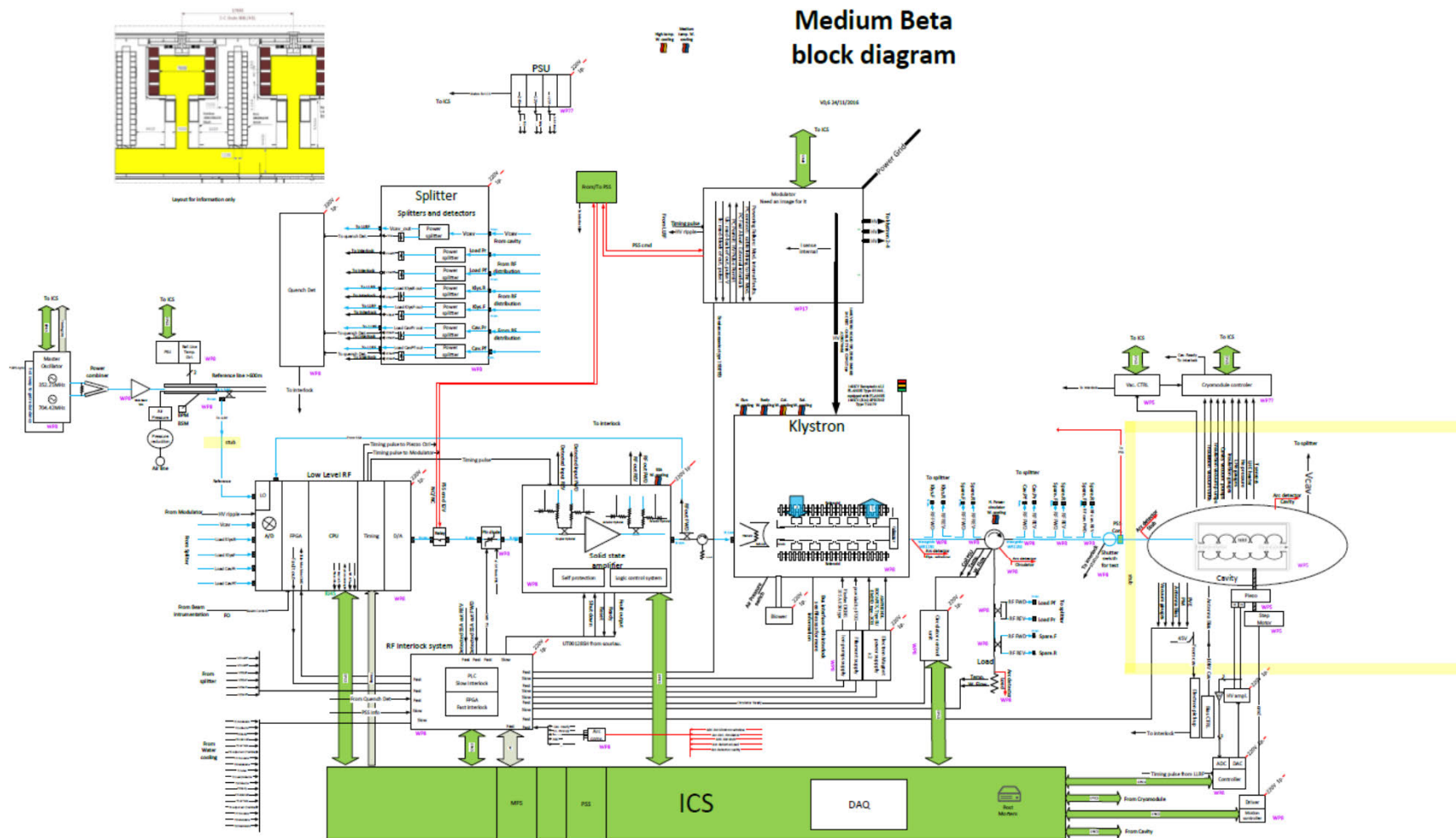


Cryogenics

- Three cryoplanes
- Two under construction (for the accelerator)
- Liquid helium plant



Control system, EPICS, MPS and PSS



Installation of IS-LEBT in Tunnel



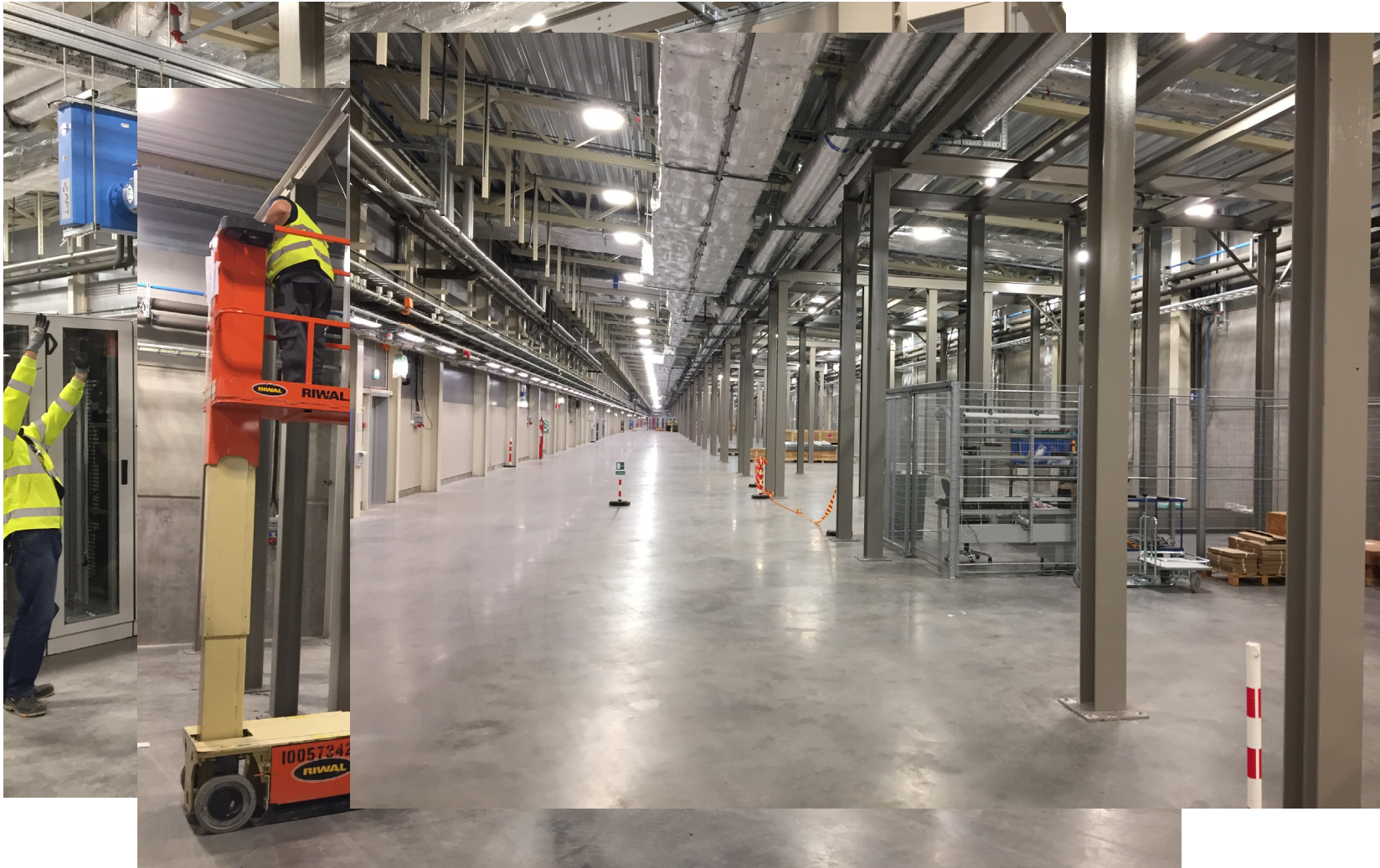
Installation RF components in gallery



Installation RF components in gallery



Installation RF components in gallery



Test stand – HV supplies, Amplifier tubes



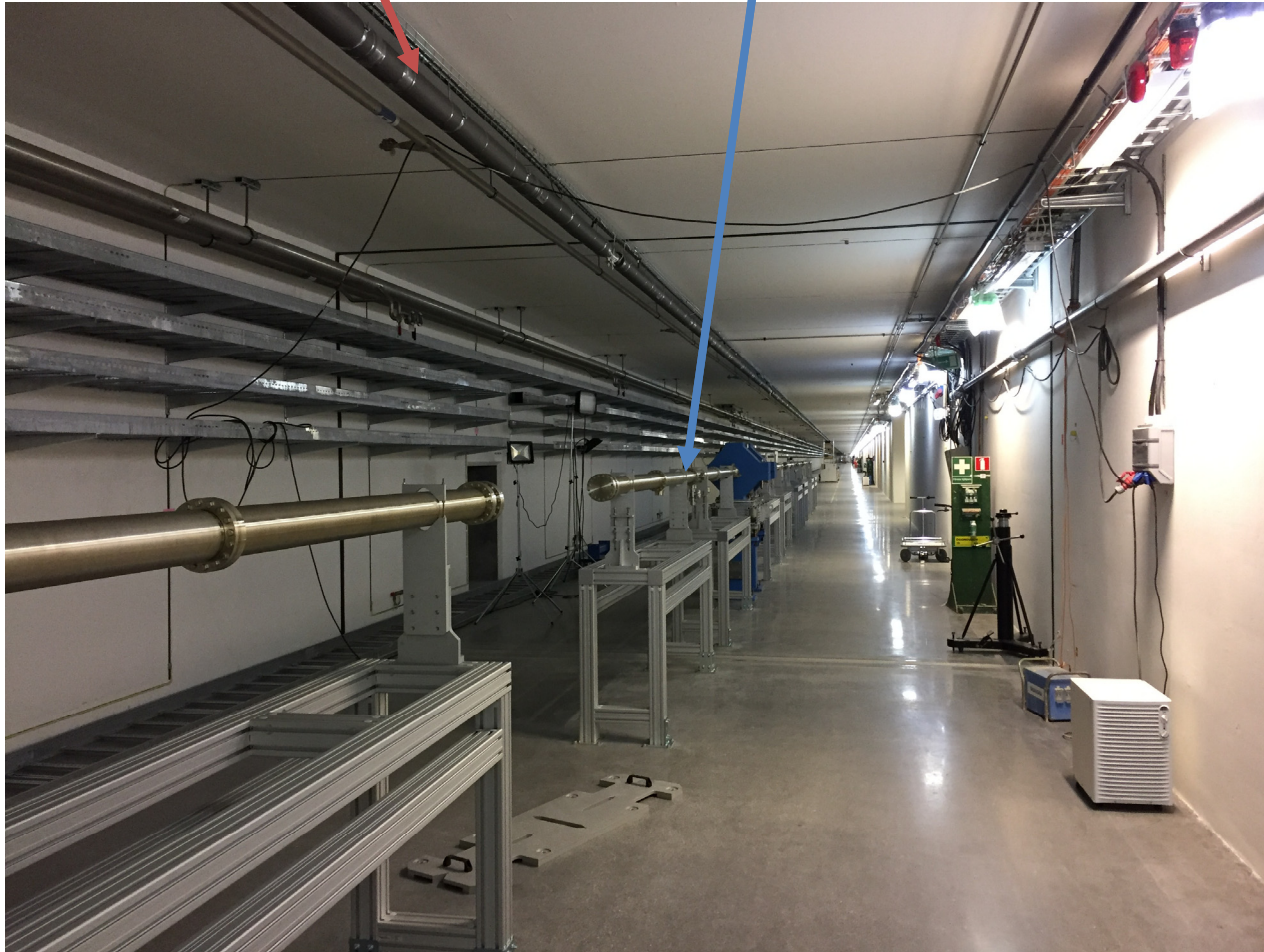
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Test stand – HV supplies, Amplifier tubes



Tunnel – phase ref and beam lines



Summary



- ESS is a joint European research facility
- ESS is being constructed and installed in Lund
- ESS has the world's largest linear proton accelerator
- Neutrons are generated in a Tungsten target
- ESS neutron flux will be the largest in any facility
- The neutrons can be used for world-leading materials science
- The construction and installation are in a very intensive phase
- Start of user program 2023

Questions?
Thank you

Help from my co-authors is gratefully acknowledged:
R. Garoby, M. Lindroos, M. Jensen, C. Martins, T. Shea
J. Weisend, P. Arnold, A. Nordt, S. Birch