



EUROPEAN
SPALLATION
SOURCE

RECENT PROGRESS ON THE ESS PROJECT

Mamad Eshraqi
HB 2018, Daejeon, South Korea

FROM LARGEST ARCHAEOLOGY SITE IN SWEDEN



2013 September

FROM LARGEST ARCHAEOLOGY SITE IN SWEDEN



Forntid möter framtid
– Arkeologi på ESS-området

Archaeology at the ESS-site



antiquity meets future

2013 September

... TO ESS SITE



2014 September

... TO ESS SITE

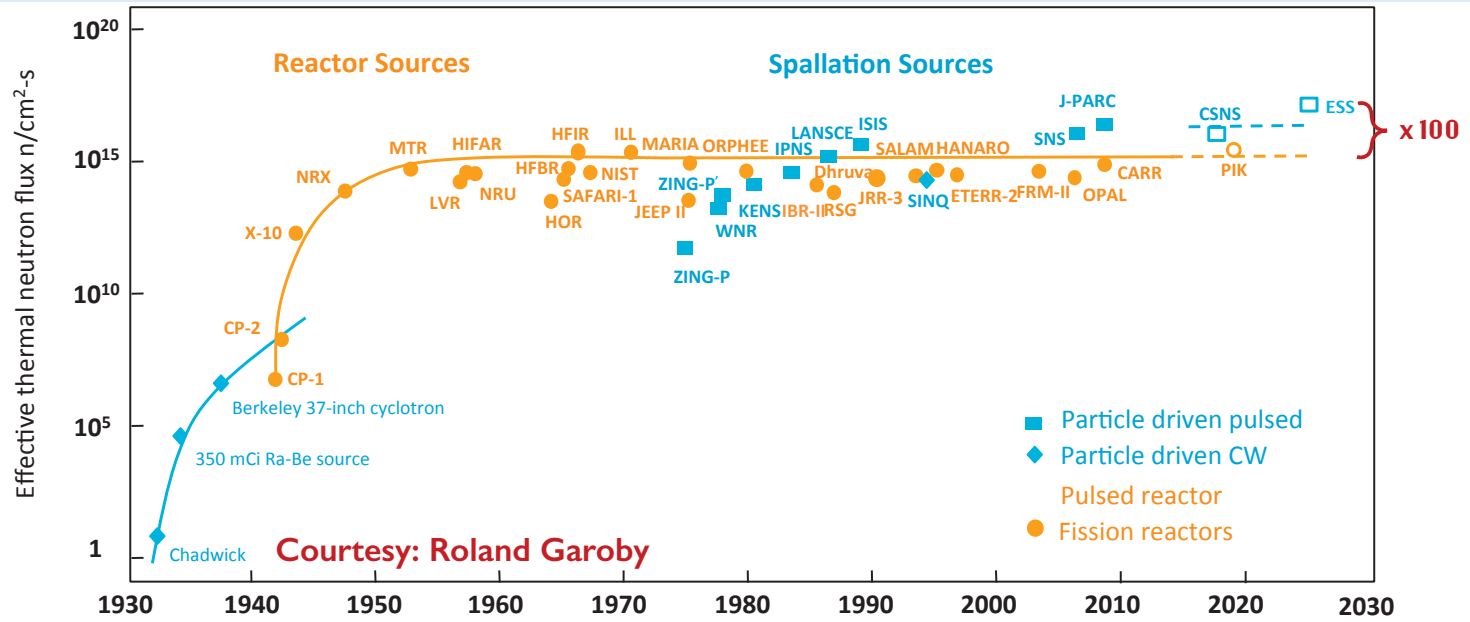


2018 June

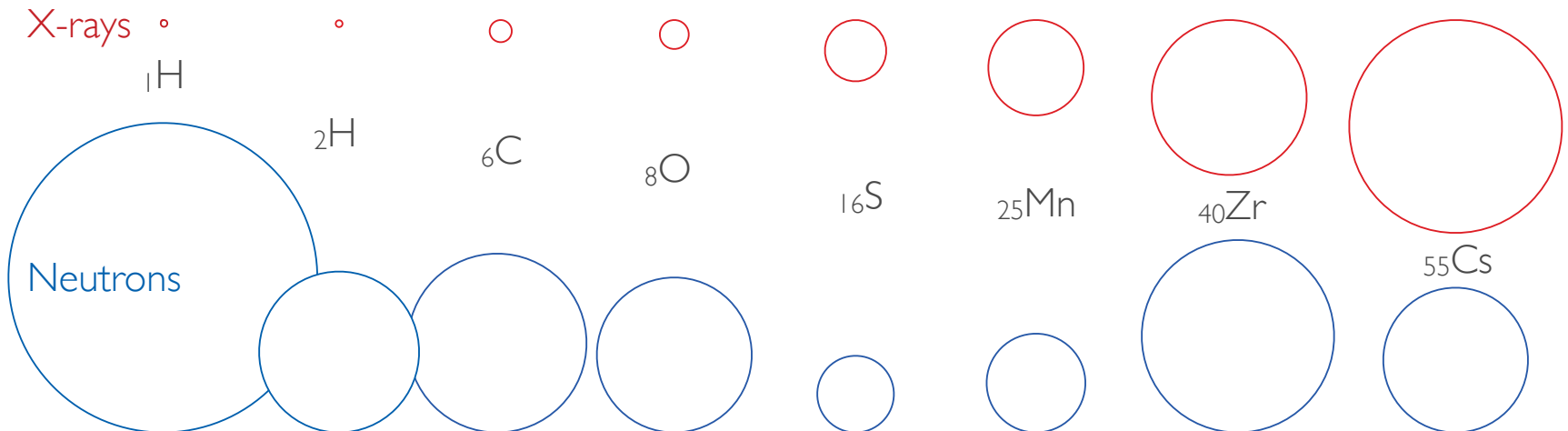
CONSTRUCTION STATUS



NEUTRONS



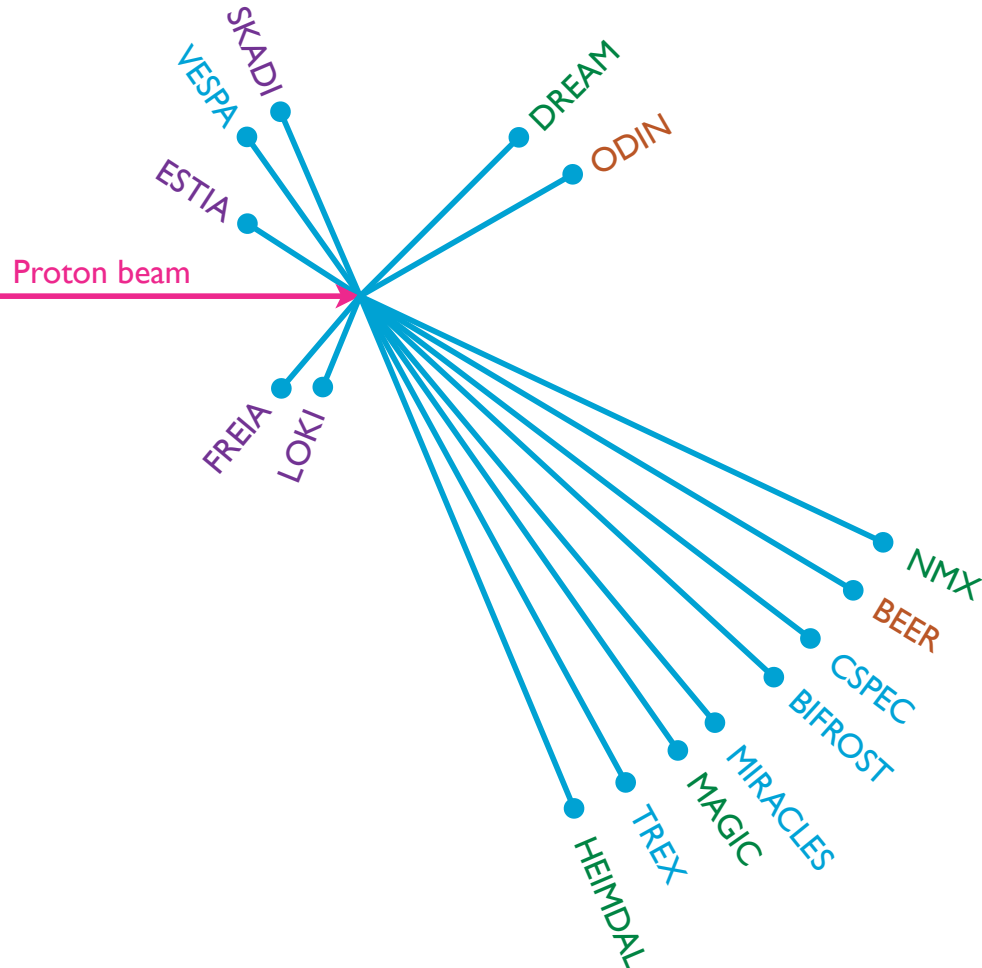
(Updated from *Neutron Scattering*, K. Skold and D. L. Price, eds., Academic Press, 1986)



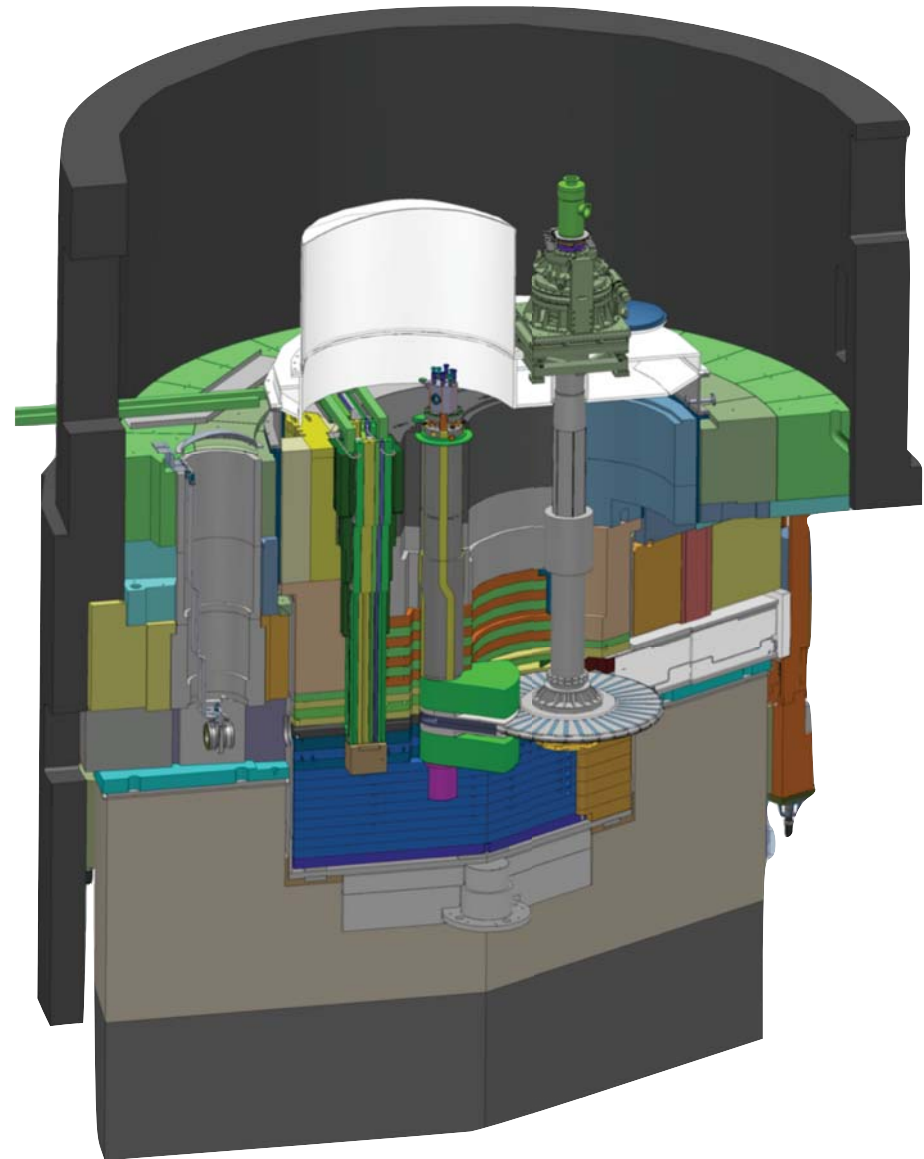
INSTRUMENTS



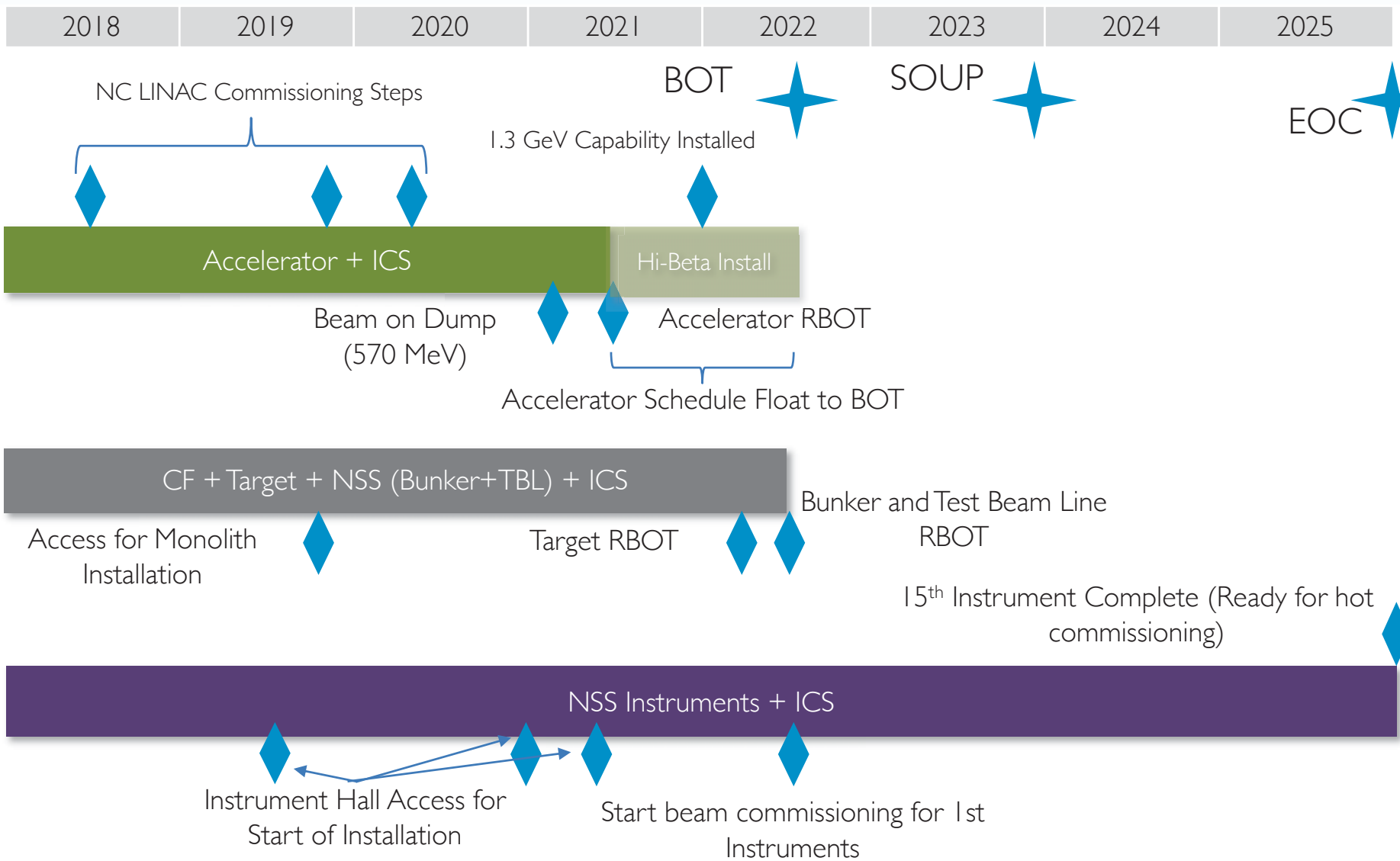
- Large scale structures**
 - LOKI Broadband SANS
 - SKADI general purpose SANS
 - ESTIA focusing reflectometer
 - FREIA liquids reflectometer
- Engineering**
 - BEER engineering diffractometer
 - ODIN multi-purpose imaging
- Diffraction**
 - NMX macromolecular crystallography
 - DREAM powder diffractometer (bispectral)
 - HEIMDAL hybrid diffractometer
 - MAGIC magnetism single-crystal diffractometer
- Spectroscopy**
 - C-SPEC cold chopper spectrometer
 - BIFROST extreme-environments spectrometer
 - T-REX bispectral chopper spectrometer
 - VESPA vibrational spectroscopy
 - MIRACLES backscattering spectrometer



- Rotating tungsten target
 - Target diameter: 2.6 m
 - Mass: 11 & 3 (Total & Tungsten)
 - 36 sectors
 - Tungsten depth: 0.45 m
 - Revolution frequency: ~ 0.4 Hz
 - Expected lifetime: 5 years
 - He gas cooled
 - inlet 40 °C, outlet 240 °C
 - Pressure: 11 bar
 - Mass flow: 3 kg/s
- Neutron beam ports: 42
- Peak flux: ~ 30 -100 x ILL flux
- Cold moderator: Liquid H₂, 17 K, 30 mm
- Thermal moderator: H₂O, 300 K, 30 mm

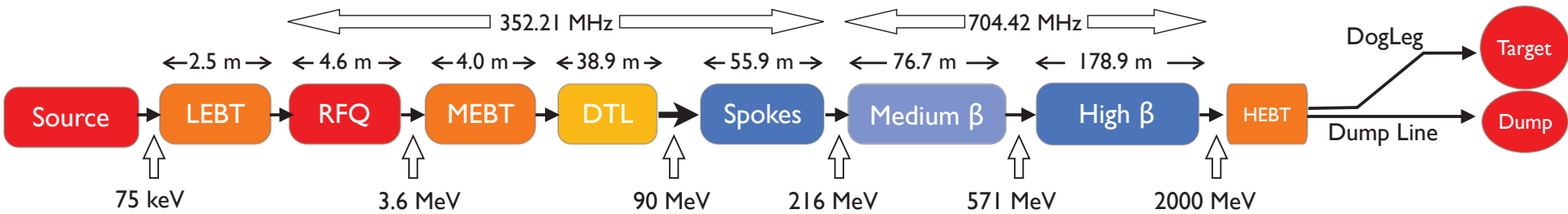


SUMMARY SCHEDULE FOR REMAINING WORK



Courtesy: John Womersley

ACCELERATOR



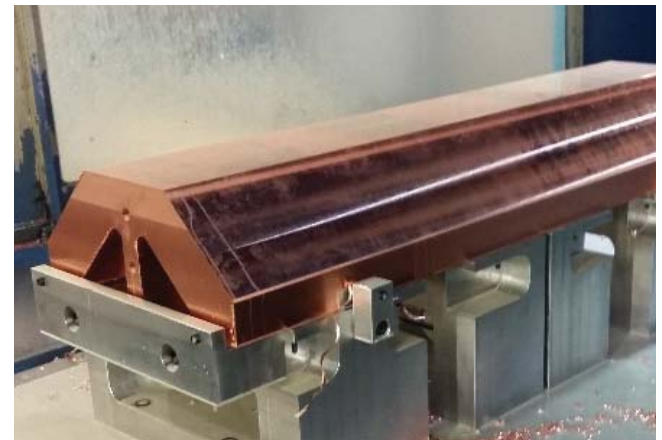
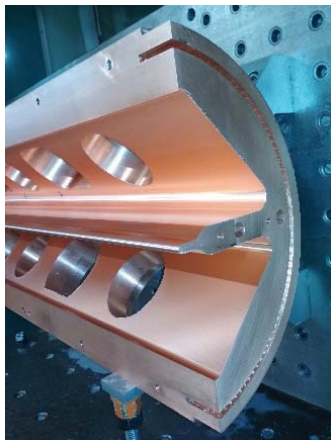
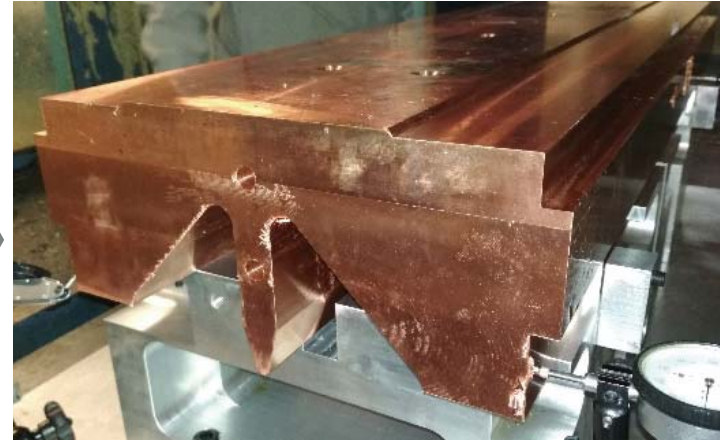
	Length	No. Magnet	#Cav × β_g (Opt)	No. Sections	Power (kW)	IK partner
LEBT (from Plasma)	2.7	2 Solenoids	—	1	—	INFN-LNS
RFQ	4.5	—	1	1	1600	CEA Saclay
MEBT	4.0	11 Quads	3	1	15	ESS-Bilbao
DTL	38.9		5	5	2200	INFN-LNL
LEDP + Spoke	55.9	26 Quads	26 × (0.50)	13	330	IPNO
Medium Beta	76.7	18 Quads	36 × 0.67	9	870	LASA / CEA
High Beta I (~1.3 GeV)	93.7	22 Quads	44 × 0.86	11	1100	STFC / CEA
High Beta II	85.2	20 Quads	40 × 0.86	10	1100	STFC / CEA
Contingency + HEDP	132.3	32 Quads	—	15	—	Elettra
DogLeg	64.4	12 Quads + 2	—	1	—	Elettra
A2T	44.7	6 Quads + 8 Raster	—	1		Aarhus Uni
	603.0					

- ISrc & LEBT hardware installed
- ISrc safety fence installed
- Racks & electronics installed (except chopper)
- Cable pulling done
- Cable terminations being finalized
- Grounding to be done
- Racks not powered yet (some temporarily)
- Water-cooling skid delivered yesterday!
- Hardware testing will start soon.



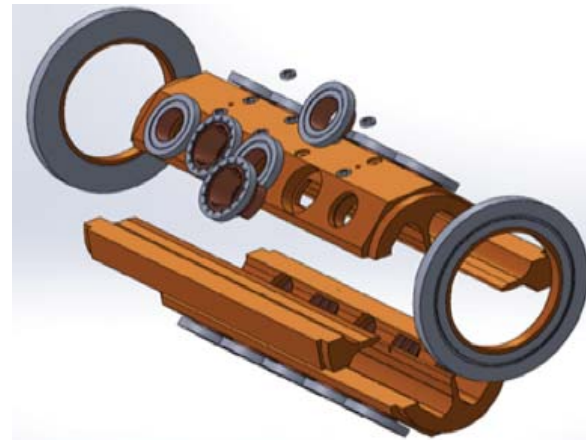
Courtesy: Edgar Sargsyan

- Major vanes machining



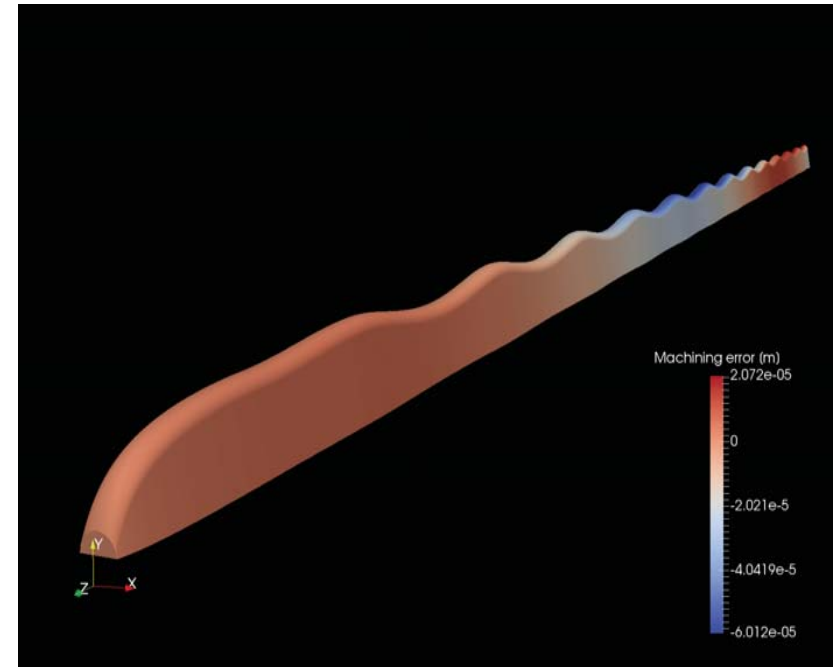
Courtesy: Anne-Catherine Chauveau

- Minor vanes machining

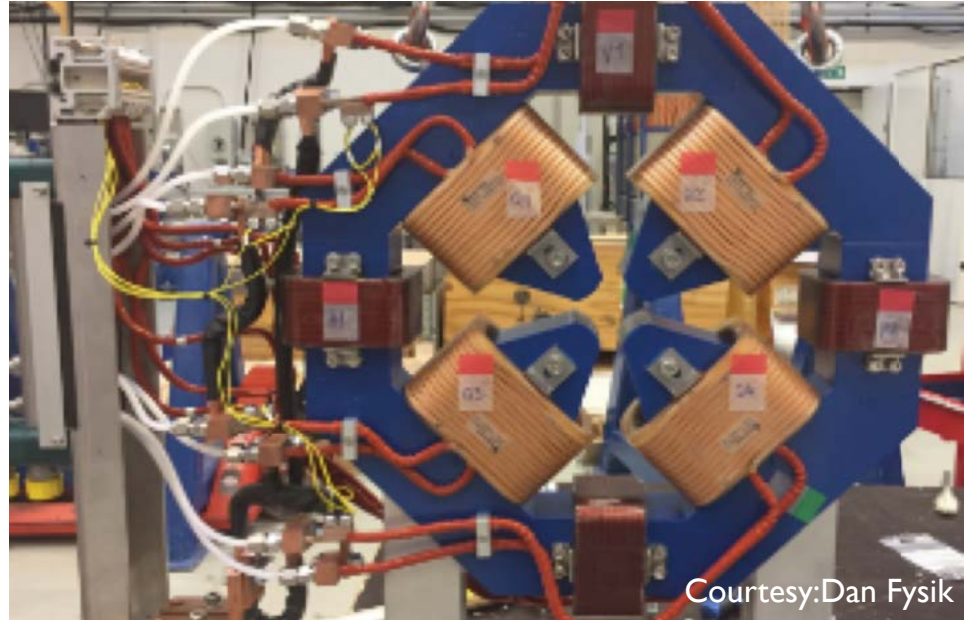
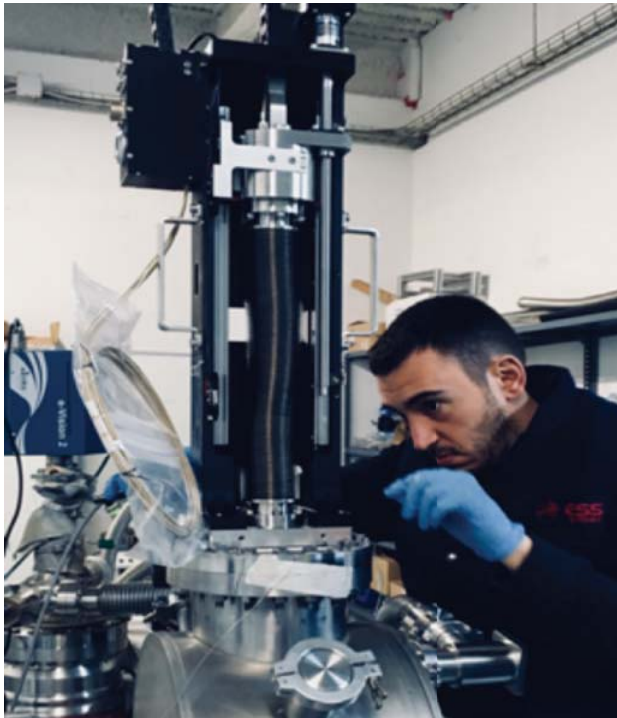


Courtesy: Anne-Catherine Chauveau

- A Fourier analysis based error generation for the RFQ vanes is developed.
 - RFQ error analysis based on this model including machining error, individual positioning vanes and section and global alignment of the RFQ.
 - A simulation framework is prepared for the beam physics treatment of the RFQ non-conformities during the fabrication process



Machining error of one of RFQ vanes as generated by the model. No unphysical abrupt changes on the vane profile.



- Bead pulling and tuning on DTL Aluminum model (Tank #2 as mock-up) on going in Legnaro



- DTL Tank 4 section I at the GSI copper plating facility





First pair of ESS series spoke cavities, March 2018

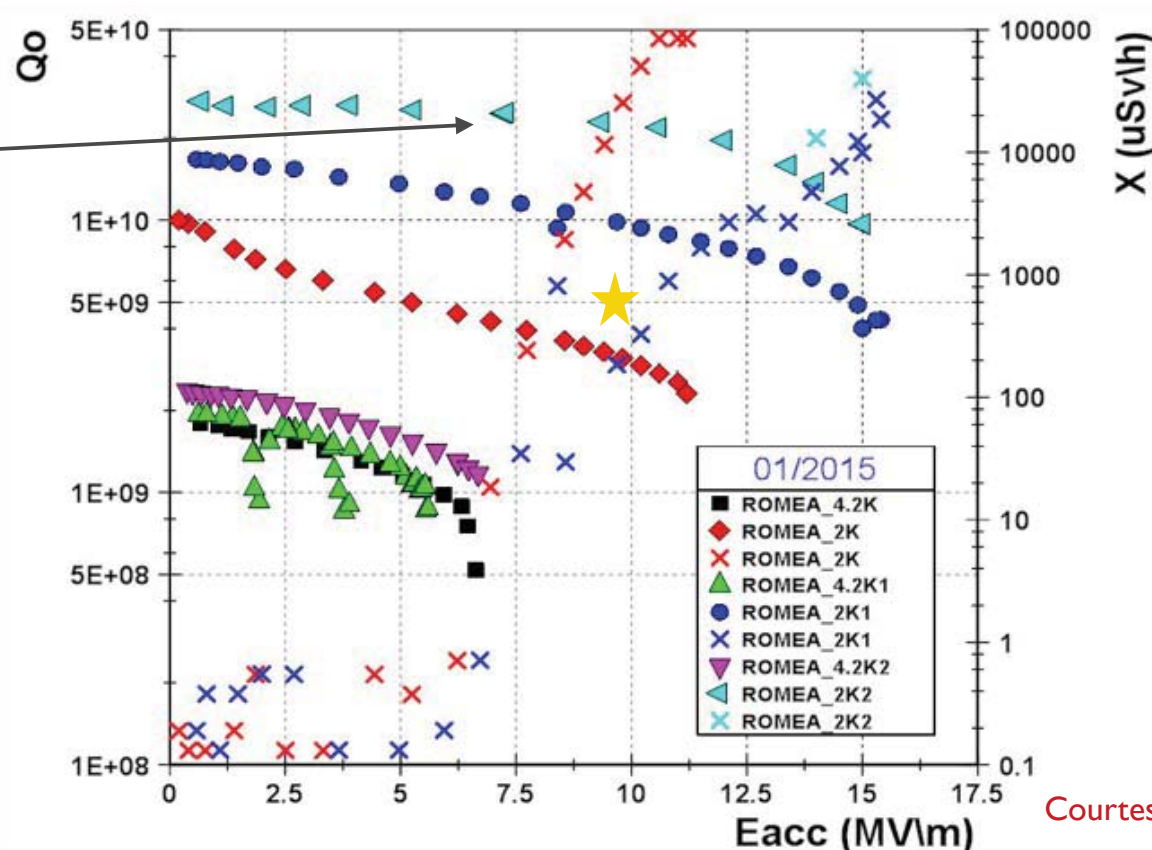


Series production on-going at Zanon



- Final validation of the cavity preparation process including heat treatment at 650 °C:
 - Eacc max 15 MV/m
 - $Q_0 > 2 \times 10^{10}$ at operational gradient

After degassing at 650°C for 10 h + BCP



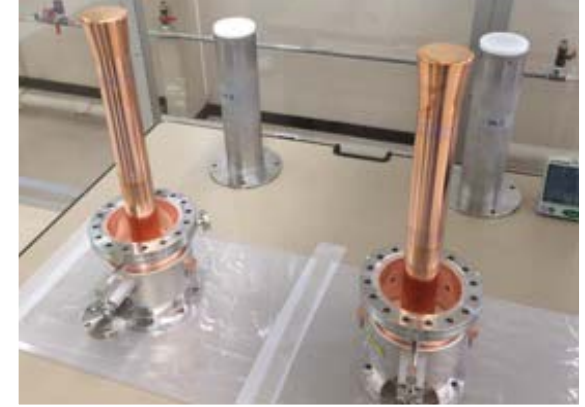
Courtesy: Guillaume Olry



Coupler-cavity assembly stand



Assembly and adjustment of the cold tuning systems



Main power couplers conditioned for up to 1.1 MW at travelling waves and reflection



String of cavities for M-ECCTD



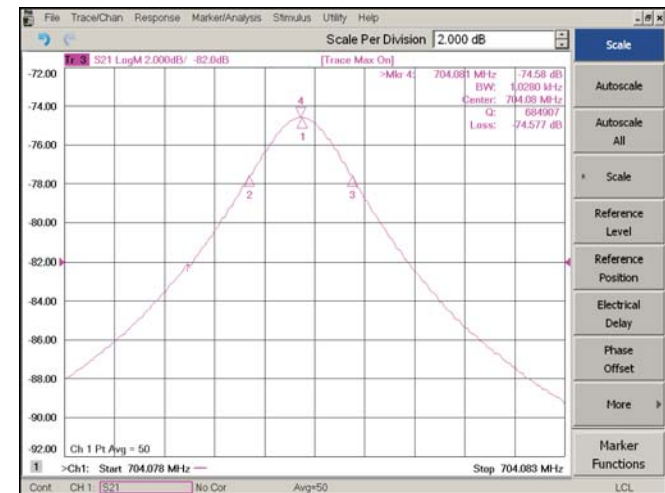
Pre-series thermal shield



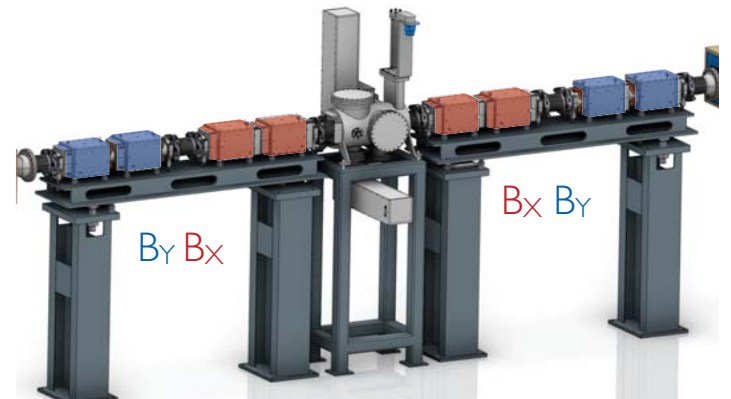
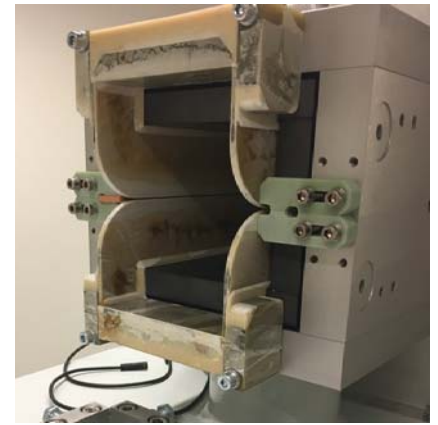
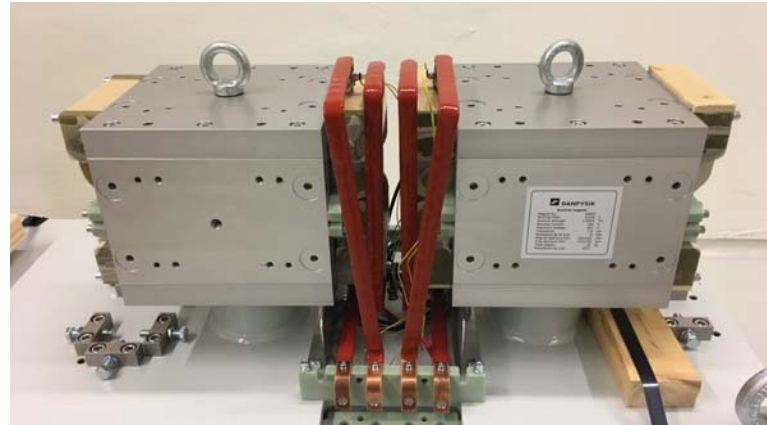
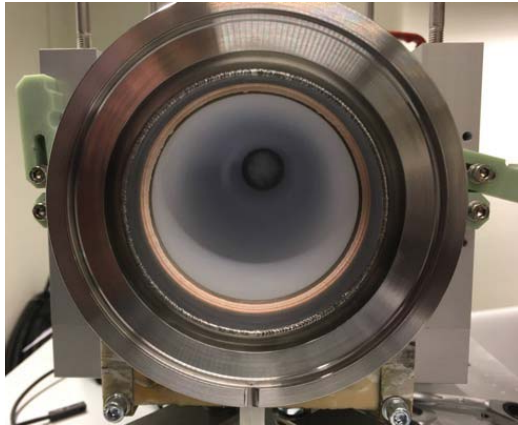
Pre-series space-frame

- Passband frequency measurement at different temperature
 - Frequency distance between nearest SOM and the nominal frequency is >1.2 MHz
- Checking the cavity frequency shift as a function of helium pressure during cool down from 4.2 K (~ 1080 mbar) to 2 K (~ 30 mbar)
 - Frequency sensitivity to Pressure = 37 Hz/mbar
- Measurement of Q_{ext} for FPC at different temperatures
 - $Q_{\text{ext}} \sim 6.8 \times 10^5$

Parameter	f @ 300 K	f @ 4 K	f @ 2 K
Π mode	702.991	704.120	704.081
$4\Pi/5$ mode	701.761	702.889	702.848
$3\Pi/5$ mode	698.464	699.592	699.551
$2\Pi/5$ mode	694.370	695.494	695.454
$\Pi/5$ mode	691.104	692.227	692.187



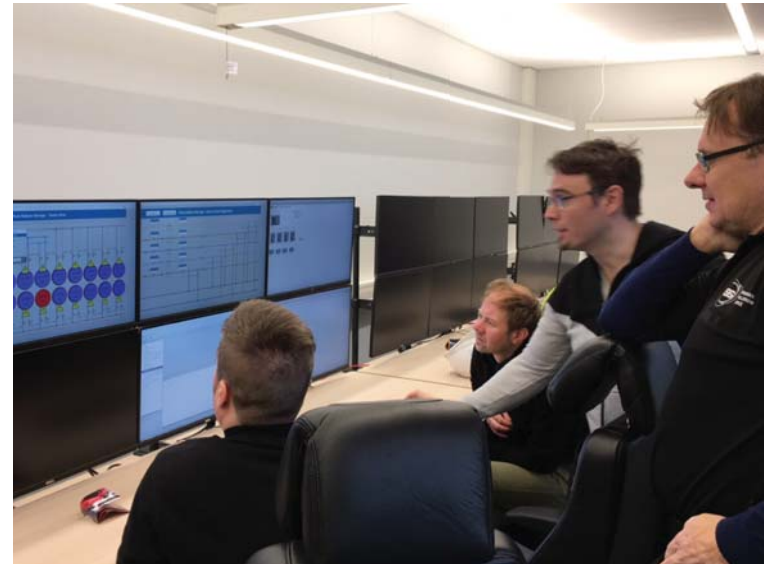
Courtesy: Thibault Hamelin, Han Li



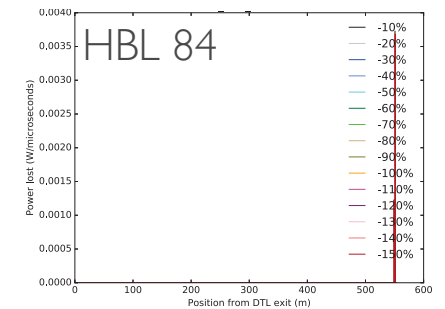
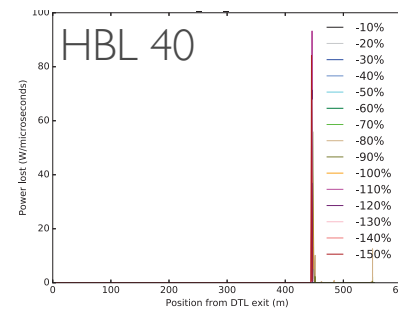
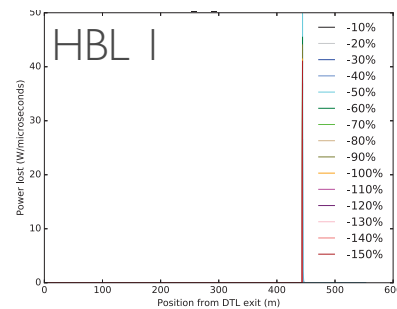
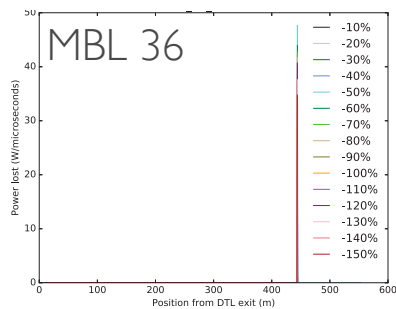
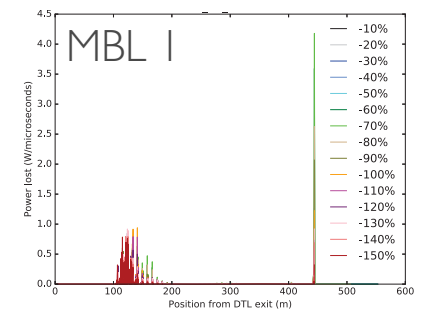
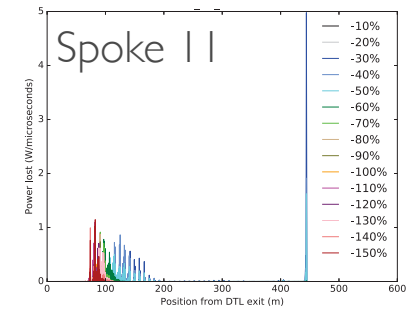
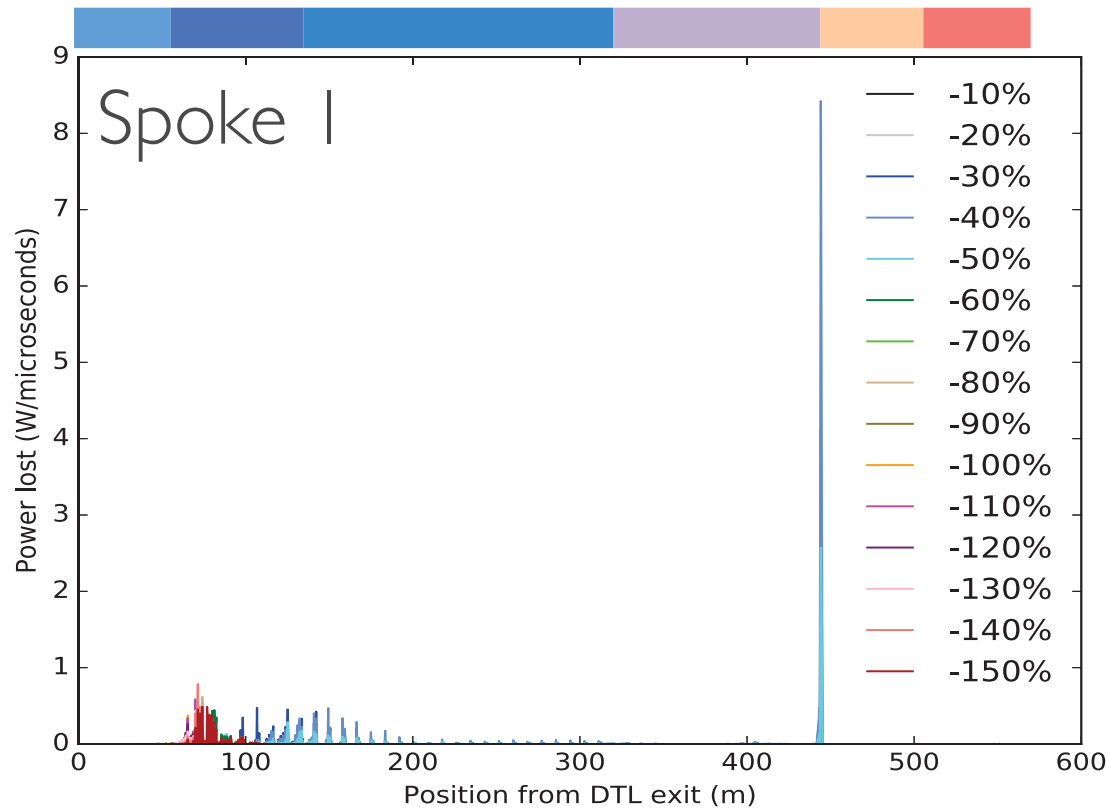


- Delivery of Beam Shape Monitors for MEBT (3.62 MeV) and Spoke (~ 90 MeV)

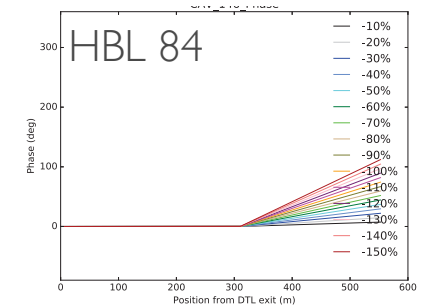
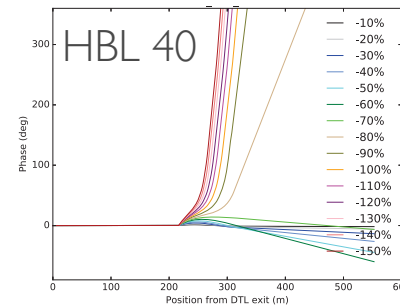
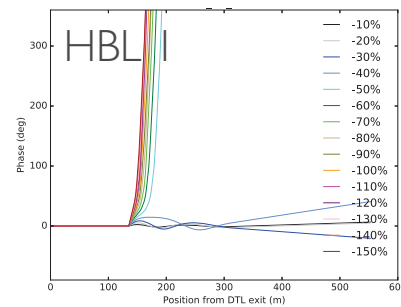
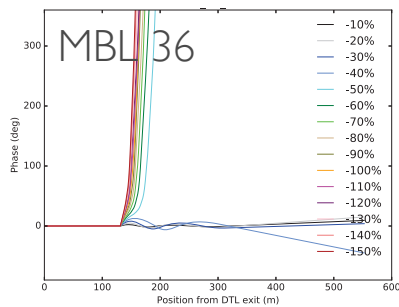
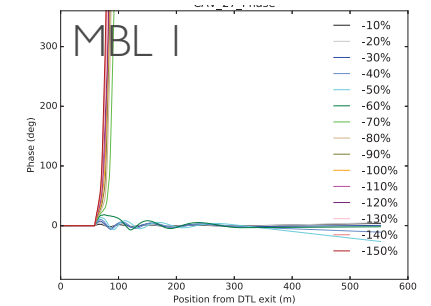
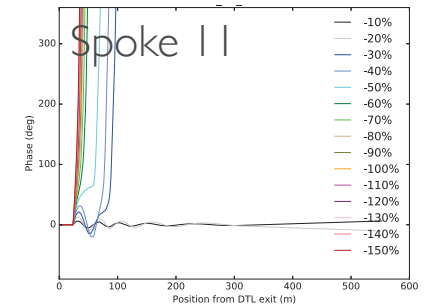
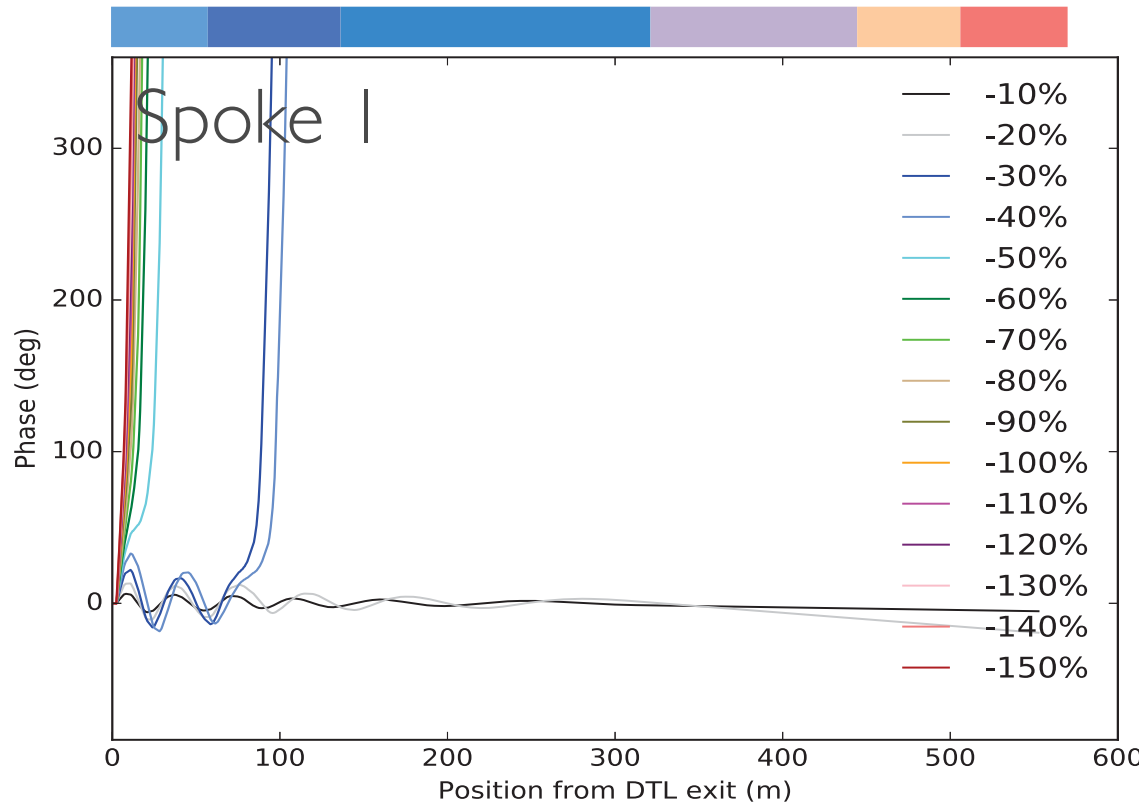
CRYOPLANT



LOSSES DUE TO CAVITY FAILURE



PREVENTING LOSSES

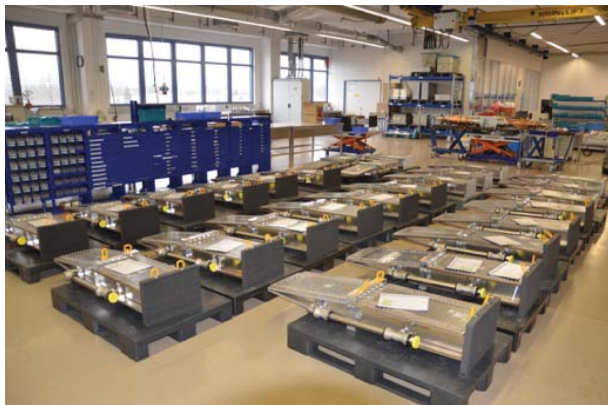
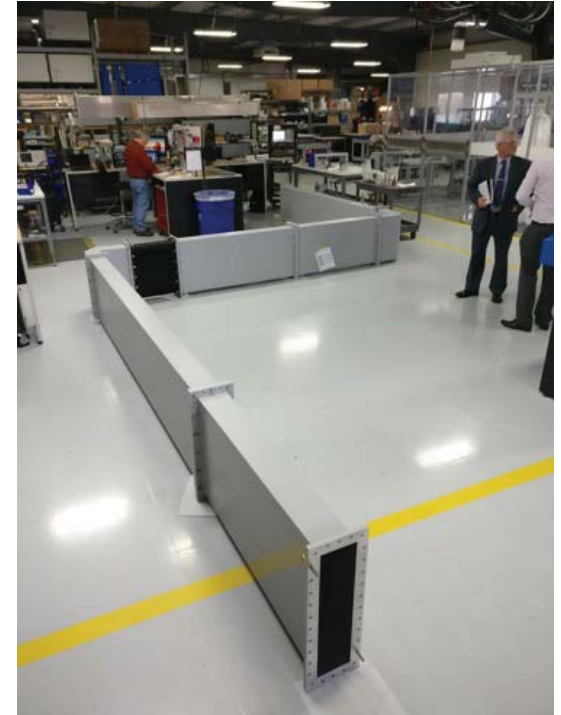




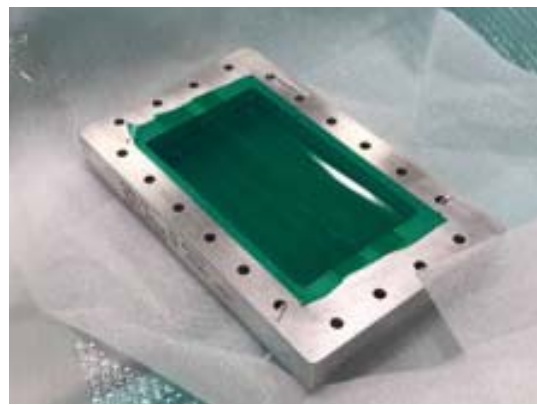
RFDS



- All Spoke Loads and Circulators now at ESS
- All super structure delivered
- Spoke and MB RF windows now at ESS
- Spoke waveguide mounts for stub sections at ESS
- All Stub waveguides arrived
- Delivery rate about once per week!



M. Eshraqi



HB2018, Daejeon, South Korea



2018 June 19

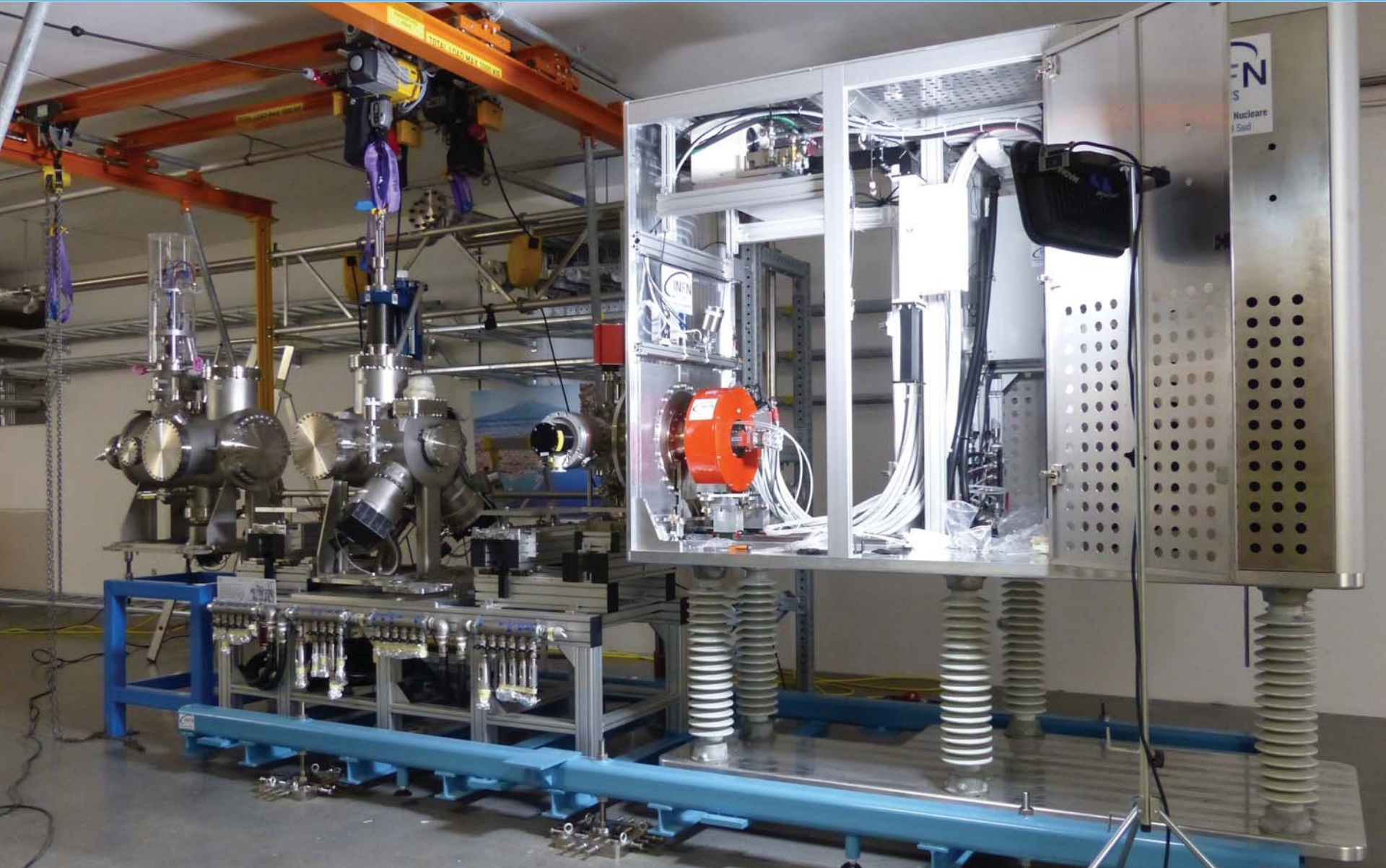
- Construction of the accelerator buildings is finished
 - Target and Instrument halls have a good progress
 - All ESS staff moved to temporary offices on site and construction of the permanent offices will commence soon
- Project is at 50% completion
 - Ion Source and LEBT are installed and will be commissioned this summer
 - Major pieces are arriving for installation in the Klystron Gallery or the Tunnel
- Details of commissioning, beam dynamics and target:
 - You just missed Natalia Milas' talk on Commissioning "ESS Commissioning Plans"
 - Wednesday, Hall-A, 14:00, Natalia Milas (Yngve Levinsen), "Beam Dynamics of the ESS linac"
 - Tuesday, Hall-A, 16:30, Yong Joong Lee, "The Beam Conditions on the Target and Its Operational Impacts on Beam Intercepting Devices at ESS"
 - Wednesday, Hall-A, Rihua Zeng, "Influence of field flatness of the SC cavities and effect of the phase reference line errors on the beam dynamics of the ESS linac"



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THANK YOU!

ION SOURCE / LEBT



RFQ SKID INSTALLED AT ESS



Courtesy: Anne-Catherine Chauveau

- Power couplers ready
- Nominal power per coupler: 0.8 MW
- Maximum power per coupler: 1 MW
- Voltage pulse length: 3.6 ms
- Voltage pulse rate: 14 Hz

