EUROPEAN SPALLATION SOURCE

The ESS Cryomodule Test Stand

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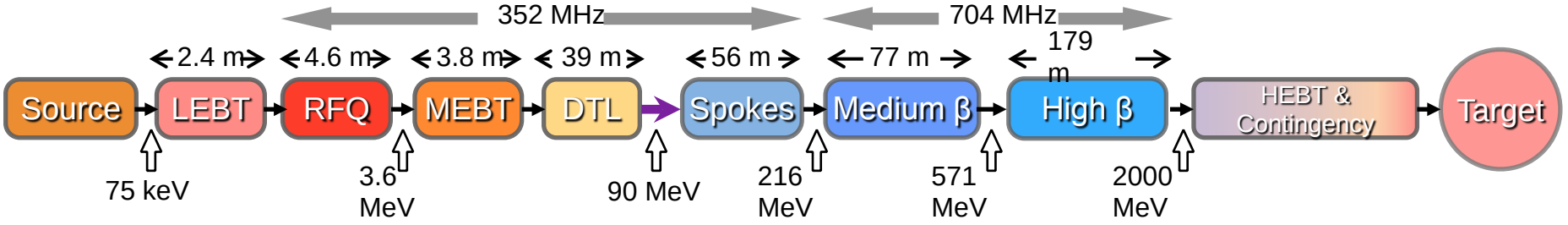
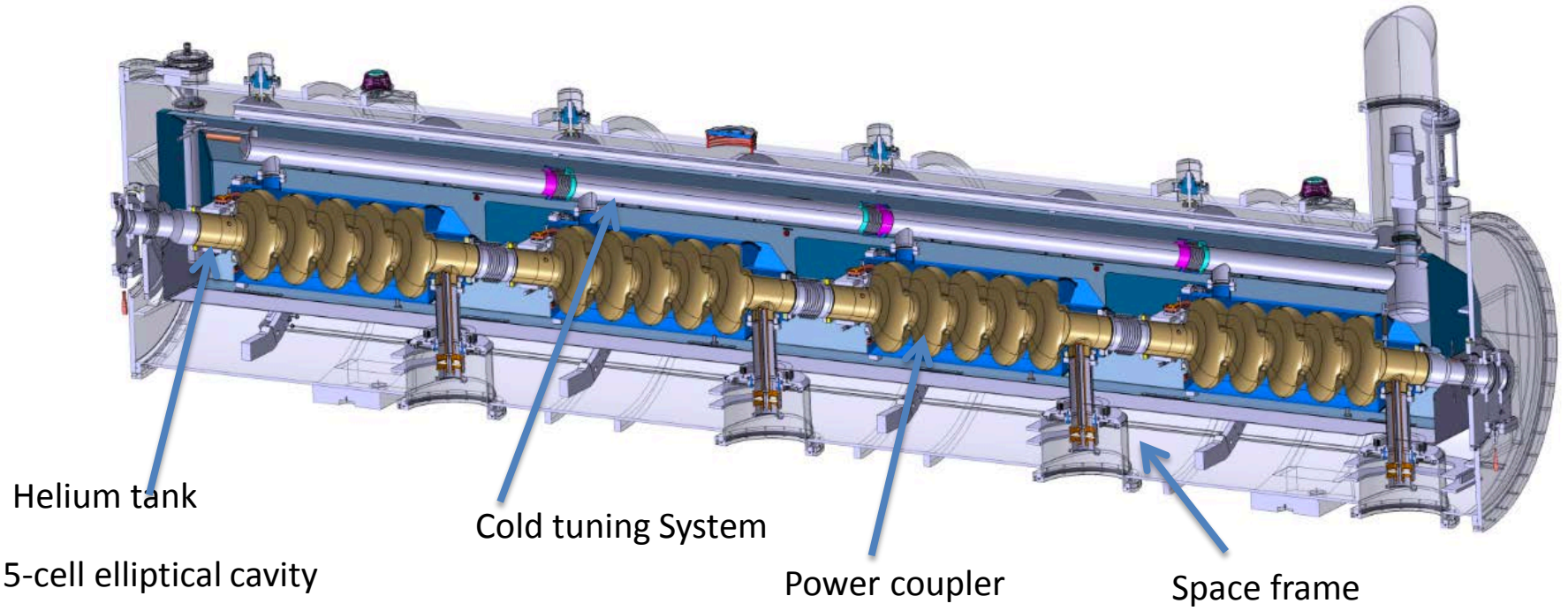
ESS - An international collaboration to build the world's leading neutron source for science & research



- driven by a superconducting proton linac: 5 MW at 2 GeV
- 146 niobium RF cavities cooled by 2K superfluid helium
- 120 elliptical cavities, grouped by 4 in 30 cryomodules
- 26 spoke cavities, grouped by 2 in 13 cryomodules
- cryoplant supplies single-phase helium via cryogenic distribution line
- 30 elliptical cryomodules are tested on test stand in Lund
- 4.5 K cryoplant with warm sub-atmospheric compression
- test bunker & RF equipment for 2 types of ell.-cavity cryomodules
- spoke cavity cryomodules tested on Uni of Uppsala's test stand

The ESS elliptical cryomodule



- comes in two variants: medium-β (0.67) and high-β (0.86)
- both types are interchangeable, so the test stand can accommodate both types without major changes in waveguide arrangement and installations of other services

testing

- acceptance tests and preparation of cryomodules, including coupler conditioning
- main purpose to verify proper functioning of the series production cryomodules
- measuring key parameters of subsystems: heat loads, resonant efficiencies, etc …
- test bench program:
  - reception of cryomodules at ESS & prep. for test bench
  - installation on test bench & initial testing
  - warm main power coupler conditioning & RF tests
  - cool down & cold main power coupler conditioning
  - cold low level RF tests & cold high power RF tests
  - cryogenic heat load measurements
  - warm up & disconnection from test bench
  - preparation for storage and/or tunnel installation

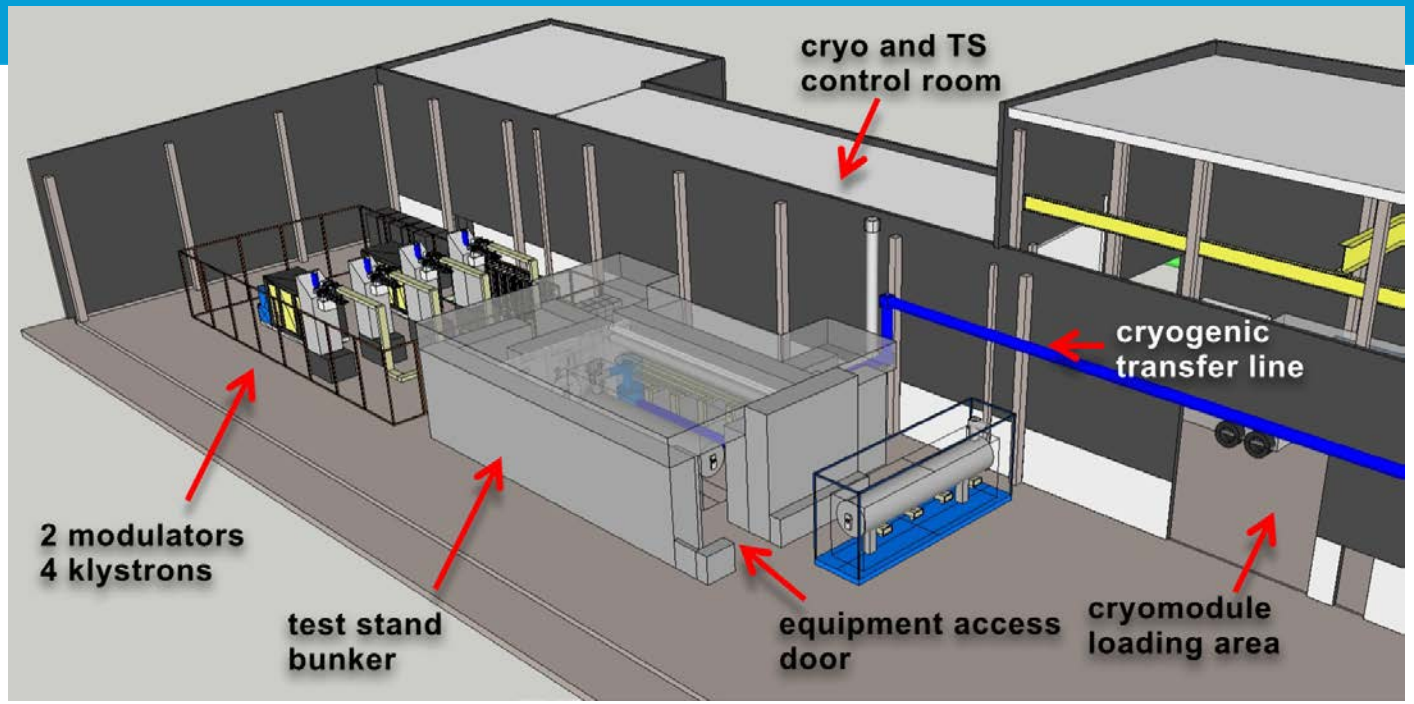
appx. 4 weeks

- RF tests include:
  - measurement of couplers' RF properties including external Q-factor and impedance
  - measurement of the couplers' thermal dynamics
  - measurement of the couplers' static and dynamic heat losses
  - measurement of the cavities' maximum accelerating gradient, X-ray emissions, dynamic RF losses, quality factors, the Lorentz detuning and compensation thereof

Layout proposal for test stand

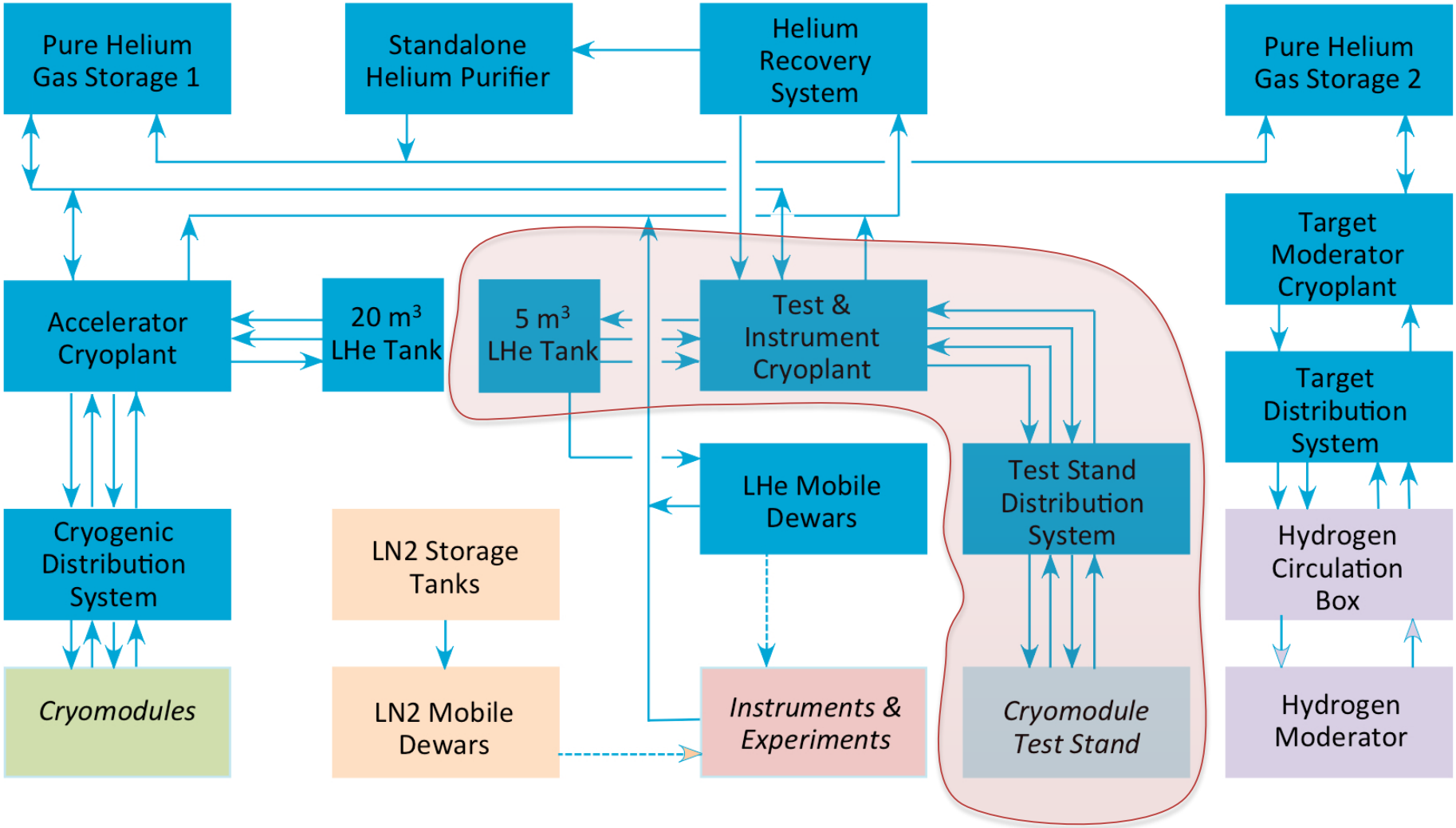
bunker:

- magnetite loaded concrete (4 t/m3)
- wall t=1 m
- 3 chicanes



- cryoplant is about 100 m away in the coldbox hall
- start in late 2017 with the first medium-β cryomodule
- production schedule foresees delivery of 1 CM/month
- windows of 5 m for 1st and 3 m for 2nd module for starting up of procedures and honing production and testing

The ESS cryogenic system



cryogenic supply

Level	Heat load, W	Mass flow, g/s		Pressure, bar		Temperature, K	
		Supply	Return	Supply	Return	Supply	Return
2 K	76	**4.0**	**3.8**	**≥3**	**≤0.027**	**4.5**	6.0
4.5 K Liqu.	-		**0.2**	**≥3**	**1.05**	**4.5**	300
TS	**422**	tbd	tbd	**12.8**	**12.3**	**≥33**	**≤53**

- the test stand cryoplant also provides liquid helium for neutron instruments and sample environments
- cryomodule testing dominates capacity requirements & plant design
- LN_2 pre-cooling under investigation
- connects to test stand through a vacuum insulated transfer line containing 4 process pipes
- cryoplant sized to provide 76 W at 2 K and 6 l/hr of liquefaction
- cryoplant provides more than the required 7500 liters per month when operated in pure liquefaction mode
- due to the small 2 K load, sub-atmospheric pumping is done by warm vacuum pumps

outlook

- operation of ESS will last 40+ years
- test stand will be used for testing replacements and additions
- most of the time, though, it will be available for other activities
- the vision:
  - to make the test stand part of an ESS SRF R&D facility, needed for repair and maintenance, but also serving the wider SRF community to do R&D
  - such a facility is important for ESS, because availability of third party labs can not be guaranteed
  - without on-site repair and maintenance facilities, downtimes can reach significant lengths
- Such an R&D facility is at this point, however, neither planned nor financed !

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