

PROGRESS AND PRELIMINARY STATISTICS FOR THE ESS SERIES SPOKE CRYOMODULE TEST



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Parameter	ESS Spoke
	cavity
Frequency (MHz)	352.21
Temperature(K)	2
Pulse beam mode duty factor	4
(%)	
Repetition rate(Hz)	14
Nominal gradient (MV/m)	9
Beta (optimal)	0.5

- The European spallation source (ESS), as a world-class high power proton accelerator facility, will be the first one to adopt 26 double spoke resonators (DSR) at its low energy section.
- Since 2019, FREIA Laboratory, Uppsala university, has successfully tested the first DSR prototype cryomodule and is now in charge of the acceptance tests of the 13 ESS series cryomodules prior to installation in the tunnel.



≻Dedicate test stand for ESS DSR test has been developed at FREIA since 2015,

 $> 1 \times prototype$ CM and 5 $\times ESS$ series DSR CM have been tested,

≻CM installation and disconnection require well-planned schedules both in logistic and human source in advance,

➢FPC conditioning has become the most time-consuming part throughout the whole CM test,➢Points within the potential operating gradient range from 8 to 12 MV/m are chose for the quality factor measurement.





Preliminary test results:

- All CMs show an excellent performance with a max accelerating gradience higher than nominal value of 9 MV/m and 80% reach 12 MV/m (limited by test),
- ➢ Field emission onset is above 9 MV/m,
- The plausible dynamic heat load lower than 1 W at nominal gradient is way better than the ESS target of 2.5 W,
- The static heat load of about 14 W at FREIA with an 80 K thermal shielding and is the major consideration for heat load for ESS,
- The average overall test time for each CM is around 7.1 weeks and can be improved by stressed on the mechanical installation/disconnection.

To be improved:

➤ Malfunctional CTS (3 out of 12)

700 Statistics study of ESS DSR FPC conditionig



FPC conditioning:

A strategy of simultaneous FPC conditioning has been applied. The FPC overall conditioning improves from 4 weeks to 4 days.

- Two pumping carts are installed on both sides of the CM for better pumping capacity,
- > Upgrade of auto-conditioning system:
 - Embedded safety program was implemented to cut the RF whenever the software is non-responsive
 - Allows for a reliable automatic conditioning running 24 hours without supervision
- > Localized and solved most of the system issues
 - Blocked flow meters
 - Trouble shooting of the high power station
 - Communication or hardware issues in LLRF
- Better coordination to minimize technical intervention.



- One step motor requires double driving current
- Two step motors stuck
- Further study and repair at IJClab Orsay
- Unexpected lower Q_{ext} of FPC after cooldown
 Consistent Q_{ext} measurement results with outgoing test at Orsay at RT
- Several FPC were about 20% lower the measured value at RT
- Investigation is ongoing
- leakage of the FPC double-wall structure
 Weak welding of the FPC double-wall and flange structure can cause leakage
 - More careful welding procedure and strict quality control is necessary



