



Cryogenic status of SM18, SPS and HL-LHC and challenges/open points

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on behalf of HL-LHC WP4 and WP9 working teams



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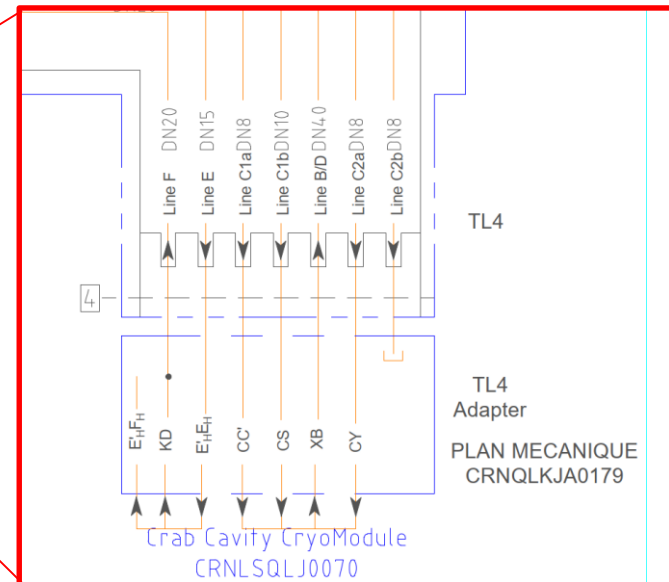
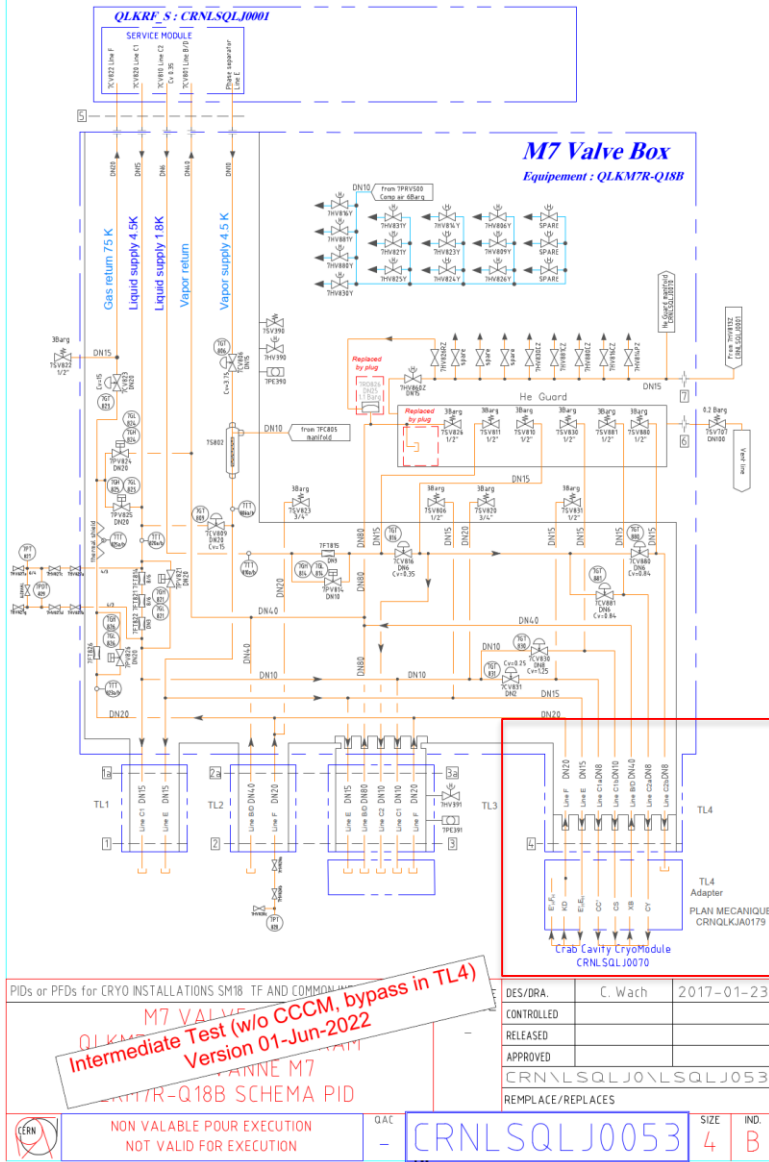
Outlook

- SM18 preparation status
- SPS status
 - Feedback from 2021 operation
 - Consolidation needs
 - Needs of adaptation for RFD proto module
- HL-LHC – work progress
- Specific open points
- Conclusions

SM18 – M7 preparation

Because of fact that the cryo Service Box from first DQW is installed in SPS (as initially foreseen) and RFD is equipped with Beam Screen circuit we had to adapt the interface of the M7 Valve Box:

- System analyzed and adapted,
- PID prepared,
- Temporary testing equipment installed,
- Commissioning of the system is underway,

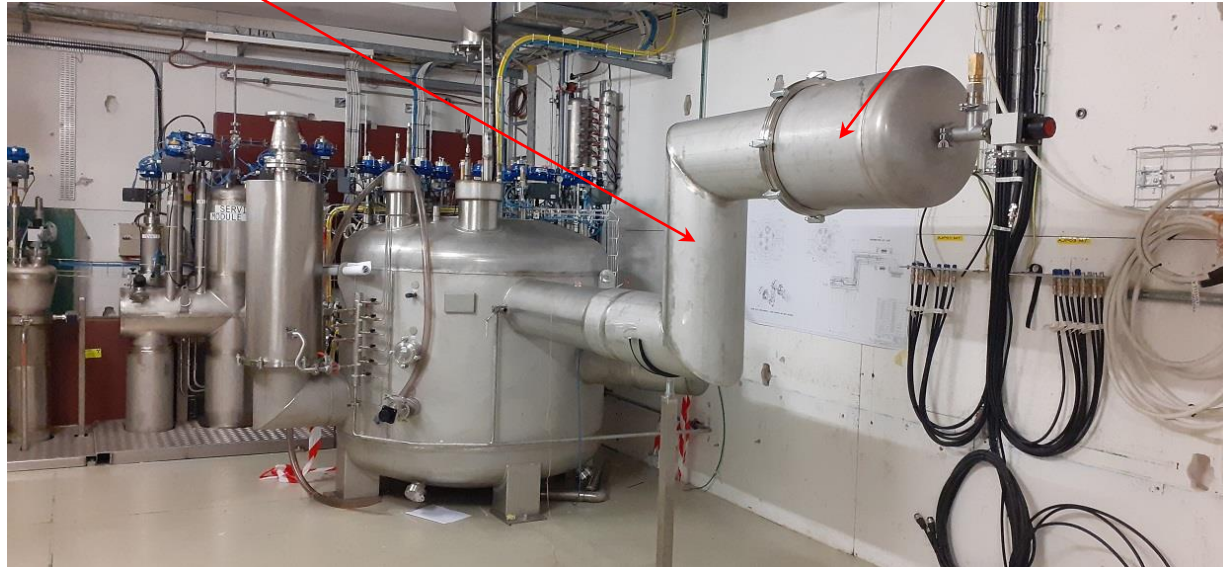


PIDs or PFDs for CRYO INSTALLATIONS SM18 TF AND COMMON...
M7 VALVE
Intermediate Test (w/o CCCM, bypass in TL4)
Version 01-Jun-2022

SM18 – M7 preparation

New transfer line installed as interface to cryomodule jumper

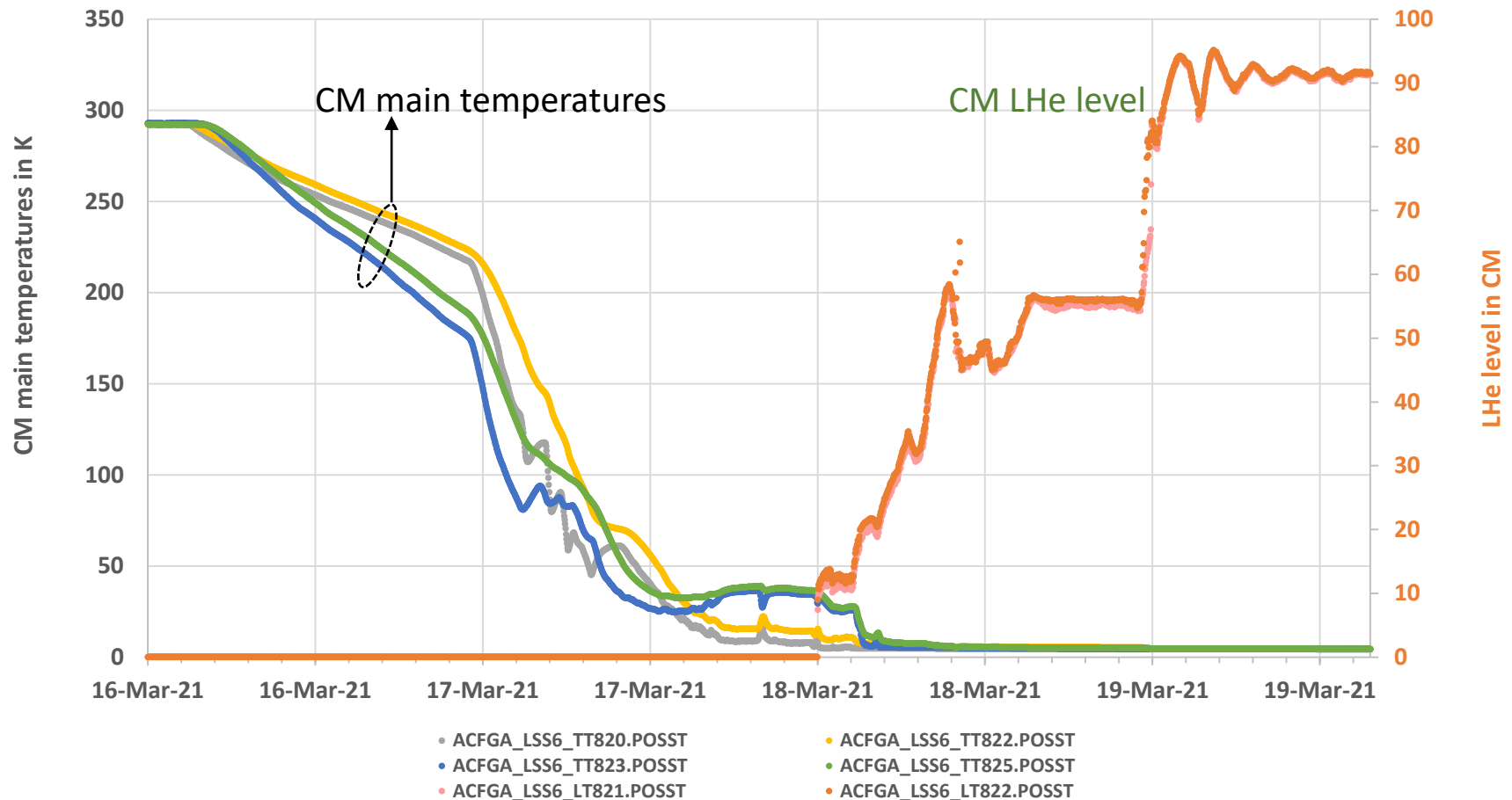
Test equipment/interface to the crab cryomodule



Status:

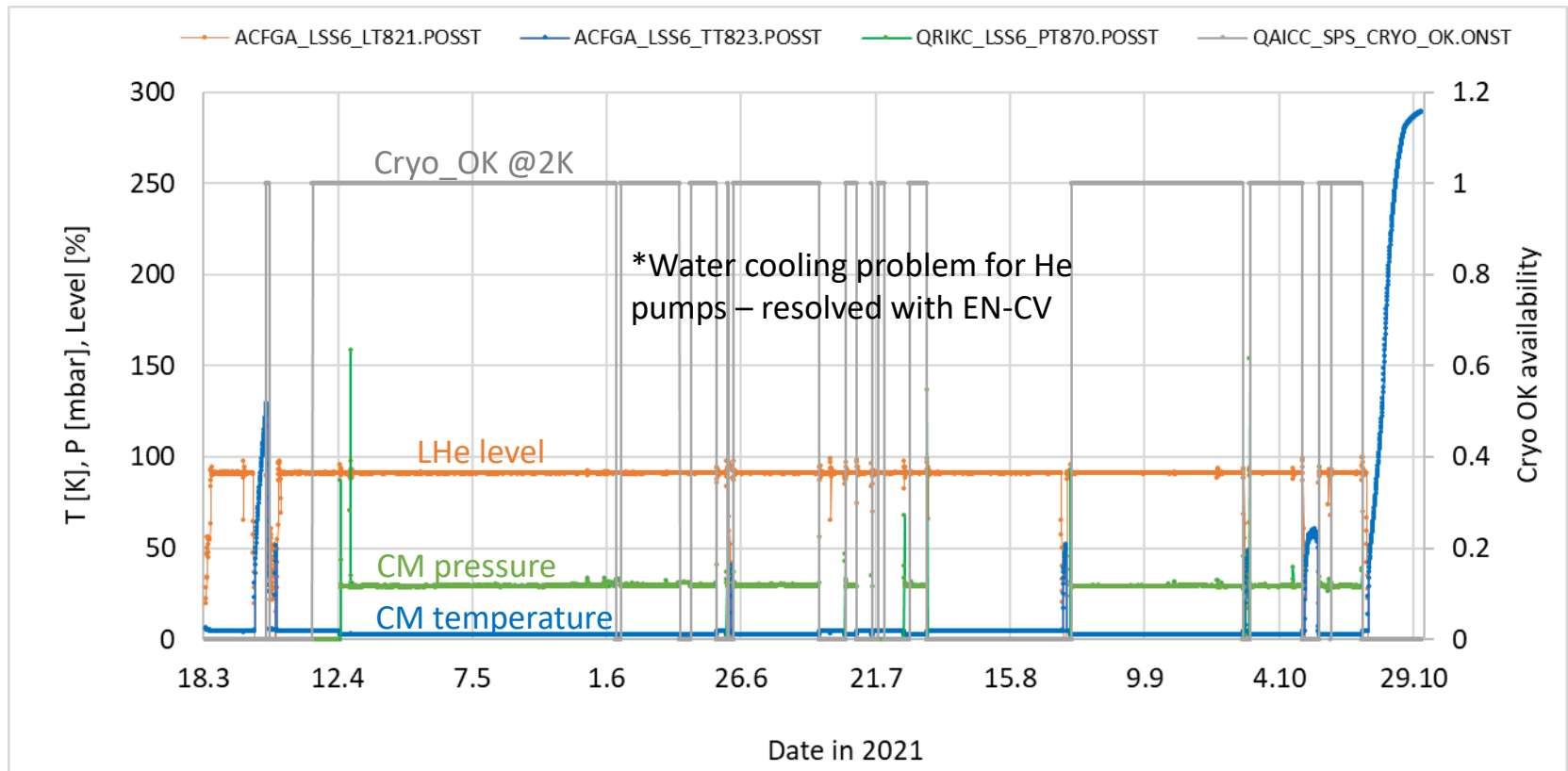
- Mechanical adaptation is completed,
- VB commissioning is underway and will be completed by end of September 2022,
- Instrumentation treatment electrical chain is under construction (cards received, electrical racks preparation is ongoing),
- M7 cryogenics should be ready to receive a crab cryomodule for mechanical and electrical connection by end of 2022.

SPS – feedback from 2021



About 3 days from cool down start @300K up to LHe regulation at 90% (~1 hour needed to transit from stable 4.5 K to 2 K)

SPS – feedback from 2021



* Overheating of the helium pump and triggered stop interlock was supposed to come from clogging of the oil/water heat exchanger in the pumps assembly. After several checks and work done with EN-CV, it was found that water supply was not set correctly to provide required cooling water flow – corrected by EN-CV and OK since then.

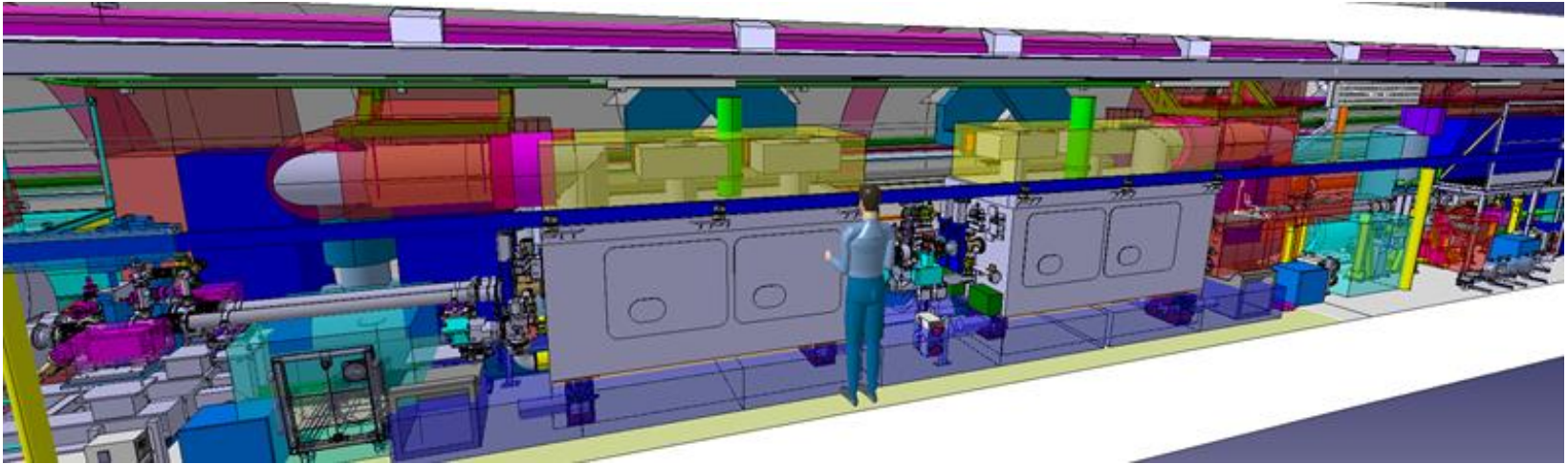
SPS – perspectives

Regarding future operation there is **one consolidation and one modification to be done** in SPS:

1. After first year of operation we noticed failure of the main helium flowmeter, caused by non-sufficient oil separation in the pumping system. In order to avoid migration of oil from the pump into other part of the system, additional separation device shall be installed close to flowmeter area. The equipment is present at CERN (ex-CMS coalescing filter), manpower and integration to be planned → **Action TE-CRG**
2. Jumper interface between the Service Box and the cryomodule must be redesigned and adapted for next modules → **Action EN-MME and TE-CRG**

Notice: Added to the system Beam Screen cooling loop can be tested in SM18 M7 but cannot be operated in SPS. To have it operational in SPS major modification to the system would be required.

HL-LHC cryo work progress



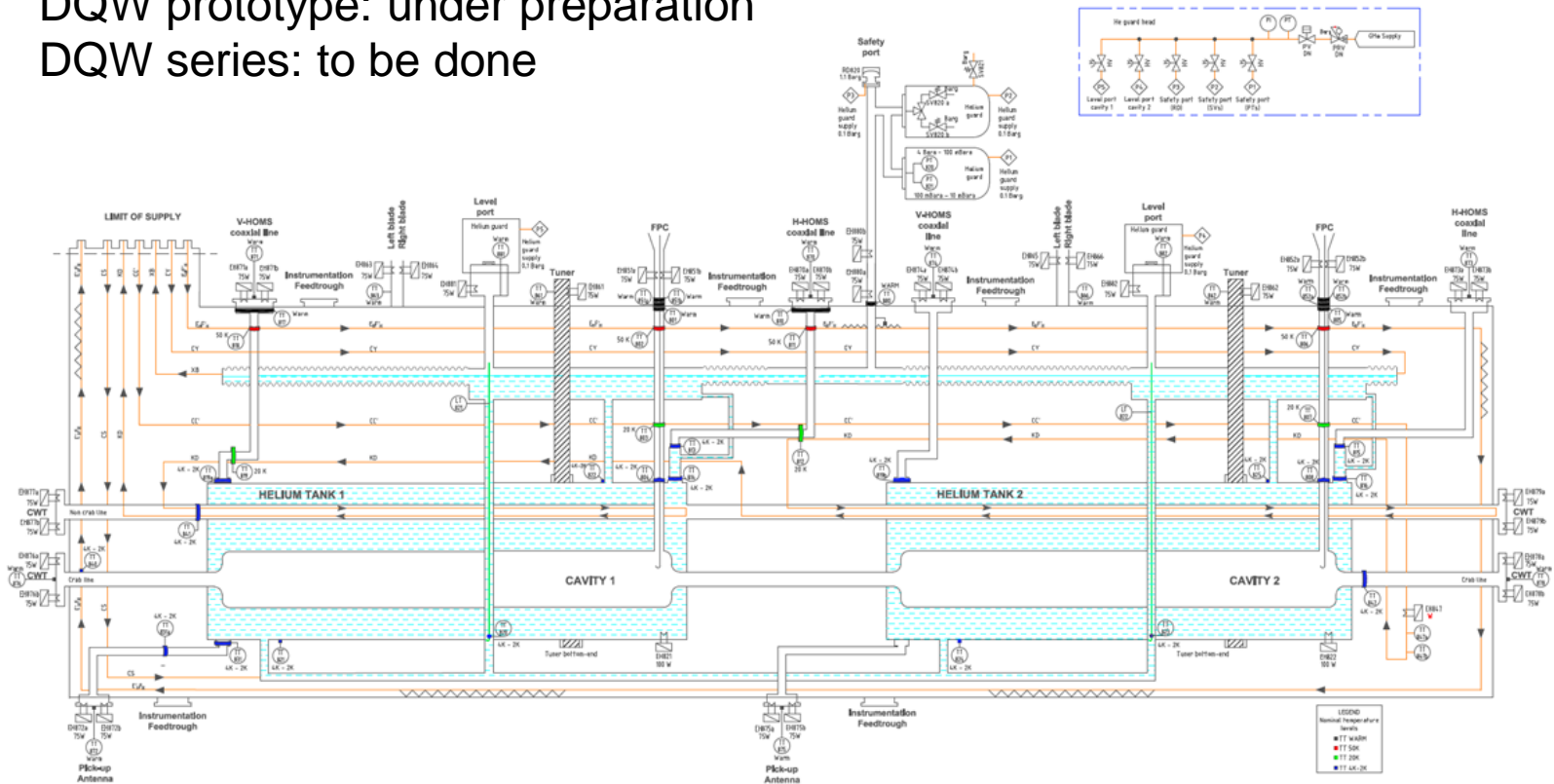
Example of CC IP5R integration

Work progress status:

- Integration work of the cryomodules is progressing well.
- Option for full warmup/cool down of the cavities confirmed and incorporated in the design and integration study
- Jumper interface design: started and ongoing

Flow schemes

- RFD prototype: flow scheme is validated and available
- RFD series: under preparation
- DQW prototype: under preparation
- DQW series: to be done



HL-LHC CRAB CAVITY CM RFD PROTO	DLKMTB - 388 P&I DIAGRAM	HL-LHC CRAB CAVITY CM RFD PROTO	DLKMTB - 388 SCHEMA P&I
CRNLSQLJ0070	CRNLSQLJ0070	CRNLSQLJ0070	CRNLSQLJ0070
NOT VALID FOR EXECUTION NOT VALID FOR EXCLUSION - [CRNLSQLJ0070] 1			

NO.	DATE	NO./NAME	ZONE	MODIFICATION

Instrumentation

All instrumentation for RFD prototype is available at CERN

Status of instrumentation for the series modules:

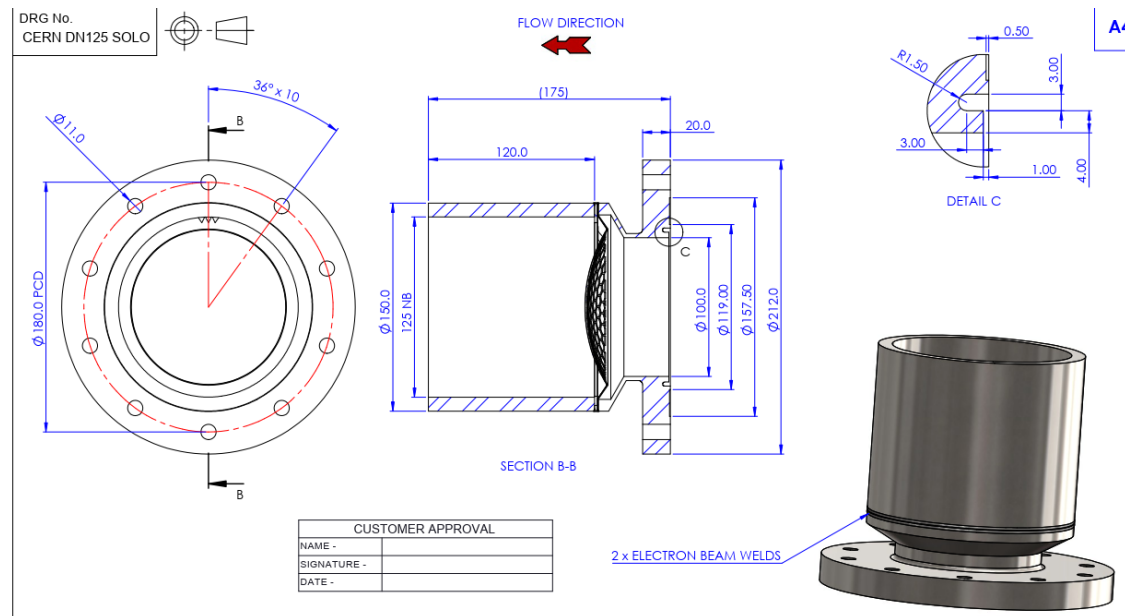
- All sensitive items (long delivery CERNOX thermometers) were delivered at CERN
- Level gauges: to be ordered
- Pressure transducers: to be ordered
- External heaters: to be ordered
- Beam screen heaters: available number at CERN to be confirmed
- Helium tank heaters: too be built in house at CERN from November 2022

Safety devices

Both safety devices for RDF prototype: safety valves and rupture disc are available at CERN with the below numbers:

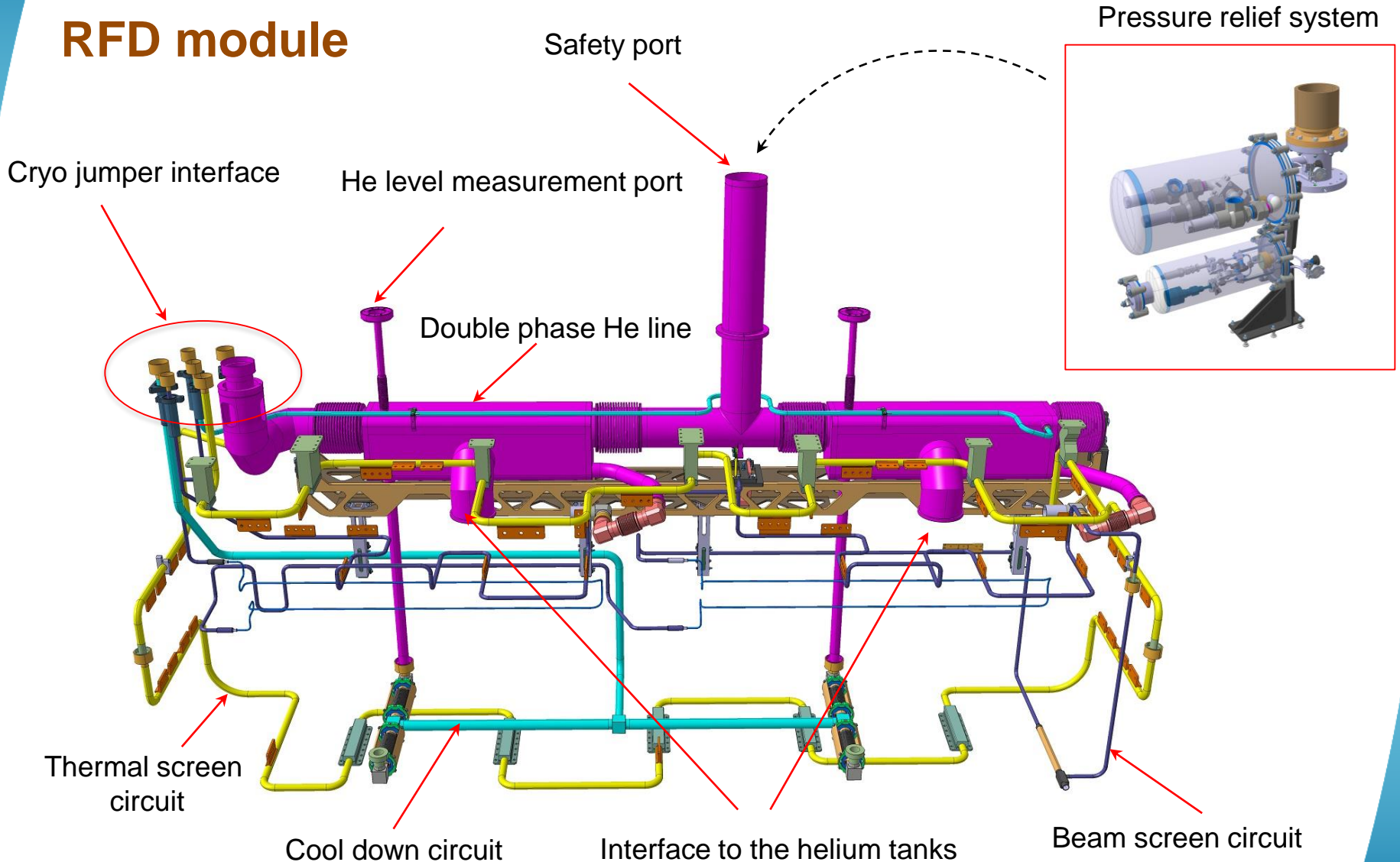
- SV: one set of 3 valves + one spare valve in storage
- RD: one disc for installation + two spare discs in storage

Safety devices for series modules will be ordered in next months (delivery delay ~4 weeks).



Cryomodule design – cryogenic circuits

RFD module



Cryomodule design – open points

Open actions for TE-CRG and EN-MME:

- Optimization in the pressure relief system design, work started
- Integration of instrumentation, especially cernox thermometers for DQW prototype and series modules
 - Heaters for tuners: integration is challenging but a few ideas/solutions are on the table and work is ongoing
- Order of the components for the pressure safety system (SVs and RDs)
- Preparation and approval of documentation/drawings – ongoing
- Design of the jumper interface for HL-LHC modules – progressing
- Design of jumper adaptation between the cryomodule and the service box in the SPS – to be done

Conclusions

- Test facility at BA6 – cryogenics is fully operational, operated reliably in 2021 (water cooling problem resolved) and in 2022,
- SPS consolidations: oil separation system to be improved, adaptation of interface for RFD and series to be done,
- SM18 M7 preparation for RFD tests nearly completed: mechanical work done, helium process is being commissioned, instrumentation and electrical aspect to be completed this year,
- HL-LHC: integration and functionality of the infrastructure is defined, design of distribution system is progressing,
- Cryomodule design is progressing well considering helium cooling circuits, instrumentation and safety relief system – some optimizations are still to be done but w/o showstopper for progress as per general planning.

*Great thanks to design team from EN-MME
for smooth and efficient collaboration !*



***Thank you for your attention!
Questions?***



Great thanks to all people involved in HiLumi adventure!