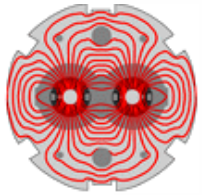
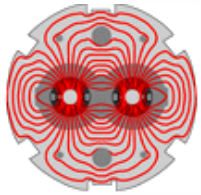


Cryogenics for SPS, LHC & SM18

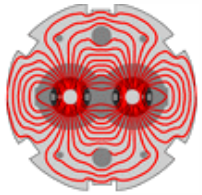
V. Benda, N. Delruelle, G. Ferlin, O. Pirotte,
B. Vullierme



Cryogenics for SPS, LHC & SM18

- Operating temperature options, helium pressure and availability, cryo circuits and controls, safety valves and protection, overall installation effort, cost and time line, heat loads, impact on the overall LHC during regular operation

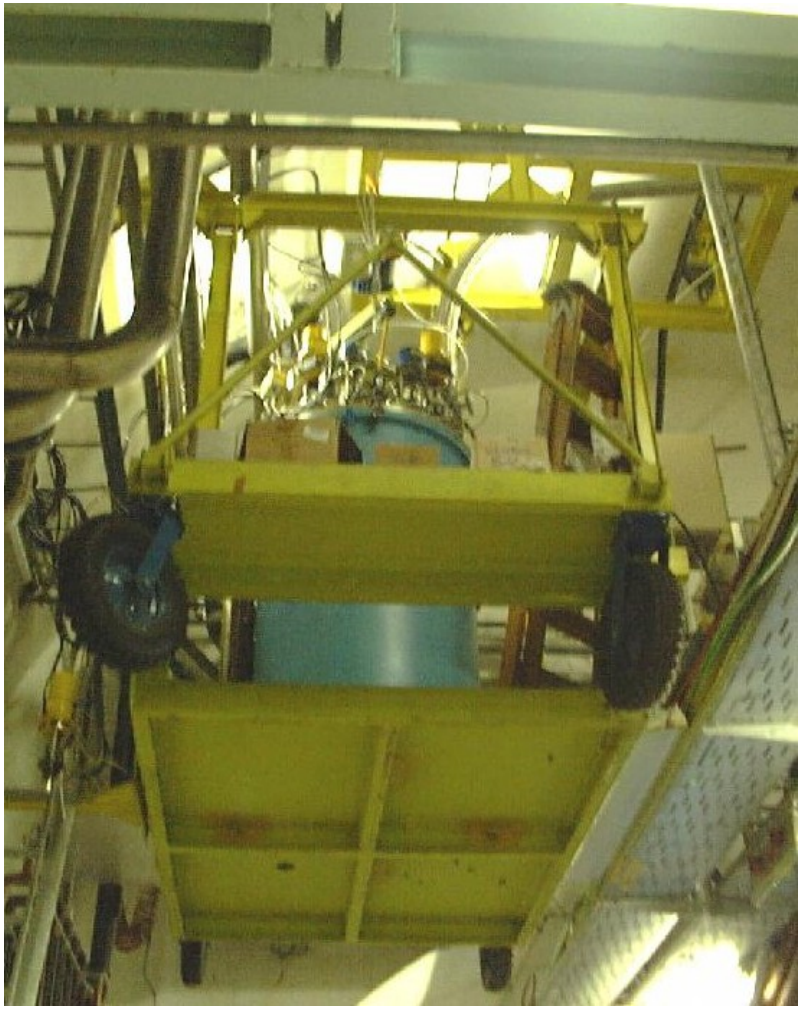
Crab Cavity location at SPS



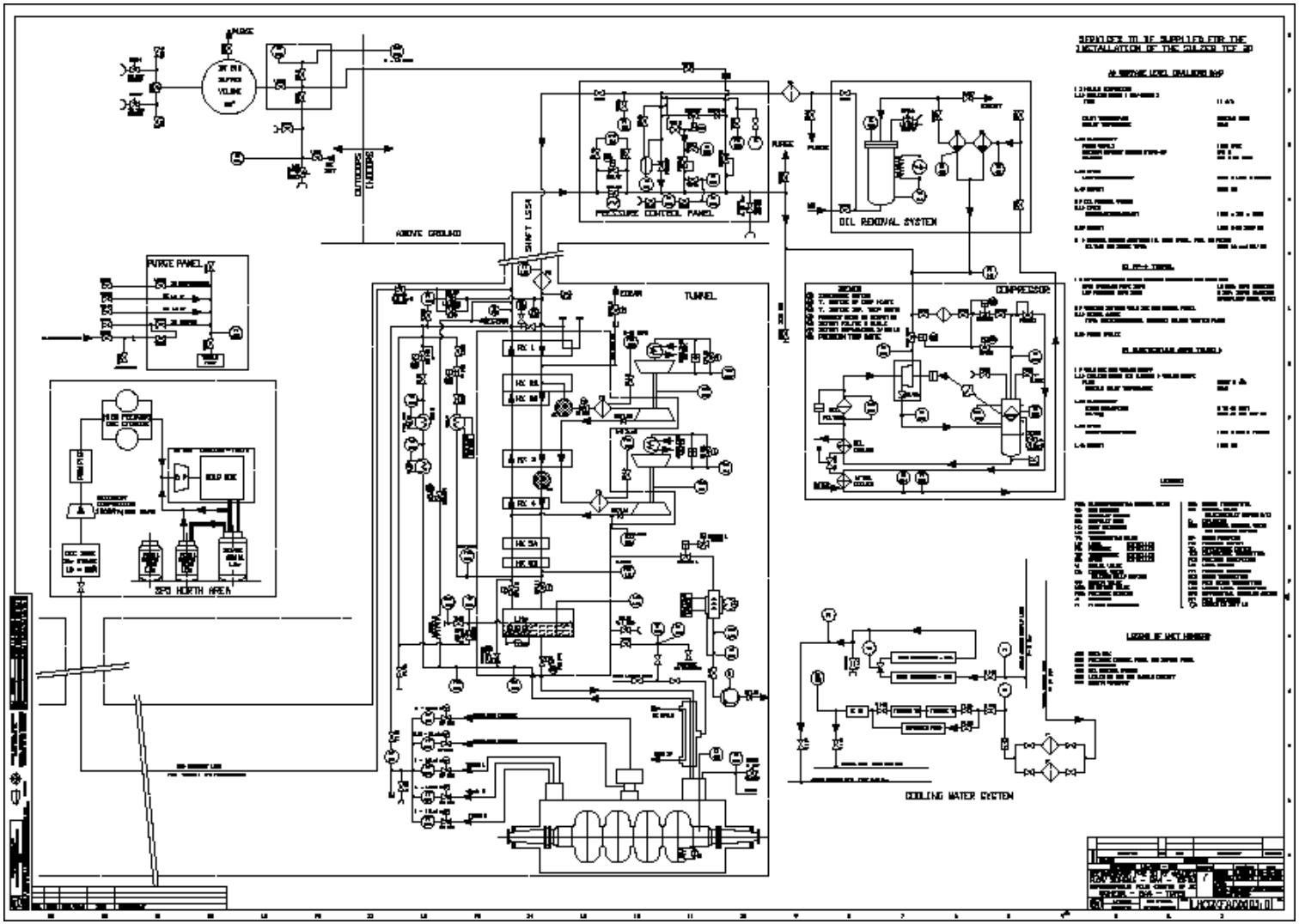
Cryogenics for Crab Cavities at SPS

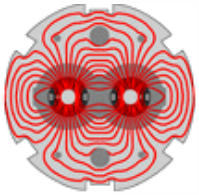
- The KEKB Crab Cavities Cryostat will be connected to the Sulzer/Linde helium refrigerator TCF20 located in BA4.
- New cryogenic transfer lines of length L ~10 m will be required to connect LHe and thermal shield circuits of the CC cryostat to theTCF20.
- Available refrigeration power: 100 W @ 4.5 K.
- The TCF20 control system has to be refurbished.
- Overall cost: ~250 kCHF

Sulzer-Linde TCF20 in BA4



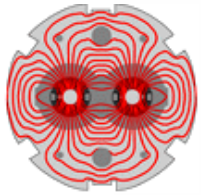
TCF20 in BA4 – P&I Diagram





Cryogenics for Global Scheme 1/2

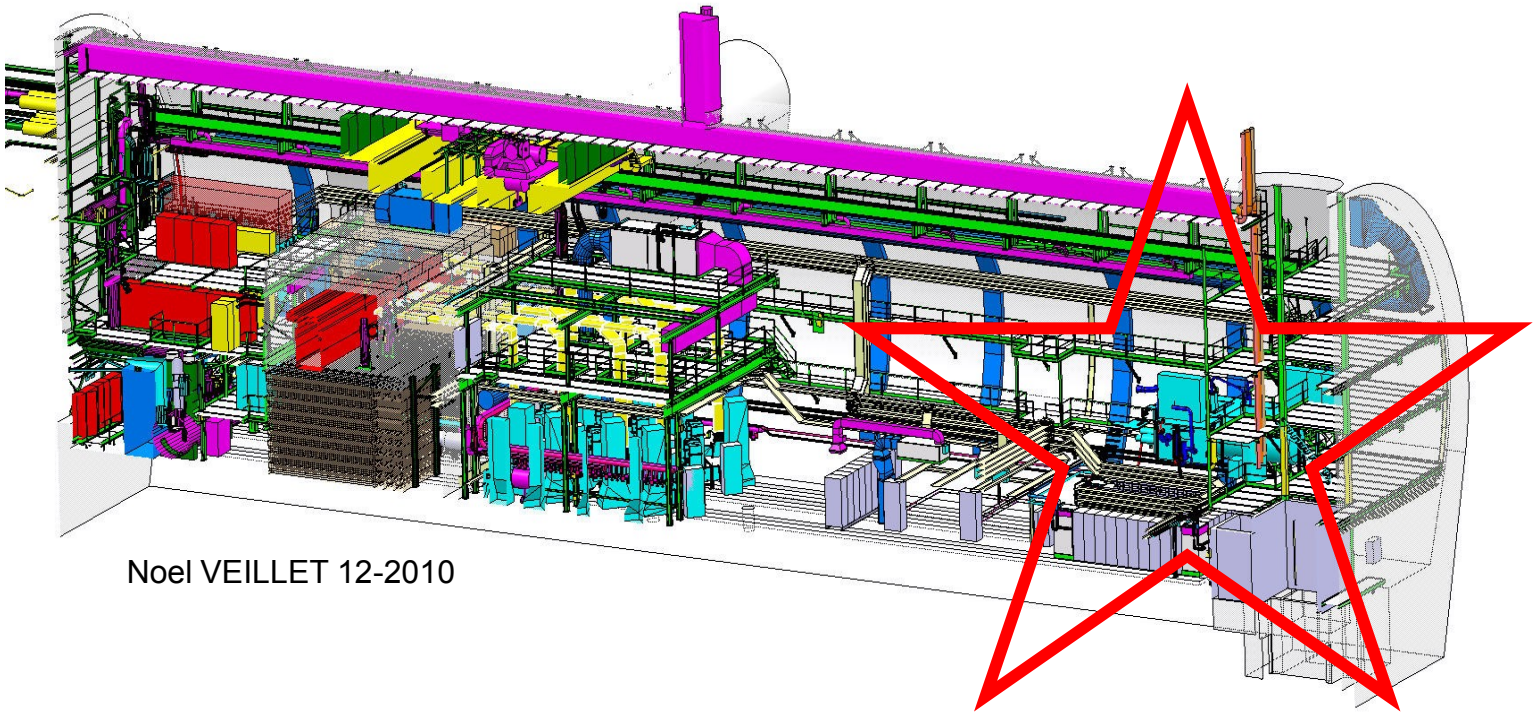
- Introduction
  - The LHC RF cavities draw their cooling power at 4.5 K from the same refrigeration source as the whole 3.3 km long magnet sector they belong to.
  - When going to high luminosities this sharing can no longer be maintained and a dedicated cryo-plant for RF@ 4.5 K needs to be installed in P4 , as close as possible near the RF-cavities.
- This cryo-plant can be used for cooling crab-cavities at Point 4, at 4.5 K.



Cryogenics for Global Scheme 2/2

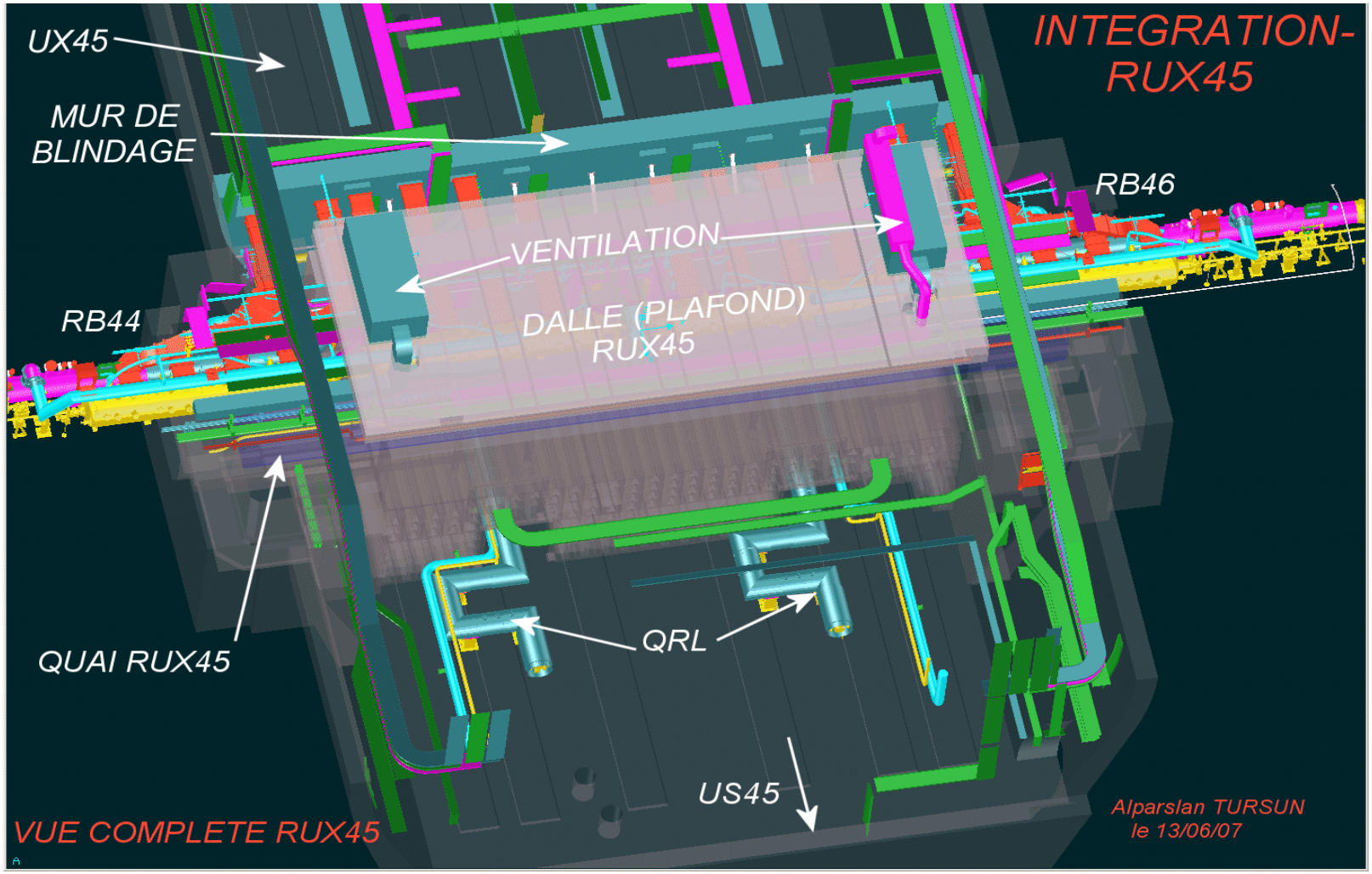
- One feature of the new RF cooling scheme will be the redundancy with the former one, i.e. at 4.5 K, with the Cryogenic Ring Line (QRL)
- The present baseline, due to integration problems and QRL redundancy constrains, provides the same cooling scheme for the CC.
- The available cooling power for the CC will be in the range of 2 x ~ 500 W @ 4.5K .

New 4.5K refrigerator in UX45

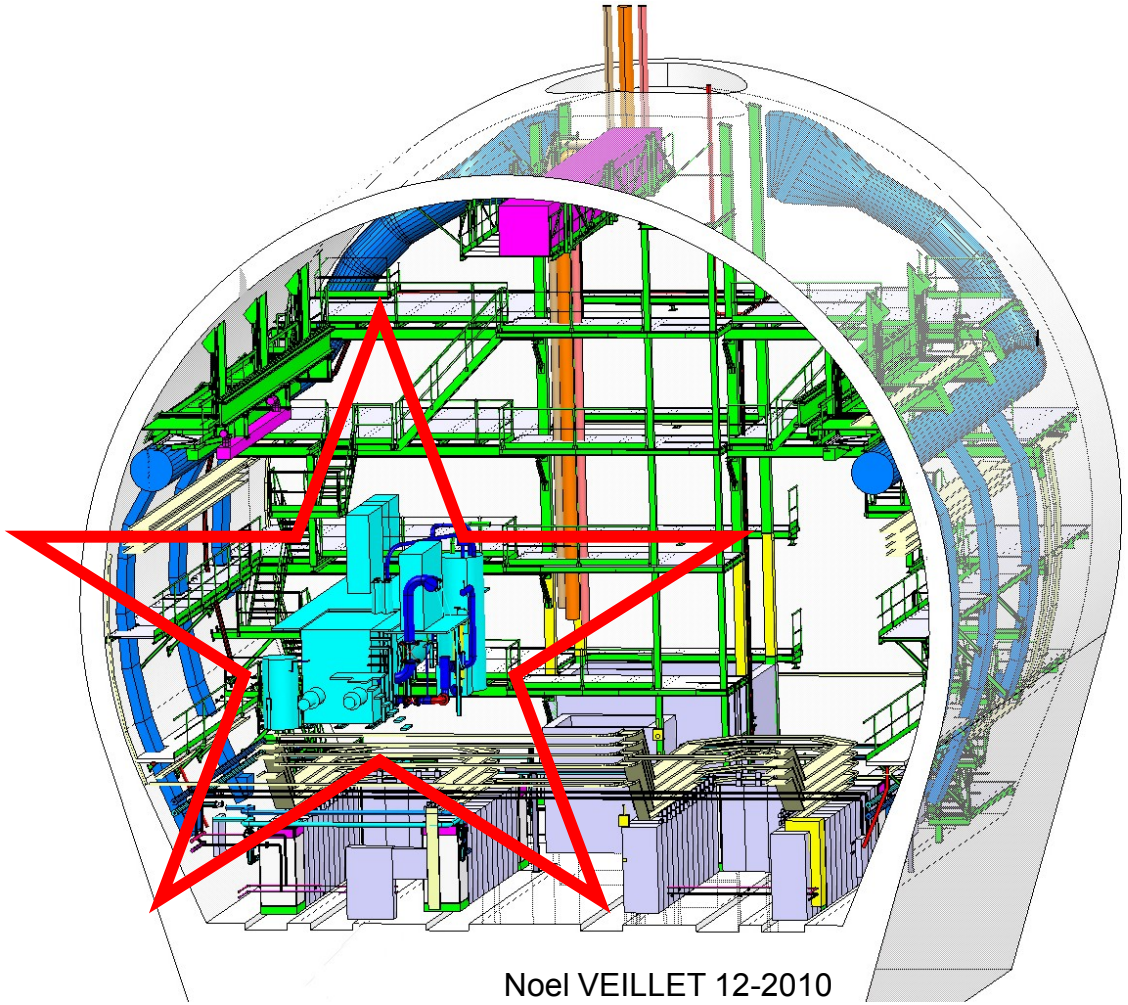


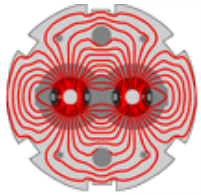
Noel VEILLET 12-2010

UX45, as a reminder



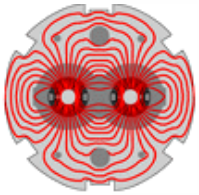
New 4.5K refrigerator in UX45





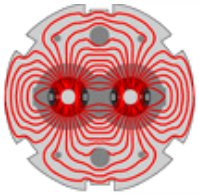
New 4.5K refrigeration in UX45

- Warm compressor installed in surface
- Warm gas lines in Pit
- Cold box installed in UX 45 (cavern)
- LHe Transfer lines to RF cavities
- LHe Transfer lines to Crab cavities
- Valve boxes for redundancy with QRL
- Upgrade of actual LHe distribution to RF cavities



Cryogenics for Local Scheme, 1/3

- Introduction.
  - For HL-LHC Project, the inner triplets will need to be upgraded for higher aperture and higher field gradients. The high luminosities will increase the thermal load on these magnets. At present these magnets share cooling resources with the 3.3 km long magnet sector they belong to, a situation which cannot be maintained.
  - Therefore new Cryo-plants in interaction points 1 and 5 of about 2-4 kW per IP need to be installed.

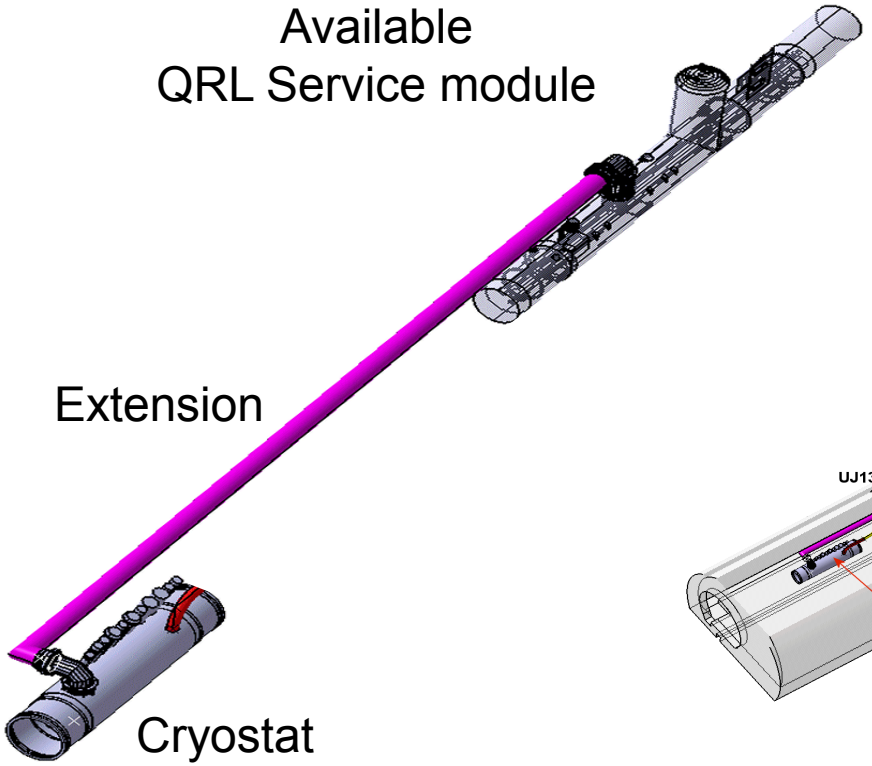


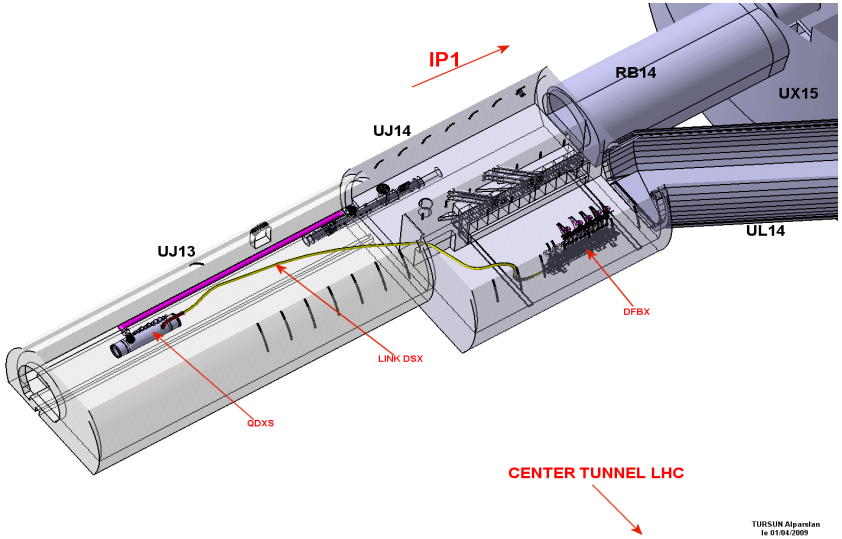
Cryogenics for Local Scheme, 2/3

- Taking into account the independent cooling scheme for the new inner triplets, a fraction of the cooling power at 2 K made available on the QRL can be used for the cooling of crab cavities.
- The proposed cryogenic scheme will be based on the study done in 2009 for the former project of LHC IR Upgrade Phase-1: The QRL jumpers to the former inner triplets feed boxes (DFBX) could be re-used to connect local cryogenic extension lines to the crab cavities cryostats.
- This solution is valid for P1 L & R and P5 L & R.

LHC IR Upgrade Phase-1, IT P1 left

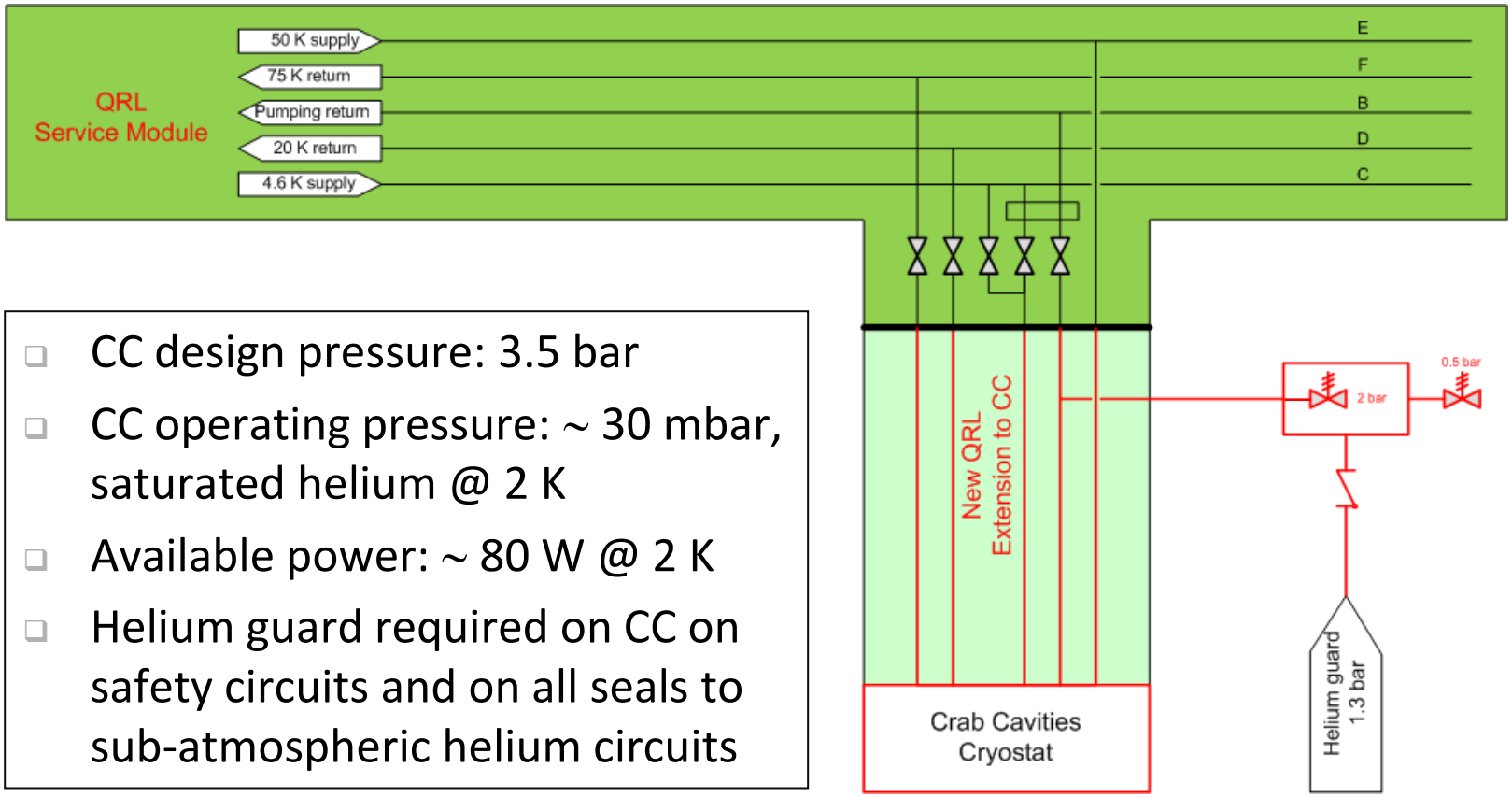
(out of date solution for ITs)



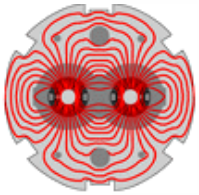


Cryogenics for Local Scheme

Simplified flow scheme



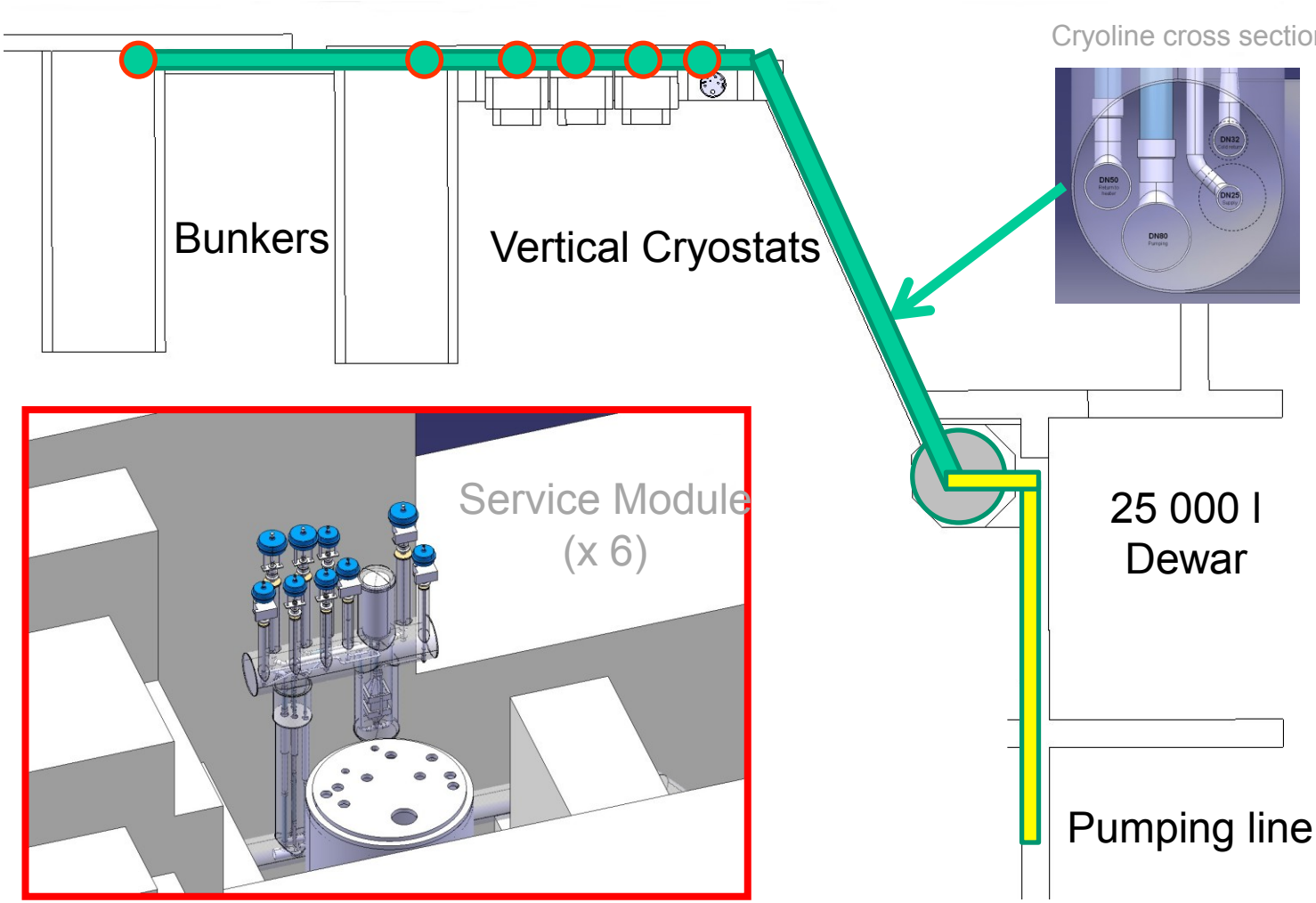
- CC design pressure: 3.5 bar
- CC operating pressure: ~ 30 mbar, saturated helium @ 2 K
- Available power: ~ 80 W @ 2 K
- Helium guard required on CC on safety circuits and on all seals to sub-atmospheric helium circuits



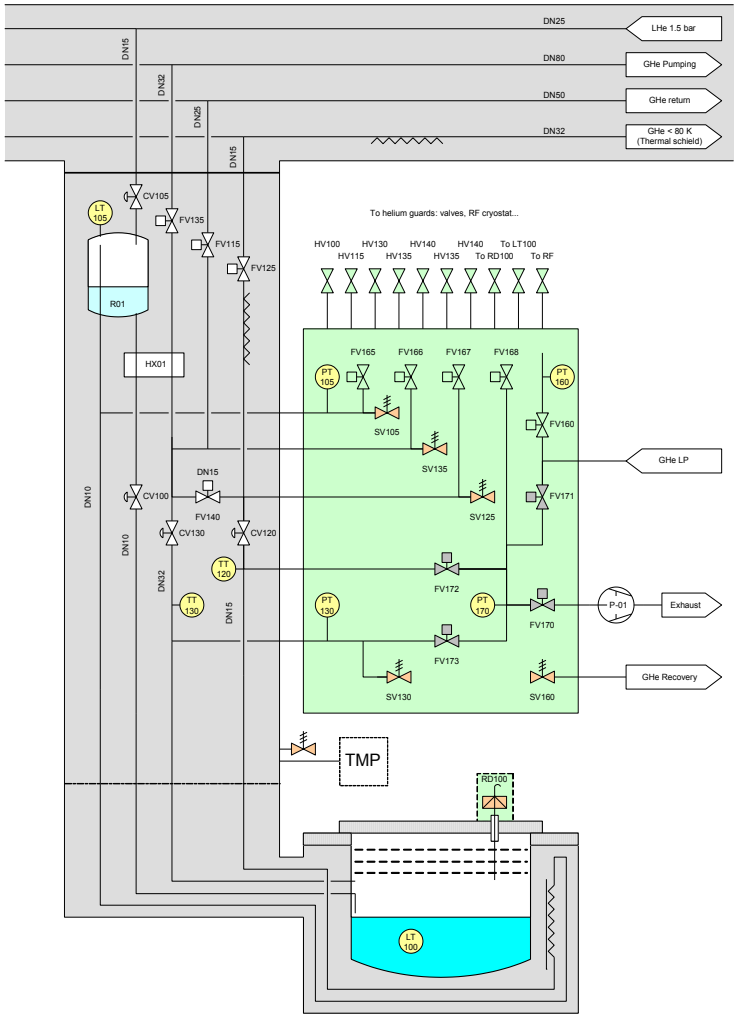
Cryogenics for RF in SM18

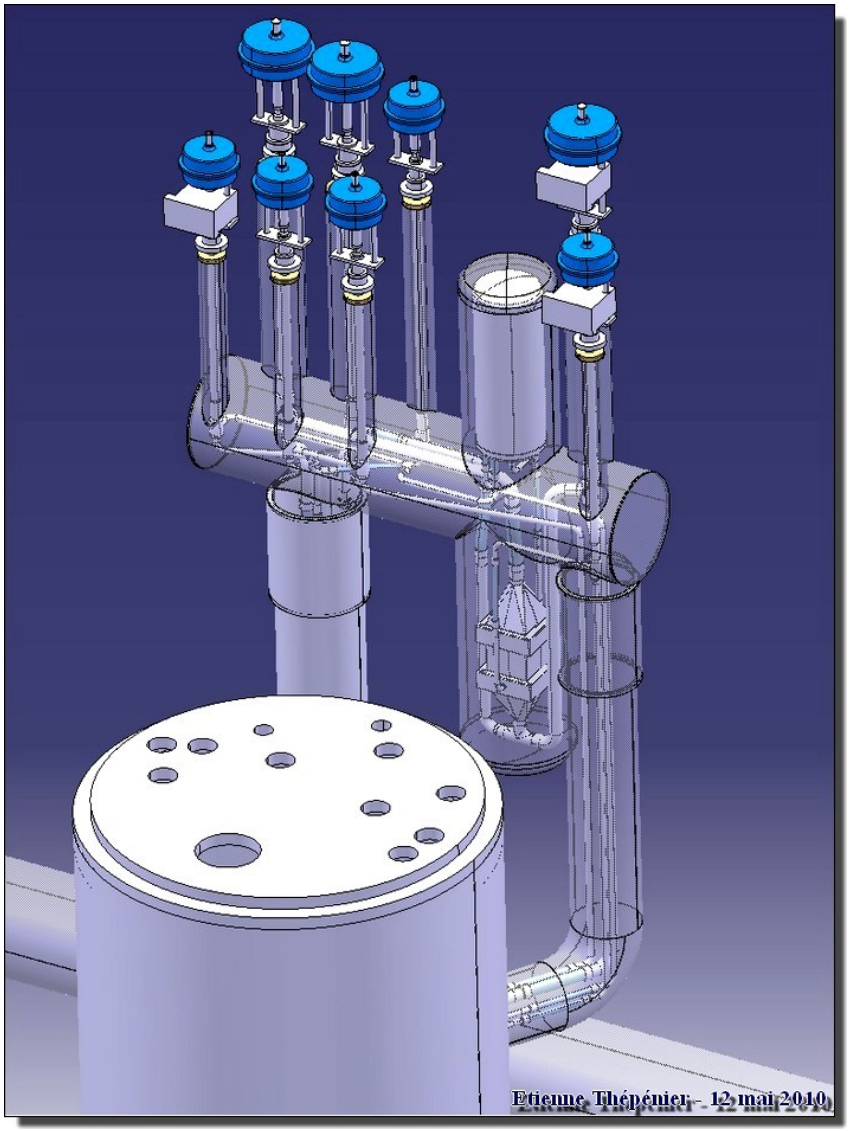
- In 2012 will be installed in SM18 a new 4-way cryogenic line and 6 service modules for the 2 bunkers and the 4 vertical cryostats.
- Service modules are designed for up to 200 W @2 K.
- The design of the interfaces to the existing vertical cryostats (and cryomodule 2 K) has to be finalized.
- A helium gas pumping capacity of up to 18 g/s @ 30 mbar will be fully dedicated to RF tests (cold pumping line, low pressure heater and warm pumping unit).
- *It is understood that the LHe production in SM18 (presently maximum ~24 g/s) will have to be shared by all SM18 users (management of priorities!)*

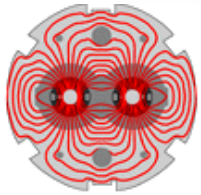
New Cryo-line for RF in SM18



Service Module for Vertical Cryostats







Conclusions

- The available refrigeration power for CC test at SPS will be 100 W @ 4.5 K. The overall TCF20 connection & refurbishing cost will be ~ 250 kCHF. No critical issue.
- Operation at 2 K is not the present baseline for the Crab Cavities of the Global Scheme. A CC cooling power of 2 x ~ 500 W @ 4.5K can be provided with a new RF refrigerator at Point 4 (with redundancy from QRL).
- Operation at 2 K is the present baseline for the Crab Cavities of the Local Scheme. A CC cooling power of 2 x ~ 80 W @ 2 K can be available from QRL at P1 and at P5.
- Cryogenics for CC tests in SM 18, at 4.5 K or 2 K, in a vertical cryostat or in a cryomodule: no critical issue*

** Except LHe availability for concurrent applications in SM18: management of priorities !*