HiLumi HL-LHC PROJECT

Hollow e- lens, Cryogenic aspects

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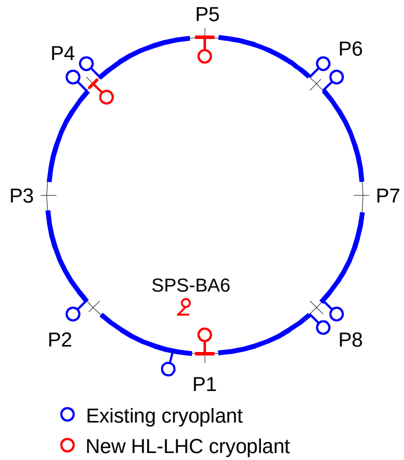
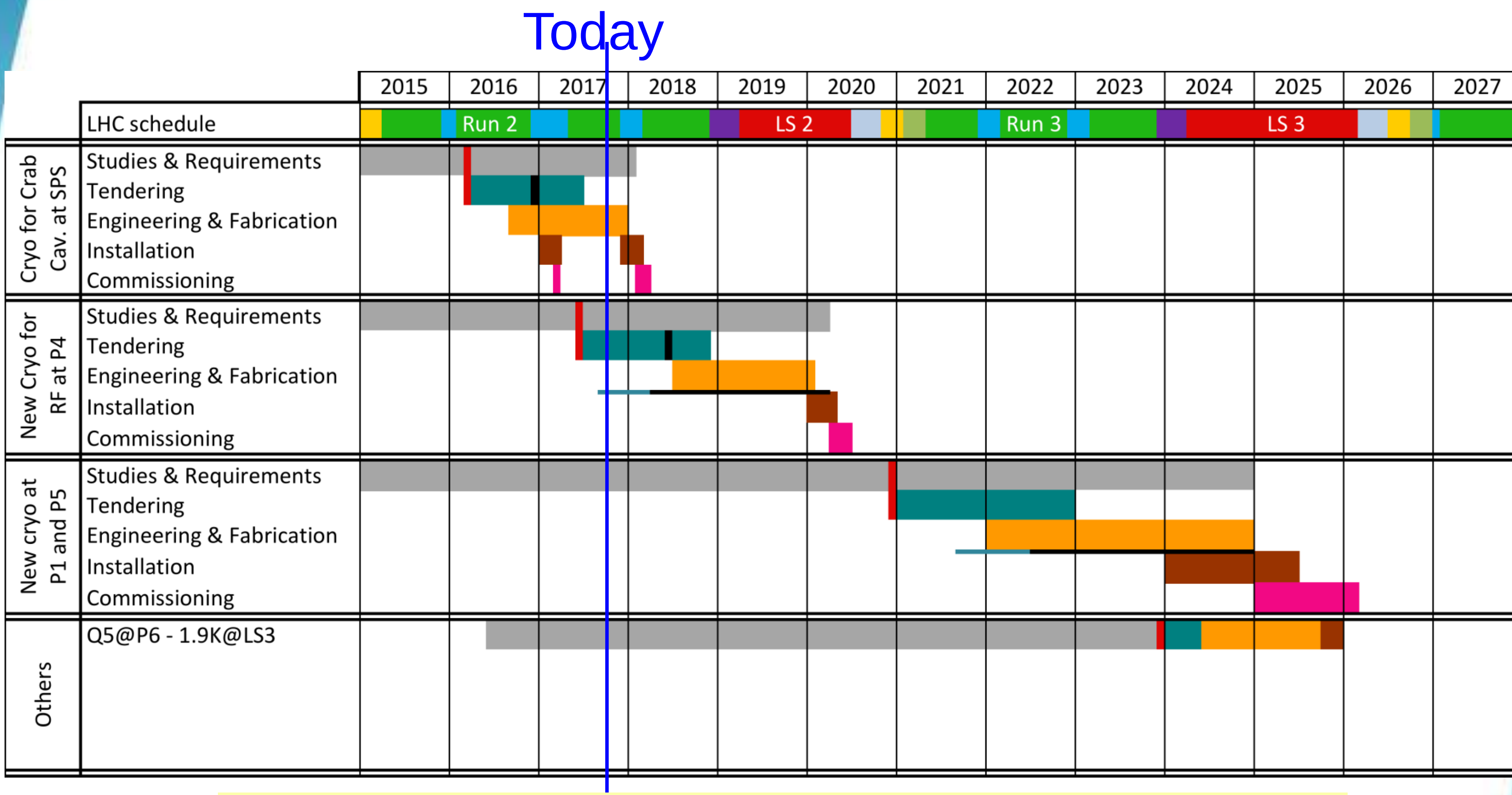
E- lens concept readiness Review, 19-20 Oct 2017

Introduction



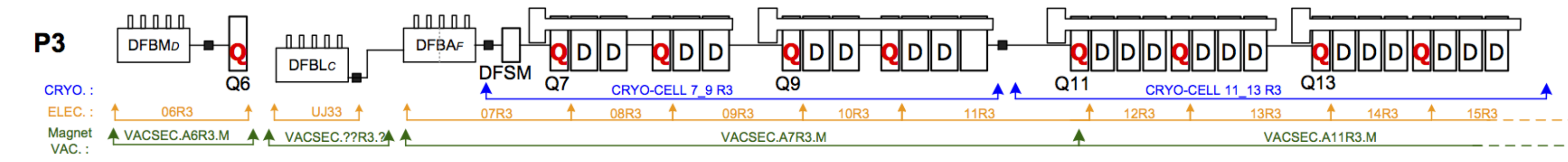
- HiLumi Cryogenics as know today:
  - 2 new cryoplants (~18 kW @ 4.5 K incl. ~3 kW @ 1.8 K) P1/P5
  - 1 new cryoplant (~4 kW @ 4.5 K) at P4 for SRF cryomodules
  - And 11T magnets + Q5@P6
  - + SRF test facility with beam at SPS-BA6 for Crab-Cavities
- Few alternatives or concept studied under evaluation
- Hollow e-lens is one of them

HiLumi Cryogenic masterplan



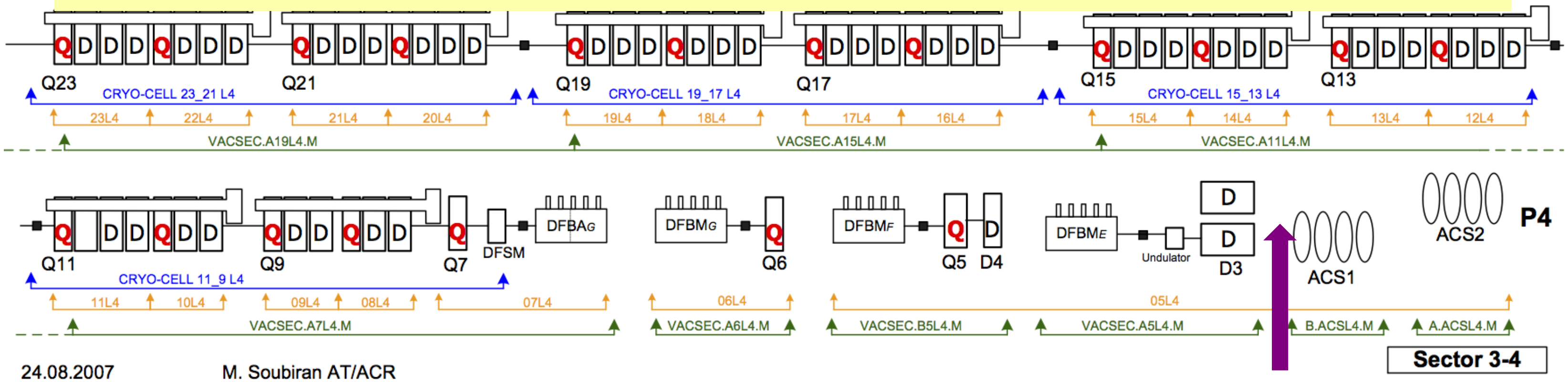
From 2 to 3 years from decision to installation in LHC existing infrastructure

Equipment to be cooled in a typical LHC sector



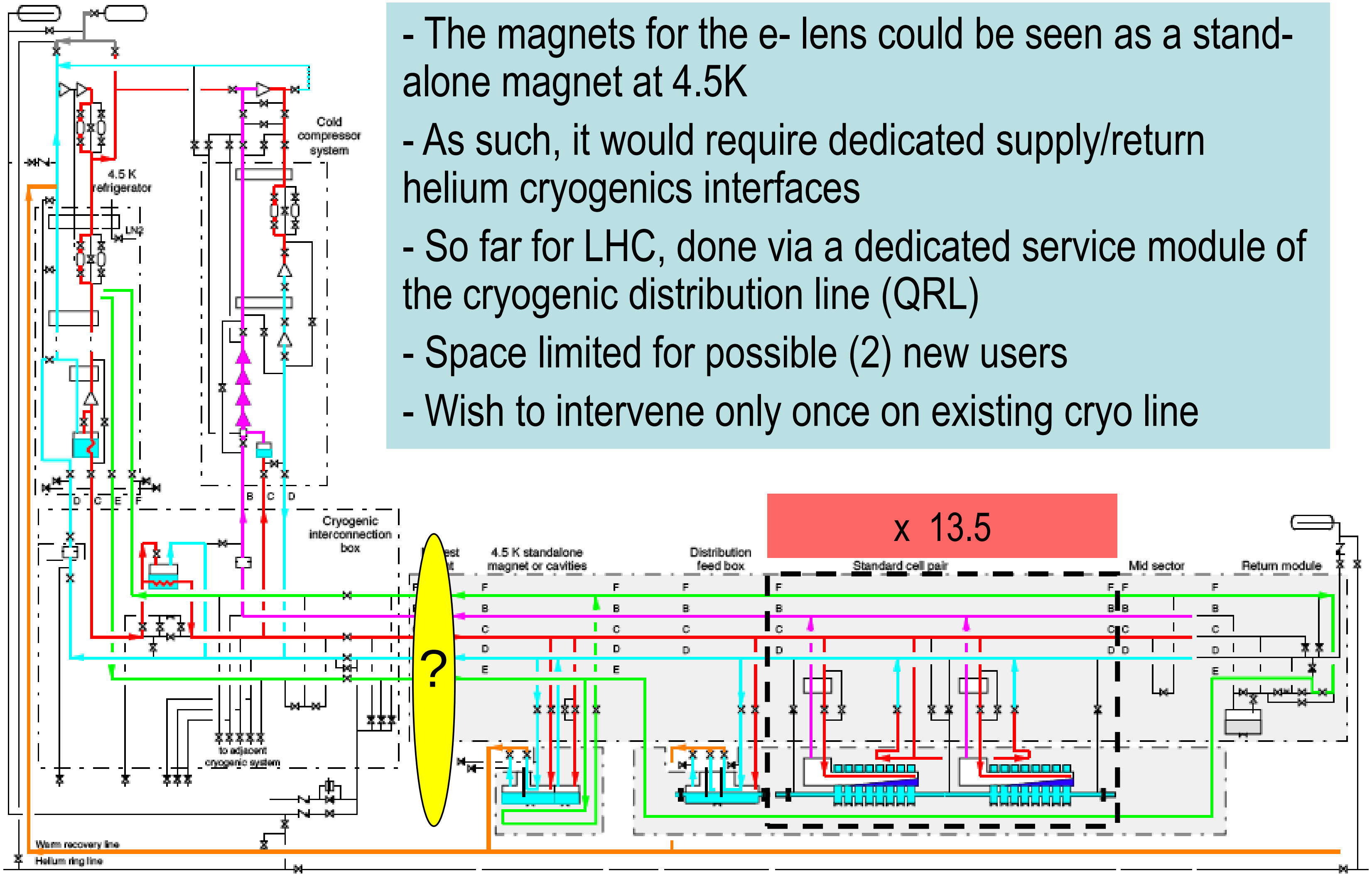
Arc @ 1.9K – Long Straight Sections @ 4.5K
Equipment to be cooled: 4’500t
Number of control loops: 400

⇒Compulsory boundary conditions to be able to operate any superconducting device with required availability and safety for interventions



Typical flow scheme of a LHC sector for cryogenics

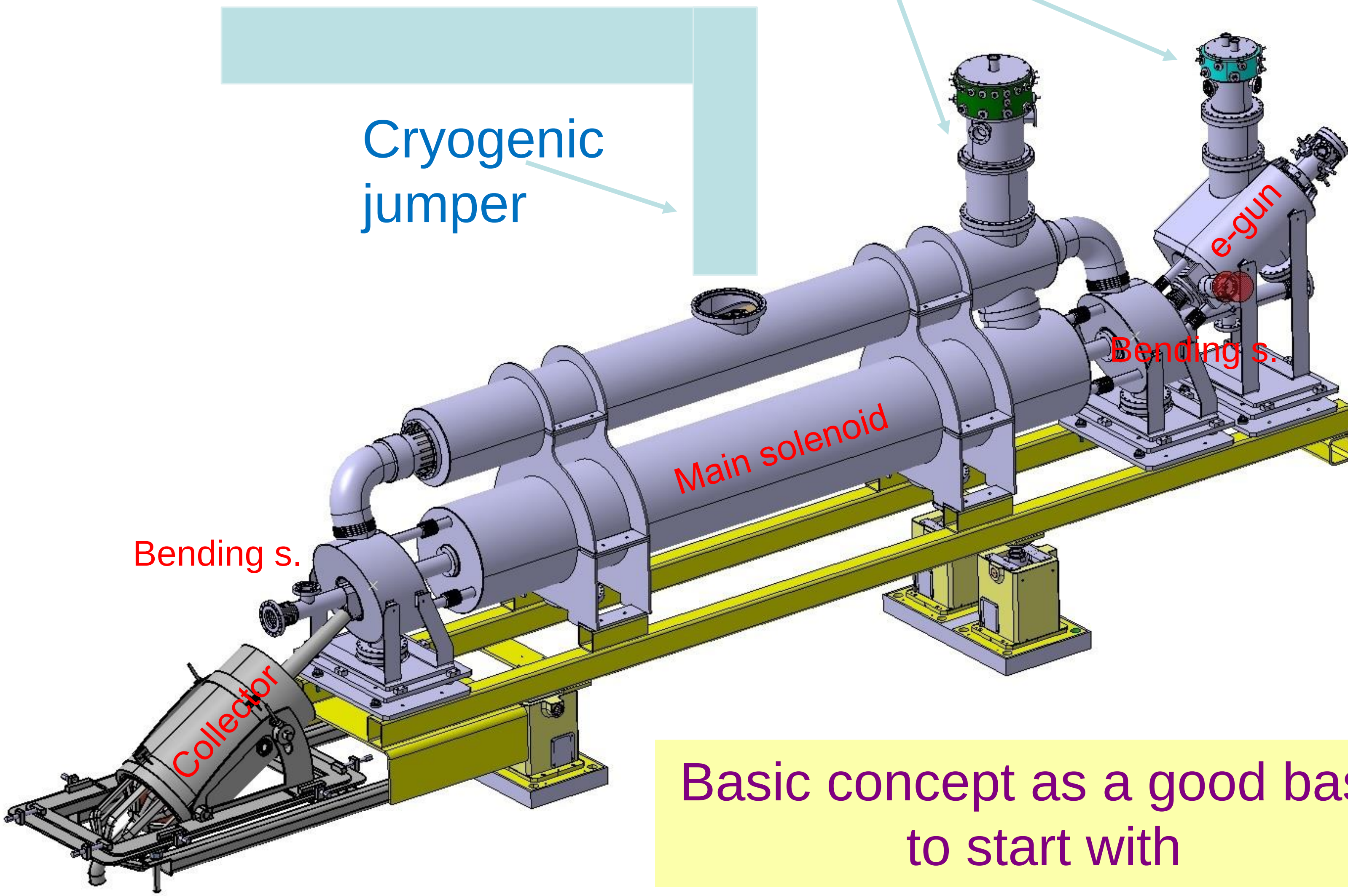
- The magnets for the e- lens could be seen as a stand-alone magnet at 4.5K
- As such, it would require dedicated supply/return helium cryogenics interfaces
- So far for LHC, done via a dedicated service module of the cryogenic distribution line (QRL)
- Space limited for possible (2) new users
- Wish to intervene only once on existing cryo line



Specific Cryogenic interfaces to be considered

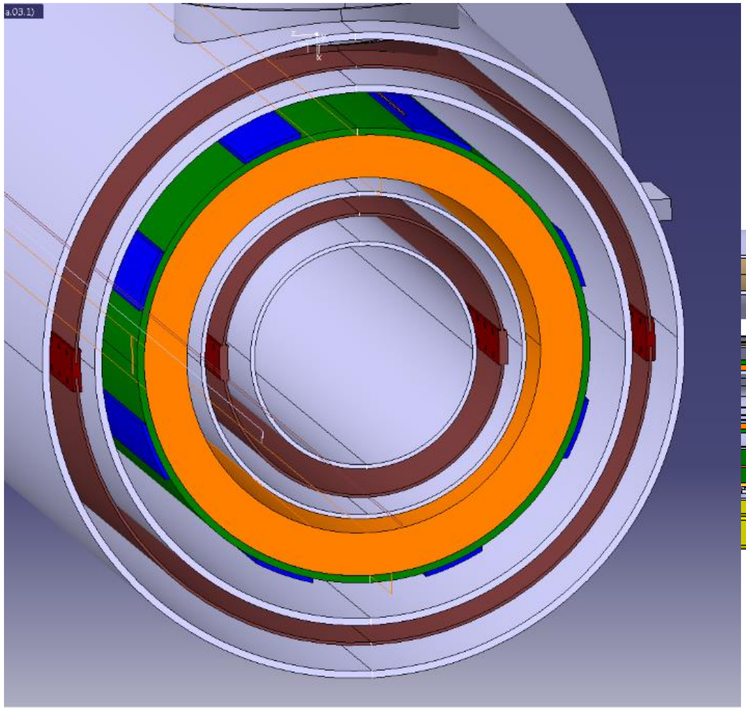
Besides 3D integration

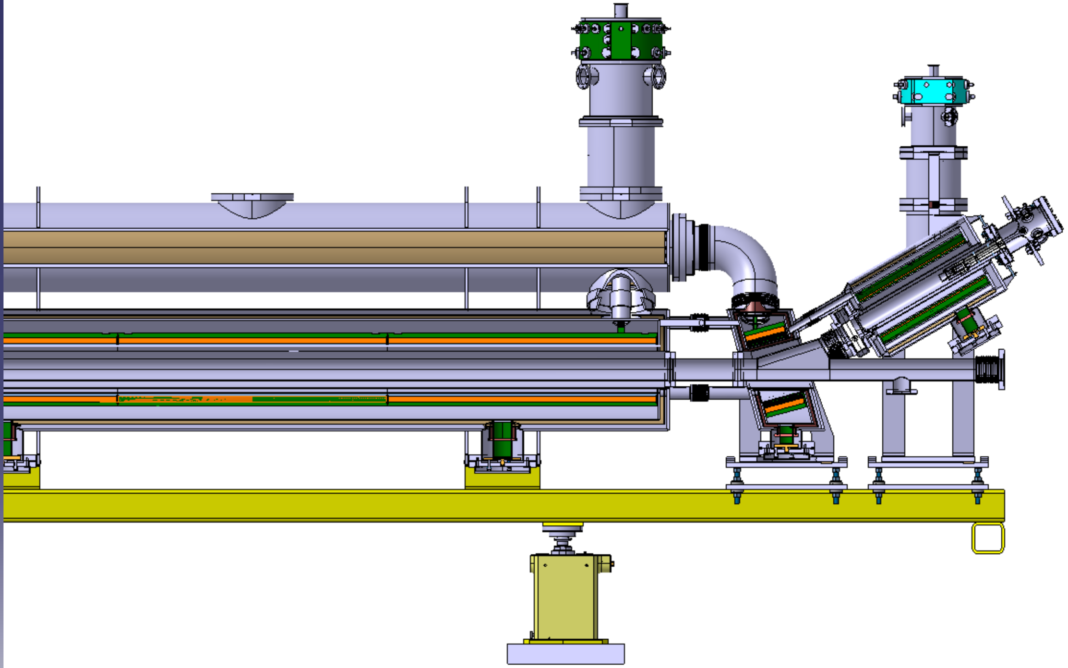
- Mechanical:
  - Operating pressure, stability required, maximum allowed pressure (safety devices), test pressure
  - Number and type of interfaces for supply/return piping
- Thermal:
  - Heat loads at different temperatures (4.5K, 75K, GHe returned at 300K)
  - Particular constraints for cool-down & warm-up
  - Operational transients (powering or beam induced heat loads)
- Electrical (power):
  - How to power and protect the leads and magnets (QPS?)
- Instrumentation/Controls:
  - Input signals (pressure, temperature, level)
  - Output signals (Cryo start/maintain for powering)



Basic concept as a good basis to start with

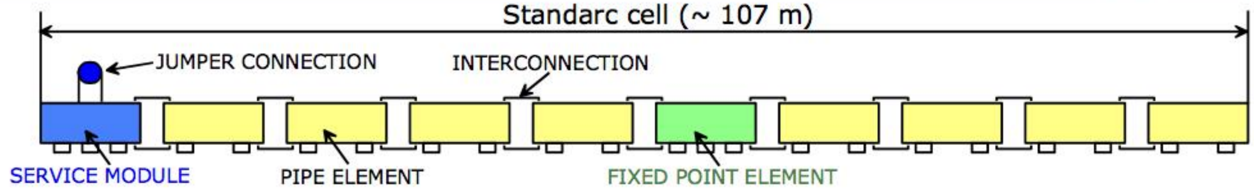
Understood as a series of 4.5K bath cooled sc magnets, with 75K thermal shielding and gas cooled current leads

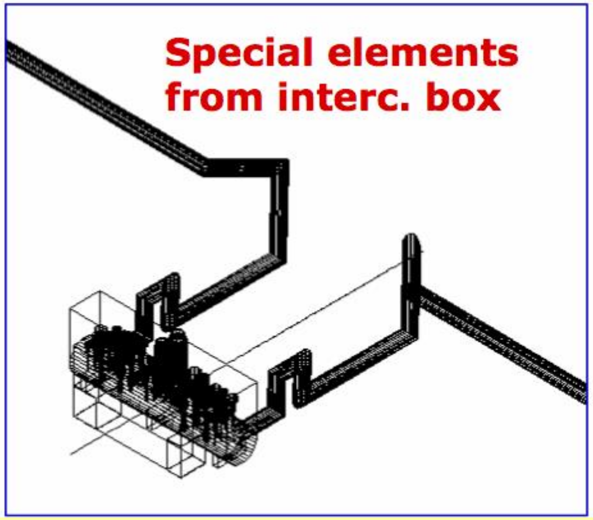


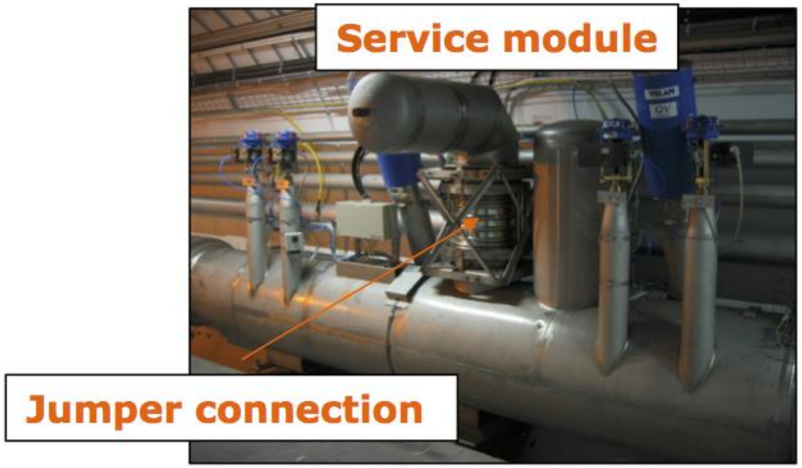


Next step would be to establish functional requirements and check their implementation

QRL Main Elements







Thermal compensation to be revised if new service module inserted

Service Module Production at Simic and FCM

Accelerator Technology Department

SIMIC: 168 standard and special service modules

FCM: 106 standard service modules

L = ~6.6 m, vacuum vessel in stainless steel

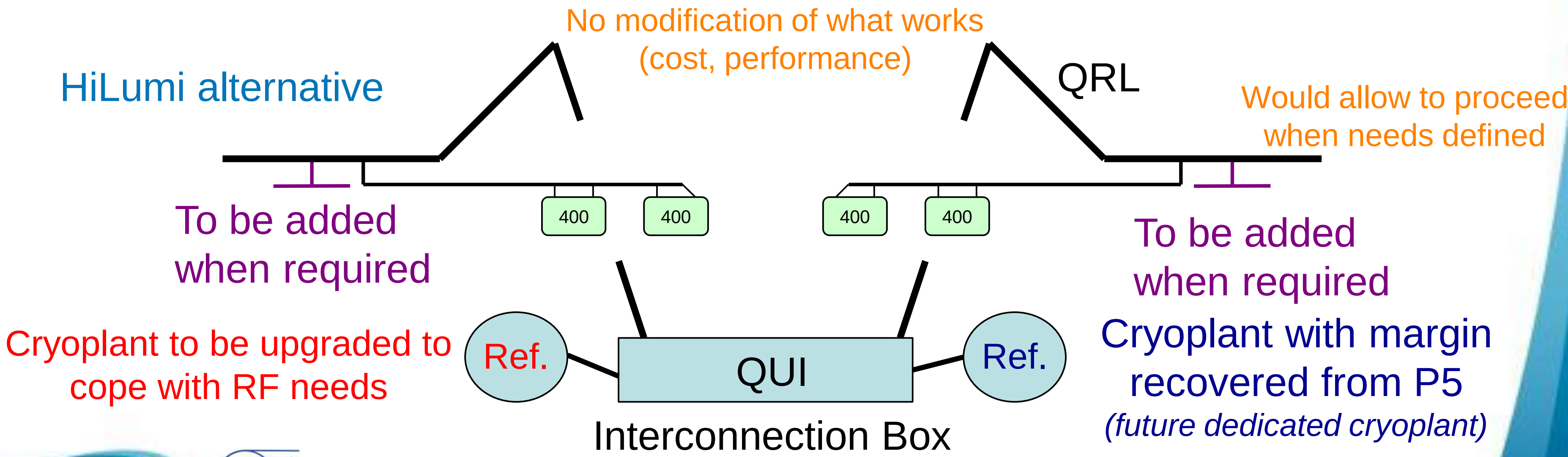
Production of service modules and cryogenic extensions at Air Liquide

- 9 double jumper service modules
- 30 standard service modules

- 11 cryogenic extensions (Φ=355 mm, Invar® internal piping)

LHC-P4-RF main focus

- Continued efforts to define the global cooling capacity needs to match the existing and future RF needs at P4 *(incl possible e-lens)*
- Our aim: provide cooling capacity and distribution to match the needs with efficient solutions, not making it the weakest sector, avoiding unnecessary modifications (Cryo and others)
- Having the possibility to connect future users (hollow e- lens or RF harmonic) is part of our scope



Usual sequence to be considered

In addition to 3D integration study for final lay-out
Formal validation required after each step

- Gathering of information, clarification of interfaces, studies
- Qualification of HW at surface (SM18 or equivalent) to check technological aspects (cryo, powering, protection)
- *Possible qualification with beam (SPS or another accelerator) if appropriate, as done for crab cavities because LHC is not considered as a test bench!*
- => *Does this apply for e- lens ?*
- Final installation in LHC

Summary

- Discussions for superconducting e- lens started in 2012 with possible recovered hardware, continued since with a series of evaluations and reviews (including a test facility at CERN)
- Present concept could be integrated to the cryogenic system of the LHC
(No identified blocking point at this stage)
- Of course more serious studies to be conducted for definition of hardware to be installed, once decision is taken to proceed
- Installation at LS3 or after would profit from recovered service modules from P1-P5 during LS3
(or re-established production facilities)