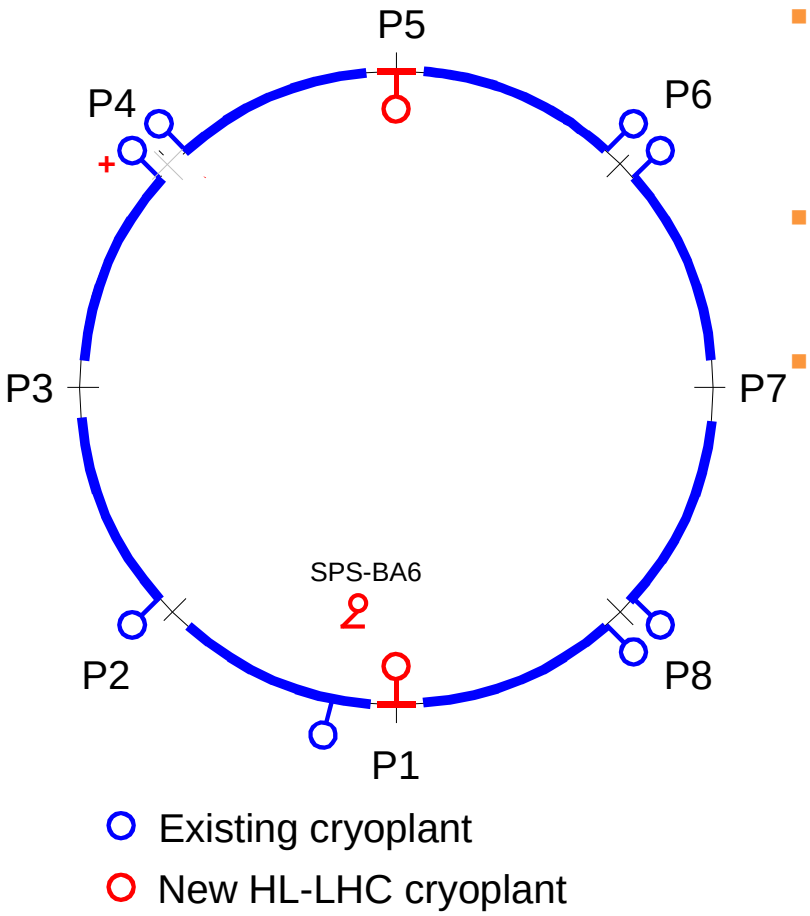
HiLumi Cryogenics, WHAT-WHEN-WHO for cryogenic instrumentation needs and interfaces

Serge Claudet,

On behalf of the Cryogenic project team

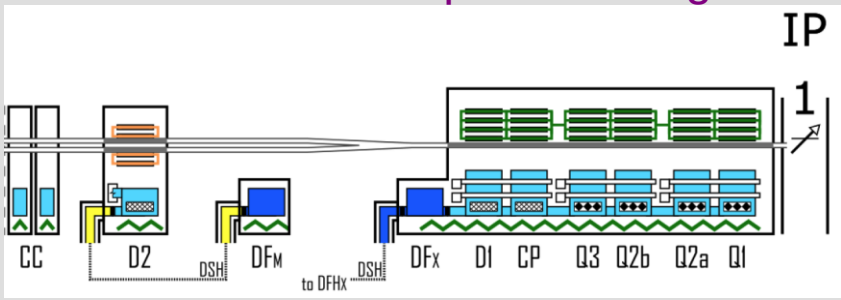
December 17th 2019

HL-LHC cryogenic upgrade



- P1-P5: 2 new cryoplants (~15 kW @ 4.5 K incl. ~3 kW @ 1.8 K) and 2 x 750m cryo-distribution for high-luminosity insertions
- P4: upgrade (+2 kW @ 4.5 K) of an existing LHC 18 kW @ 4.5K cryoplant
- *SPS-BA6: SRF test facility with beam primarily for Crab-Cavities*

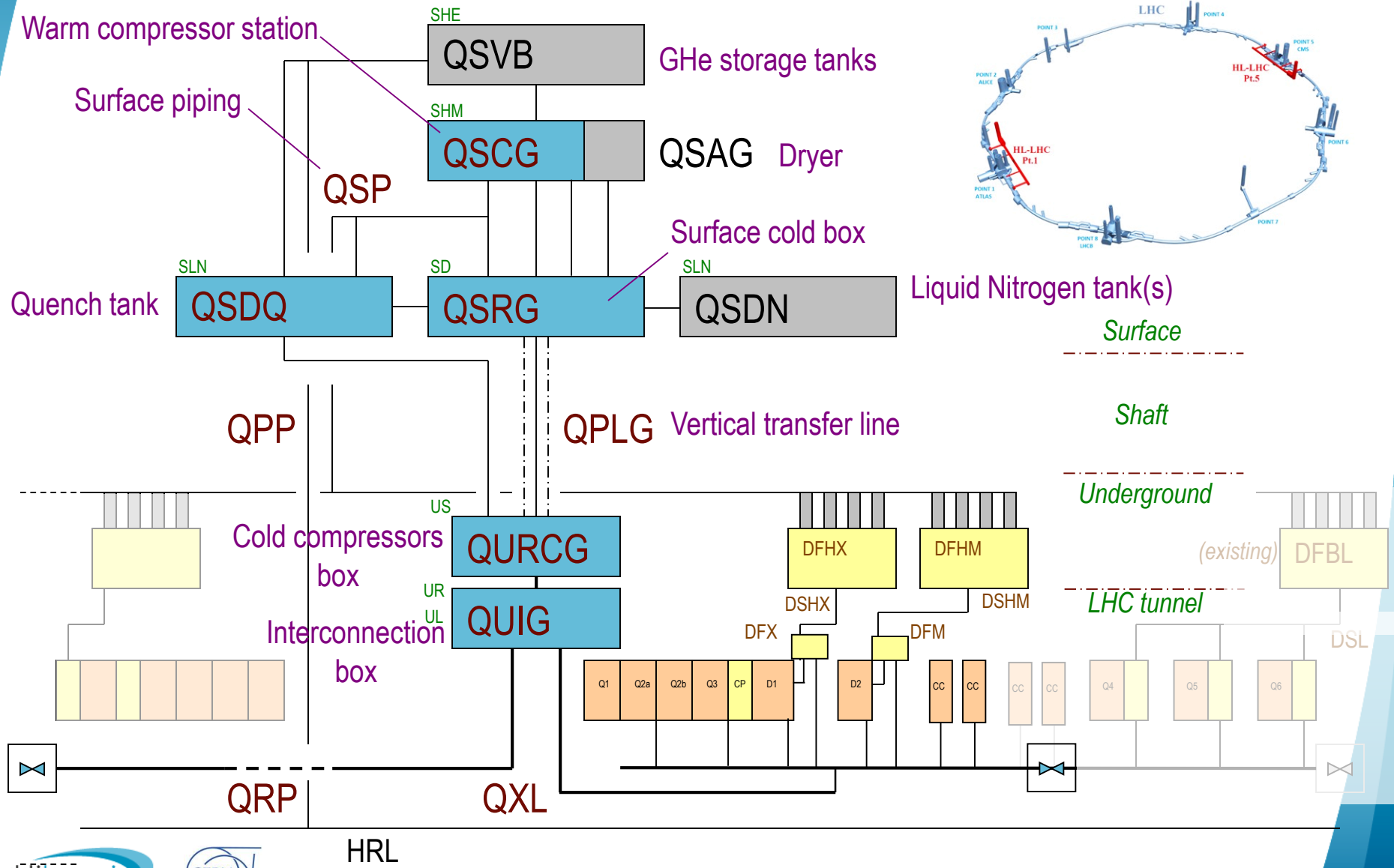
P1/P5: Provide adequate cooling for this



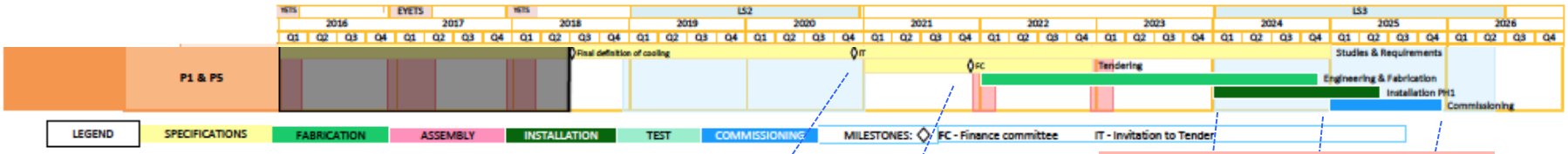
Other test facilities related activities not reported here

P1/P5 Cryogenic architecture

15 kW equivalent at 4.5 K, including 3 kW at 1.8 K



Project plans Refrigeration-Distribution



HL-LHC Cryo-distribution

M. Sisti, 18 Dec 2018

LS3

Overall project plan

2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026

Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4

- **Project Start**
- **Study**
  - *Functional Specs* — *Functional Specs*
- **Conceptual Design**
  - *Conceptual design reports* — *Conceptual design reports*
- **Design for Technical Specs**
  - *Technical Specs* — *Technical Specs Committee*
- **Procurement**
  - *Finance Committee* — *Finance Committee*
- **Design for manufacturing**
- **Manufacturing**
  - *Factory acceptance test* — *Factory Acceptance Tests*
- **LHC Warm-up & Dismounting**
- **Installation**
  - IP1 — *Site Acceptance Tests (IP1)*
  - IP5 — *Site Acceptance Tests (IP5)*
- **Commissioning**
  - IP1 (including cold test) — *Ready for Users (IP1)*
  - IP5 (including cold test) — *Ready for Users (IP5)*
- **As-built documentation**
- **Project End** — *Project end*

UR's available

UL's available

Today

Fine for Cryo deliveries,
Need to catch-up for "users"

Interfaces to be frozen by end 2020

Used now to discuss for LS3 (ready to install, P1 w.r.t P5)

WP9 organisation and roles

Re-inforced 2019

- Coordination: Serge Claudet, Rob Van Weelderen
- Quality, documentation, project management: Antonio Perin + Sigrid Knoops*
- Magnet cooling requirements: Rob Van Weelderen + *K. Puthran*
- Crab cavities cooling requirements: Krzysztof Brodzinski
- Heat Load management: Antonio Perin + *M. Spitoni*
- General process overview: *Udo Wagner + Vanessa Gahier + Benjamin Bradu*
- 3D models and integration: Jos Metselaar *(+ designers)*
- Instrumentation & controls: so far CRG/CE-CI experts
- P4-RF and P1-P5
  - Refrigeration: Emmanuel Monneret (Sep'17)
  - Cryodistribution: Michele Sisti (Jun'17)
  - Cryogenic infrastructure: Gérard Ferlin (Jul'19)
- SPS-BA6:
  - Refri tion: Laurent Delpr
  - Cryodistribution: S. Claudet + Jos Metselaar
  - Cryogenic infrastructure: Krzysztof Brodzinski + Hendrie Derking
  - Jos Metselaar + O. Pirotte

Part time contributors during LS2, but valuable help expected from experienced colleagues

Done!

Towards new organgram

Coordination:
QA, documentation
Heat loads – Process
3D models
Incl. instrumentation

Cryo sub-systems

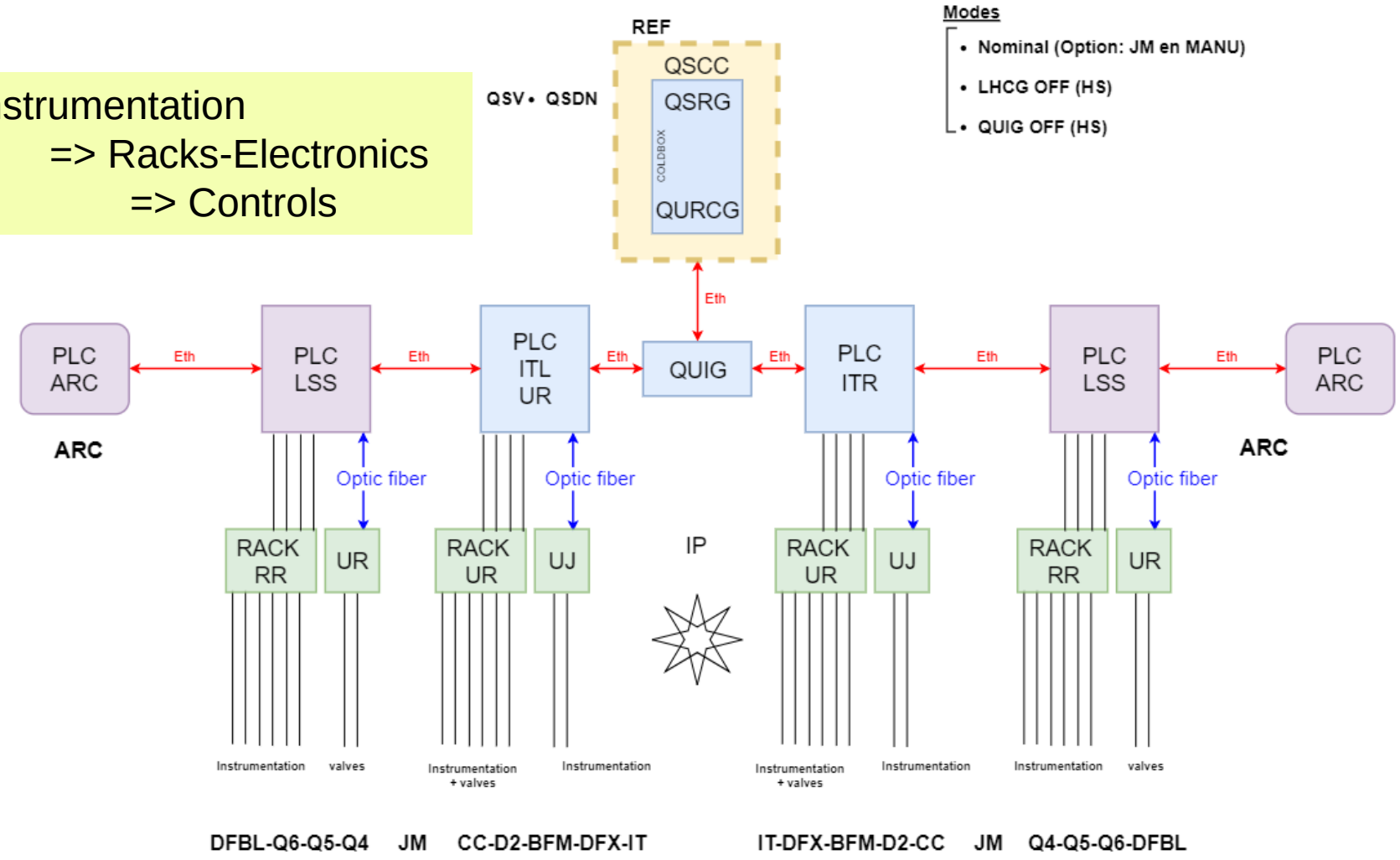
Incl Refrigerators, …
- QXL Cryoline: M. Sisti

Interfaces:
- IT+D1 cooling: Rob van Weelderen
- IT+D1 techno: M. Sisti
- 11T-connect-cryostats: R.v.W
- D2: A. Perin + t.b.d
- Crab Cavities: K. Brodzinski (+ t.b.d)
- Cold Powering: V. Gahier

SPARES SLIDES

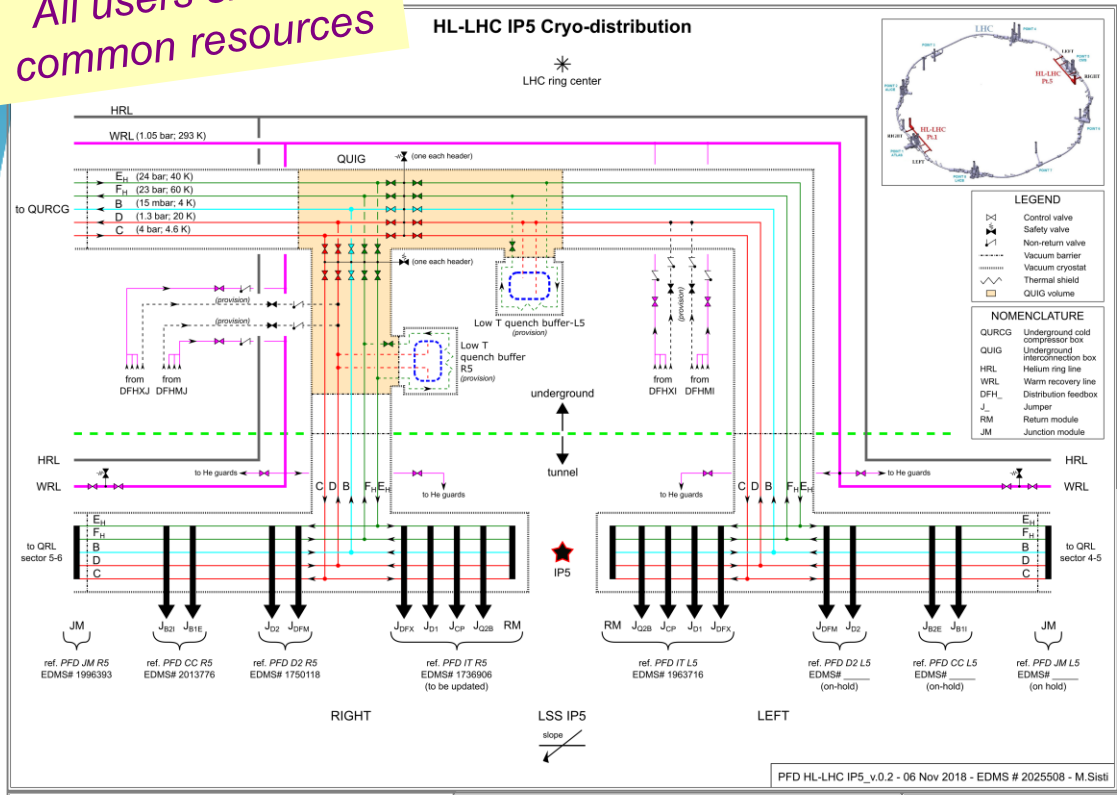
HL-LHC cryogenic "control" principles

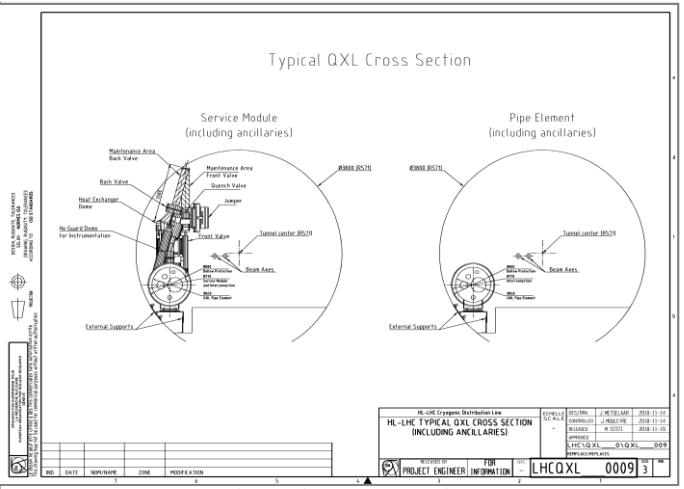
Instrumentation
=> Racks-Electronics
=> Controls

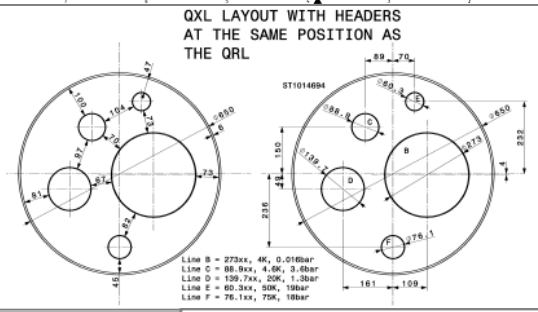


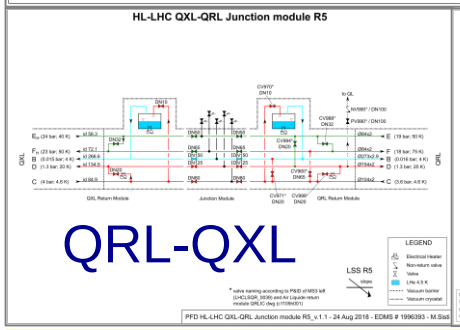
Cryo-distribution reference

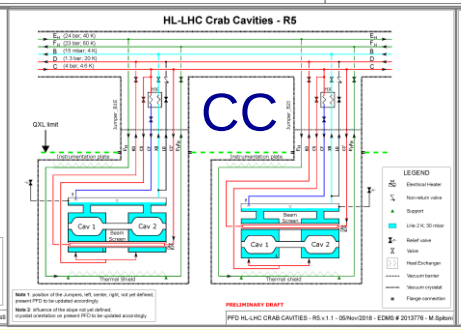
All users sharing common resources

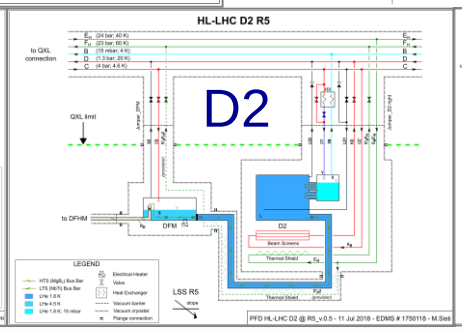


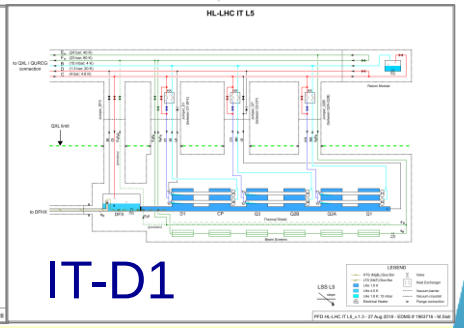






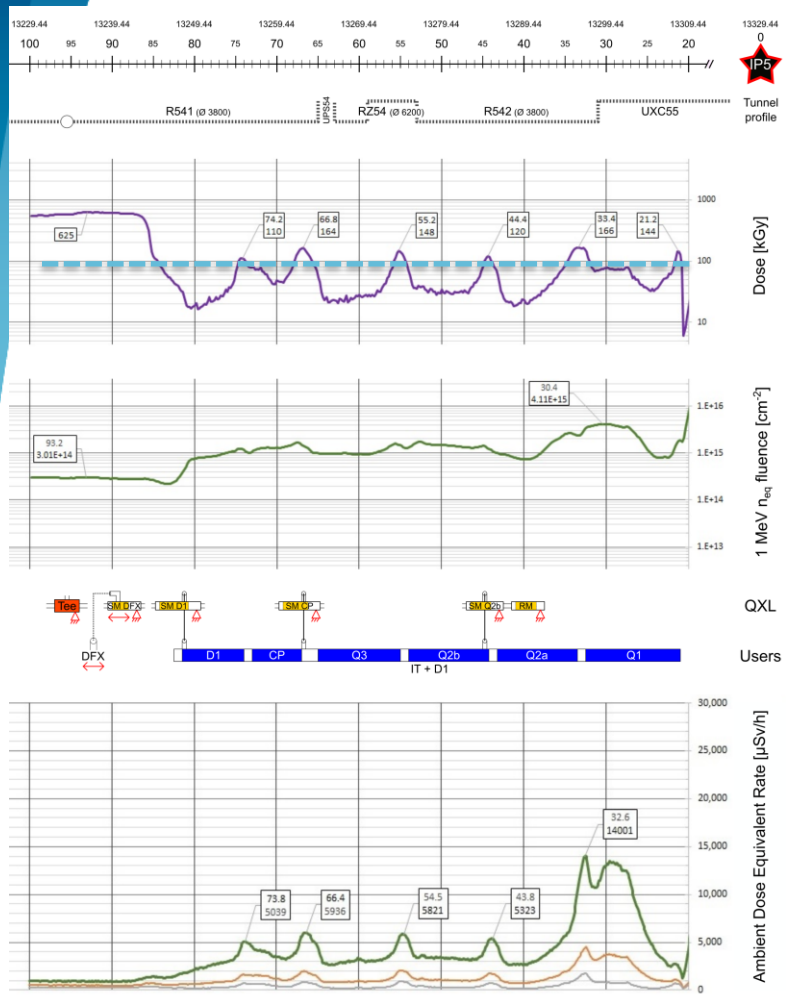


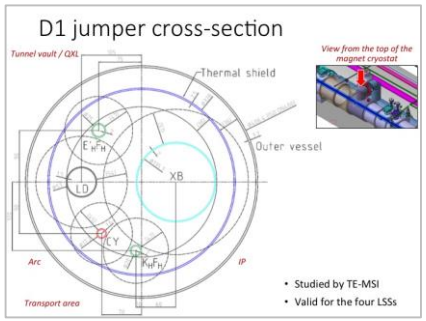


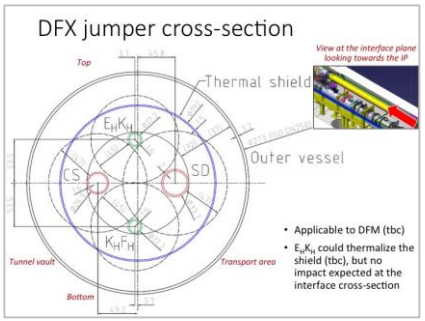


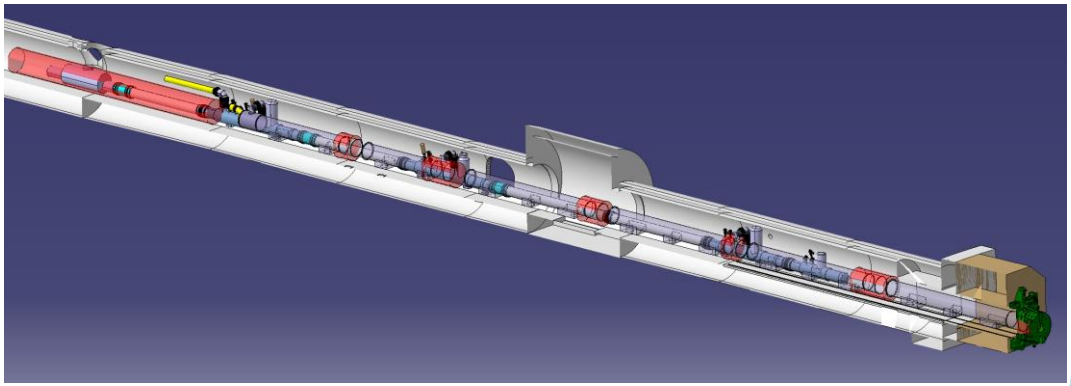
Reference established, optimised considering project requirements and CRG expertise

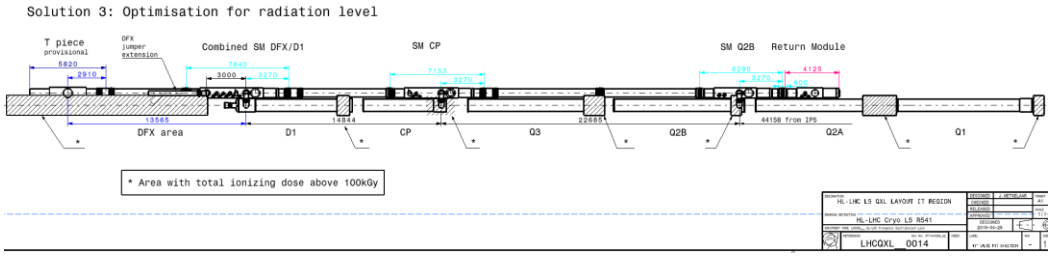
QXL Cryoline integration & interfaces











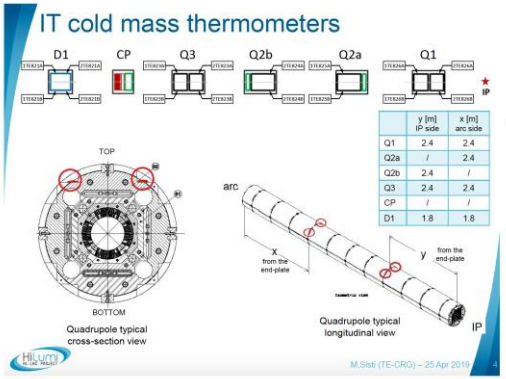
Radiation level:
instrumentation considered OK up to 100kGy

TID on Cryo instrumentation

Thanks to G. Lerner and EN-STI team

IT cold mass thermometers / 1

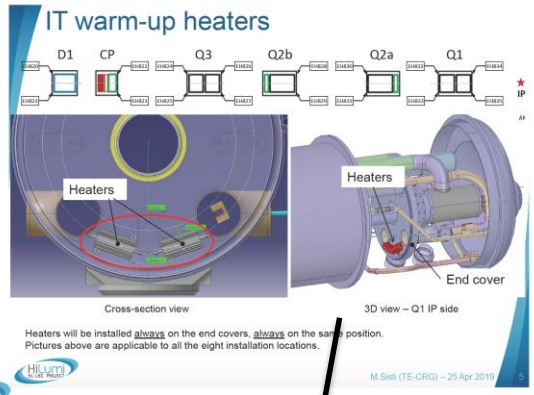
- Equipment layout (from M.Sisti):



	y [m] IP side	x [m] arc side
Q1	2.4	2.4
Q2a	/	2.4
Q2b	2.4	/
Q3	2.4	2.4
CP	/	/
D1	1.8	1.8

IT warm-up heaters / 1

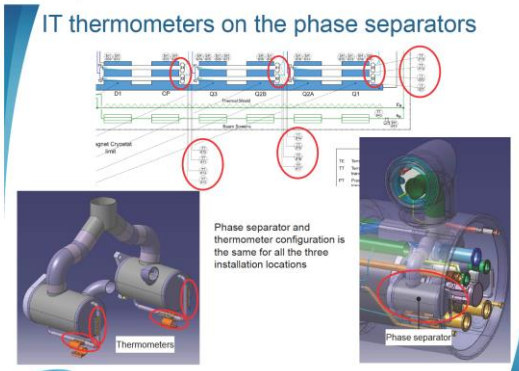
- Layout input from M.Sisti:



Heaters will be installed always on the end covers, always on the same position.
Pictures above are applicable to all the eight installation locations.

IT thermometers on phase separators / 1

- Layout input from M.Sisti:

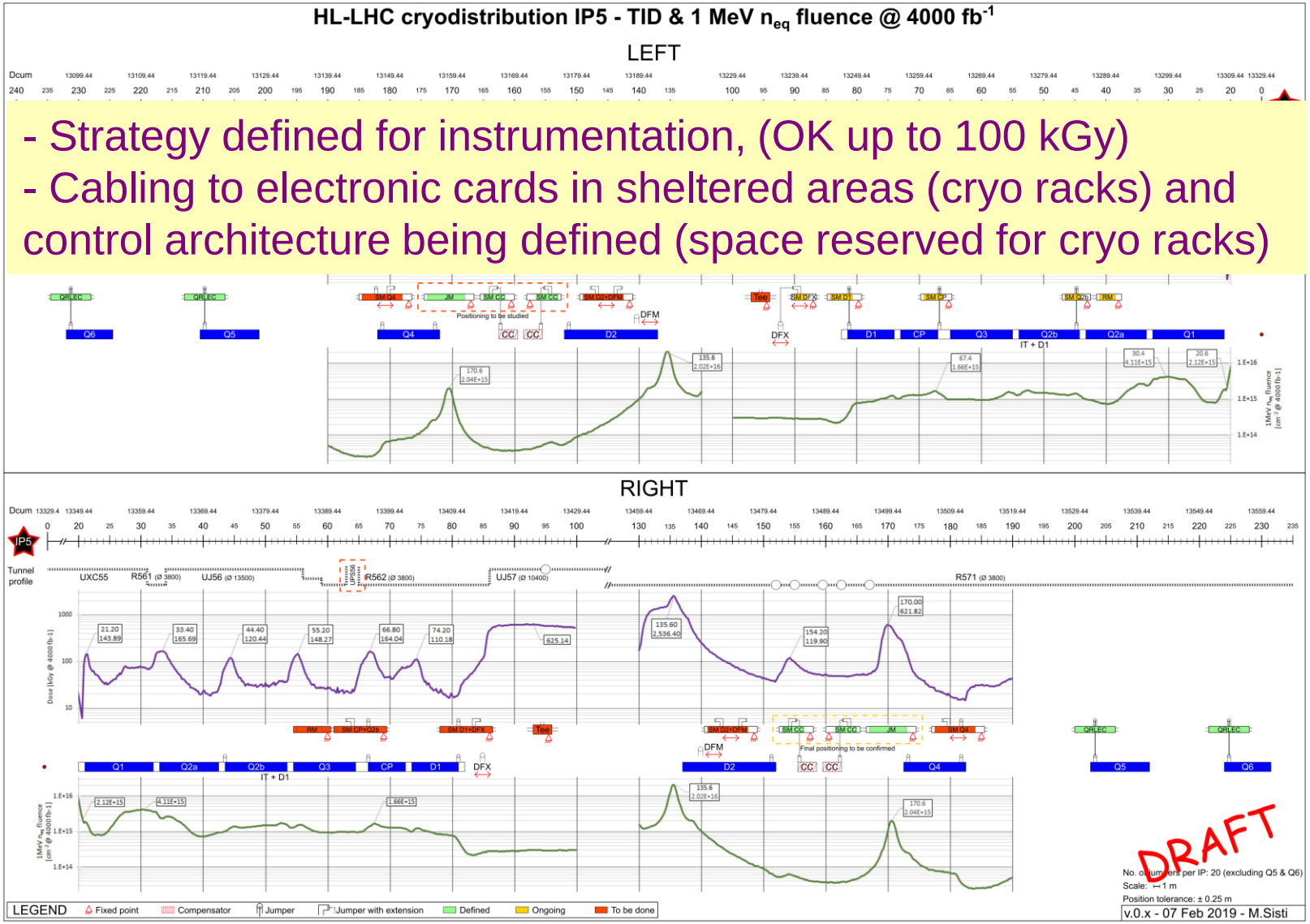


Summary Table

- Upper limits on the dose per equipment type for 4000 fb^{-1} (ultimate HL-LHC scenario) based on the results in the previous slides:

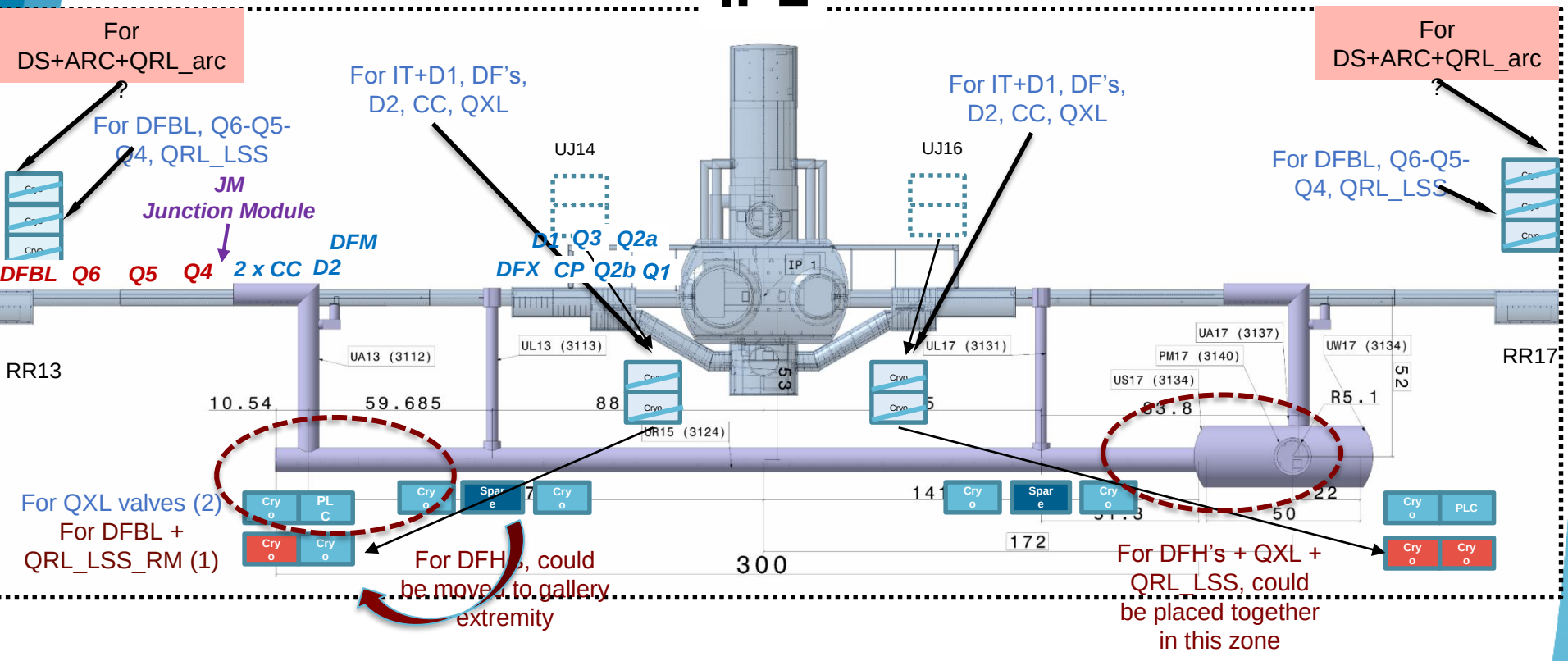
Equipment	Dose upper limit / 4000 fb^{-1} [kGy]	
IT cold mass thermometers	200	OK
IT warm-up heaters	1500	NotOK, alternative!
IT thermometers on phase separators	2000	Ok for less accurate technology
IT beam screen heaters and thermometers	750	
D2 beam screen heater and therm., and heat exchanger level gauges	200	

QXL Cryoline integration and radiation constraints



- Strategy defined for instrumentation, (OK up to 100 kGy)
- Cabling to electronic cards in sheltered areas (cryo racks) and control architecture being defined (space reserved for cryo racks)

HL-LHC cryogenic "Valve" and "RadTol instrumentation" Racks



They will be free after LS3, R2E-LS3 relocation due to the increase of the radiation levels in UJ's

- LHC Cryo "RadTol instrumentation" racks, **re-work required**
- HL-LHC Cryo "valves" cabinets !New HL!
- LHC Cryo "valves" racks, R2E-LS3 relocated **and re-work requ**
- HL-LHC rack, *Spare to adapt to SC-Link instrumentation*

1. Identify RR cryo racks to separate arc from LSS (!all LSS cables dismounted for LS3 => Re-work required!)
2. Move cryo instrum racks from UJ to UL (R2E-LS3)
3. Proposal to re-group all non Rad-Tol Cryo racks for LSS (LHC+HL) at gallery extremities
4. Then cabling + fibers requirements to be made on solid grounds!