



High Luminosity LHC

Introduction to the Review & Overview of the Cryomodule

Rama Calaga, Ofelia Capatina
On behalf of Crab Cavity collaboration



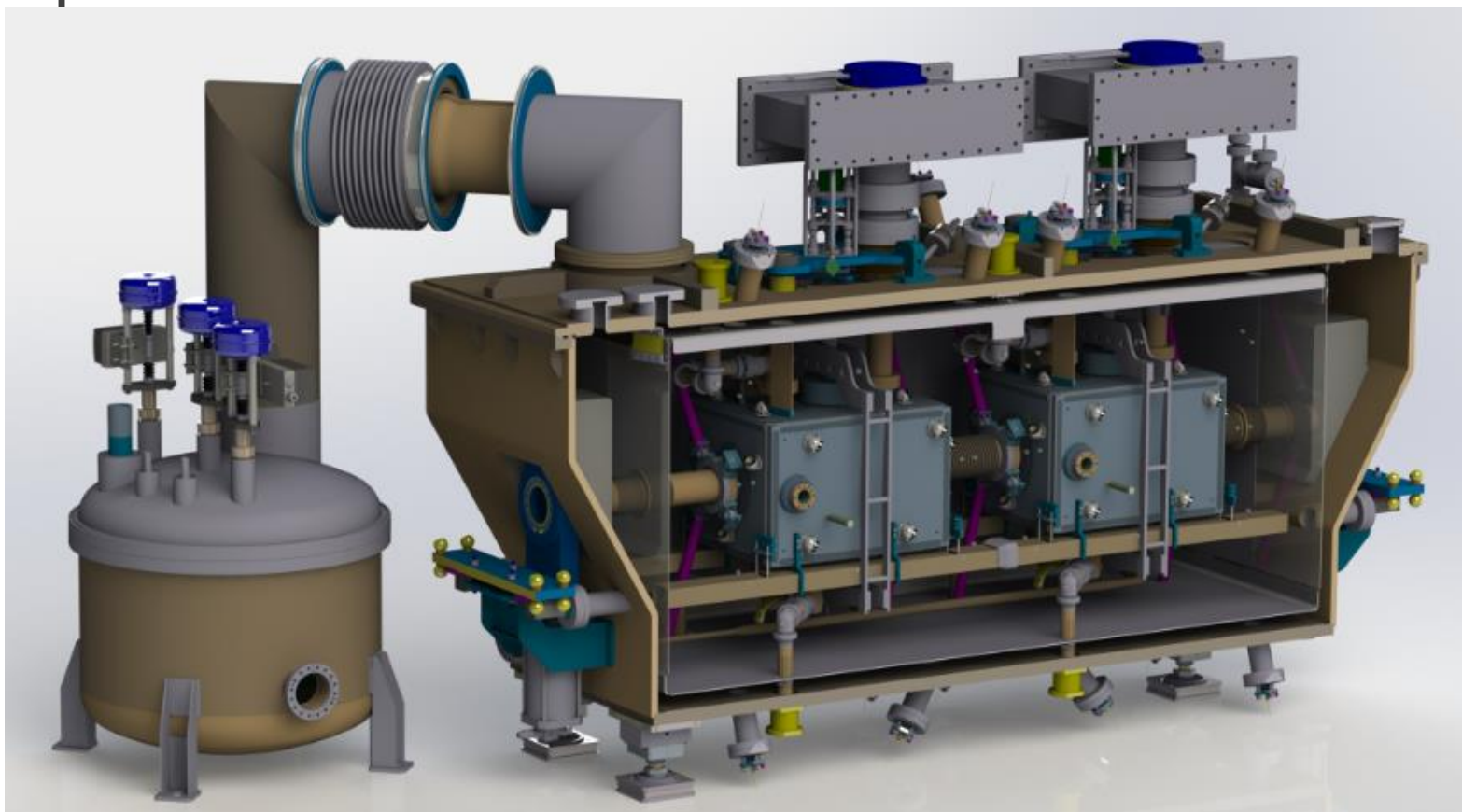
The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.



Reviewers

Pierre Bosland, Philippe Lebrun, Vittorio Parma,
Leonardo Ristori, Akira Yamamoto (Chair)

Scope of the review



SPS crab cavity cryomodules components design :

- vacuum vessel, thermal and magnetic shielding, thermal insulation, cryogenic distribution, internal support structure, RF internal lines, alignment adjustment and monitoring;



the physical and functional interfaces to the: RF cavities, HOM couplers and helium vessel, cryogenic and vacuum systems

Specific questions to be addressed by the review

- 1) Does the design meet all the functional requirements of such a cryomodule?
- 2) Have all important issues been covered by the project team ?
- 3) Have all the design aspects been studied sufficiently in detail in preparation for manufacturing? Are-there particular area where extra design effort is needed?
- 4) Are there risks associated with the design that could or must be removed or mitigated at this stage?
- 5) Is the proposed schedule related to SPS tests realistic?
- 6) Are the general plans and criteria for cryomodule development past the SPS application and into the HL-LHC period (post-2024) correctly defined? Is there any particular area that should be studied in more detail at this stage?

Review timetable (1/3)

Tuesday

08:00	Committee Closed Session 112-R-028, CERN	Akira YAMAMOTO 08:00 - 08:20
	Introduction to the Review and Overview of the Cryomodule 112-R-028, CERN	Ofelia CAPATINA et al. 08:20 - 08:40
	Helium Vessel Design, Prototyping and Tests 112-R-028, CERN	Carlo ZANONI 08:40 - 09:05
09:00	Cold Magnetic Shielding and a Proposal for Dressed Cavity Assembly 112-R-028, CERN	Niklas TEMPLETON 09:05 - 09:25
	Tuning System 112-R-028, CERN	Kurt ARTOOS  09:25 - 09:45
	Break 112-R-028, CERN 09:45 - 10:05	
10:00	HOM couplers 112-R-028, CERN	Marco GARLASCHE 10:05 - 10:25
	Fundamental Power Coupler and RF Transmission Lines 112-R-028, CERN	Eric MONTESINOS 10:25 - 10:45
	Discussion 112-R-028, CERN 10:45 - 11:05	
11:00	Support System of the Dressed Cavity 112-R-028, CERN	Thomas JONES  11:05 - 11:25
	Alignment and Position Monitoring System 112-R-028, CERN	Mateusz SOSIN 11:25 - 11:45
	Discussion 112-R-028, CERN 11:45 - 12:10	
12:00	Lunch	

Review timetable (2/3)

Tuesday

	Cryogenics and Cryolines 112-R-028, CERN	<i>Krzysztof BRODZINSKI</i> 13:30 - 13:50
14:00	Thermal and Outer Magnetic Shields 112-R-028, CERN	<i>Niklas TEMPLETON</i> 13:50 - 14:10
	Thermal Budget and Heat Loads 112-R-028, CERN	<i>Federico CARRA</i> 📄 14:10 - 14:30
	Discussion 112-R-028, CERN	
15:00		14:30 - 15:10
	Vacuum Vessel 112-R-028, CERN	<i>Norbert KUDER et al.</i> 15:10 - 15:30
	Discussion 112-R-028, CERN	
		15:30 - 15:50
16:00	Break 112-R-028, CERN	
		15:50 - 16:10
	Cryostating 112-R-028, CERN	<i>Pierre MINGINETTE</i> 16:10 - 16:30
	Integration in SM18 & Bunker Tests 112-R-028, CERN	<i>Alick MACPHERSON</i> 16:30 - 16:45
	Integration in SPS 112-R-028, CERN	<i>Giovanna VANDONI</i> 16:45 - 17:00
17:00	Discussion 112-R-028, CERN	
		17:00 - 18:00
18:00		
19:00	Dinner - Restaurant le Florimont	

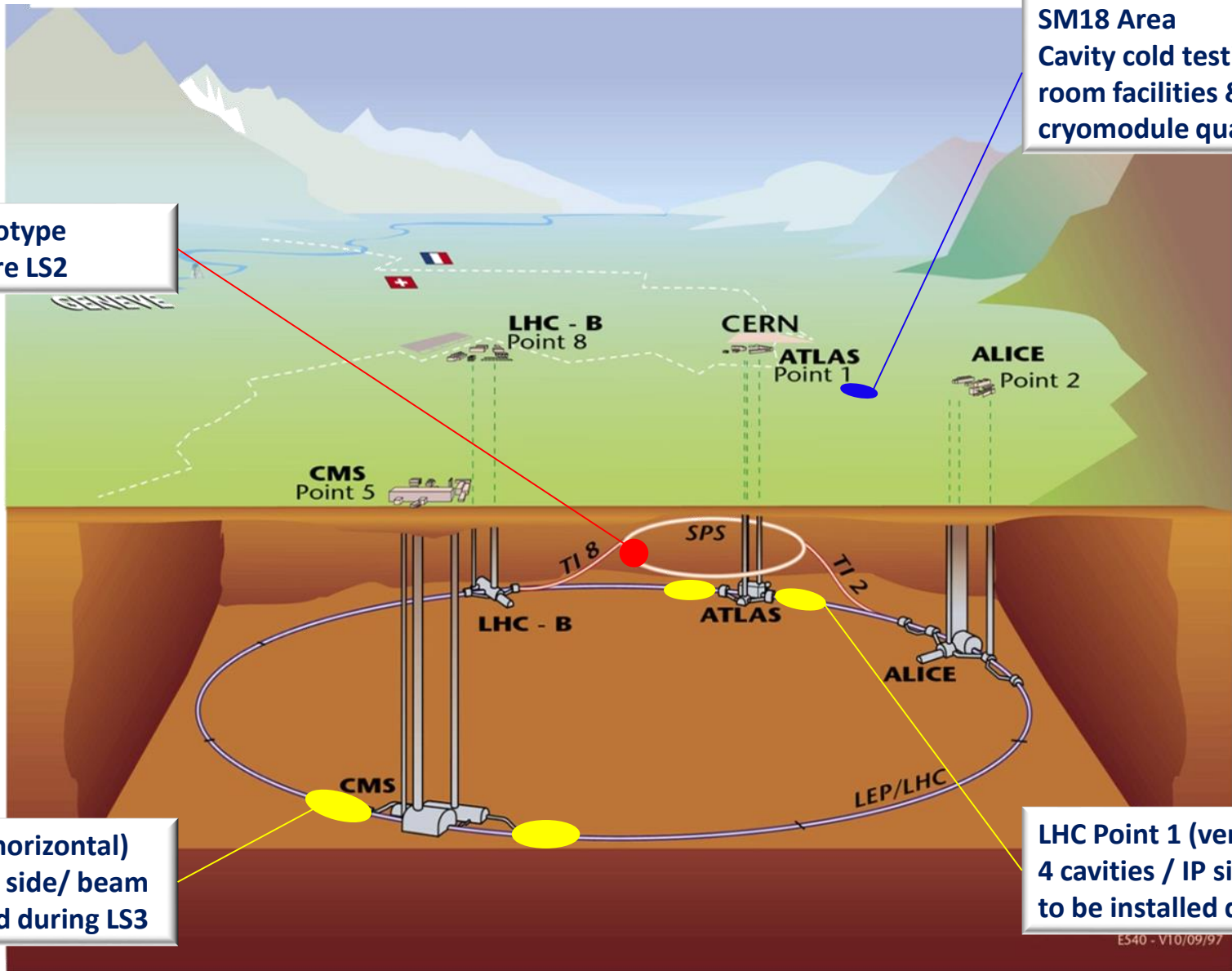
Review, 10/11/2015

Review timetable (3/3)

Wednesday

09:00	Review Committee Closed Session: Including Q&A <i>Akira Yamamoto</i> 30-7-010, CERN 09:00 - 10:15	Parallel Session: Cavity Fabrication Discussion <i>Alessandro Ratti, Carlo Zanoni...</i> 112-R-028, CERN 09:00 - 10:15
	Coffee Break 112-R-028, CERN 10:15 - 10:30	
11:00	Review Committee Closed Session <i>Akira Yamamoto</i> 30-7-010, CERN 10:30 - 11:30	Parallel Session: Cavity Treatment Discussion <i>Alessandro Ratti, Carlo Zanoni...</i> 112-R-028, CERN 10:30 - 11:30
	Final Summary 30-7-010, CERN 11:30 - 12:00	
12:00	Lunch	
14:00	Seminar: PIP-II Low Beta Cavity Development Experience <i>Leonardo Ristori</i> 30-7-010, CERN 14:00 - 15:00	
15:00		

Overview of the cryomodule



SM18 Area
 Cavity cold testing, clean room facilities & cryomodule qualification

SPS Test Prototype Module before LS2

LHC Point 5 (horizontal)
 4 cavities / IP side/ beam to be installed during LS3

LHC Point 1 (vertical)
 4 cavities / IP side/ beam to be installed during LS3

E540 - V10/09/97

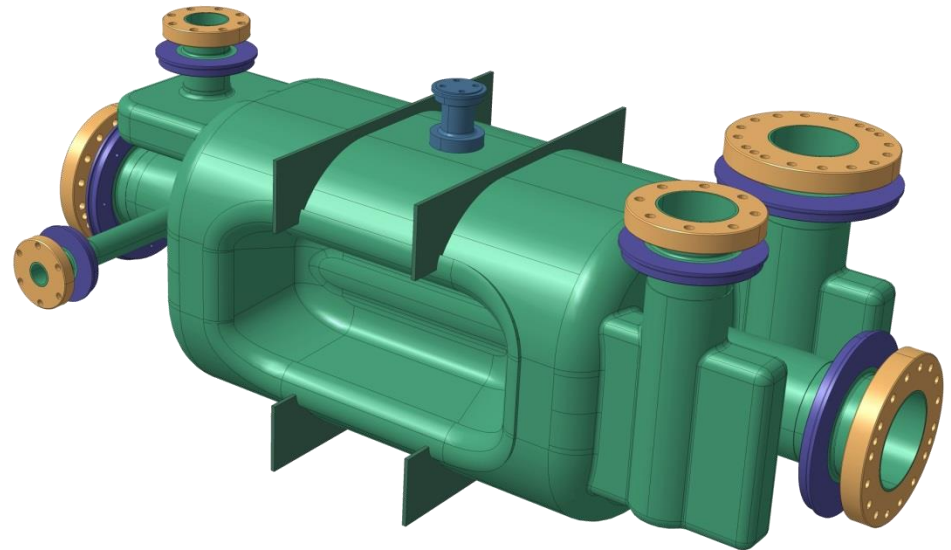
Cavities

Compact design to allow adjacent LHC beam pipe at 194 mm

Baseline : adopt both cavity types and exploit their natural RF topology



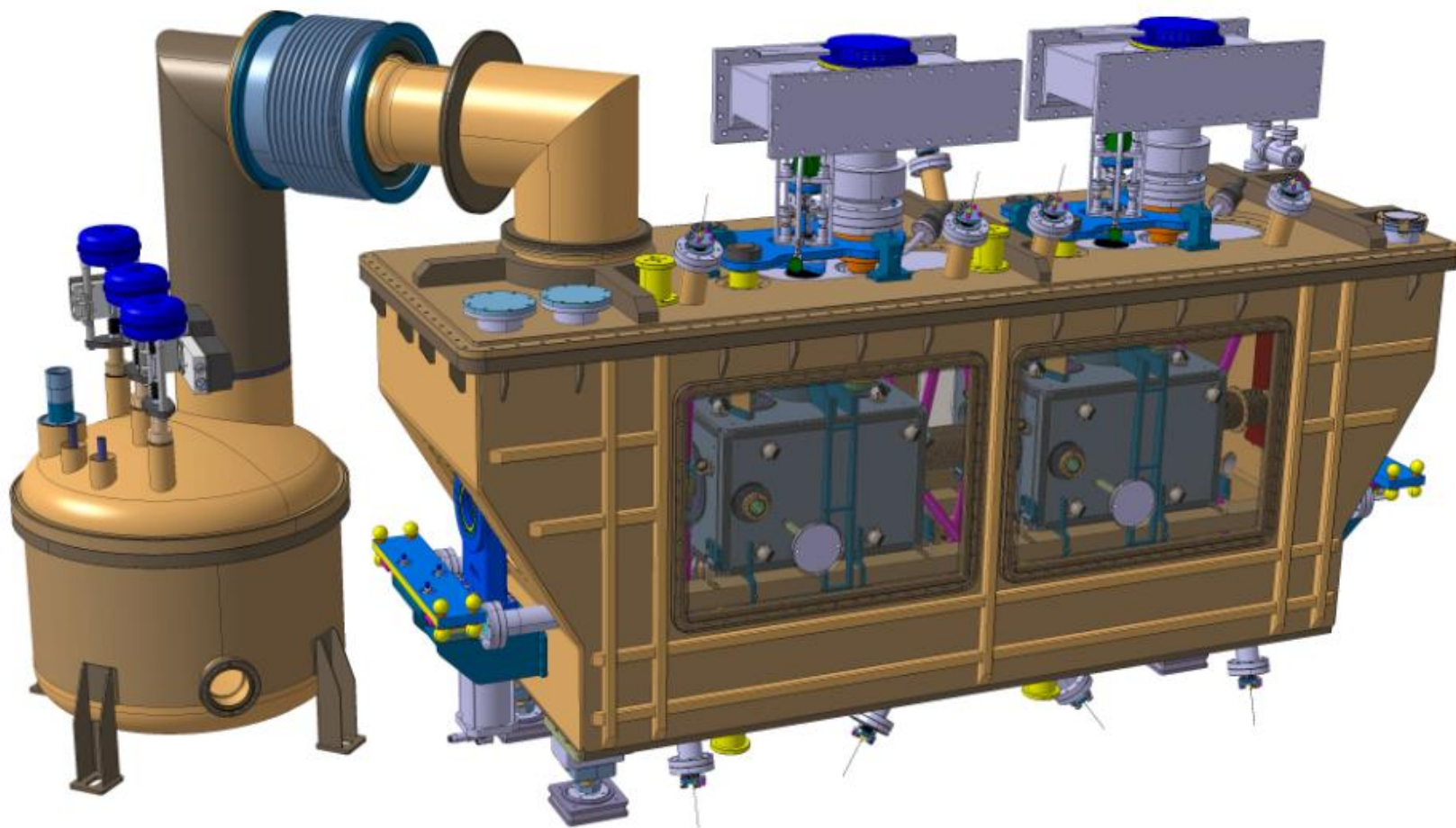
Double Quarter Wave (DQW) cavity –
Vertical – to be used in Point 1 (ATLAS)



RF Dipole (RFD) cavity –
Horizontal – to be used in Point 5 (CMS)

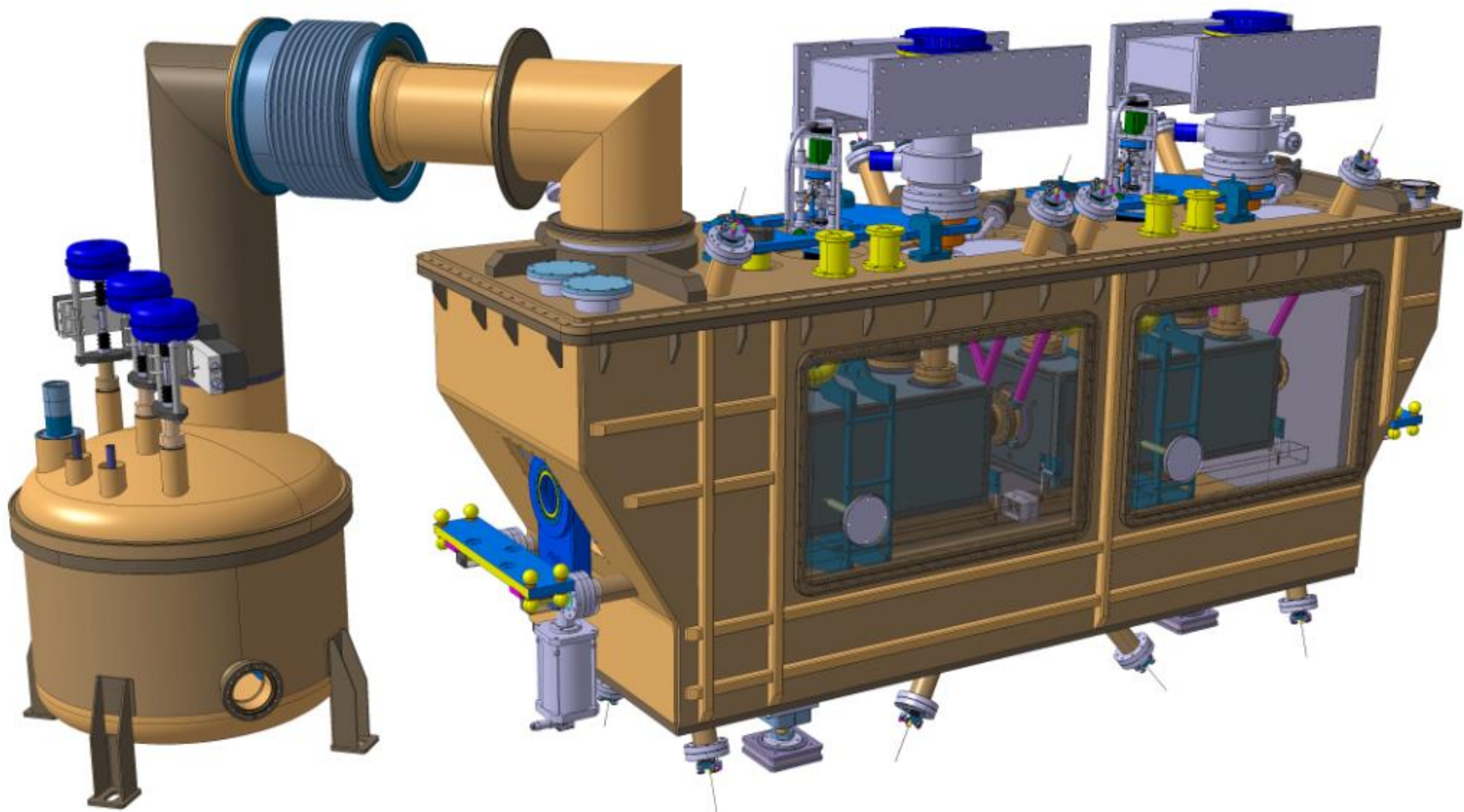
SPS Cryomodule: Include 2 identical cavities

Double Quarter Wave

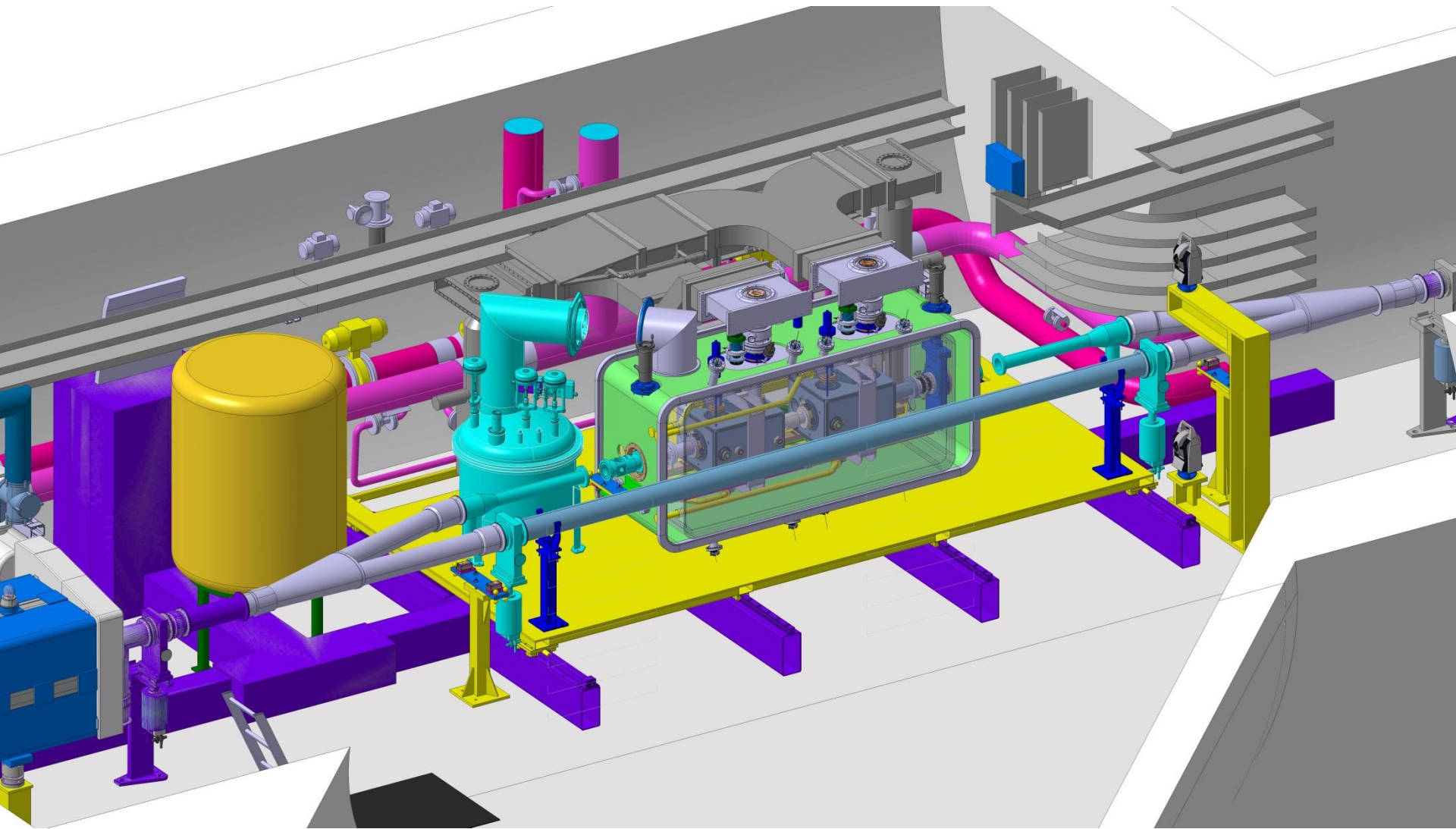


SPS Cryomodule: Include 2 identical cavities

RF Dipole

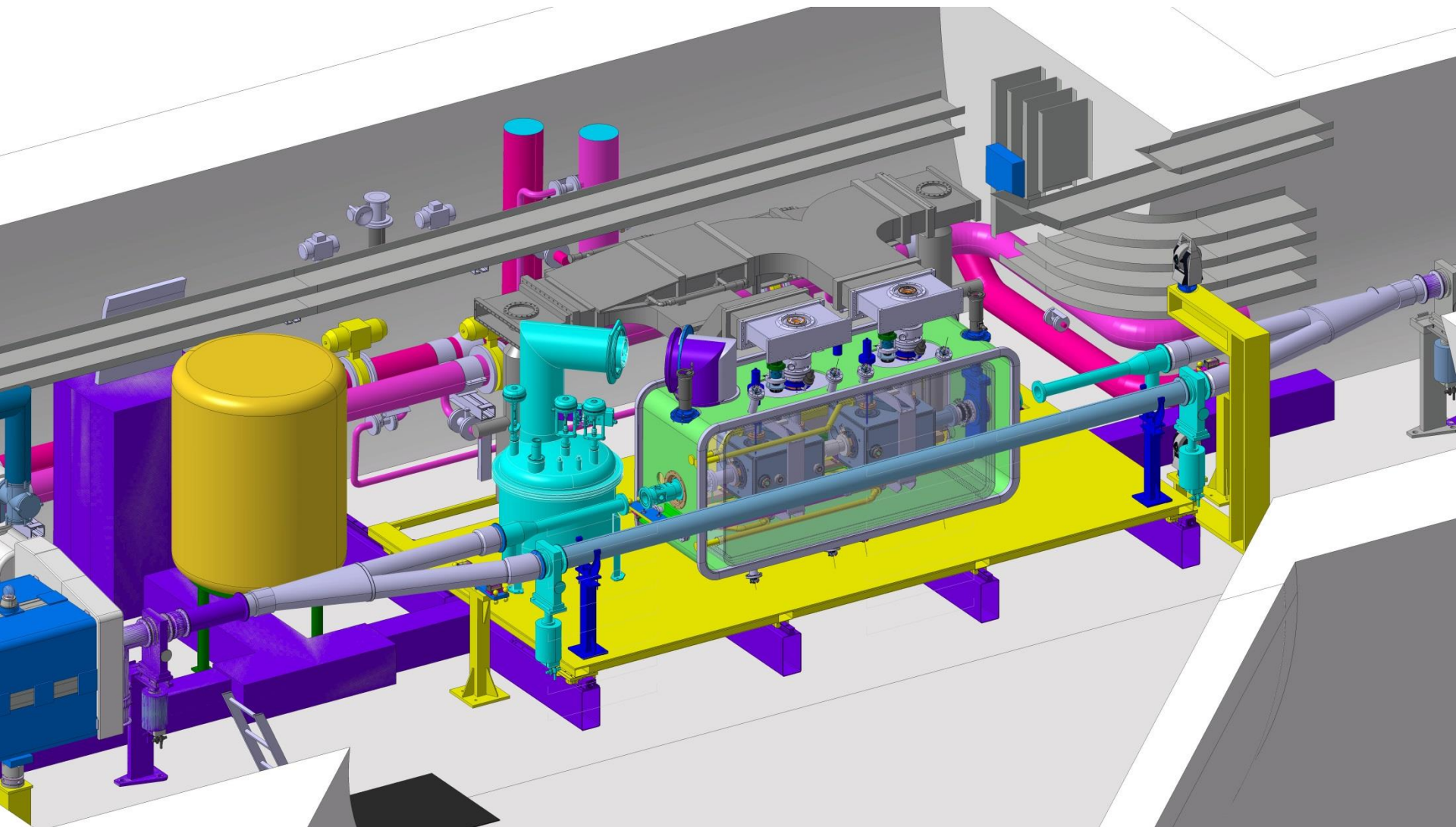


SPS: parking



this is illustration only as the location recently changed and integration in the new location is underway – see Giovanna’s talk this after-noon

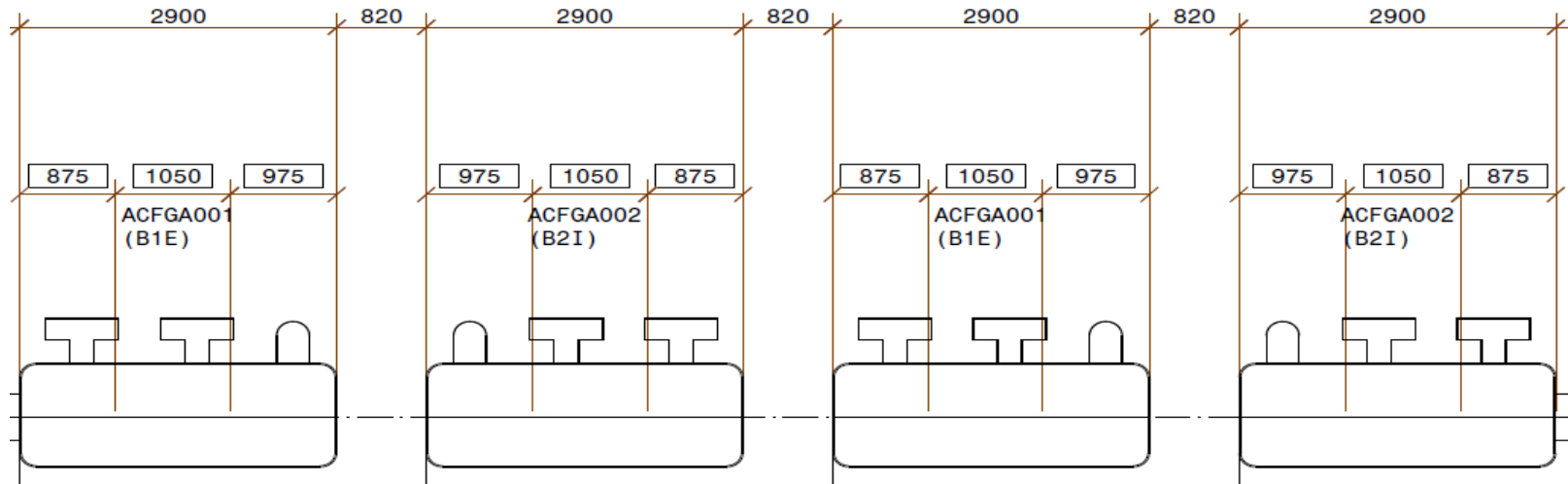
SPS: operation



this is illustration only as the location recently changed and integration in the new location is underway – see Giovanna’s talk this after-noon

LHC

- LHC layout: 4 “SPS like” cryomodules x 2 cavities each / IP side



Basic choices for the design:

Maximize modularity

Maximize compatibility between SPS and LHC

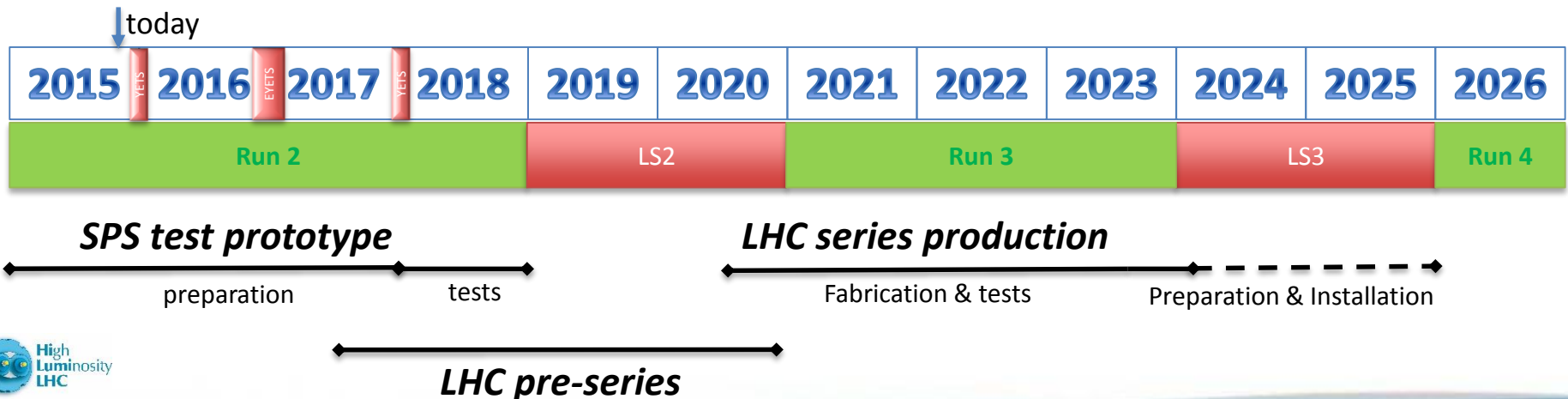
Standardize the solutions for the 2 types of cavities

General plans

- 2 cryomodules for SPS tests - test 1 cryomodule in 2018, the 2nd after LS2
 - 1 cryomodule with 2 identical cavities (type «vertical» - DQW)
 - 1 cryomodule with 2 identical cavities (type «horizontal» - RFD)
- 2 cryomodules pre-series for LHC (one of each type)
- 16 cryomodules for installation in LHC (8 of each type) + spares

post C&S review:

- all 32 dressed cavities to be produced
- only 8 cryomodules foreseen for installation in LS3 with subsequent cryomodules in the following technical stops
- this also allows schedule mitigation and flexibility to accommodate for crossing plane changes



Plans for SPS

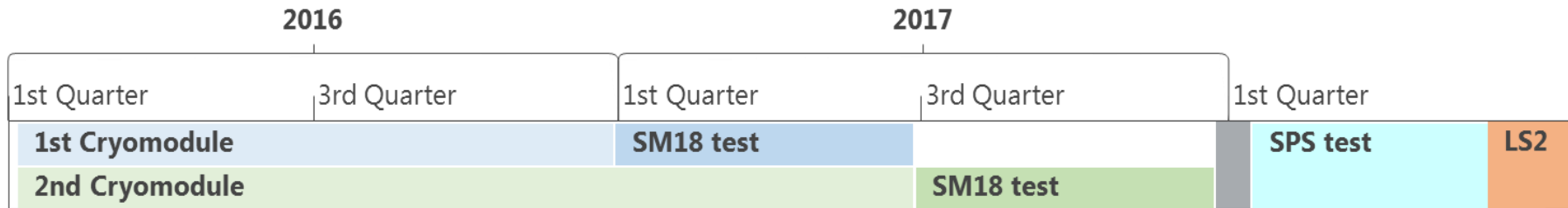
- Initial plans for SPS tests (USLARP meeting 2014):
 - Dressed cavities
 - USLARP to provide cavities fully dressed, processed and cold tested, ready for assembly in cryomodule
 - UK to provide RF and mechanical design support for the remaining two cavities (Many thanks!)
 - Cryomodules
 - Design by CERN & UK; Manufacturing, assembly and test by CERN

Plans for SPS

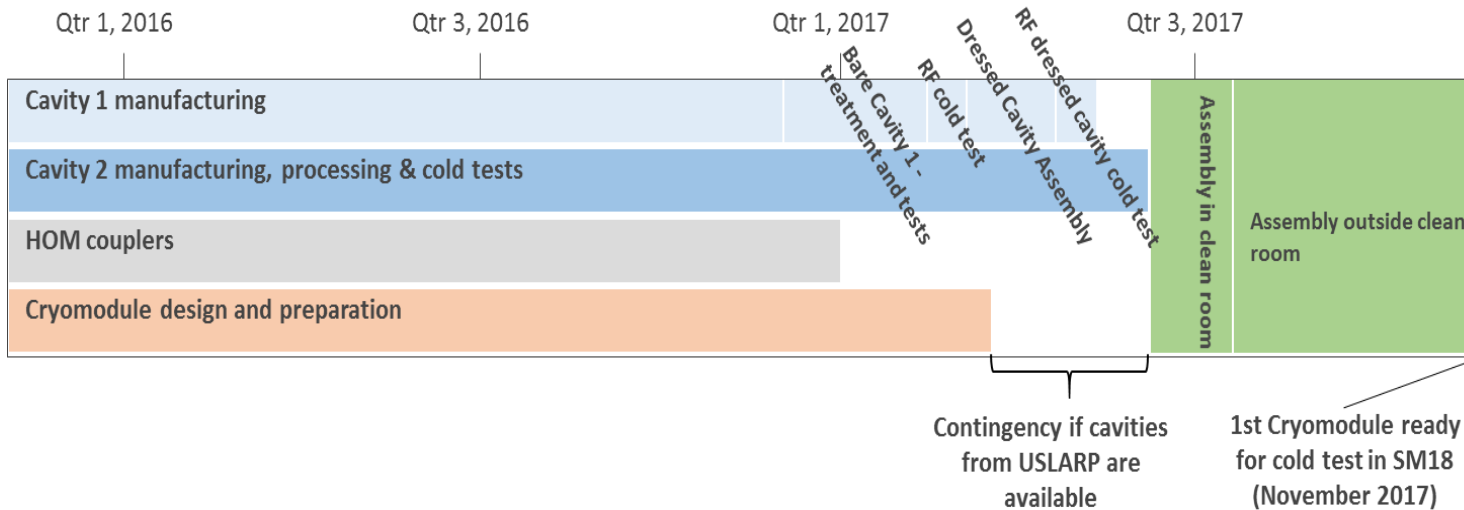
- Updated plans for SPS tests (beginning 2015):
 - Dressed cavities
 - USLARP to provide bare cavities and helium vessels;
 - UK to provide cold magnetic shielding
 - CERN to provide HOMs and tuning systems
 - USLARP to provide assembly of dressed cavities, processing and cold tests
 - Cryomodule
 - Design by CERN & UK; Manufacturing, assembly and test by CERN
- Due to lack of details, non-conformities and transparency of the fabrication process of bare cavities we have updated the plans for the SPS tests (October 2015)
 - The US production of cavities is likely to accumulate additional delays
 - CERN is accelerating the parallel production line for one type of cavities and the respective helium vessel

Plans for SPS

- Plans from C&S review for SPS cryomodules



- Recently updated plans (October 2015)



Dressed cavities

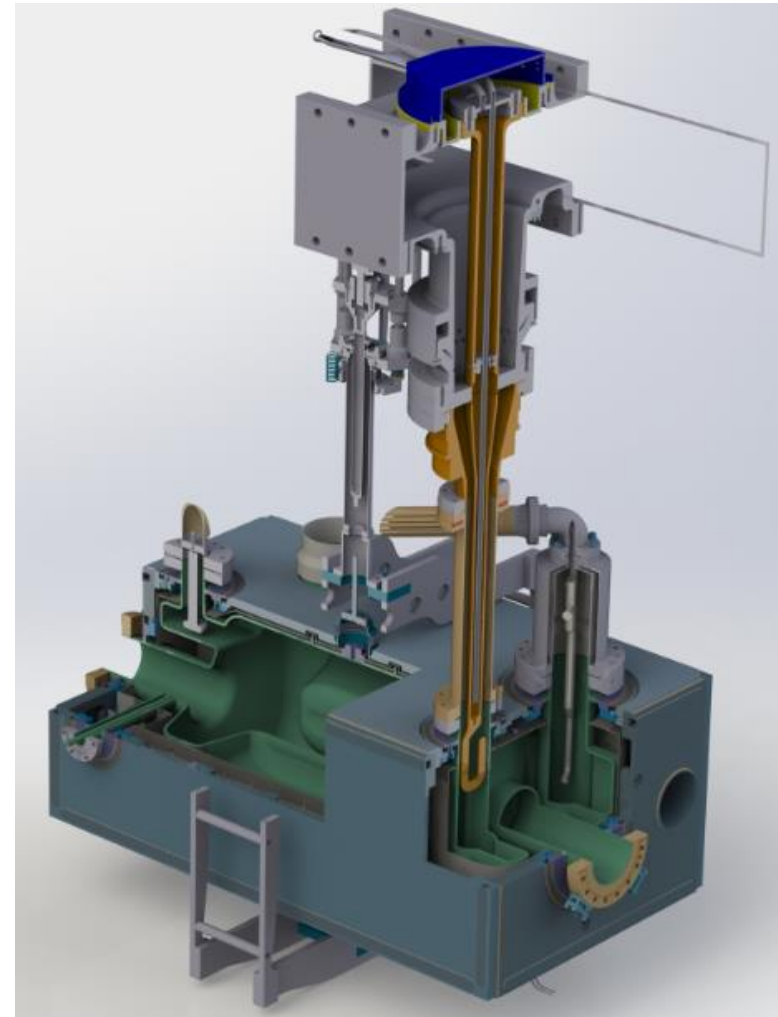
Double Quarter Wave



- Cavity Review - May 2014, BNL
- HOM Coupler Review - February 2015, JLAB
- Helium Vessel Review - May 2015, CERN

Dressed cavities

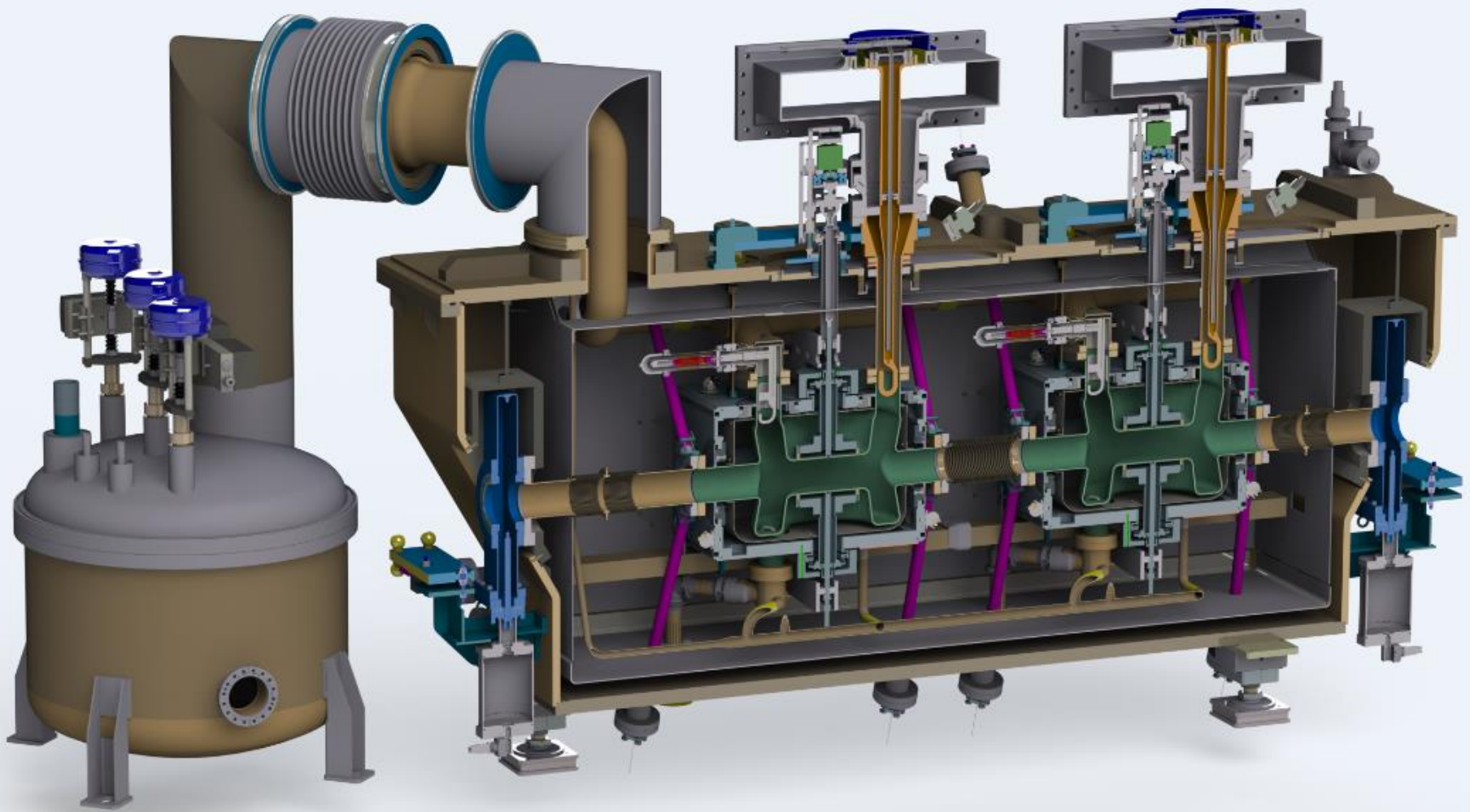
RF Dipole



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- Helium Vessel Review - May 2015, CERN

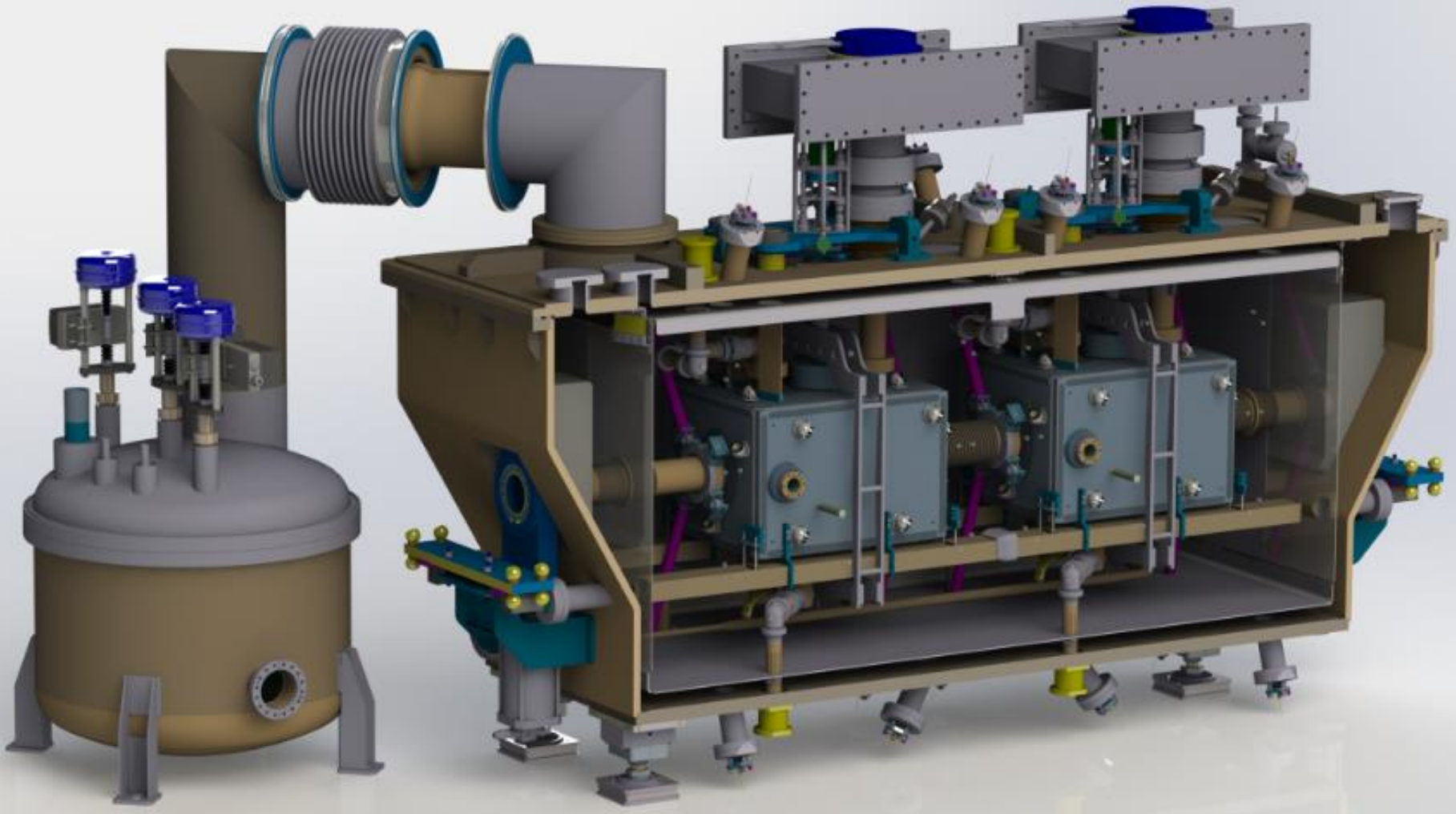
SPS Cryomodule

Double Quarter Wave



SPS Cryomodule

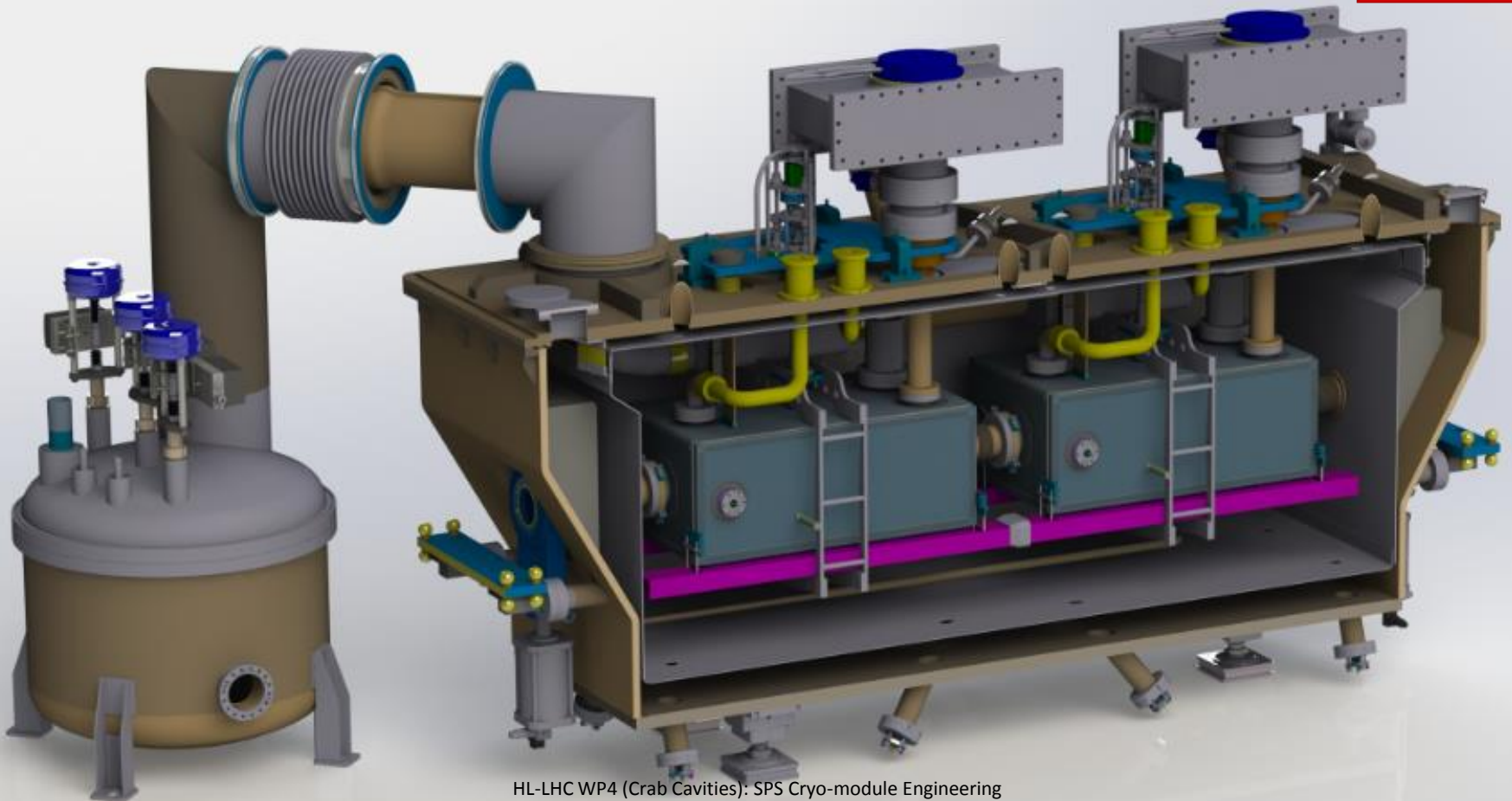
Double Quarter Wave



SPS Cryomodule

- Maximum compatibility between DQW and RFD cryomdules designs
- Both cryomodules components planned to be ready by 1st Quarter 2017 if USLARP cavities available for assembly in cryomodule

RF Dipole



HL-LHC WP4 (Crab Cavities): SPS Cryo-module Engineering
Review, 10/11/2015

Next talks will detail the different components