



**LS2 Days:**

## **Update on HL-LHC Activities during LS2**

Laurent Tavian, ATS-DO

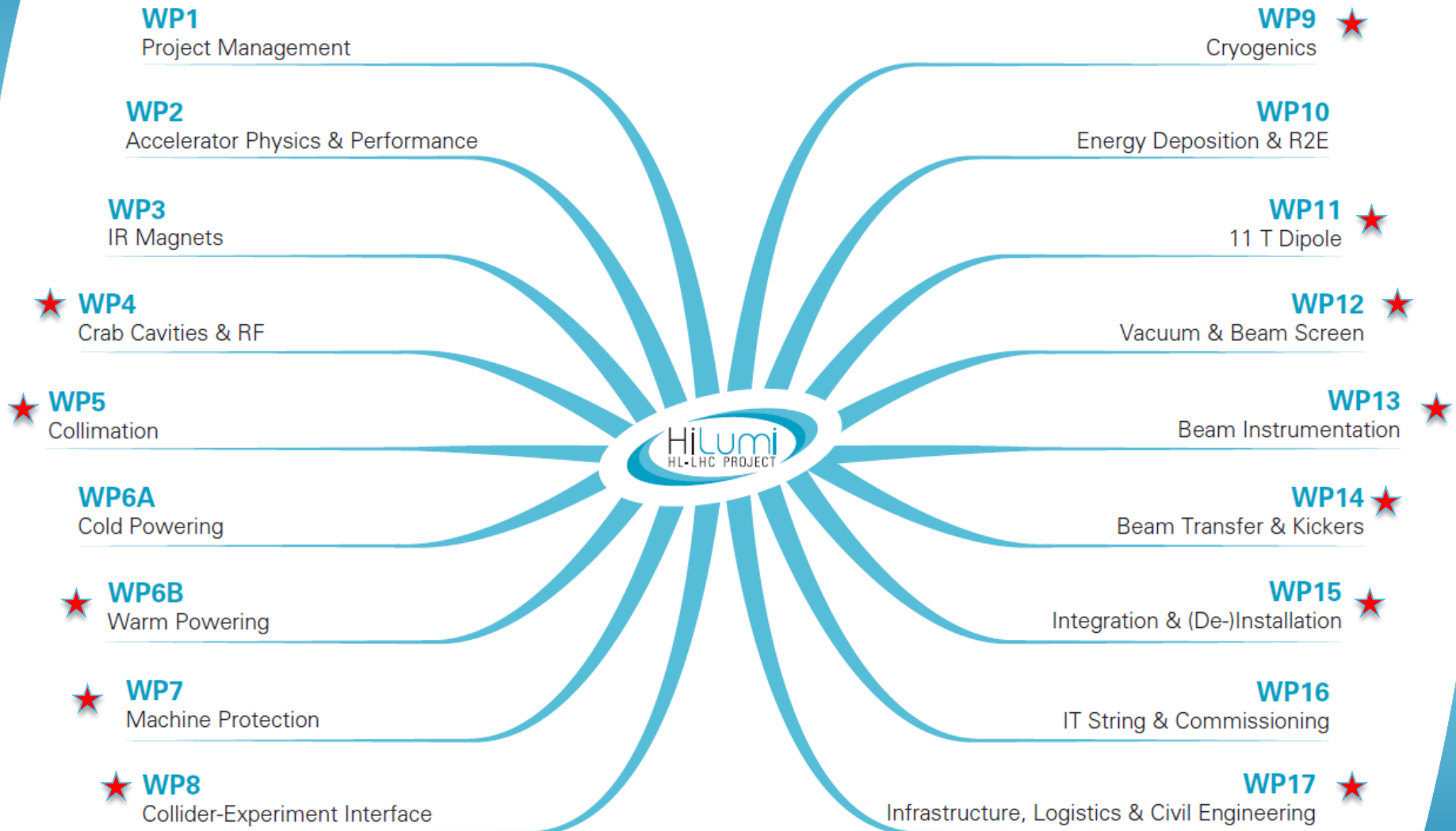
with the contribution of the HL-LHC WP Leaders

CERN, 7-8 November 2016

# Agenda

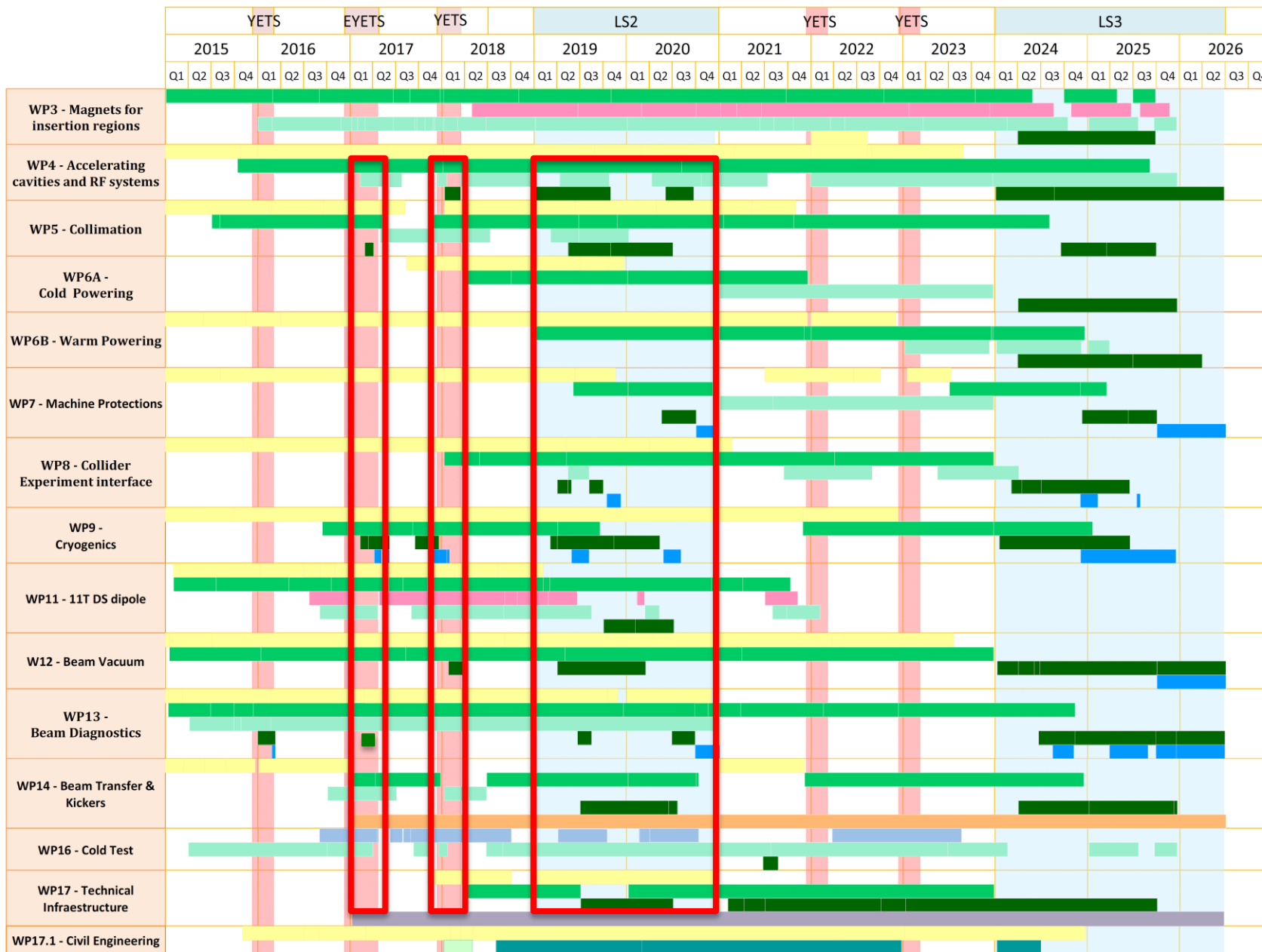
- Introduction
- HL-LHC activity inventory
  - Period and location
  - Activities by HL-LHC work-packages and Group support
  - ECR and PLAN status
- Review of activities and corresponding schedule
- Conclusion

# HL-LHC Project structure



★ With EYETS, YETS & LS2 installation activities

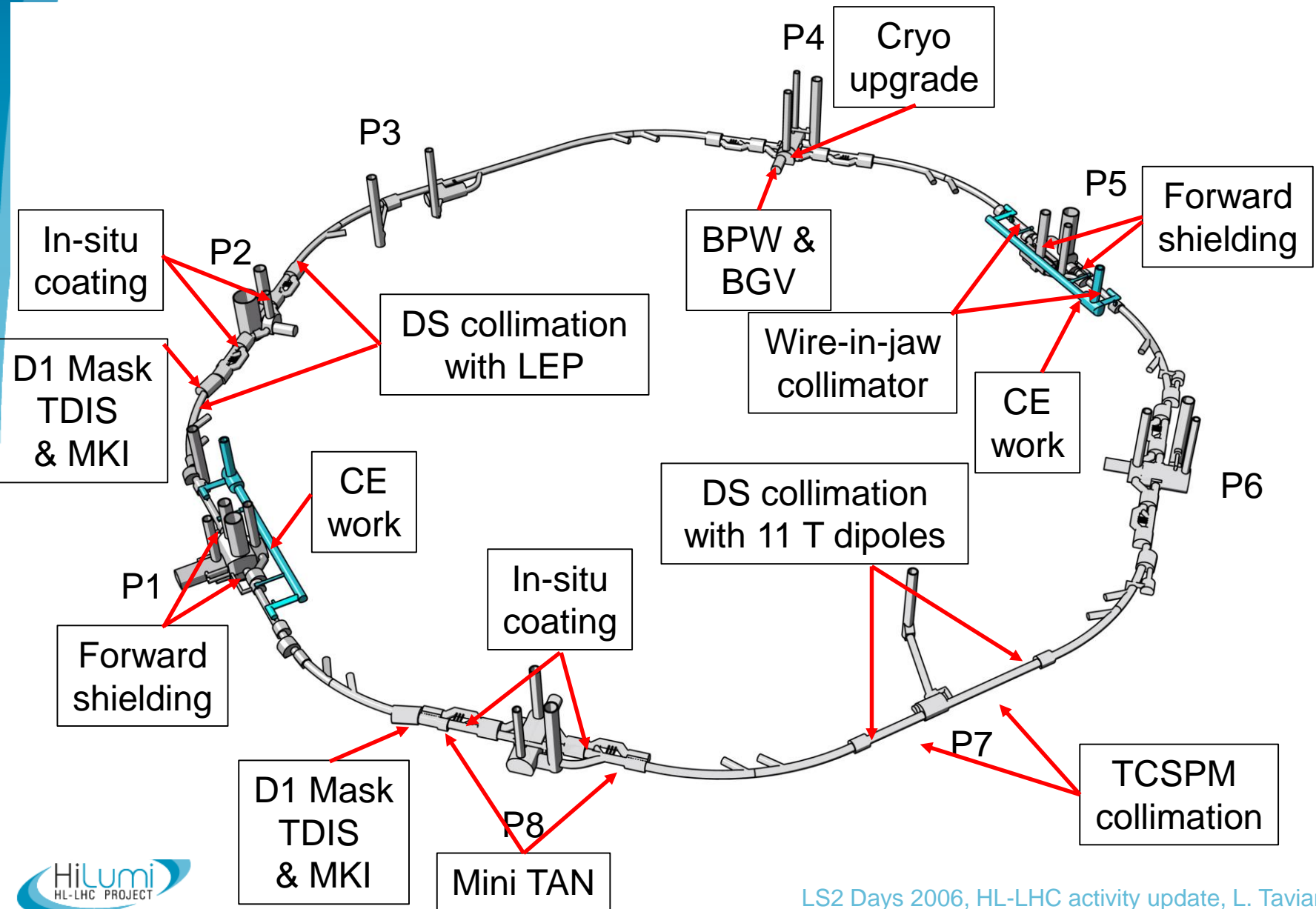
# HL-LHC master schedule



# Activity period and location

HL-LHC installation activities		Period	Location						
			P1	P2	P4	P5	P7	P8	SPS
SPS crab cavity	Crab cavity module	YETS & LS2							X
	Cryogenic system	EYETS & YETS							X
DS collimation	11 T Dipole	LS2					X		
	Cryo-bypass	LS2		X			X		
	Connection cryostat	LS2		X					
	TCLD collimator	LS2		X			X		
Halo cleaning	TCSPM sec. collimator	EYETS & LS2					X		
Beam screen in-situ coating (IT + D1)		LS2		X					X
Beam transfer & kickers	TDIS	LS2		X					X
	D1 Mask	LS2		X					X
	MKI	YETS & LS2		X					X
Beam instrument	High bandwidth BPM	LS2			X				
	Wire-in-jaw collimator	EYETS				X			
	Beam gas vertex detector	LS2			X				
P4 cryo upgrade		LS2			X				
Collider-Experiment interface	Target absorber TAXN	LS2							X
	Forward shielding	LS2	X			X			
Civil engineering & technical infrastructure	underground structure	LS2	X			X			
	Surface construction	YETS & LS2	X			X			
	EL and OF network rerouting	EYETS	X						
	technical infra for UPR	LS2	X			X			

# HL-LHC underground activities



# Activity of HL-LHC WP

HL-LHC installation activities		Period	HL-LHC WP												
			4	5	6B	7	8	9	11	12	13	14	15	17	
SPS crab cavity	Crab cavity module	YETS & LS2	X						X		X			X	X
	Cryogenic system	EYETS & YETS							X						X
DS collimation	11 T Dipole	LS2			X	X			X	X	X			X	X
	Cryo-bypass	LS2							X	X	X			X	X
	Connection cryostat	LS2							X	X	X			X	X
	TCLD collimator	LS2		X							X			X	X
Halo cleaning	TCSPM sec. collimator	EYETS & LS2		X							X			X	X
Beam screen in-situ coating (IT + D1)		LS2									X			X	
Beam transfer & kickers	TDIS	LS2									X		X		
	D1 Mask	LS2									X		X		
	MKI	YETS & LS2									X		X		
Beam instrument	High bandwidth BPM	LS2									X	X		X	
	Wire-in-jaw collimator	EYETS										X		X	
	Beam gas vertex detector	LS2										X		X	
P4 cryo upgrade		LS2							X						X
Collider-Experiment interface	Target absorber TAXN	LS2						X			X			X	X
	Forward shielding	LS2						X			X			X	X
Civil engineering & technical infrastructure	underground structure	LS2													X
	Surface construction	YETS & LS2													X
	EL and OF network rerouting	EYETS													X
	technical infra for UPR	LS2												X	X

X: Leader

# Group contribution for installation

HL-LHC installation activities		Period	Group contribution for installation																		
			ABP	ABT	ACE	BI	CRG	CV	EA	EL	EPC	HE	ICS	MME	MPE	MSC	RF	SMB	STI	VSC	
SPS crab cavity	Crab cavity module	YETS & LS2			X		X			X		X		X		X				X	
	Cryogenic system	EYETS & YETS					X	X		X		X	X								
DS collimation	11 T Dipole	LS2			X		X			X	X	X		X	X	X				X	
	Cryo-bypass	LS2			X		X					X		X		X				X	
	Connection cryostat	LS2			X		X					X		X		X				X	
	TCLD collimator	LS2	X		X					X		X		X					X	X	
Halo cleaning	TCSPM sec. collimator	EYETS & LS2	X		X					X		X		X					X	X	
Beam screen in-situ coating (IT + D1)		LS2			X		X							X		X					X
Beam transfer & kickers	TDIS	LS2		X	X							X							X	X	
	D1 Mask	LS2		X												X				X	
	MKI	YETS & LS2		X																X	
Beam instrument	High bandwidth BPM	LS2			X	X															X
	Wire-in-jaw collimator	EYETS			X	X				X	X										X
	Beam gas vertex detector	LS2			X	X															X
P4 cryo upgrade		LS2					X	X		X		X	X						X		X
Collider-Experiment interface	Target absorber TAXN	LS2			X				X			X									X
	Forward shielding	LS2			X				X			X									X
Civil engineering & technical infrastructure	underground structure	LS2																	X		
	Surface construction	YETS & LS2																	X		
	EL and OF network rerouting	EYETS								X									X		
	technical infra for UPR	LS2			X				X		X		X	X							

X: Leader

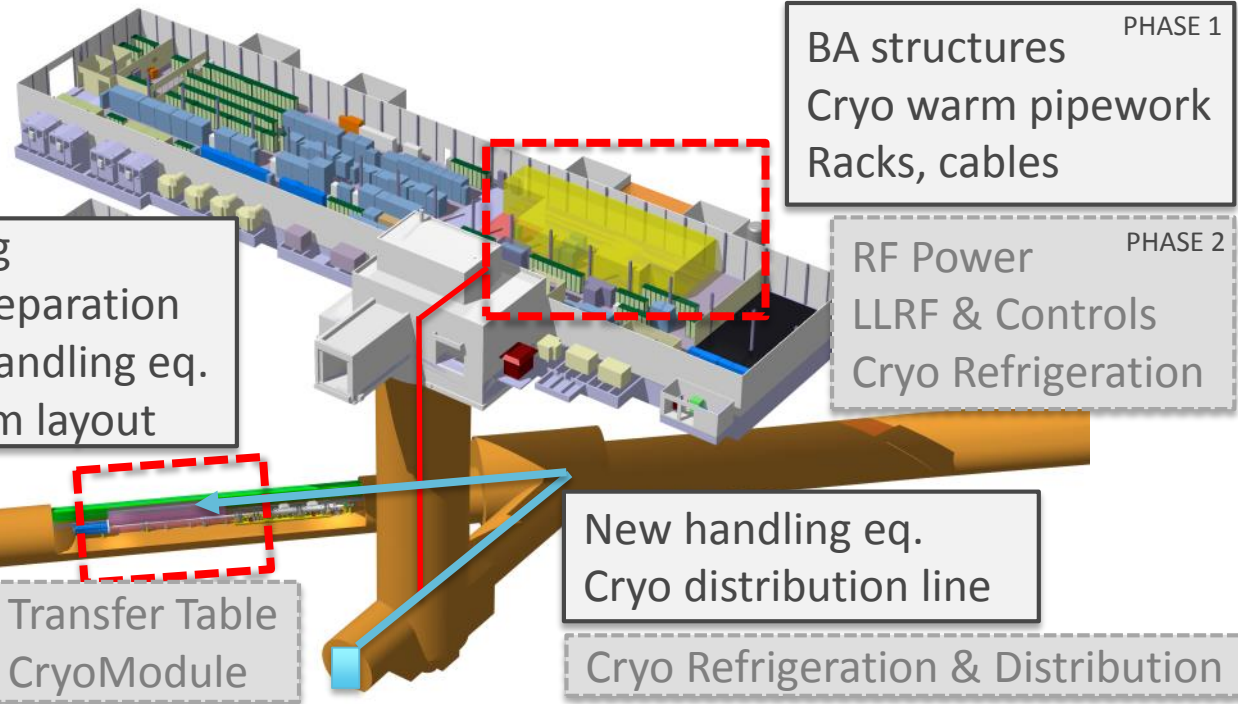


# LHC/SPS ECR and PLAN status

HL-LHC installation activities		Period	LHC or SPS ECR Status	PLAN Status	PLAN ID
SPS crab cavity	Crab cavity module	YETS & LS2	Under approval/ preparation	Resource Allocation	10843
	Cryogenic system	EYETS & YETS		Under Approval	10556
DS collimation	11 T Dipole	LS2	To be prepared	Under Approval	10677
	Cryo-bypass	LS2	To be prepared	Created/created	11216/11214
	Connection cryostat	LS2	To be prepared	To be added	To be added
	TCLD collimator	LS2	To be prepared	Under Approval/created	10643/11085
Halo cleaning	TCSPM sec. collimator	EYETS & LS2	?	Under Approval	10538
Beam screen in-situ coating (IT + DFBX +D1)		LS2	To be prepared	Created/created	11229
Beam transfer & kickers	TDIS	LS2	To be prepared	Under Approval	10015
	D1 Mask	LS2	To be prepared	?	?
	MKI	YETS & LS2	?	?	?
Beam instrument	High bandwidth BPM	LS2	To be prepared	To be added	To be added
	Wire-in-jaw collimator	EYETS	Released	Under Approval	10544
	Beam gas vertex detector	LS2	To be prepared	Under Approval	10645
P4 cryo upgrade		LS2	To be prepared	Under Approval	10540/10542/10543
Collider-Experiment	Target absorber TAXN	LS2	in preparation	Under Approval	10833
	Forward shielding	LS2	To be prepared	To be added	To be added
Civil engineering & technical infrastructure	underground structure	LS2	N/A	N/A	N/A
	Surface construction	YETS & LS2	N/A	N/A	N/A
	EL and OF network rerouting	EYETS	N/A	?	?
	technical infra for UPR	LS2	To be prepared	To be added	To be added

# SPS crab-cavity infrastructure (WP4 and WP9)

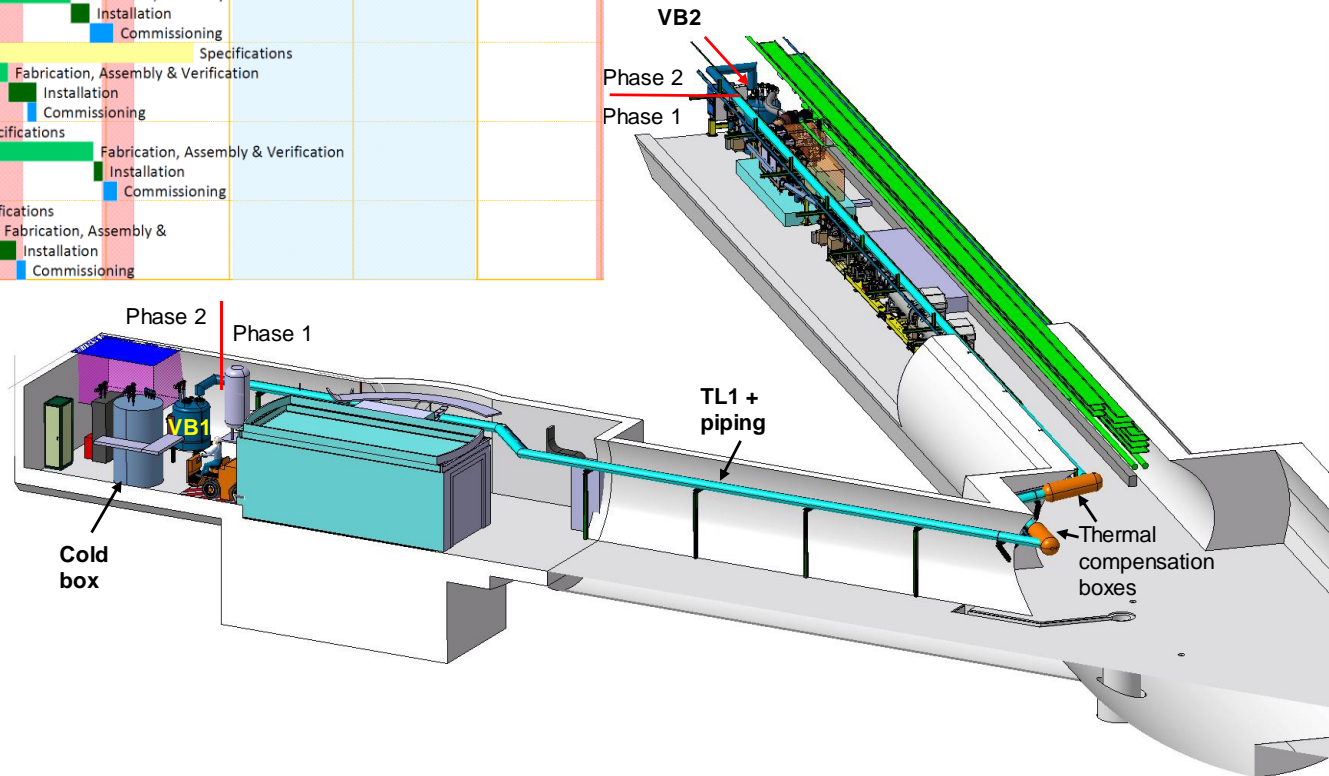
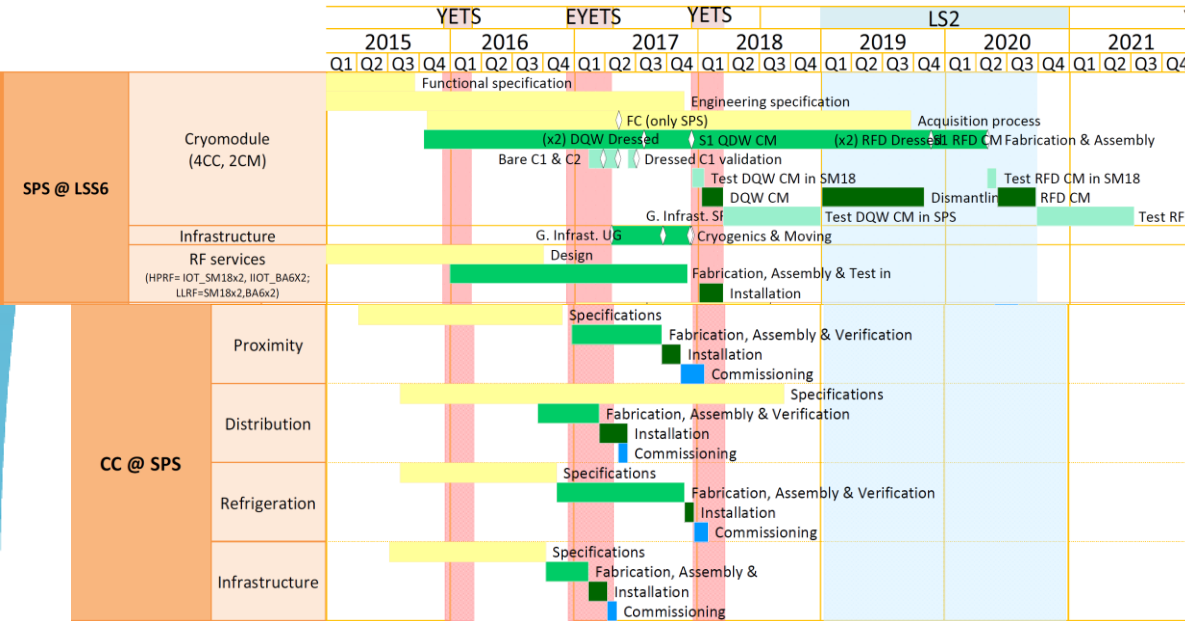
G. Vandoni



Preparation (YETS15-16)	BA6 cleared, uncabling tunnel
Integration	In progress, finalized for phase1 in EYETS16-17
Cryogenic distribution	Contract placed, phase1 in EYETS16-17
Infrastructure	Pipework, cables, handling rails: installation in EYETS16-17
Transfer Table	DPRQ 350 kCHF, MS at Spec committee, Tech.Spec in progress
Cryogenic Refrigeration	Offers received, LoI asked to confirm delivery <Jan'18

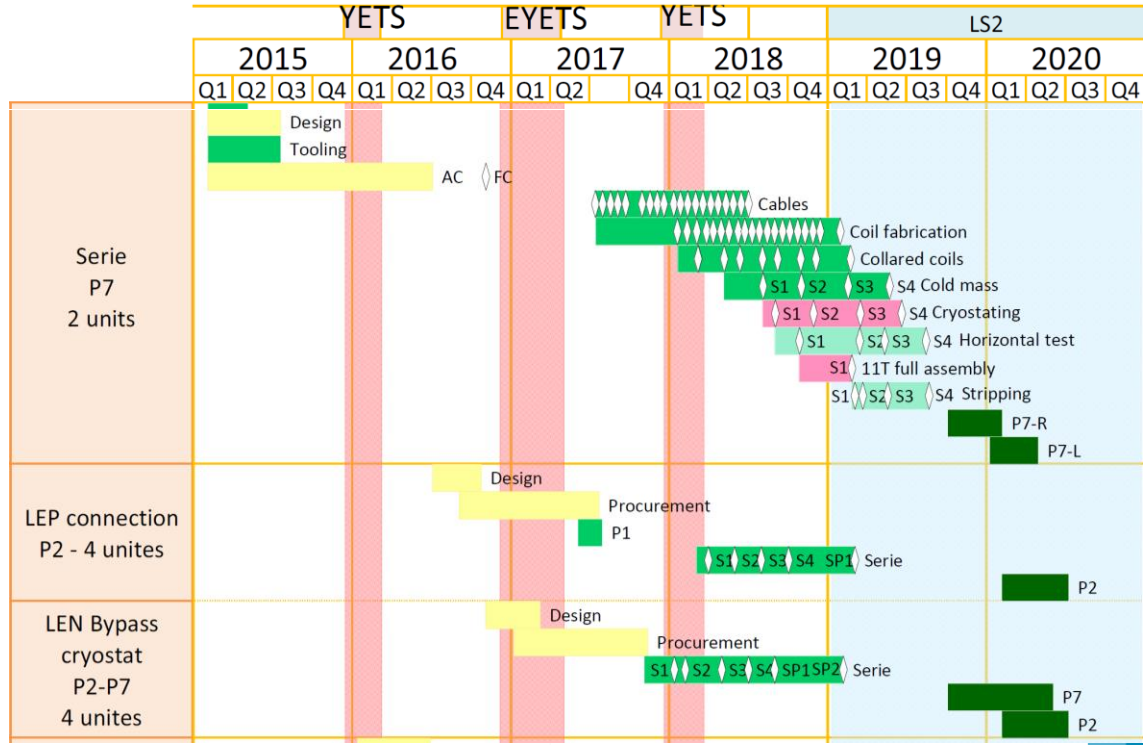
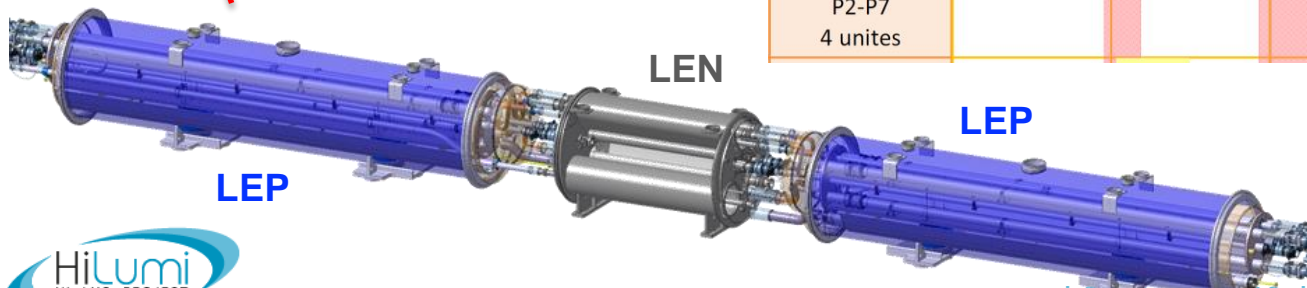
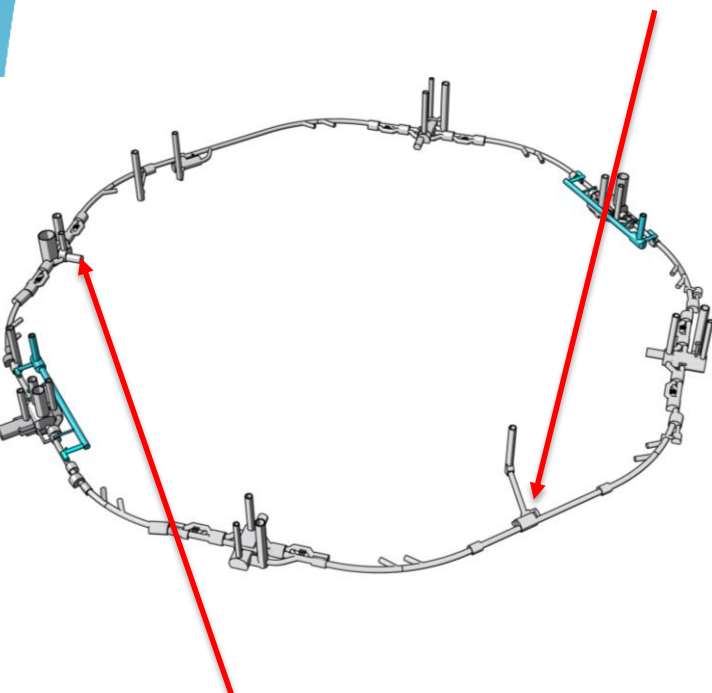
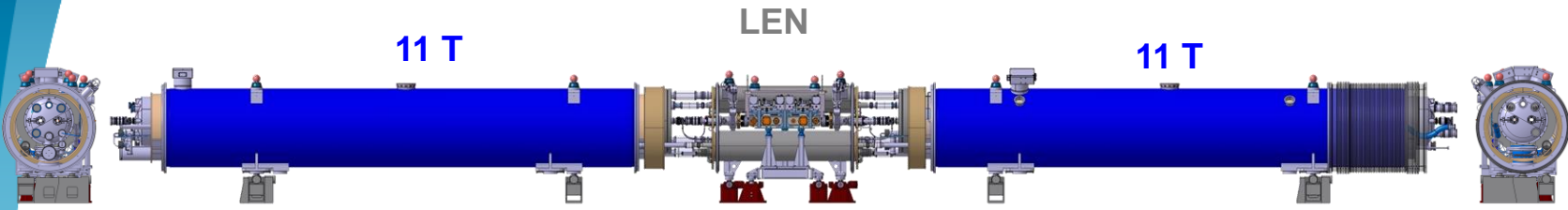
# SPS crab-cavity (WP4 and WP9)

First crab-cavity cryo-module fabrication and test as well as cryogenics equipment deliveries are on the critical path for installation readiness during EYETS and YETS.



# 11 T dipoles, bypass & connection cryostats (WP11)

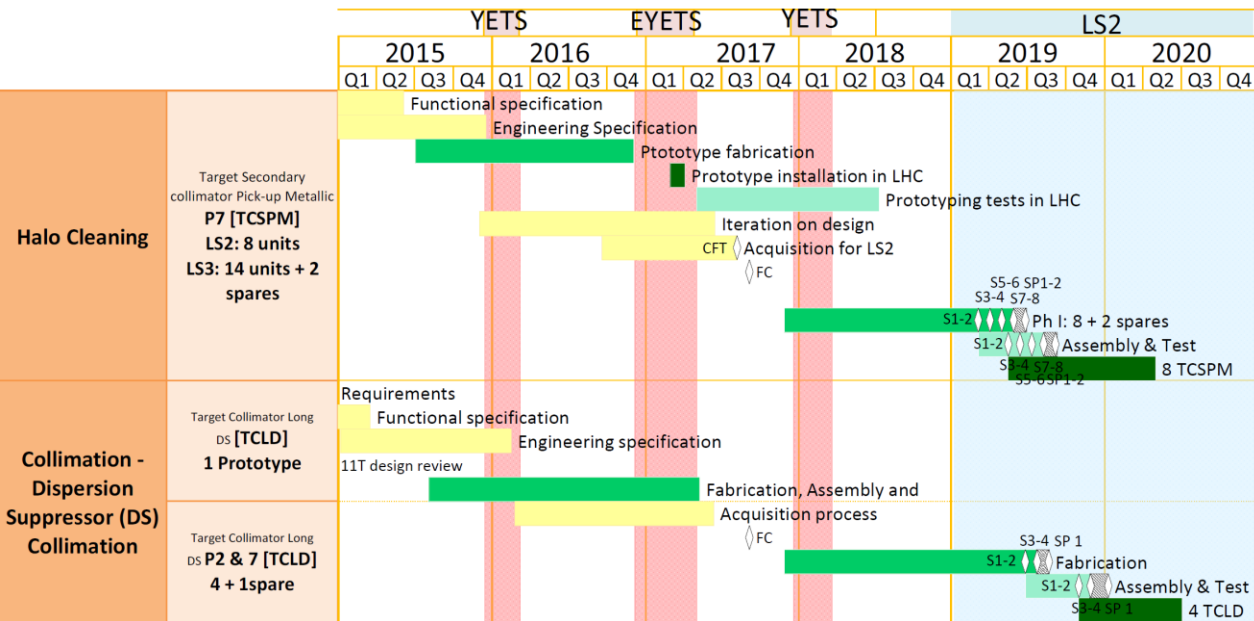
Point 7



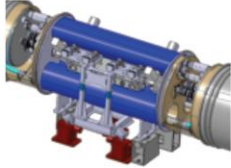
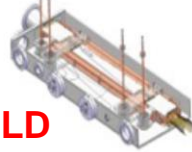
Point 2

F. Savary

# TCLD & TCSPM collimators (WP5)

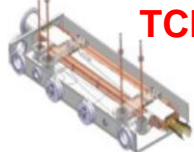


Cleaning: DS coll. + 11T dipoles, 1 unit per beam

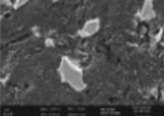



**TCLD**

Ion physics debris: DS collimation

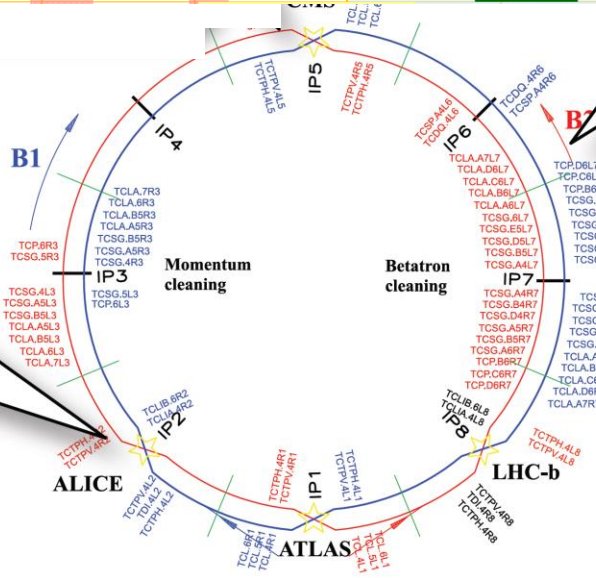


**TCLD**

Low-impedance, high robustness secondary collimators: coated MoGr

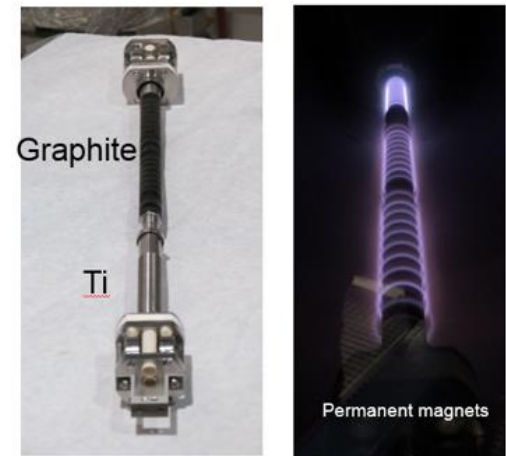
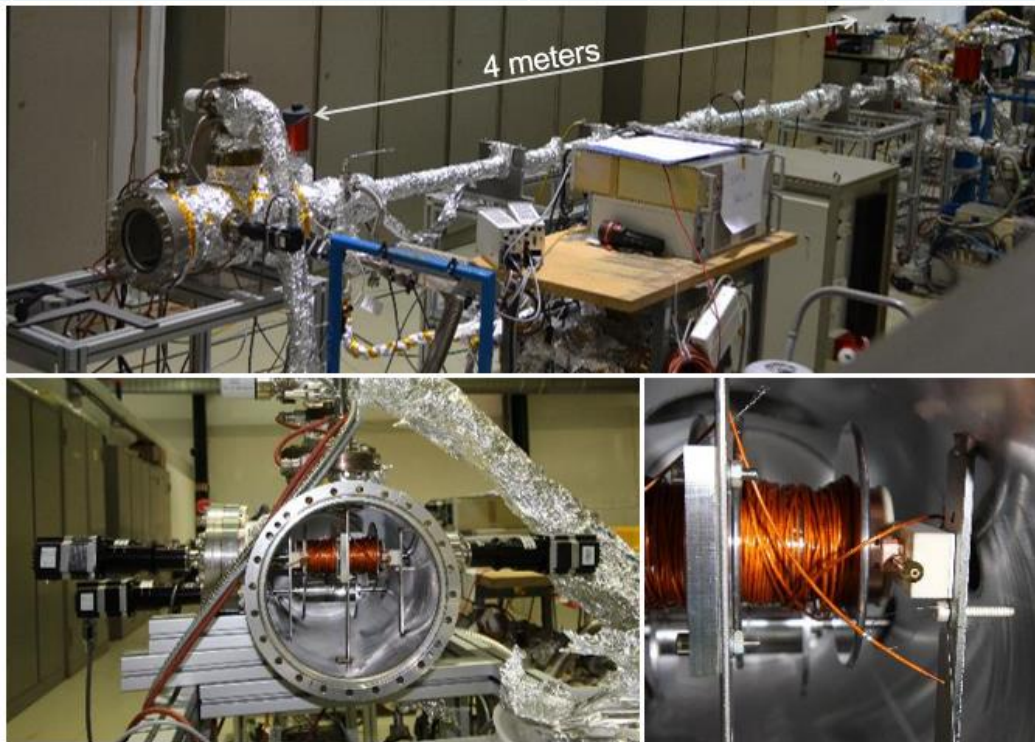





**TCSPM**



# In-situ coating of IT2 & 8 beam screens (WP12)

PBS	Equipment / Systems	March 2015 status	October 2016 status	Remarks
12.2.1	In-situ coating IT2 & 8			
	Laboratory mock-up	First tests	4 m long beam screen/ cold bore prototype assembly carbon coated	Coating procedure defined – Max secondary electron yield 1 +/- 0.1.



P. Costa Pinto  
P. Demolon

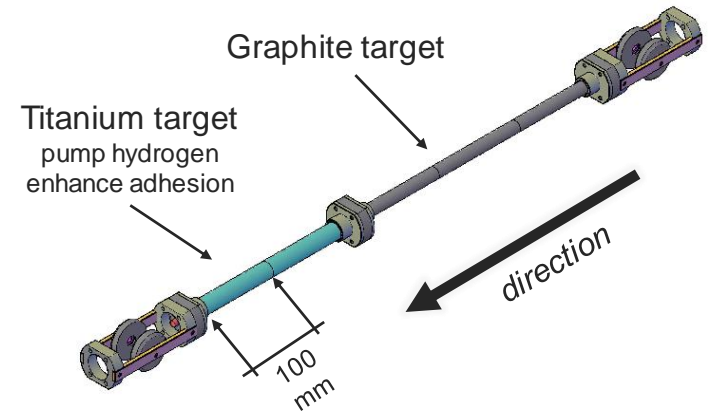
# In-situ coating of IT2 & 8 beam screens (WP12)

	YETS				EYET				YETS				LS2			
	2015		2016		2017		2018		2019		2020					
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
In-situ a-Coating P2 & P8	Requirement definition															
	Functional specification															
	Engineering specification															
					Fabrication, Assembly & Verification								Installation			

Length to be coated: ~45 meters per “string” (Q1, Q2, Q3, DFBX & D1)  
 Only 150 mm to insert a “coating device”

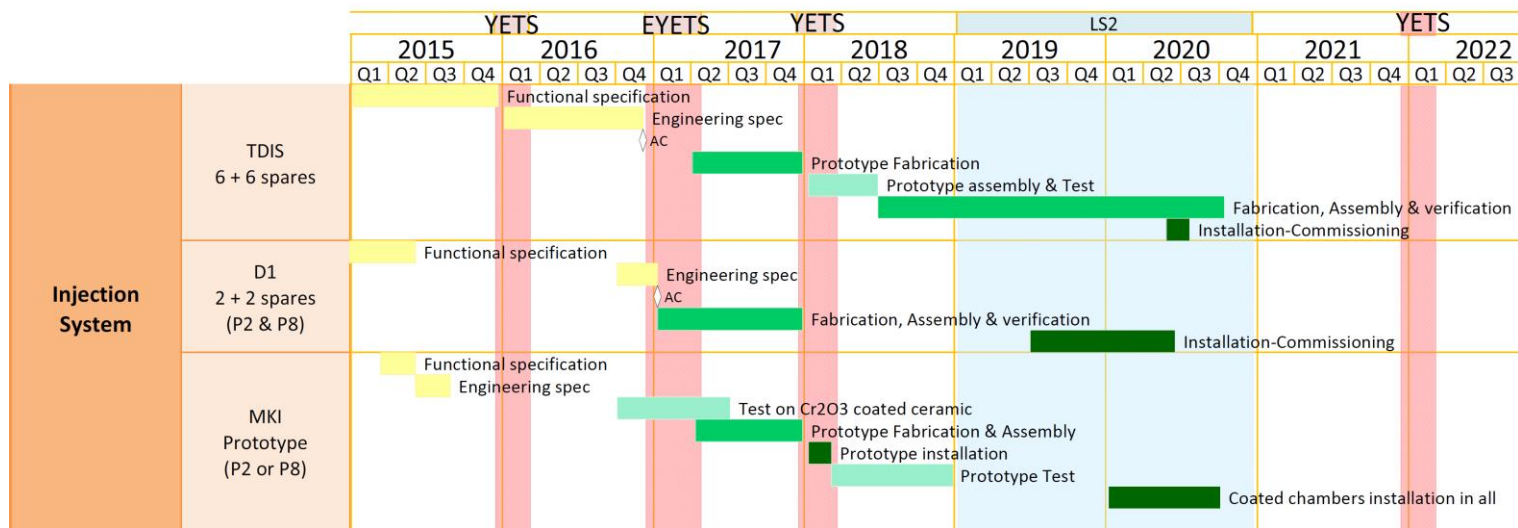


“modular sputtering source”  
 pulled by cables all along a magnet

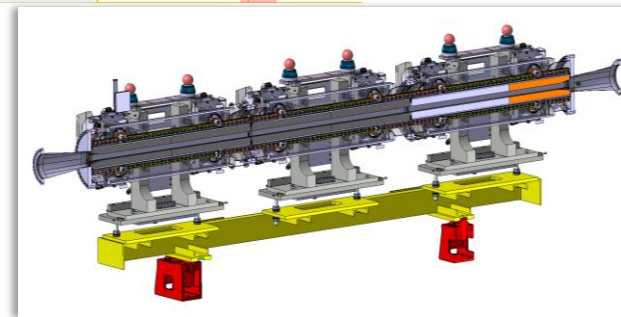


P. Costa Pinto

# Beam transfer & kickers (WP14)



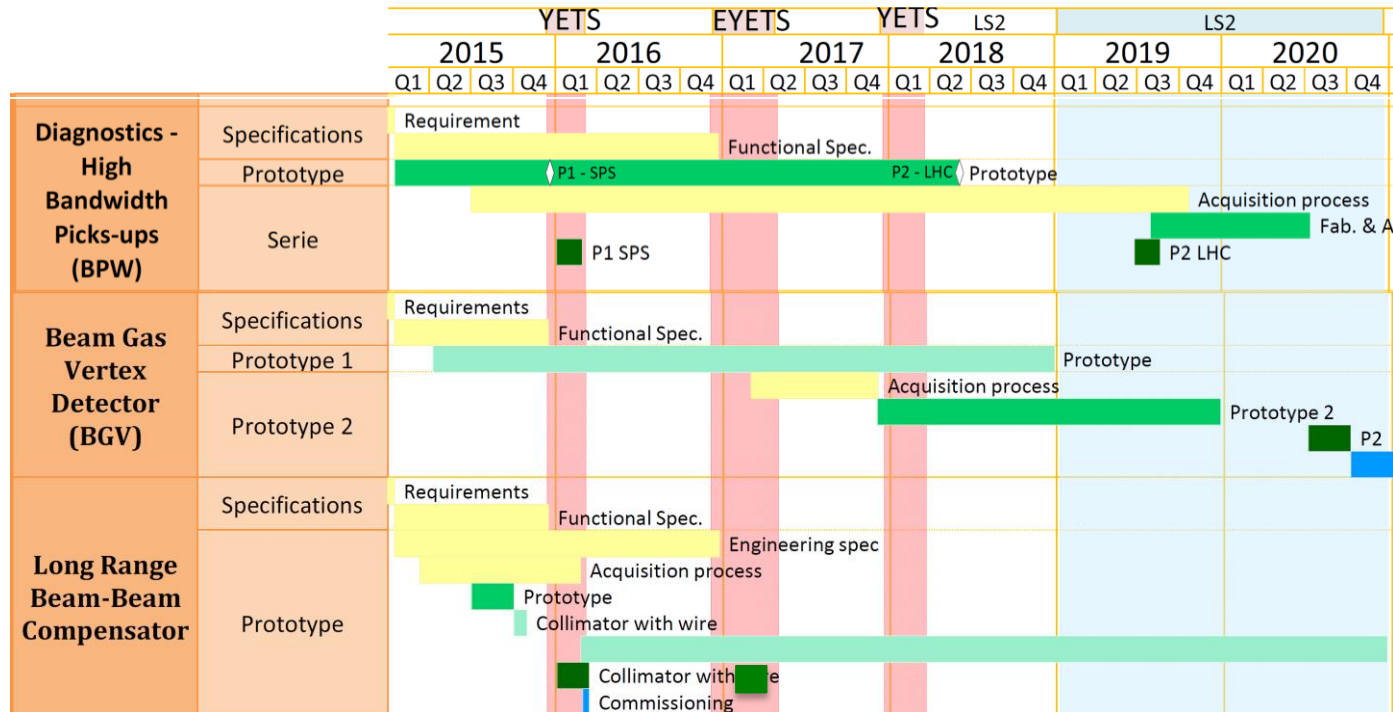
- TDIS:
  - Installation in the LHC → Q2 2020
- D1 Mask:
  - Installation in the LHC → LS2 (6 weeks including vacuum conditioning)
- MKI coated vacuum chambers:
  - Prototype installation in the LHC → YETS 2017-2018 → tests with beam until end of Run II
  - Installation of MKIs with coated chambers in LHC → LS2



C. Bracco



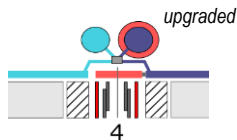
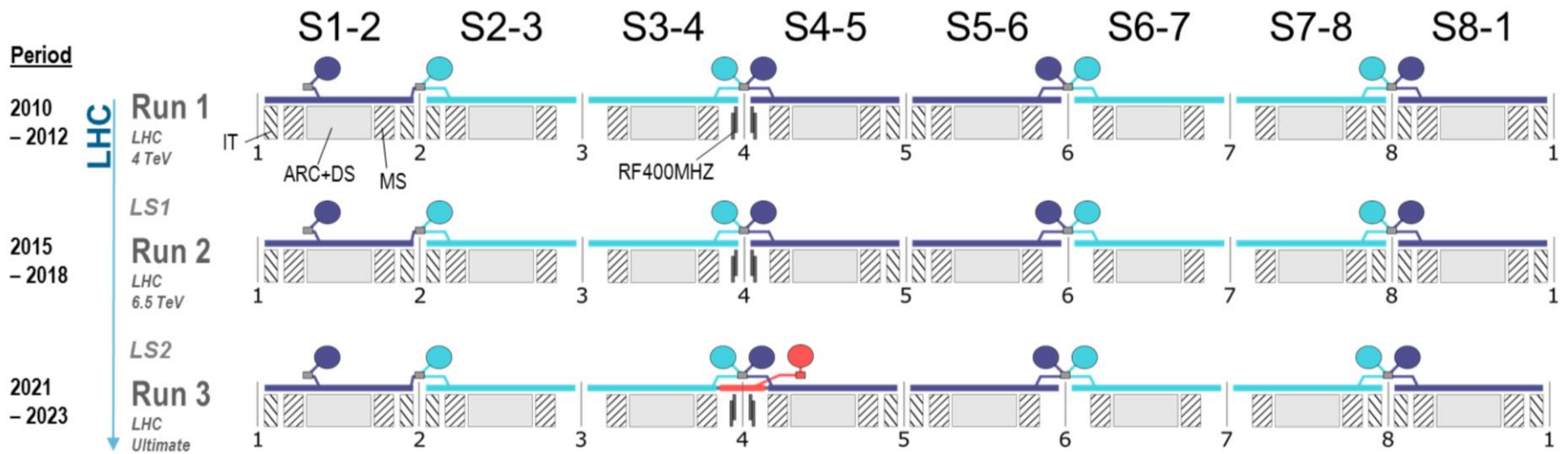
# Beam instrumentation (WP13)



- High bandwidth BPM
  - Test E/O BPM installed in SPS – optimisation ongoing
  - LHC prototype ready for LS2 installation
- Beam Gas Vertex Detector
  - Prototype 1 fully installed on Beam 2 under test
  - Decision by mid 2017 on how to equip the second beam → installation during LS2
- Wire-in-jaw collimator
  - 2 prototypes ready for installation during EYETS

R. Jones

# Cryogenics upgrade at P4 (WP9)

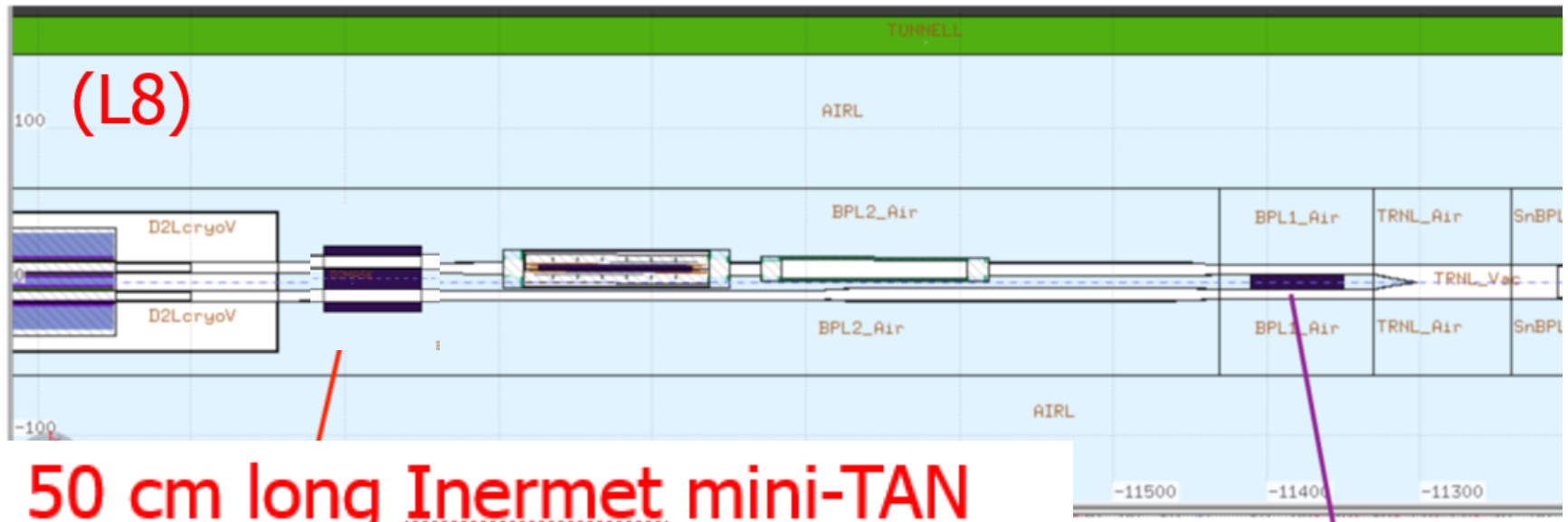


**Alternative Scenario**  
Upgrade of Refr. S4-5 for RUN3 onwards

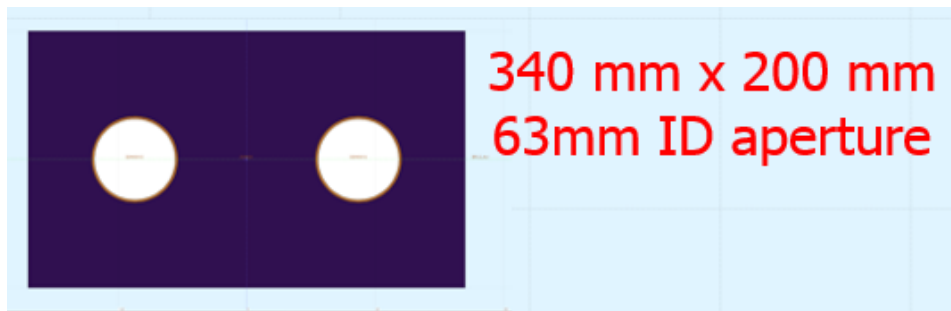
S. Claudet

P4		YETS				EYETS				YETS				LS2				2021											
		2015				2016				2017				2018				2019				2020				2021			
		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
Distribution	Specifications	[Yellow bar]																[Green bar]				[Green bar]				[Blue bar]			
	Fabrication, Assembly & Verification	[Green bar]																[Green bar]				[Green bar]				[Blue bar]			
	Installation	[Green bar]																[Green bar]				[Green bar]				[Blue bar]			
Refrigeration	Specifications	[Yellow bar]																[Green bar]				[Green bar]				[Blue bar]			
	Fabrication, Assembly & Verification	[Green bar]																[Green bar]				[Green bar]				[Blue bar]			
	Installation	[Green bar]																[Green bar]				[Green bar]				[Blue bar]			
Infrastructure	Specifications	[Yellow bar]																[Green bar]				[Green bar]				[Blue bar]			
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	Installation	[Green bar]																[Green bar]				[Green bar]				[Blue bar]			
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# Collider-experiment interface: New TAXN at P8 (WP8)

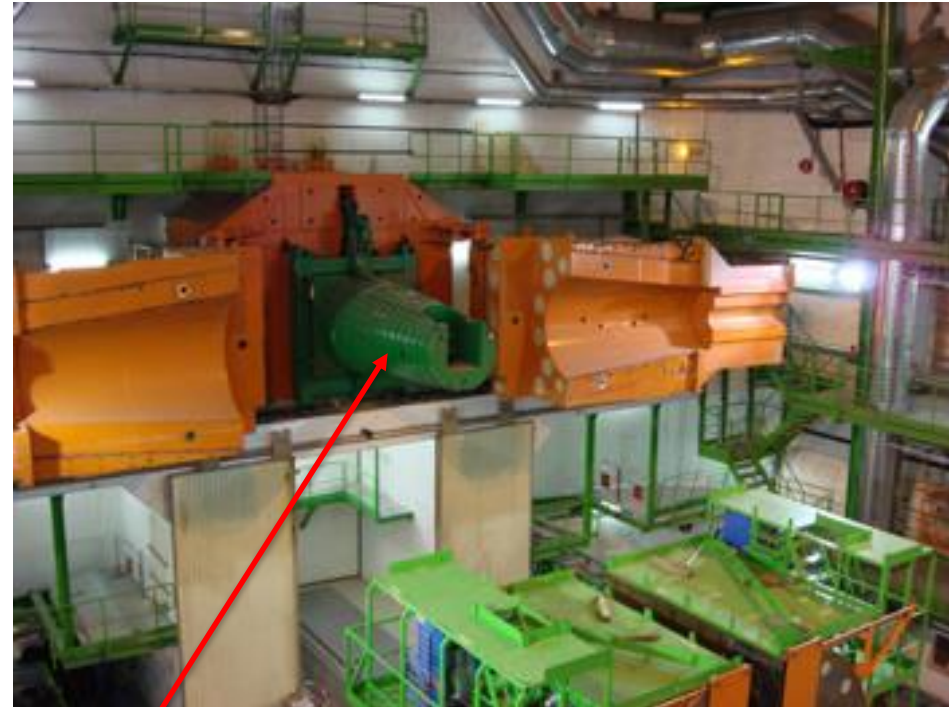
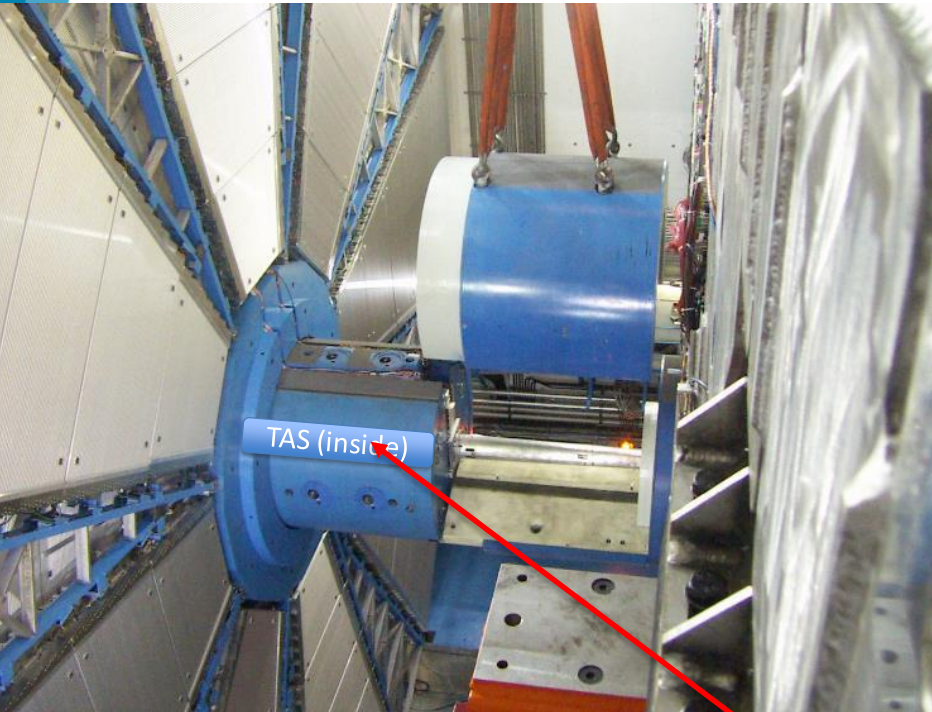


50 cm long Inermet mini-TAN  
at  $\sim 1.9$  m from the D2 IP-face

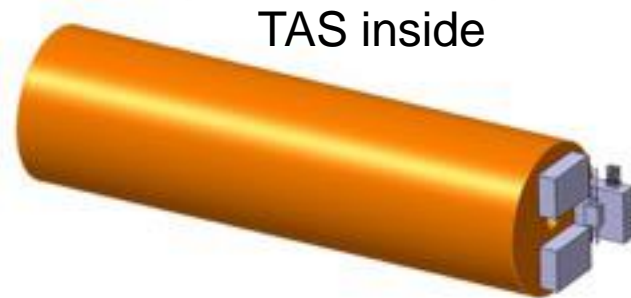


F. Sanchez-Galan

# Forward shielding modification at ATLAS and CMS (WP8)

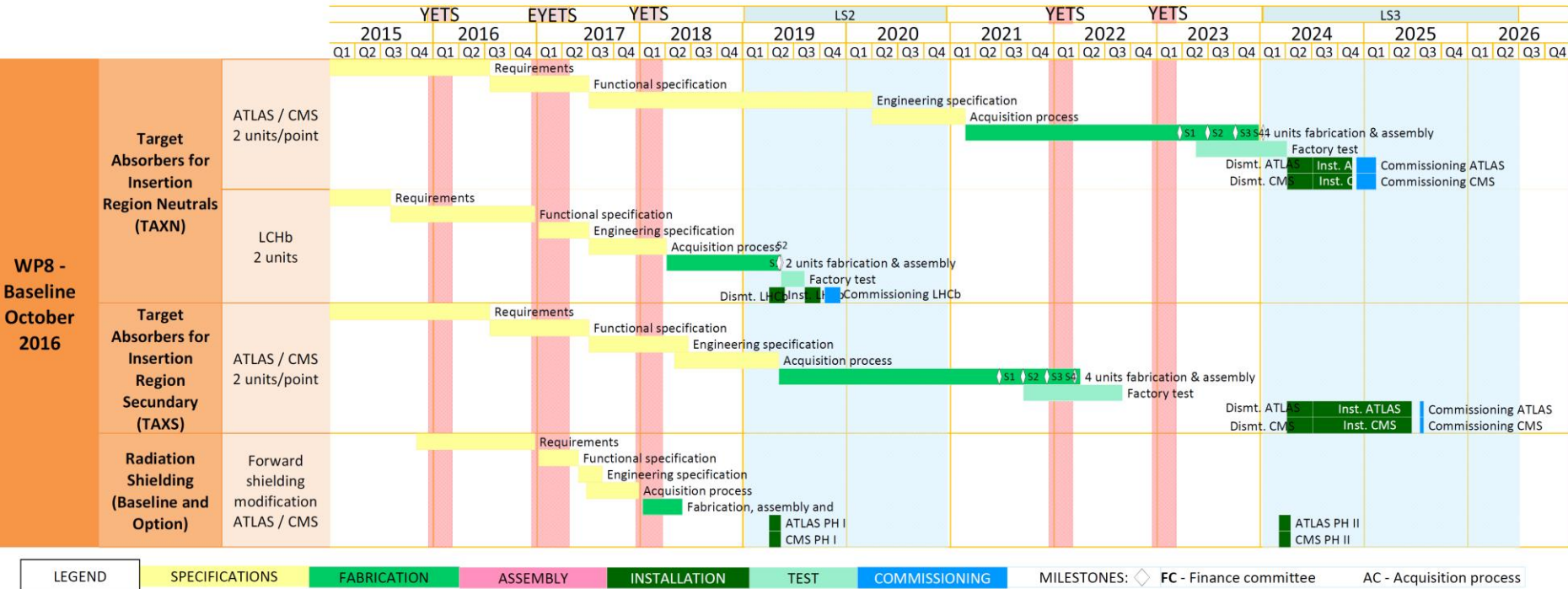


Forward Shielding is based on different principles in ATLAS and CMS



F. Sanchez-Galan

# Collider-experiment interface (WP8)

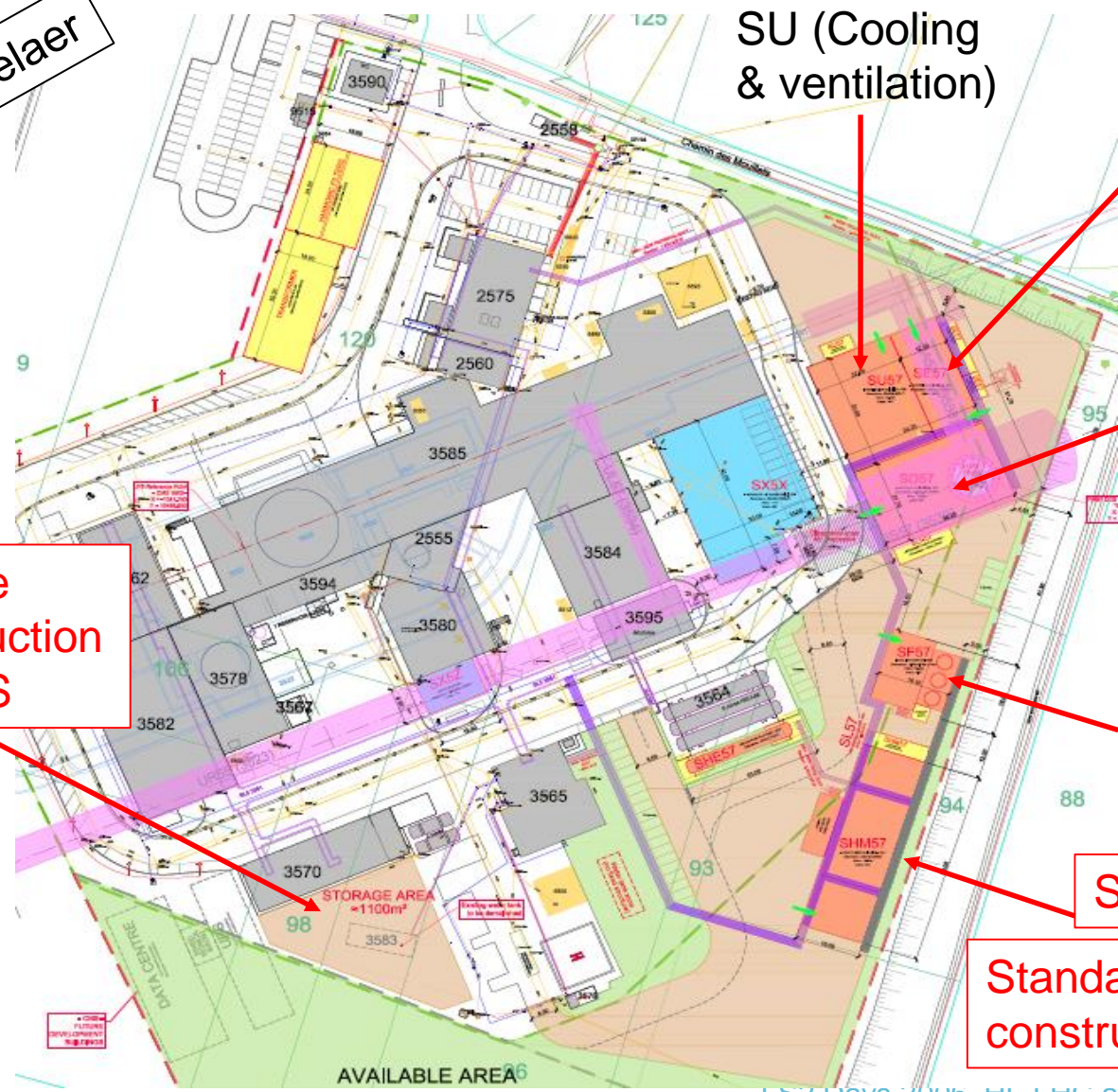


- TAXN installation @ Point 8 during LS2
- Forward shielding modification @ Points 1 and 5 during LS3 (baseline) or LS2 (option which relaxes LS3 experiment schedule & reduces radiation dose) → To be defined/approved in Q2 2017



# WP17.1: New HL-LHC surface buildings at Point 5

P. Mattelaer



New storage area construction during YETS

SF (Cooling & ventilation)

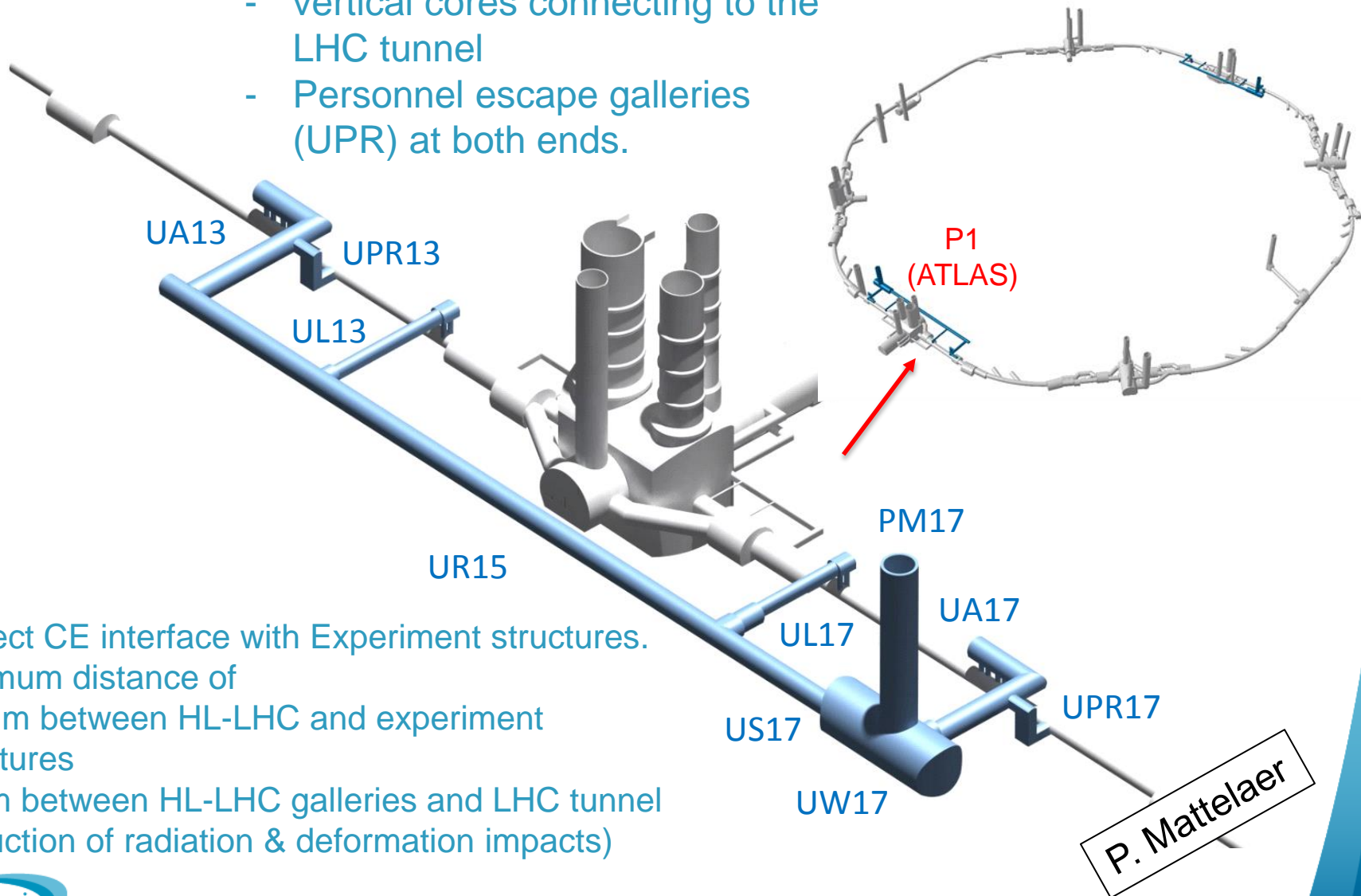
SHM (Cryogenics)

Standalone building construction during LS2

# WP17.1: HL-LHC underground structures at Point 1

Based on double-decker with:

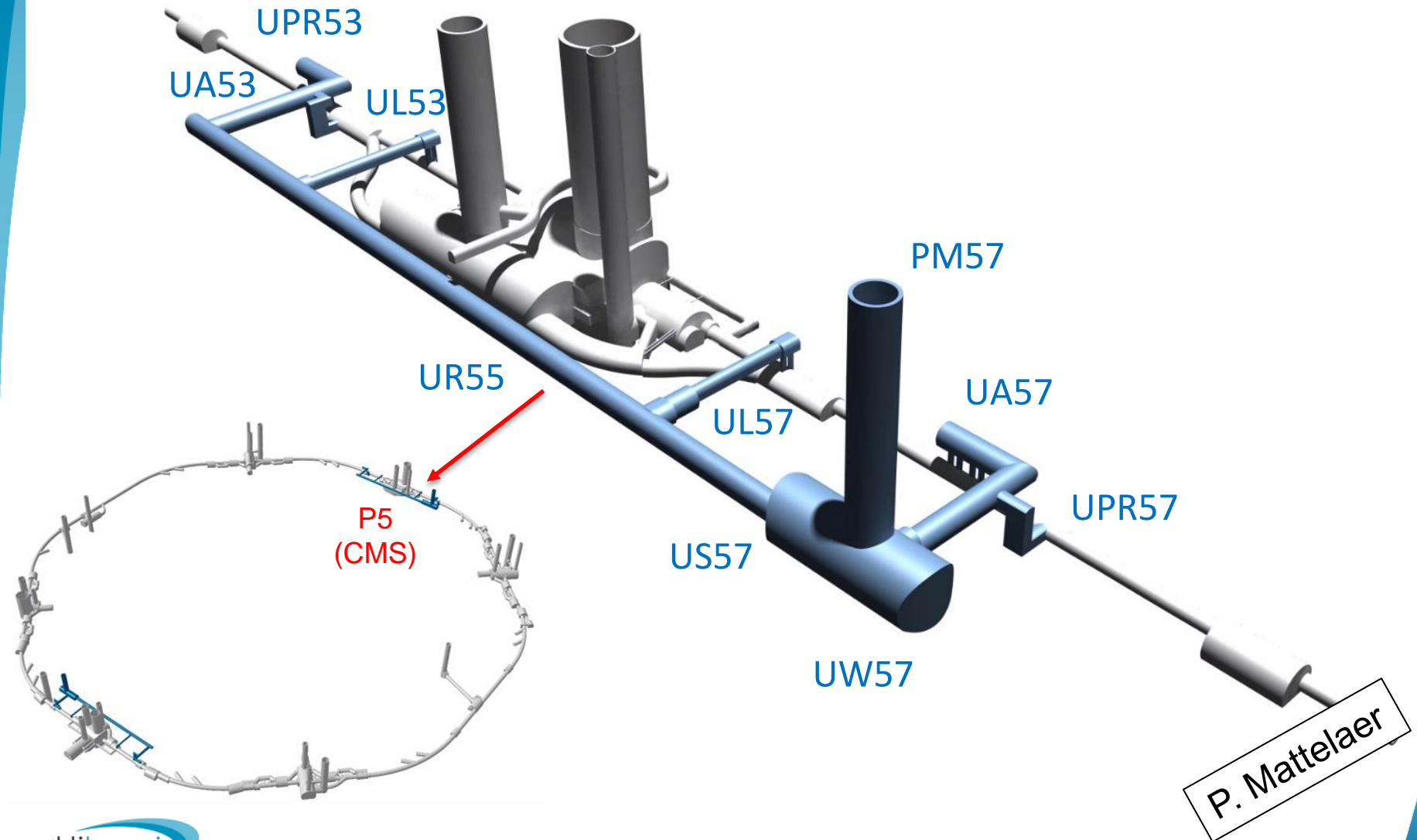
- vertical cores connecting to the LHC tunnel
- Personnel escape galleries (UPR) at both ends.



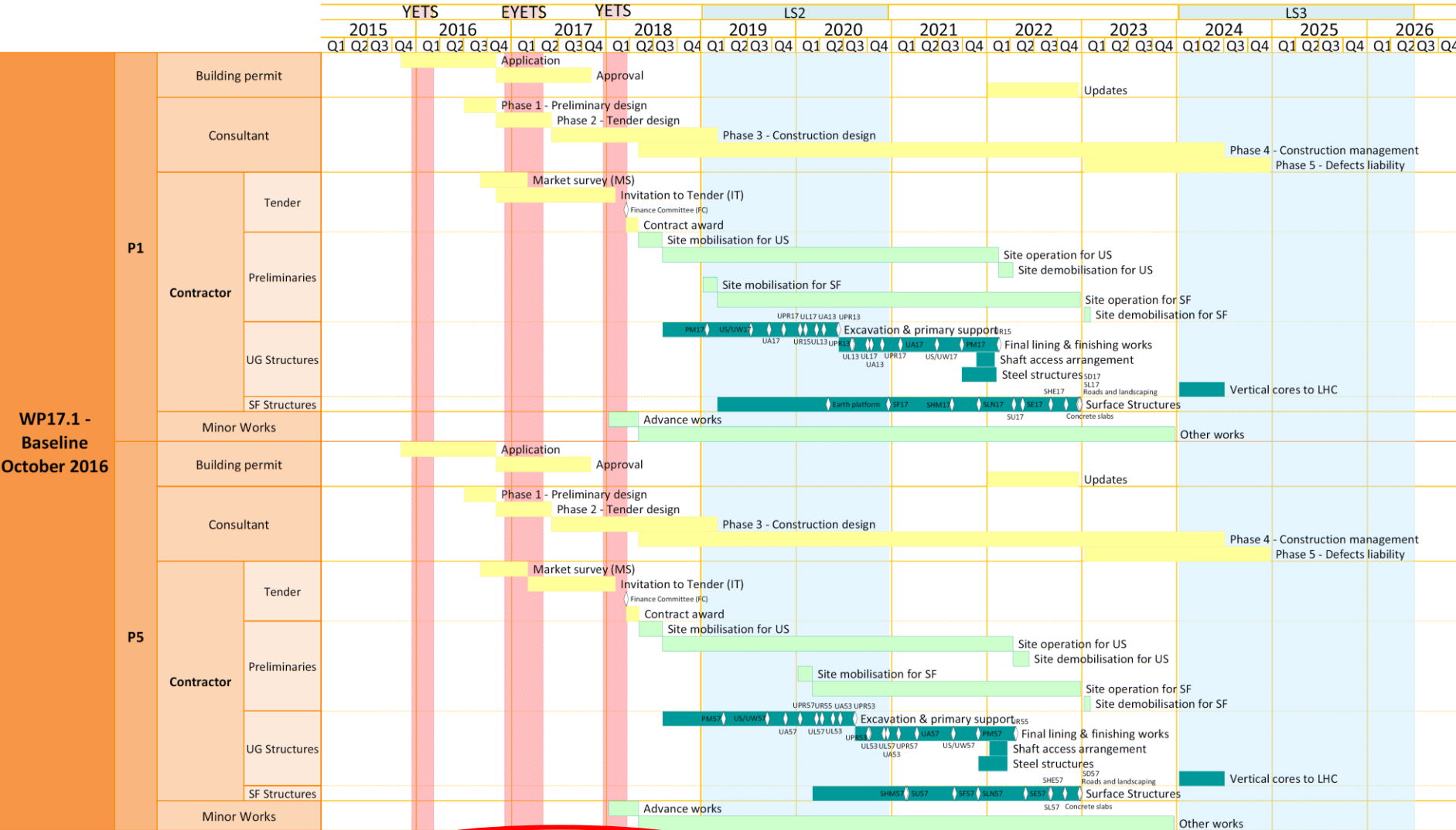
- No direct CE interface with Experiment structures.
- Minimum distance of  
~ 15 m between HL-LHC and experiment structures  
~ 7 m between HL-LHC galleries and LHC tunnel  
(reduction of radiation & deformation impacts)



# WP17.1: New HL-LHC underground structures at Point 5



# WP17.1: Civil engineering schedule

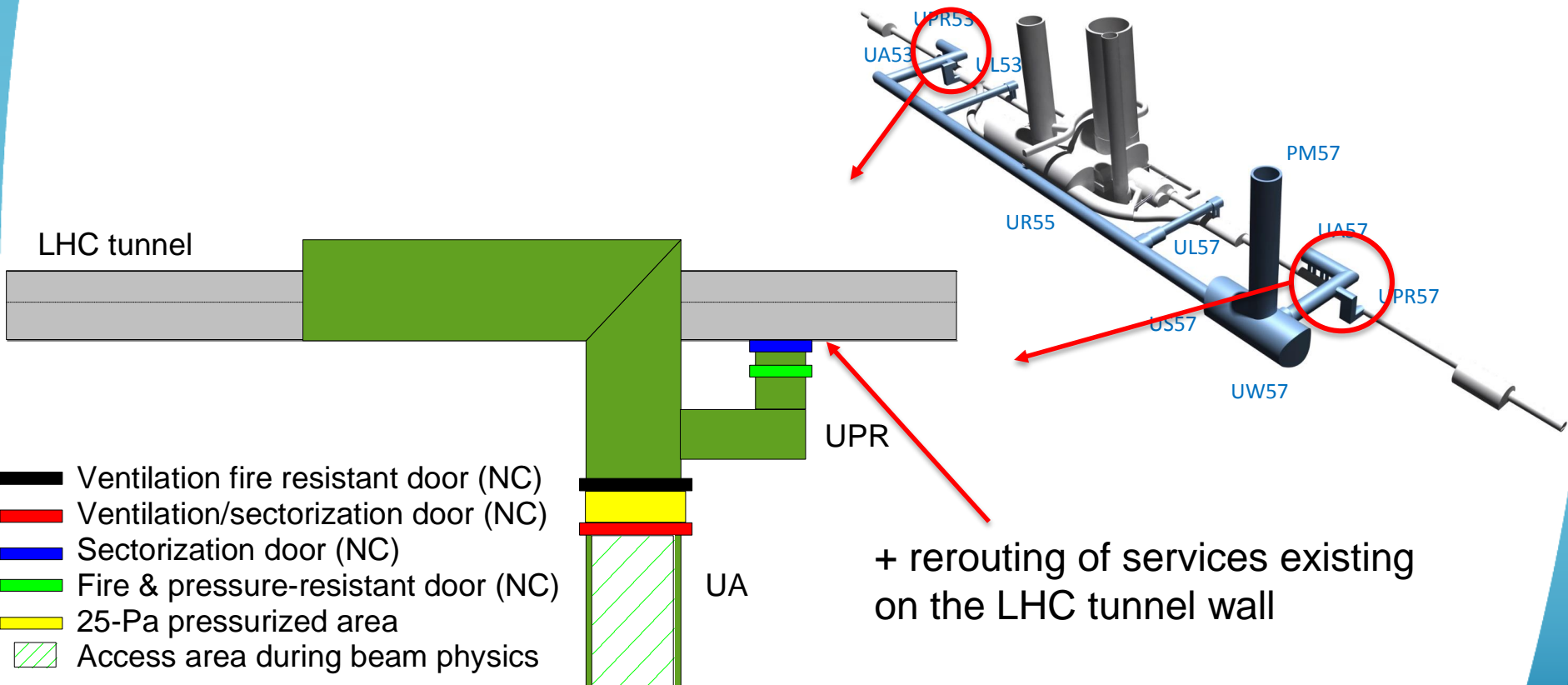


LEGEND: SPECIFICATIONS (yellow), **MAYOR WORKS** (teal), MINOR WORKS (light teal), MILESTONES: ◇ FC - Finance committee, AC - Acquisition process

# UPR ready for use during Run3

To allow safe personnel access during Run3, the two UPRs must be operational, i.e. equipped with all doors, pressurized air guards and access & alarm systems

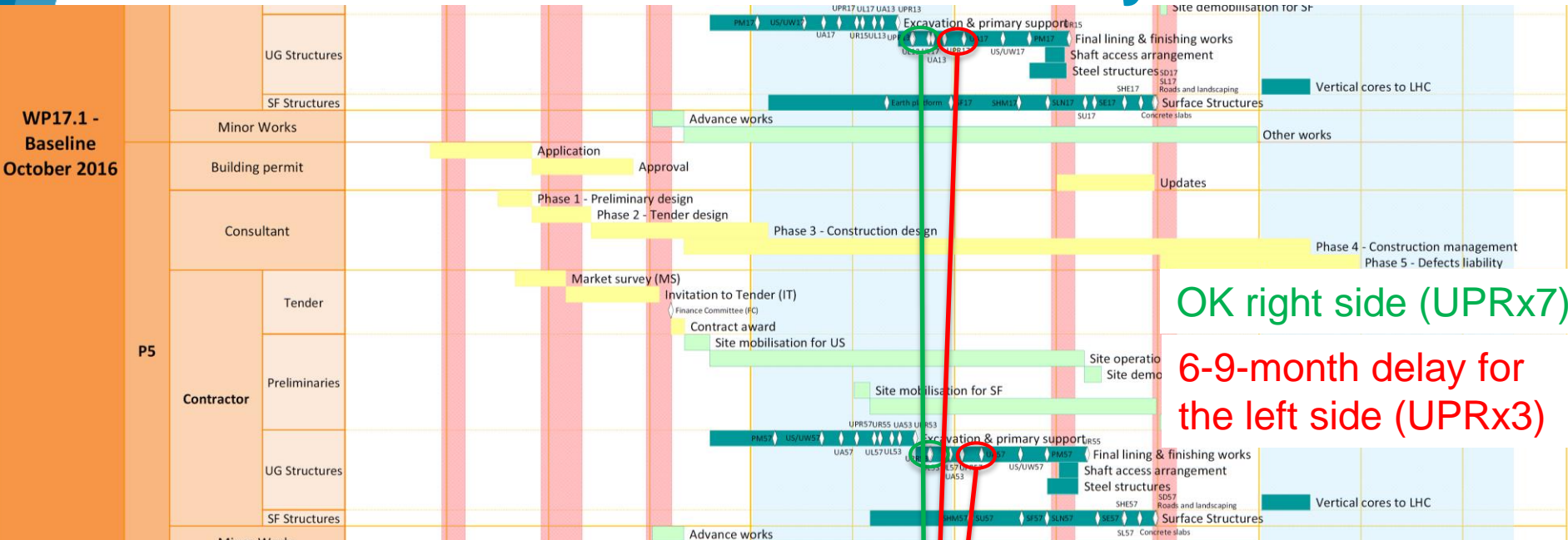
i.e. UPRs and part of the UAs completed by Sept. 2020



# Connection of UPRs

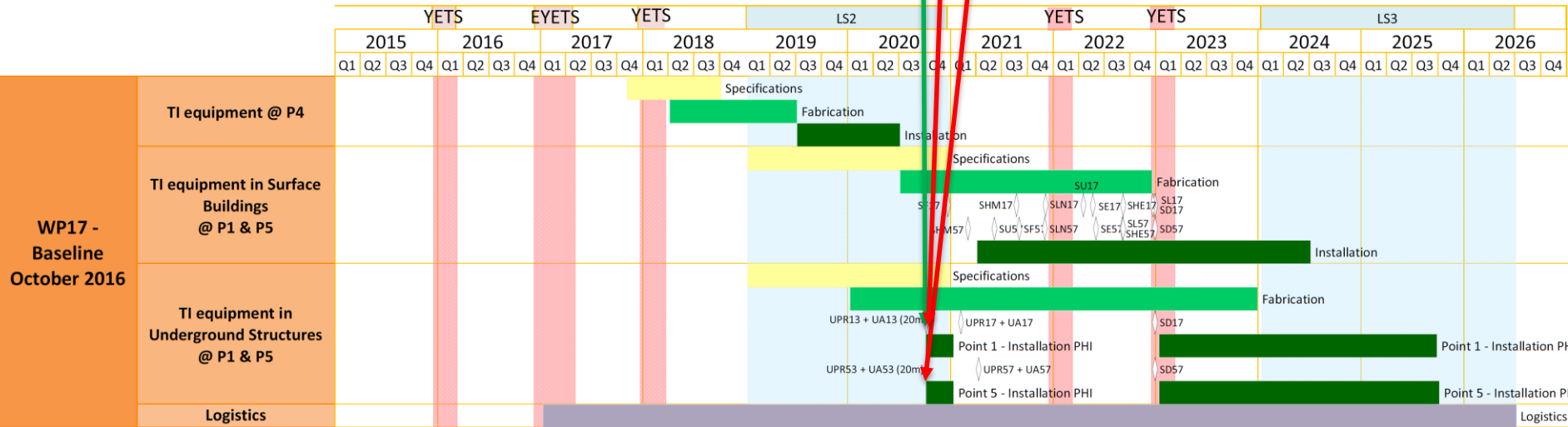
- Calendar conflicts identified:
  - Unavailability of UPR-UA civil-engineering structures (left side) in September 2020.  
Plan B: connect the UPR13 & UPR53 to the LHC tunnel only in YETS'21-22
    - excavation in two phases → CE extra cost?
    - or refill temporarily the UPRs ends with concrete blocks for radiation shielding and install a tight & pressure-resistant wall to avoid the migration of LHC tunnel air to the HL-LHC galleries.

# UPR-UA & SD availability



OK right side (UPRx7)

6-9-month delay for the left side (UPRx3)



LEGEND    SPECIFICATIONS    FABRICATION    ASSEMBLY    INSTALLATION    TEST    COMMISSIONING    LOGISTICS    MILESTONES: ◇

# Conclusion

- Inventory of HL-LHC activities during EYETS, YETS & LS2 done
- Most of the activities are identified in PLAN, corresponding ECR must be prepared.
- Installation periods and durations are proposed → a refinement is needed according to the global LS2 project schedule.
  - The civil engineering schedule will be rigid but with low level of interaction with LS2 activities (except the completion of the UPRs and their infrastructure installation)



***Thank you***