



# LHC to HL-LHC: TAS-TAN de-installation & TAXS-TAXN installation

S. Evrard, F. Sanchez Galan, EN-EA on behalf of WP8  
EDMS 1868778

Special thanks to Damien Brethoux, Paul Strähle, Isabel Naranjo De Candido, Catarina Carvalheiras, Jean-Louis Grenard.



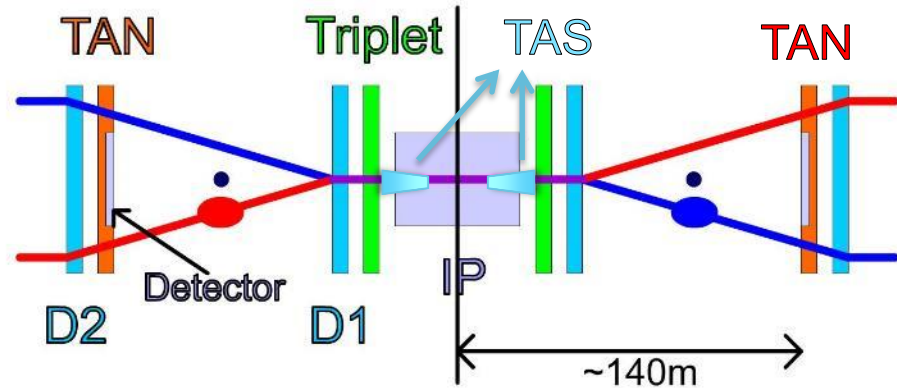
7<sup>th</sup> HL-LHC Collaboration Meeting – Madrid – 13-16 November 2017

# Table of contents

- Machine-Experiment interface: Absorbers
- Absorbers: from LHC to HL-LHC
- TAS de-installation and TAXS installation
- TAN de-installation and TAXN installation
- ALARA & Work dose Planning
- Schedule
- Summary and next steps

# Machine experiment interface: absorbers

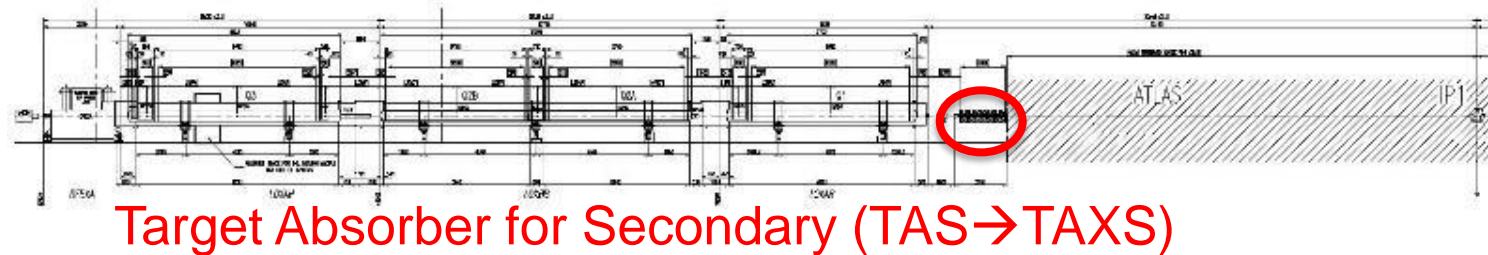
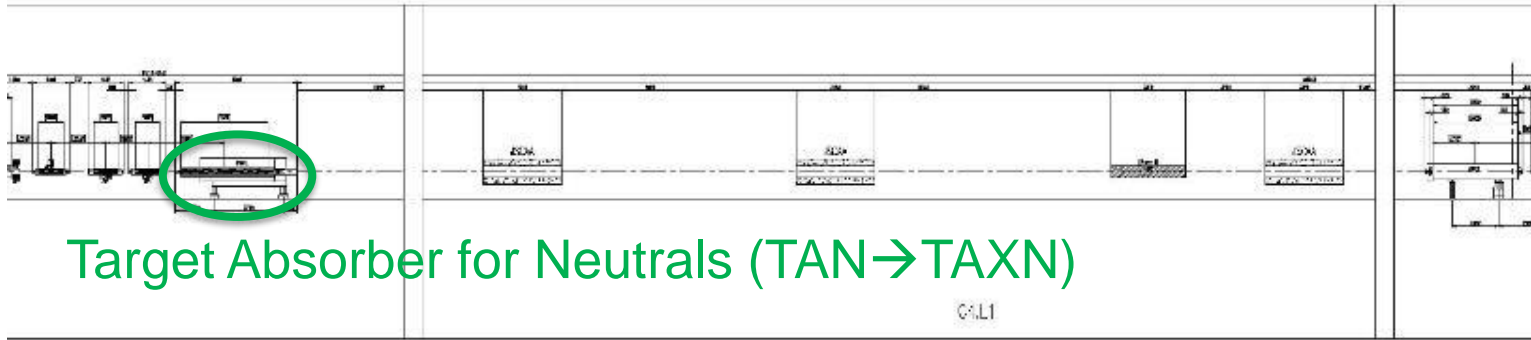
- The **passive absorbers for charged (TAS) and neutral (TAN) particles** are designed to
  - primarily protect the nearby superconducting magnets from the radiation coming out from the interaction region
  - simultaneously provide a background reduction to the experiments for beam interactions in the collimators and beam gas
- They are located on either side of IP1 and IP5



Courtesy of I. Efthymiopoulos

# Machine experiment interface: absorbers

- Absorbers to protect the inner triplets and dipoles from the collision debris generated at the interaction point.



# Machine experiment interface: absorbers

Target Absorber Secondaries  
(TAS)



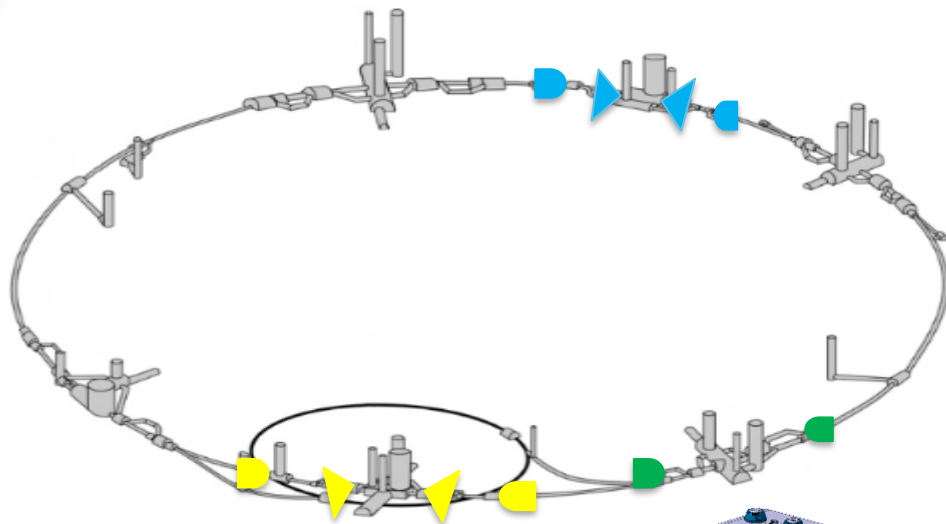
Target Absorber Neutrals (TAN)



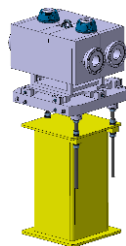
# Absorbers: from LHC to HL-LHC

- New absorbers **TAXS** and **TAXN**
  - The protection must be extended to D1 magnets that in HL-LHC will be superconducting
  - The new absorbers must have an aperture adapted to the HL-LHC beam optics and operation
  - They should be designed to cope with the increased energy deposition
  - Optimized engineering based on experience, e.g. ALARA, reduce exposure time for major operations.

# Absorbers: from LHC to HL-LHC



  TAXS  
   TAXN



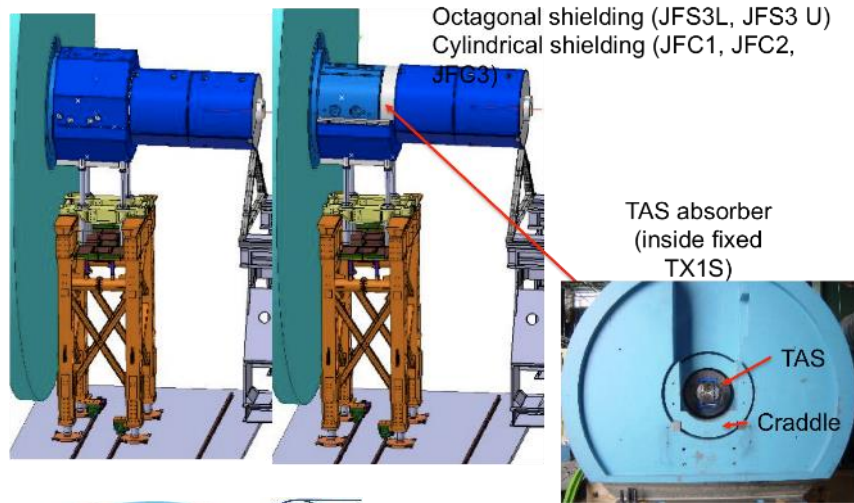
TANB for LHCb

Equipment	Quantity	Location
TANB for LHCb	2 units (1 per IP side)	P8
TAXN for ATLAS	2 units (1 per IP side)	P1
TAXN for CMS	2 units (1 per IP side)	P5
TAXS for ATLAS	2 units (1 per IP side)	P1
TAXS for CMS	2 units (1 per IP side)	P5

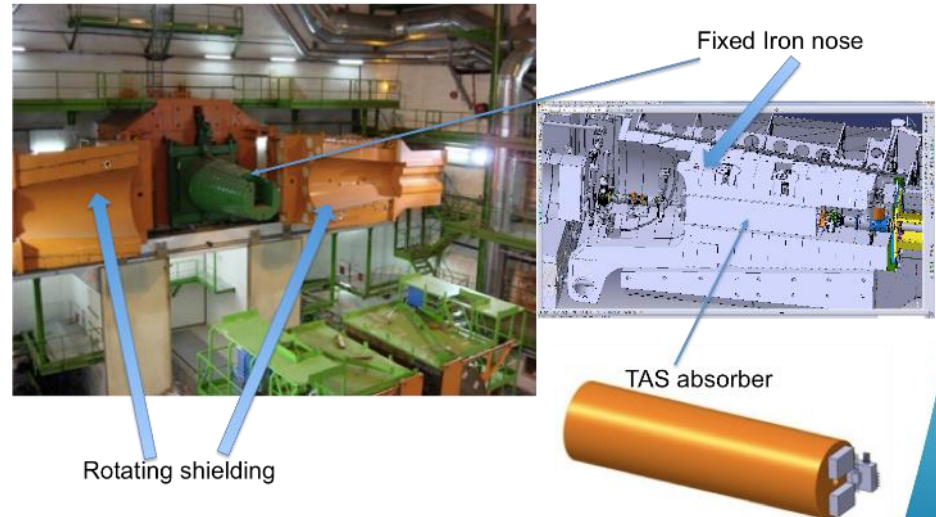
# TAS de-installation and TAXS installation

- Although conceptually similar, conception of the Forward Shielding is based on different principles in ATLAS and CMS.

TAS in ATLAS Forward Shielding



TAS in CMS Forward Shielding



# TAS de-installation

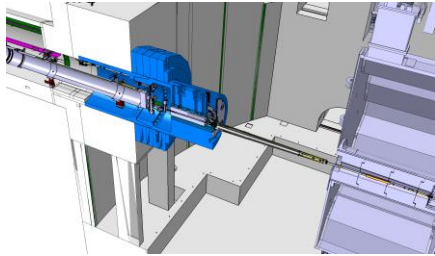
- The TAS absorbers cannot be removed exactly as they were installed in ATLAS and CMS.
  - The TAS absorbers were inserted in their cradle then in TX1S shielding at the surface before lowering the whole (TAS + cradle+ TX1S) and installation at IP1
  - The TAS absorbers were installed at IP5 together with the surrounding FIN shielding and the covering plug using the surface crane.



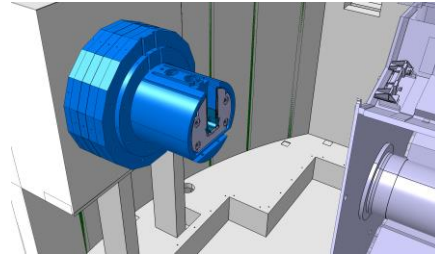
# TAS de-installation

- Two scenarios have been studied:
  - removal of TAS operating from the LHC tunnel side
  - removal of TAS operating from the Experimental caverns
- Strong baseline is to remove TAS from the experimental cavern side, taking into account:
  - the optimal phasing and schedule
  - the dose rates involved in the work in both scenarios,
  - the work on surrounding elements (in particular the inner triplet) that may be impacted by the presence or the absence of the TAS, as it will be a major source of radiation in this environment

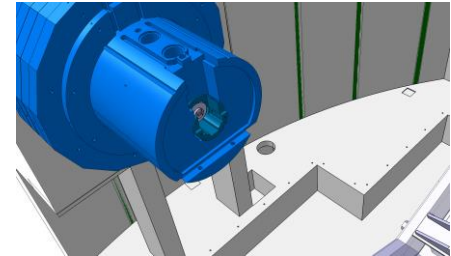
# TAS de-installation



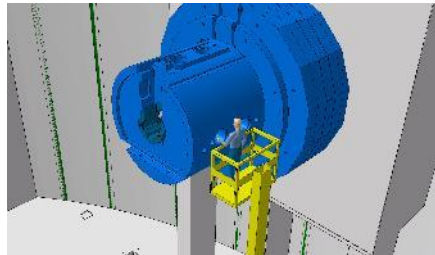
Removal of surrounding shieldings



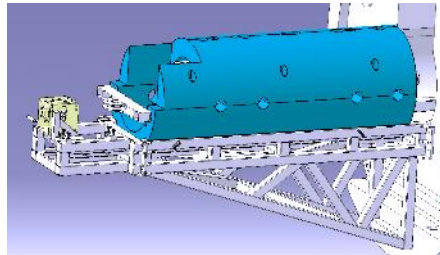
Removal of VT and VJ beam pipe sections



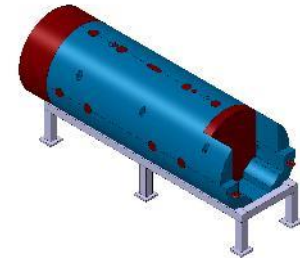
Removal of alignment plate



Removal of alignment and support rods



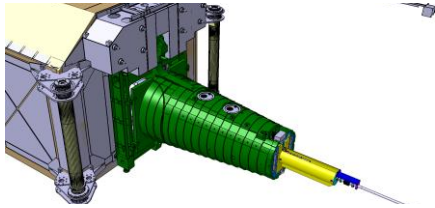
TAS cradle extraction from TX1S with winch



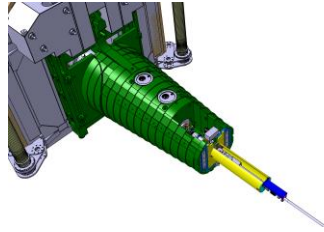
TAS + cradle (as sarcophagus) ready for long term storage

Courtesy of D. Brethoux, P. Strähle

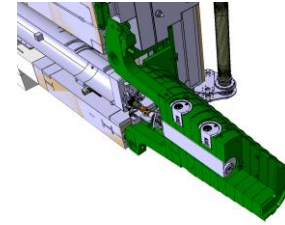
# TAS de-installation



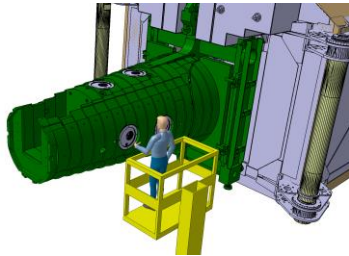
Opening of rotating shielding



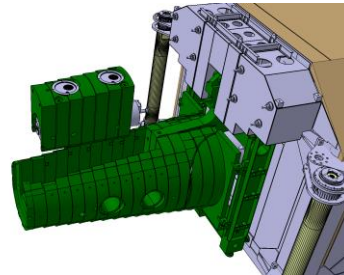
Removal of VAX Plug



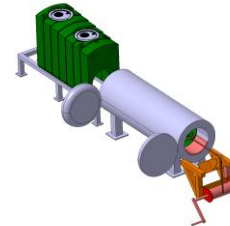
Removal of vacuum system



Removal of alignment and support rods (horizontal)



TAS and FIN plug removal with UX55 crane

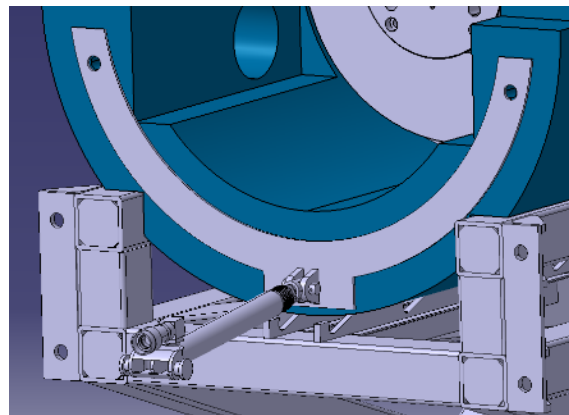
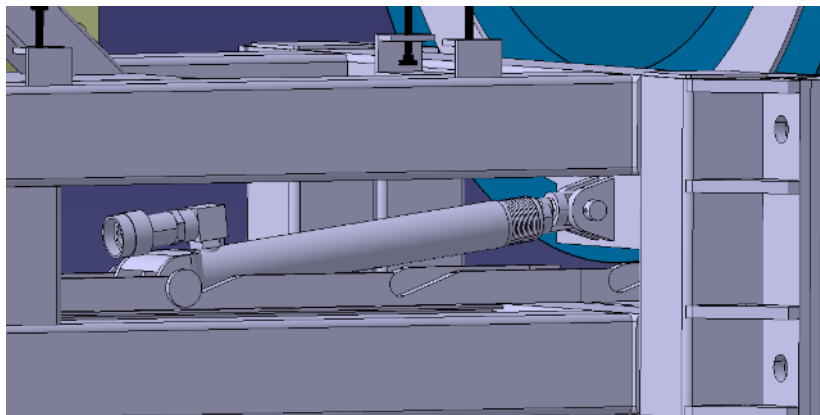


TAS insertion in sarcophagus

Courtesy of D. Brethoux

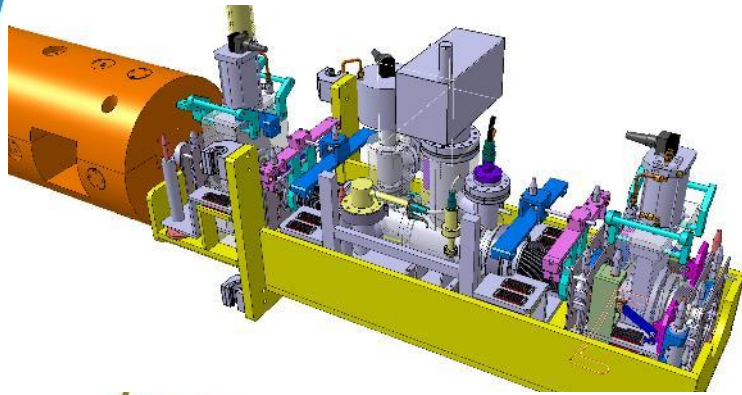
# TAXS installation

- TAXS installation using new cradle, assembly at the surface
- Usage of a push-pull system for the insertion into TX1S
- Reverse the removal procedure

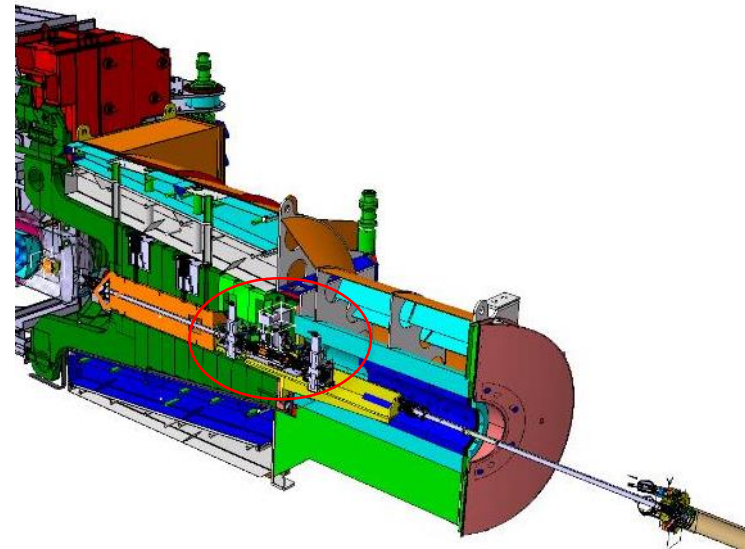
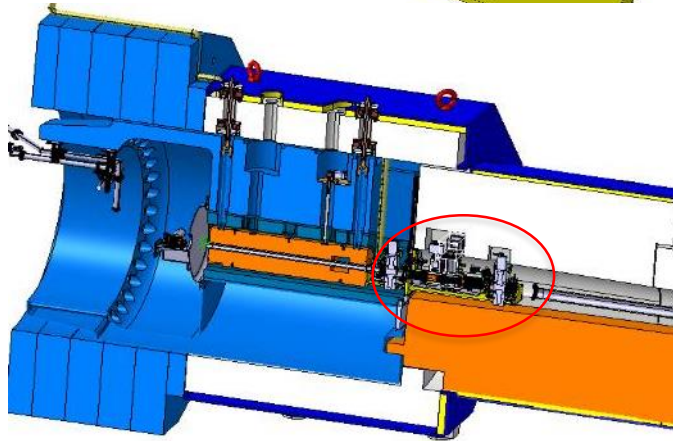


Courtesy of P. Strähle

# TAXS installation



- VAX relocated from machine to experimental side to ease operation and future dismantling
- Remote handling and connecting with TAXS
- Installation in parallel to exp. Beam pipe



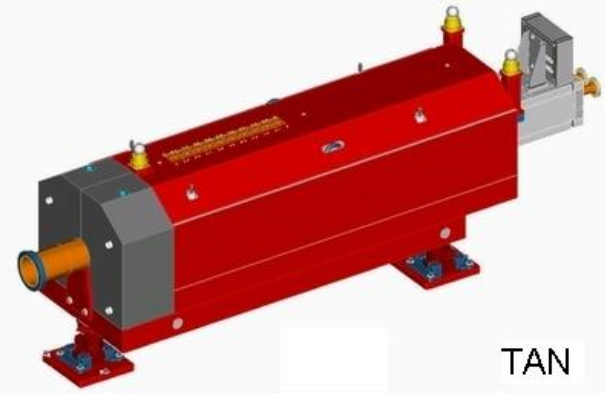
# TAN de-installation

- TAN de-installation: main steps
  - Forward experiment dismantling (procedure documented in EDMS1262764)
  - Service and vacuum remote dismantling (possibly with robot)
  - Handling equipment preparation incl. shielding
  - Transfer to vehicle
  - Driving to destination
  - Dismounting Y-vacuum chamber (for re-using the existing shielding)

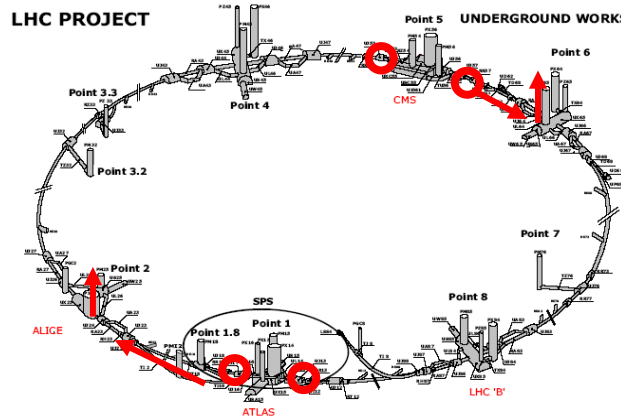


# TAN de-installation

- Destination: 2 options studied: surface or UJ's
- Access shafts: PX24 and PX65 or PX 45  $\Rightarrow$  travel distance in the tunnel  $\sim 3.3$  km instead of  $\sim 140$  m for UJ's.
- The TAN transport and installation took place before the cryomagnets were installed in the concerned sectors
- Many obstacles like R2E shielding in UJ13, 17, RR57, UX65 or UX45 and UX25 access.



TAN



## Dimensions:

Overall length=4.9 m

Width=1.1 m

Height=1.1 m

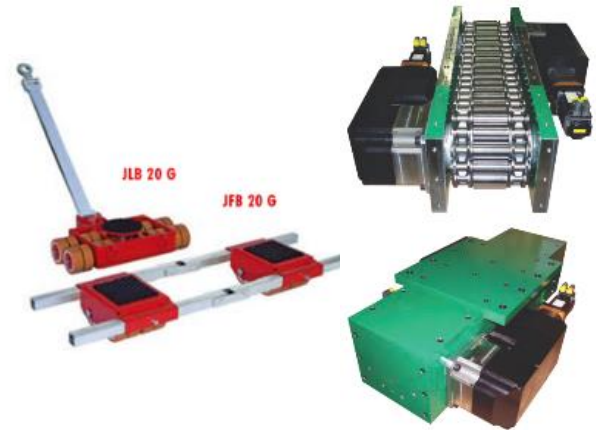
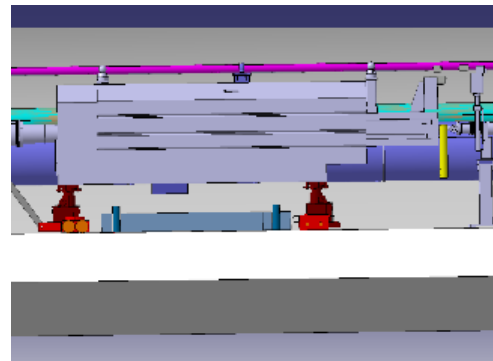
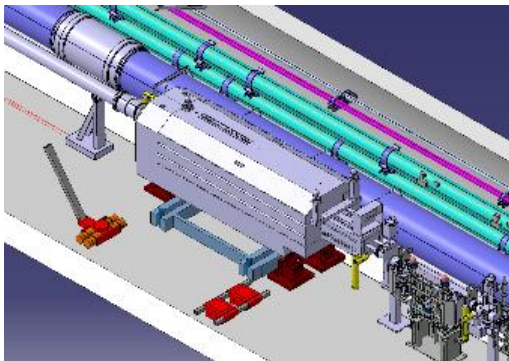
Design mass=31 t (*measured mass=29 t*)

# TAXN installation

- Bringing the TAN back to surface is tricky given LHC accelerator components & infrastructure in the way.
- Decision to re-use the existing shielding for the TAXN
- Two reasons for studying another option: perform TAN → TAXN modifications in UJ's
- However there are lot of activities to be done in the area, so this option also looks challenging.
  - 1) Civil engineering with cores
  - 2) Decabbling
  - 3) Re-routing of the new services and cabling
  - 4) Removal of the Power converters and installation of the QH power supplies
- Both options are still under investigation and all constraints shall be analyzed

# TAXN installation

- New vehicle designed by EN-HE based on
  - Industrial products (trailer, tractor, motorized rollers) JUNG dollys to act as a trailer to carry the TAN and TAXN ~3km
  - Hydraulic Transfer System: lateral displacement mechanism proposed by HILLMAN with actuated rollers.
  - Remotely controlled equipment



Courtesy of C. Carvalheiras

# ALARA & Work dose Planning

- ALARA principles already discarded some de-installation methods
- Tailor-made shielding to be manufactured (Sarcophagi for TAS and TAN shielding plates)
- Remote controlled dismantling (possibly with robot) and remote handling as much as possible
- Effects on other HL-LHC activities in machine and exp. areas
- Prepare TAXS and TAXN removal procedure and accommodate design accordingly (e.g. VAX)
- Optimization process still on-going and ALARA L3 committees foreseen

Preliminary estimates	Collective dose (mSv) per item	Total collective dose (mSv)	ALARA level
TAS removal	>2	>8	3
TAXS installation	<1	<4	2
TAN removal	>6	>24	3
TAXN installation	<1	<4	2

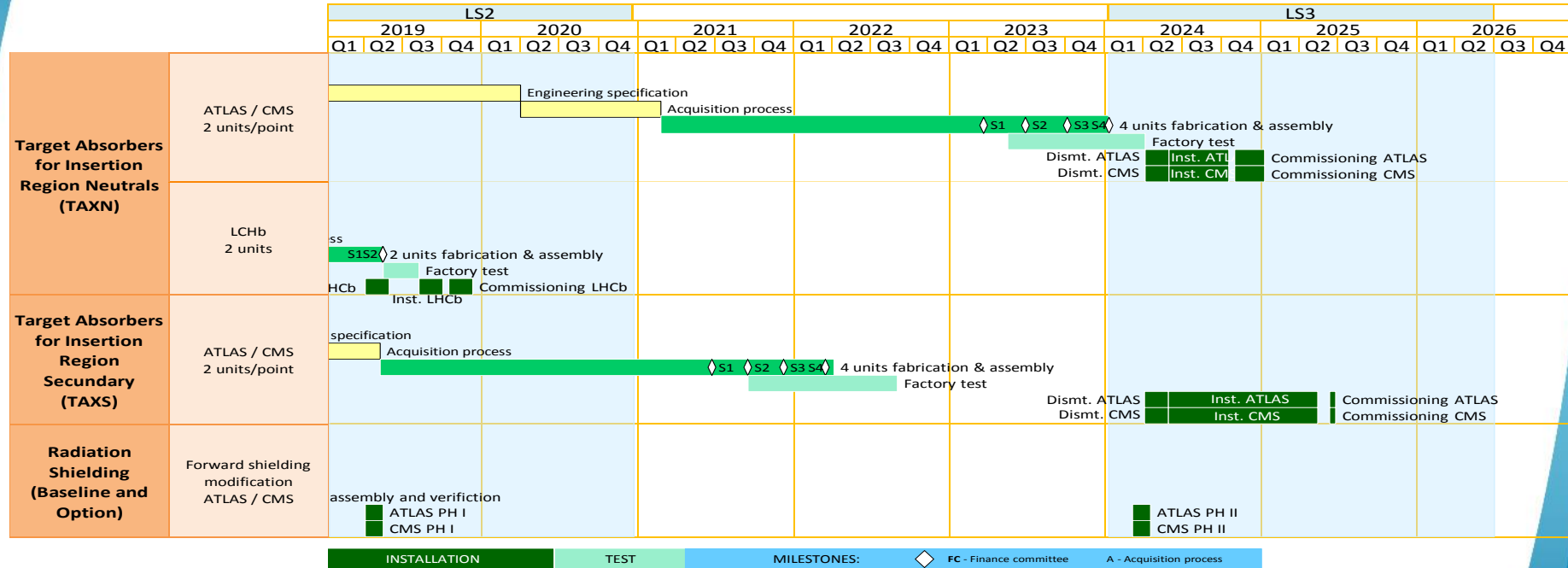
# Schedule

## Main Constraints

- TAN/TAXN: machine driven schedule
- TAS/TAXS: experiment driven schedule (but also machine connected)
  - Main Forward shielding modification during LS2 (JTT)
  - ATLAS and CMS must be in closed configuration for removing TAS and Installing TAXS i.e. at the beginning of LS3 and/or at the very end of LS3
  - LS3 Forward shielding modifications only possible when inner triplets have gone
- Machine experiment **interface** also in terms of **schedule**
- Resources/coordination required from/with many HL-LHC WP's and CERN groups

HL-LHC installation activities	Period	Location							HL-LHC WP										Group contribution for installation																			
		P1	P2	P4	P5	P7	P8	SPS	4	5	6B	7	8	9	11	12	13	14	15	17	EP-CMX	EP-ADO	ACE	BI	CRG	CV	EA	EL	EPC	HE	ICS	MME	MPE	MSC	RF	SMB	STI	VSC
TAN/TAXN	LS3	X			X								X					X	X	X	X	x	X		X	X			X									X
TAS/TAXS	LS3	X			X								X					X	X	X	X	x	X		X	X			X									X

# Schedule



INSTALLATION
TEST
MILESTONES: ◇ FC - Finance committee    A - Acquisition process



# Summary and next steps

- A first sequence of operations for the ATLAS/CMS TAS/TAN removal and TAXN/TAXS installation has been studied and presented
- Strong baseline already defined:
  - TAS removal and TAXS installation via Experimental areas
  - New vehicle for TAN removal and TAXN installation
  - VAX moved to Exp. areas to ease operation and future dismantling
- Several points in the sequence require close manual contact with the nearby equipment.
  - Detailed removal procedure and Work Dose Planning to be further studied
  - New tools must be developed to optimise the process according to ALARA
- TAN to TAXN modification location still under investigation (UJ's or surface)
- Strong interactions with machine (TAN/TAXN) and experimental area (TAS/TAXS) activities during LS3
- Resources/coordination required from/with many HL-LHC WP's and CERN groups



## ***Thanks to all members of WP8 & contributors***

C. Adorisio, J. Albertone, V. Baglin, C. Boccard, I. Bergstrom, E. Bravin, D. Brethoux, H. Burkhardt, F. Cerutti, JP Corso, F. Sanchez Galan, M. Lino Diogo Dos Santos, P. Fessia, A. Gaddi, B. Di Girolamo, L. Krzempek, M. Lazzaroni, H. Mainaud-Durand, R. De Maria, D. Mergelkuhl, G. Pigny, J. Perez Espinos, A-L Perrot, S. Bartolome, M. Raymond, A. Santamaria Garcia, P. Santos Diaz, E. Thomas, B. Vazquez De Prada, H. Vincke.





## References

- “Scenarios for the removal of IR1 and IR5 TAS” by F. Butin, EDMS 1254919*
- Supply of a vehicle for TAN’s installation in the LHC tunnel, EDMS 520770*
- Procedure de transport des Neutral Beam Absorbers (TAN), EDMS 716474*
- Instruction Handbook of the PTS35-CERN, EDMS 1222478*
- Various Talks given at WP8 meetings, # 42, 49, 51 and 53*

