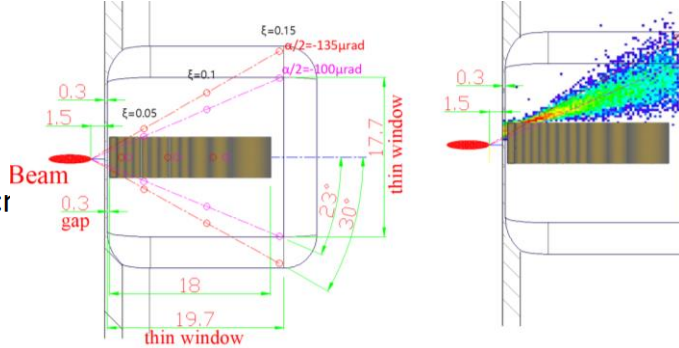
Reinstallation of PPS in YETS 2024-2025

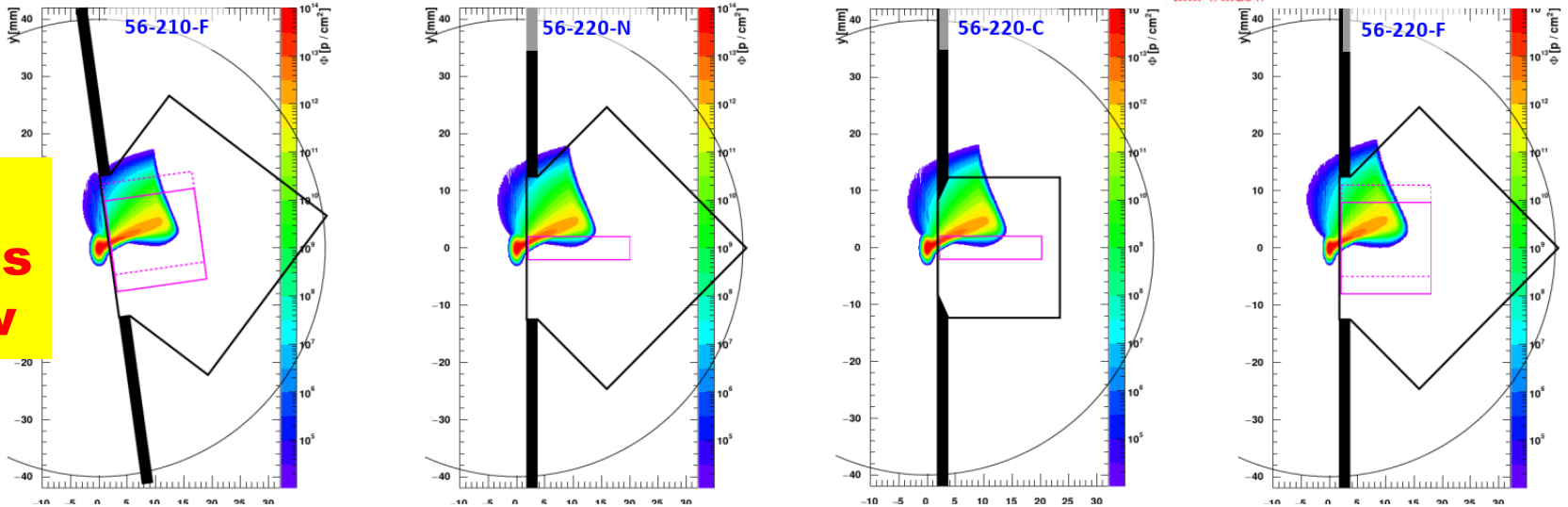
Motivation

Optics for 2025 from S. Fartoukh:

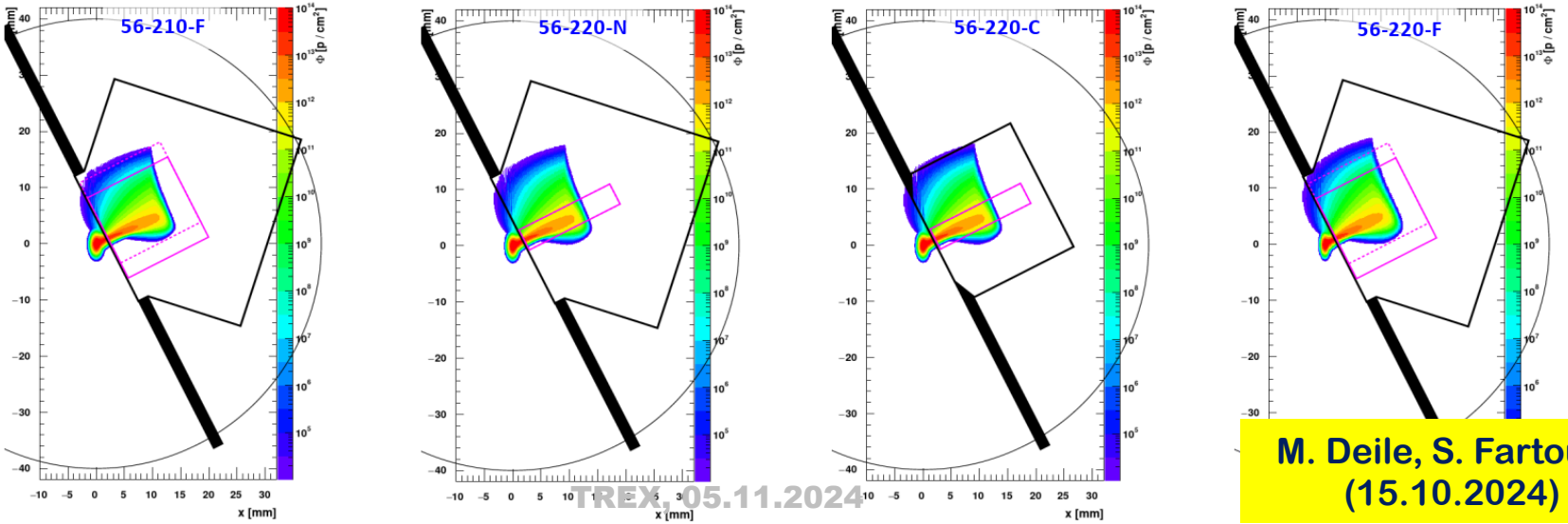
- transition to flat optics: (β_x*, β_y*) = (120cm, 120cm) → (60cm, 60cm) → (18cm, 60cr
- const. crossing-angle: 160 μrad until end point of β* levelling
- then crossing-angle levelling: 160 – 130 (– 120) μrad



0° XRPs now



27°



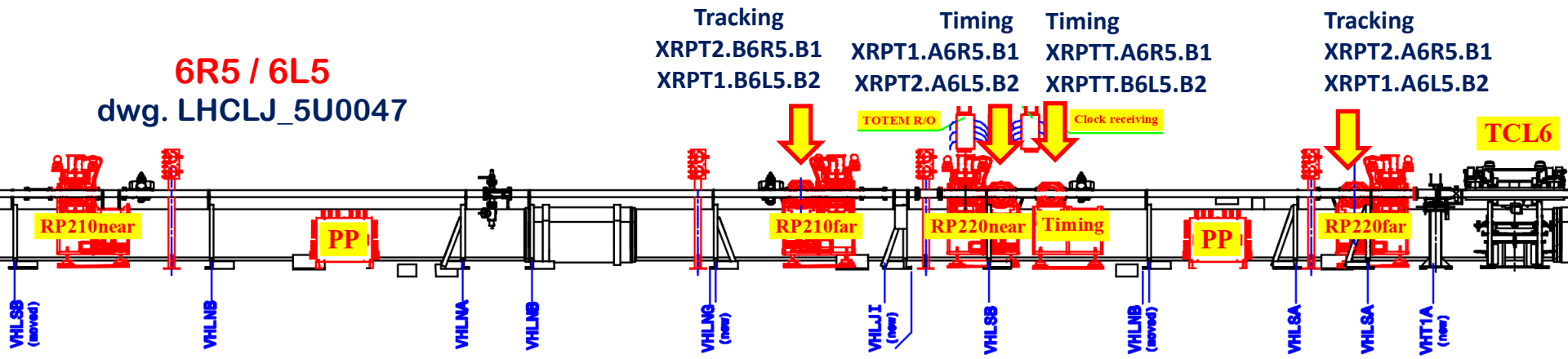
M. Deile, S. Fartoukh (15.10.2024)

Reinstallation of PPS in YETS 2024-2025

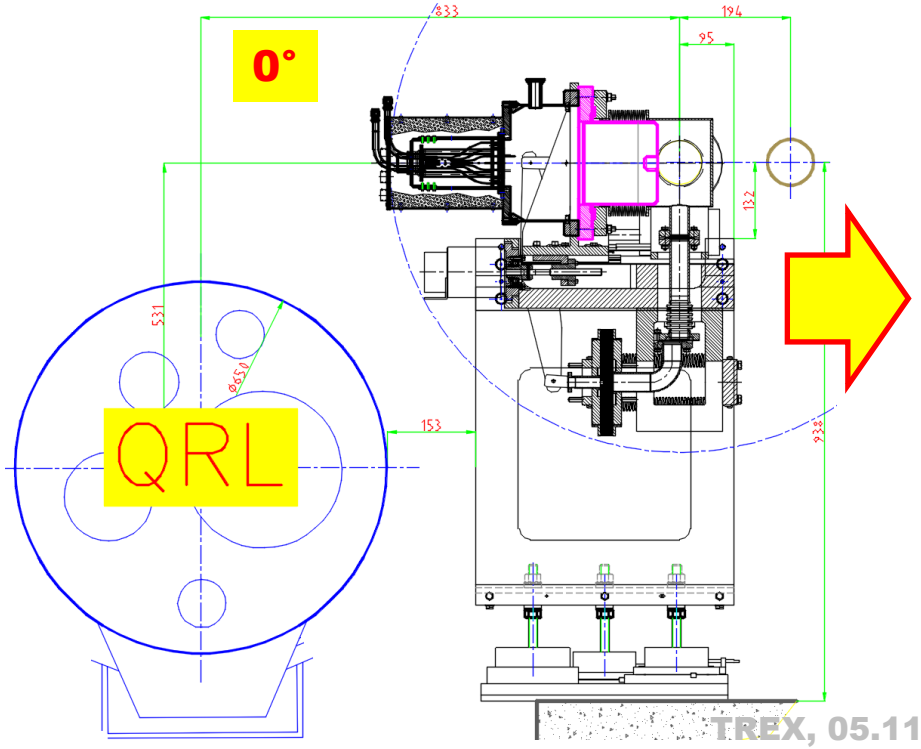
Work in half-cells C6R5 and C6L5

6R5 / 6L5

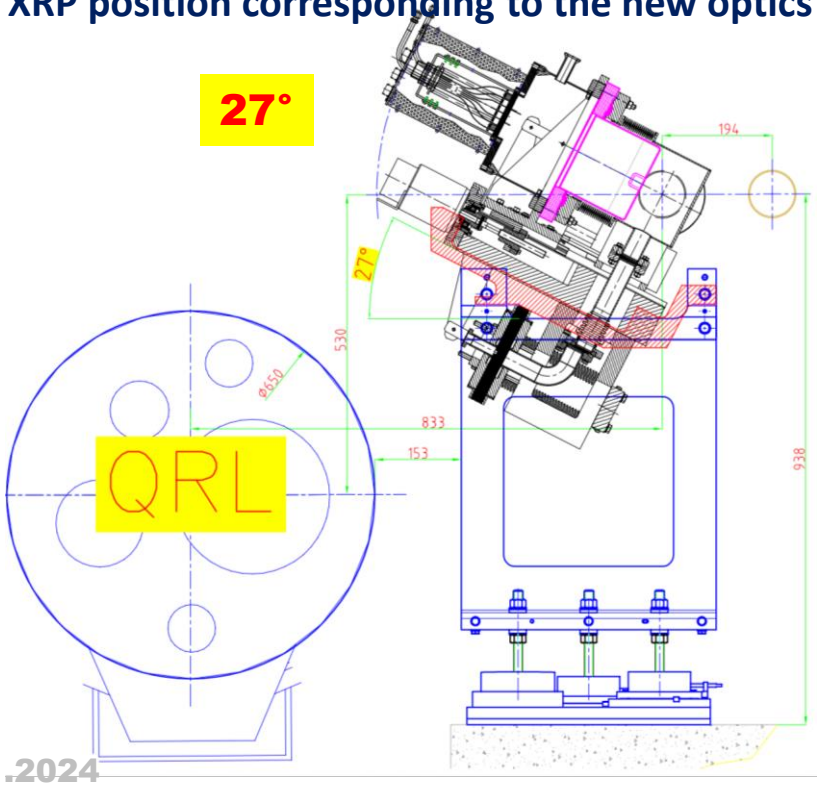
dwg. LHCLJ_5U0047



Present XRP position on LHC beam



XRP position corresponding to the new optics



Sequence of steps to perform rotation of Roman pots to match new CMS optics (vertical plane of the crossing angle)

Preparatory work:

1) Design verification. Ordering blanks, waterjet cutting, CERN or CERN-affiliated companies. 16 pieces (+ 2 spare)
2) Final machining at P.5 workshop. Manufacturing of fasteners and adjusting shims.
3) Rotation test check for one XRP at surface P.5

Work in the tunnel:

The plan was to remove all detector packages at the TS2.

1) Radioprotection sweeping. (Make sure there are no parallel operations in this area).
2) Survey, Determining the current position of the XRP flanges. *Survey group, tbd.*
3) **Opening the LHC vacuum**. Removing all connection XRP bellows. *LHC vacuum group*.
4) Preparing the space for XRP lifting with a crane: removing PP boxes inside frames (for installing jacks) and above XRP; removal of cables, hoses and protruding parts. *Large PPS team, DT*.
5) **Reinstalling the XRP210far station in a vertical position.**
6) **Unfastening and lifting of XRP Horizontal blocks to a certain height using a lifting device. Performing a turn on special equipment while suspended. Lowering and securing horizontal blocks. Adjusting and checking the position.** *PPS crew. It is proposed to start these works with the timing cylindrical XRP and immediately begin movement tests and all other checks. If everything goes OK go to the next timing detector (with faraday cage). Next, if we fit within the time frame, move on to tracker detectors.*
7) Cyclic test with 1000 movement cycles (overnight). *Mario +*. Checking the condition of the Faraday cage mount and other components. *Roman*. (Laser calibration if needed? *Mario*).
8) Verification and commissioning all XRP systems. *Large PPS team*.
9) Survey and tuning of new position of the XRP flanges. *Survey group.*
10) **Setting the vacuum. Sector Bakeout**. *LHC vacuum group*.
11) (or 9) X-ray for all 16 connection bellows. *LHC vacuum group*. (*Maybe I forgot some important point*?)

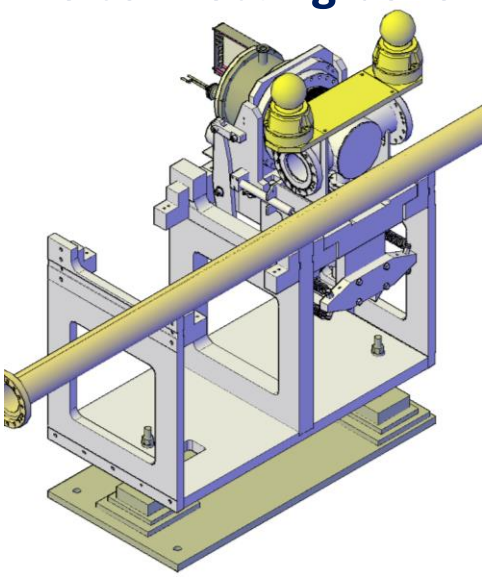
Once the LHC beam is restarted, be prepared to re-adjust and realign with the beam line.

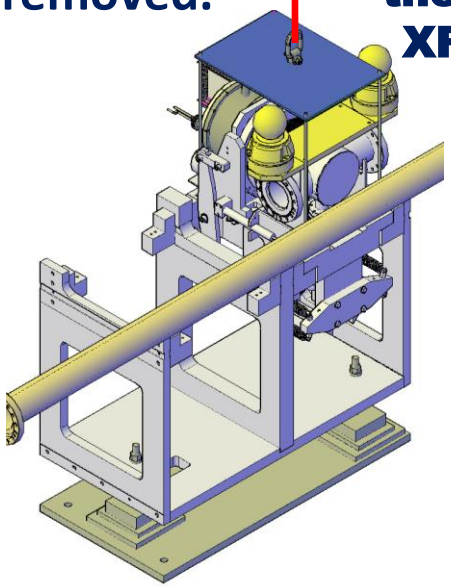
Sequence of operations

Pre-conditions:

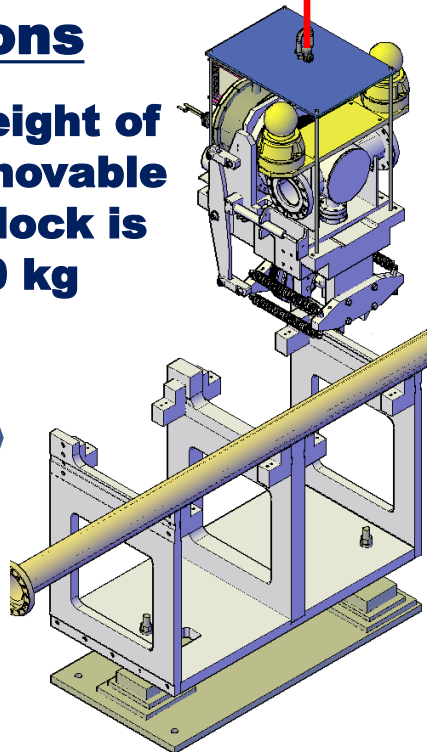
Outcoming BP under air;

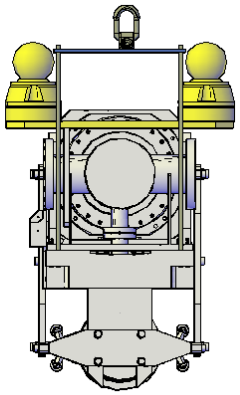
The connecting bellows are removed.

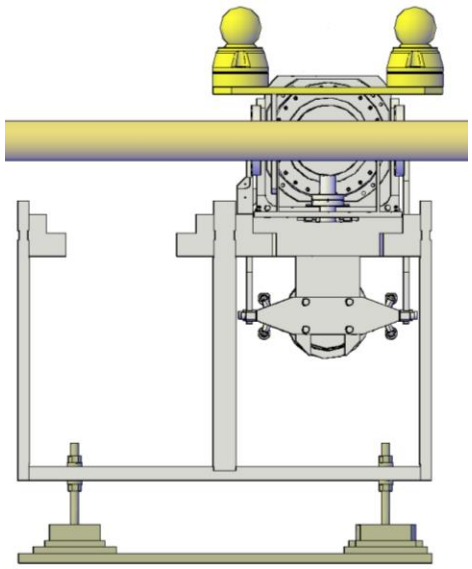


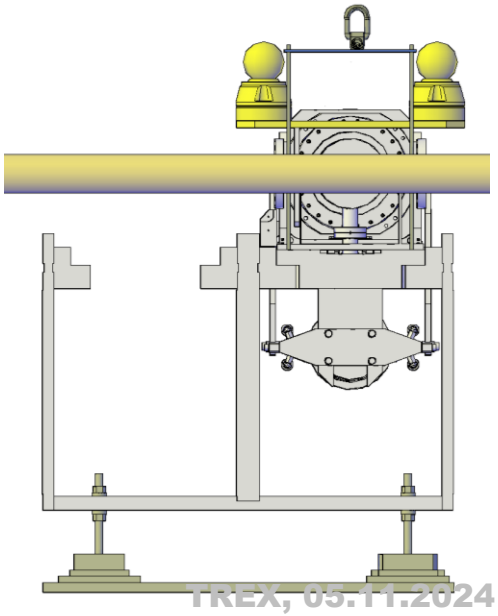


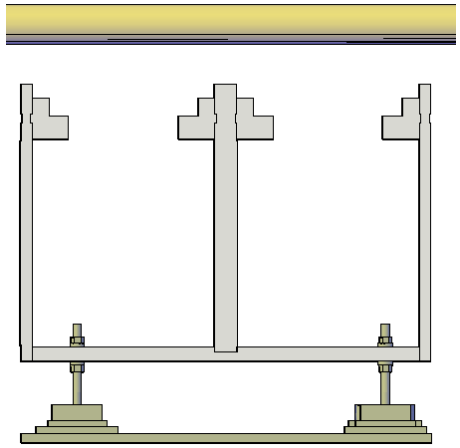
The weight of the removable XRP block is ~70 kg



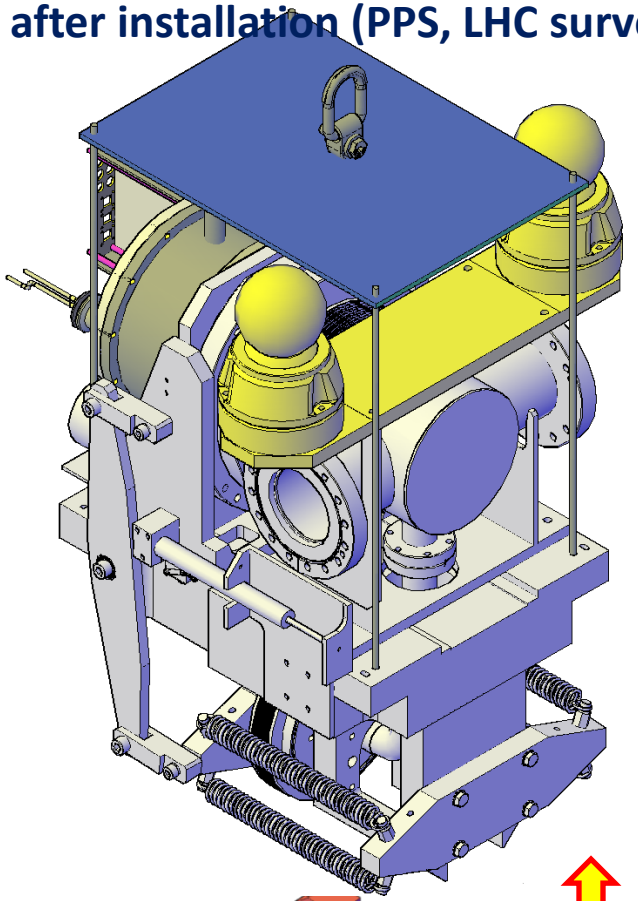


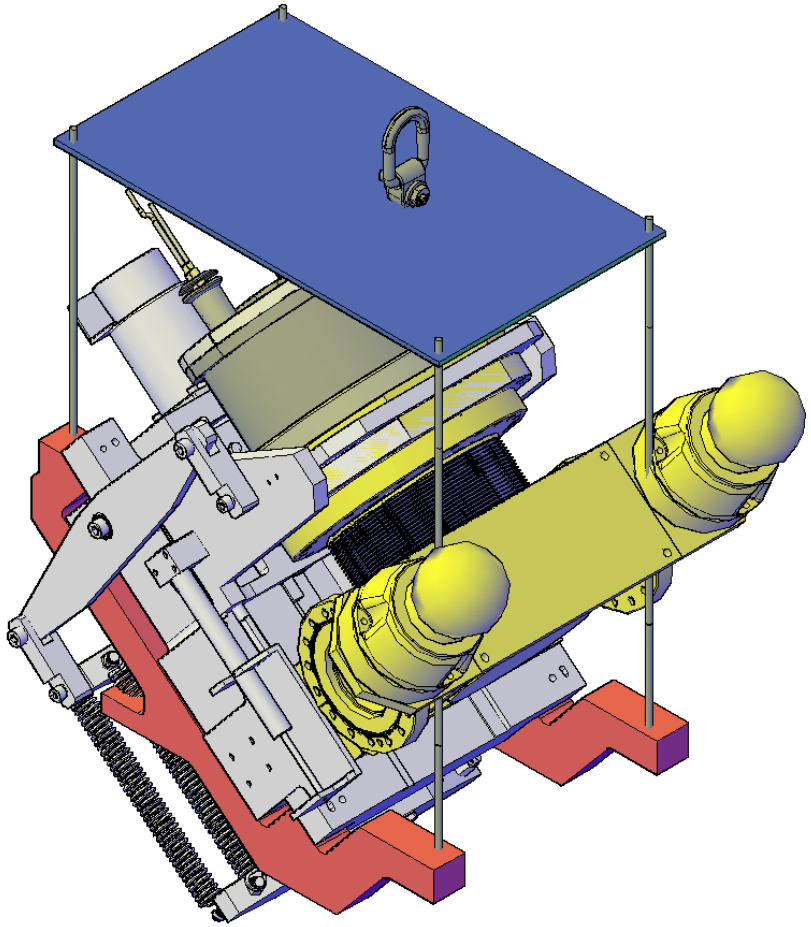


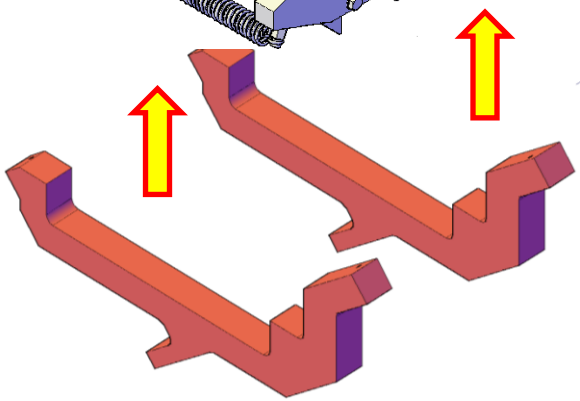




We remove and rotate only the horizontal units of the Roman Pots. Each Horizontal unit (70kg) has to be removed and rotated to a certain angle, equipped by support brackets and put than back on his place on the LHC beam. The position of the flanges is checked before removal and after installation (PPS, LHC survey group).



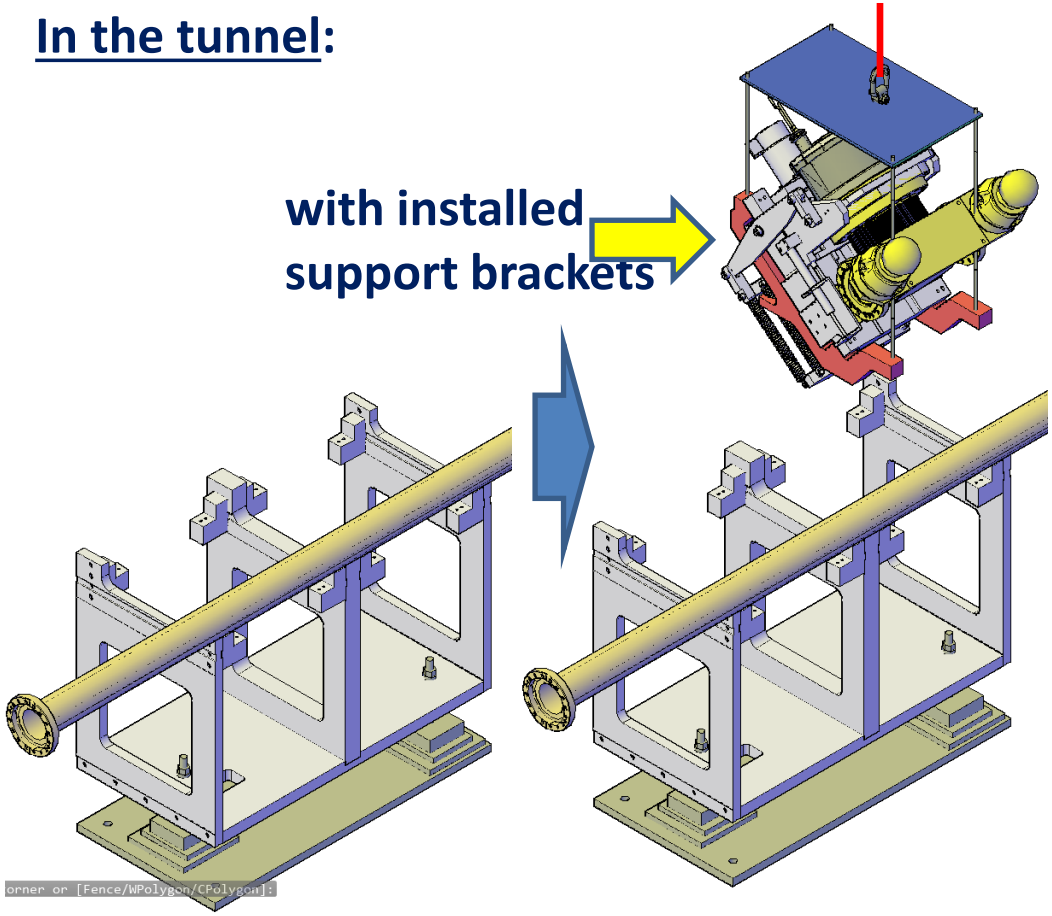


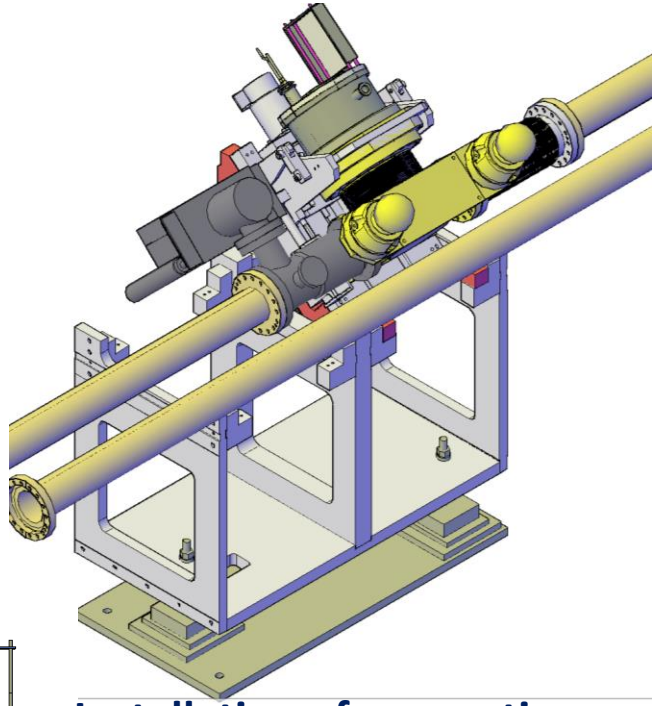


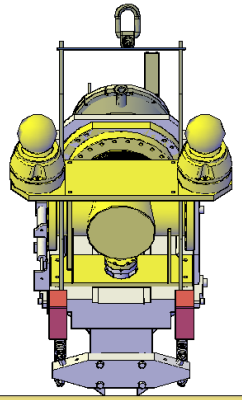
Only these 2 additional details are added, plus a set of shims to adjust

In the tunnel:

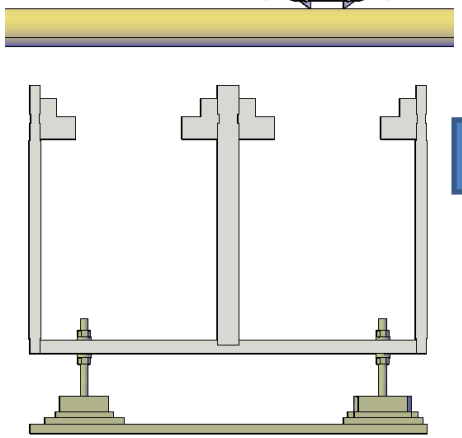
with installed support brackets

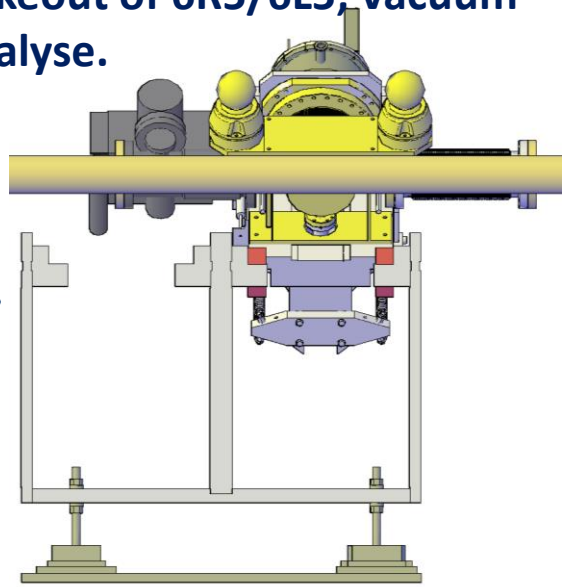




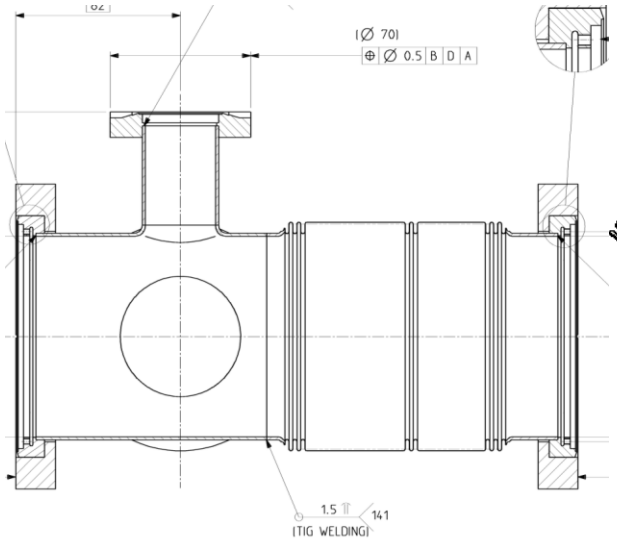


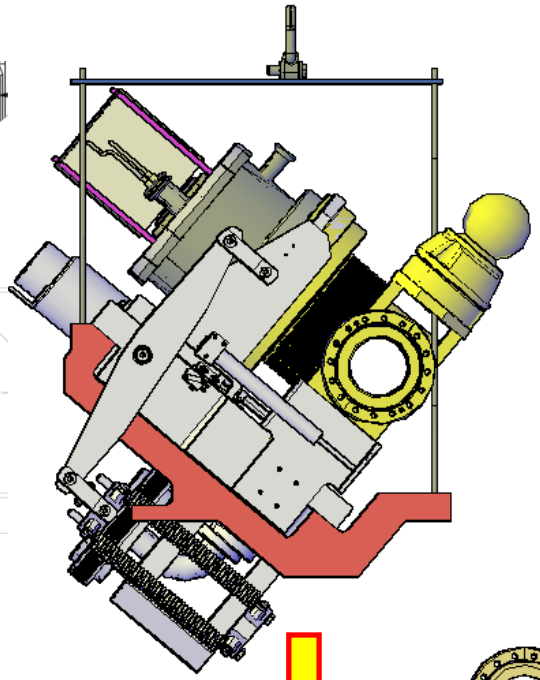
Installation of connection bellows (X-rays ?); vacuum; bakeout of 6R5/6L5; vacuum analyse.

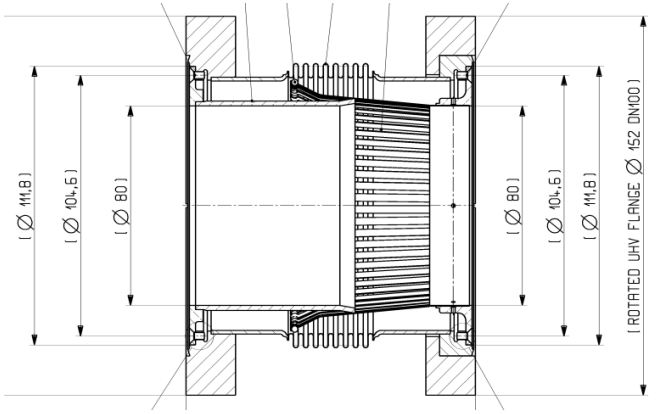


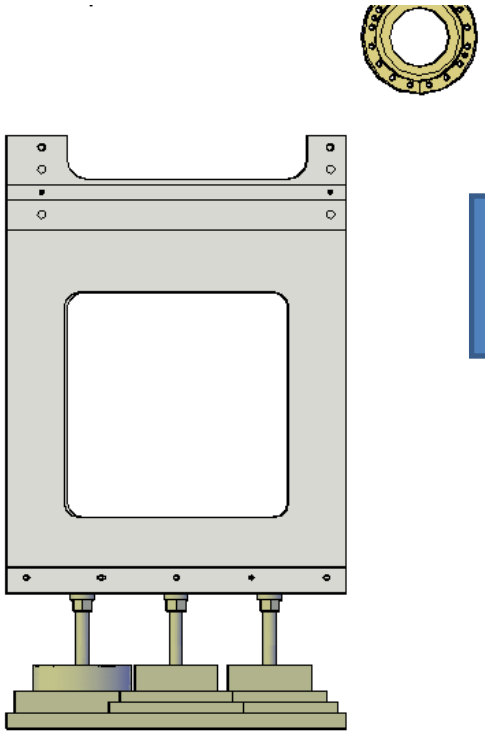


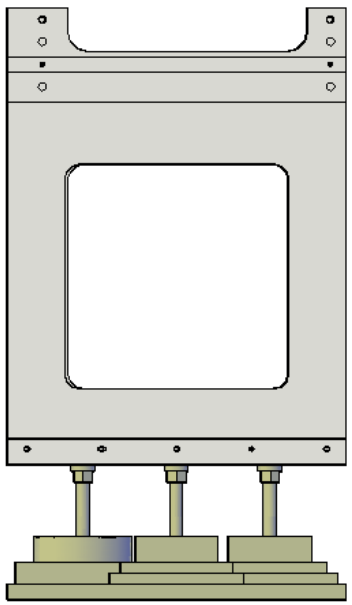
In the tunnel:

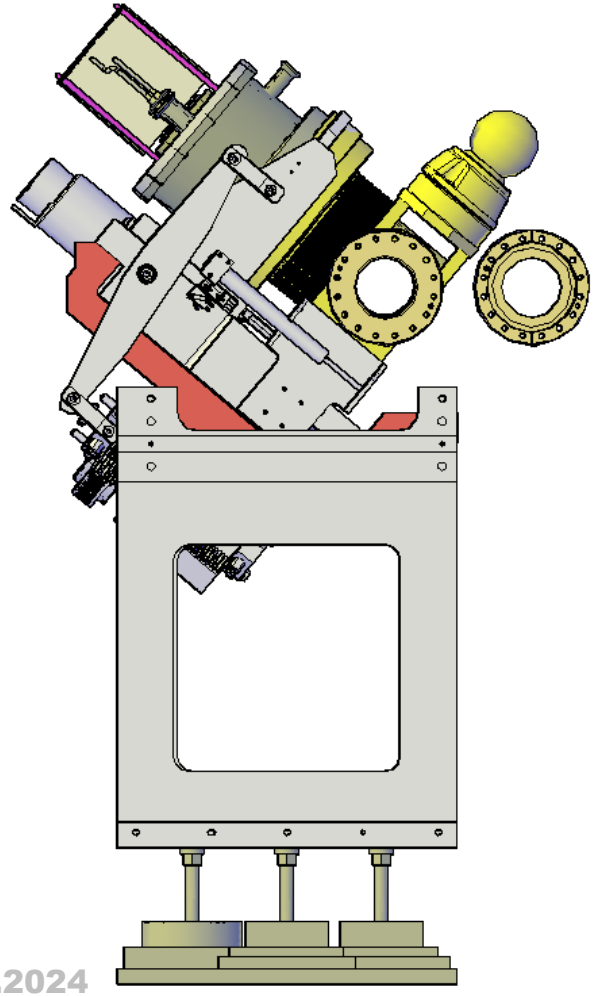




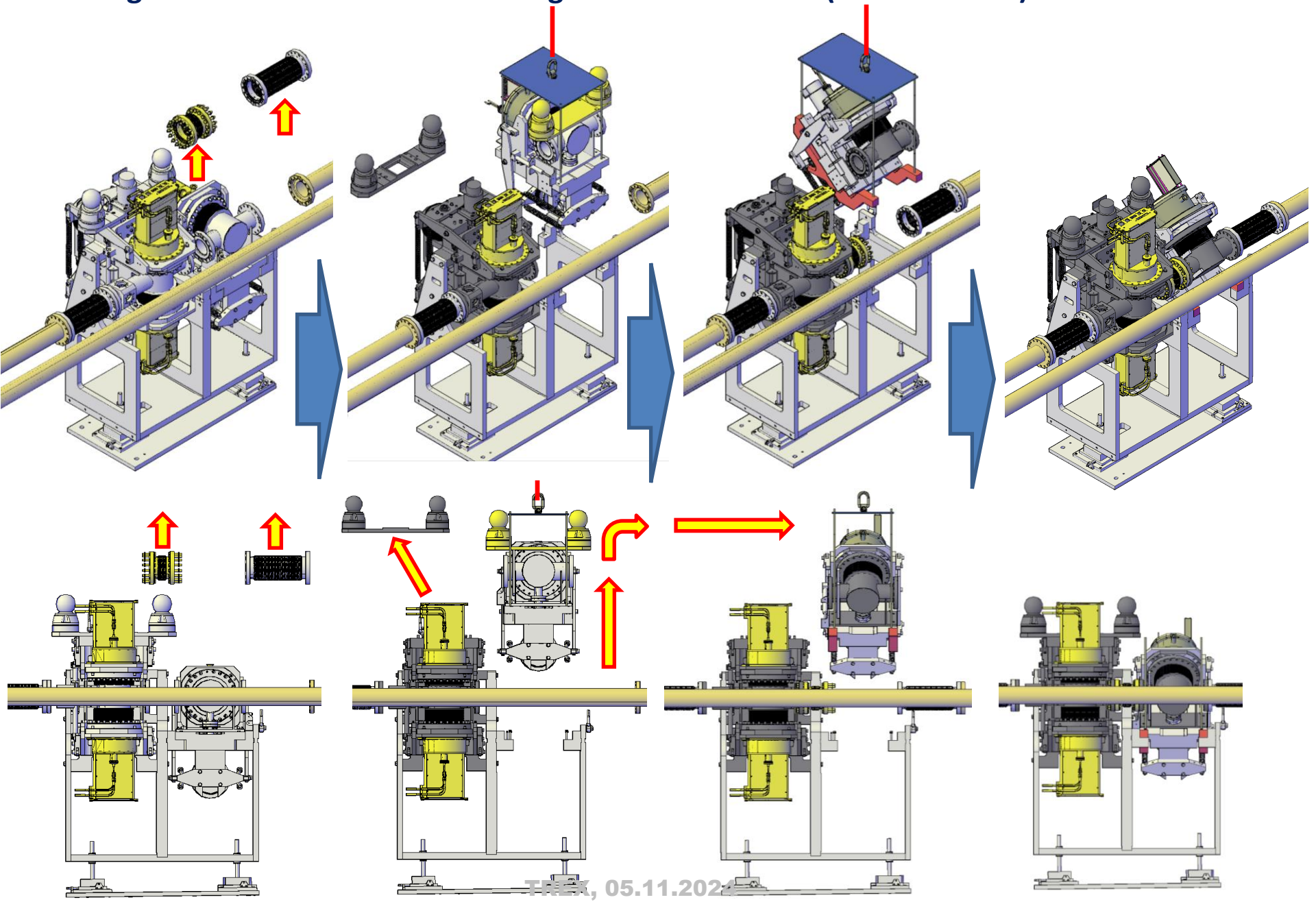






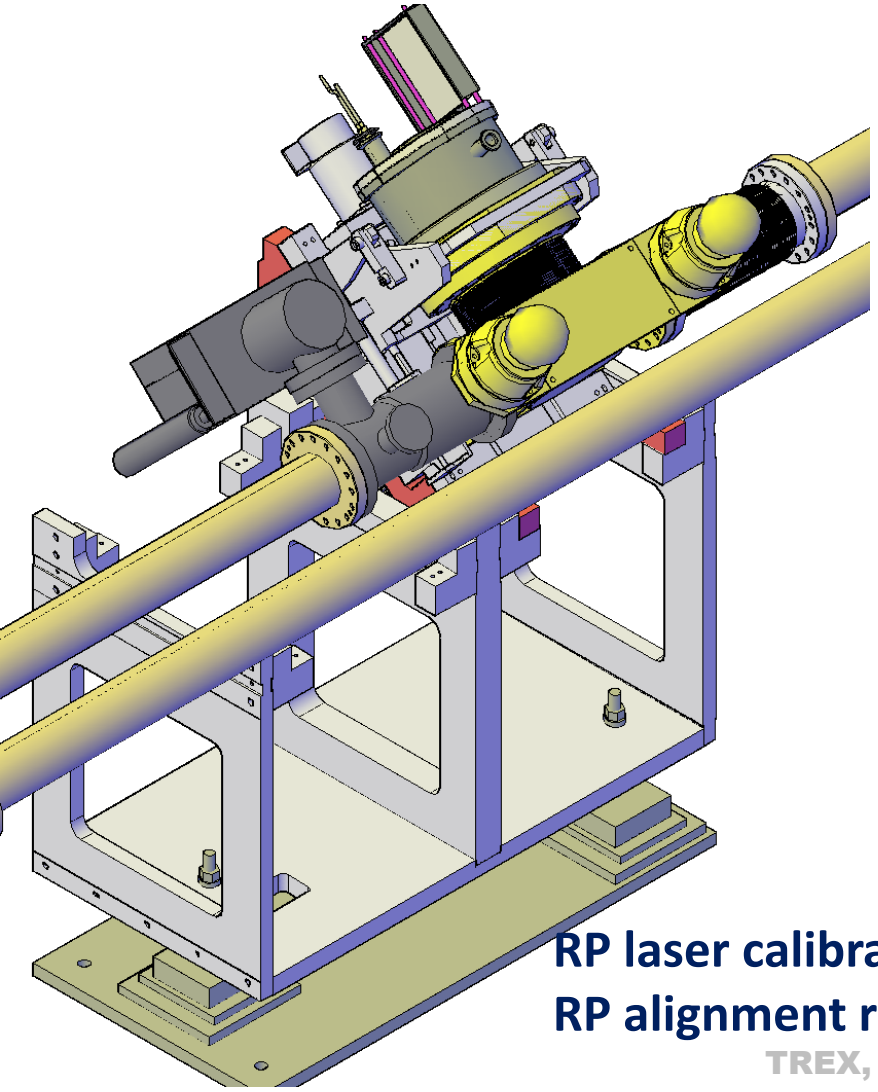


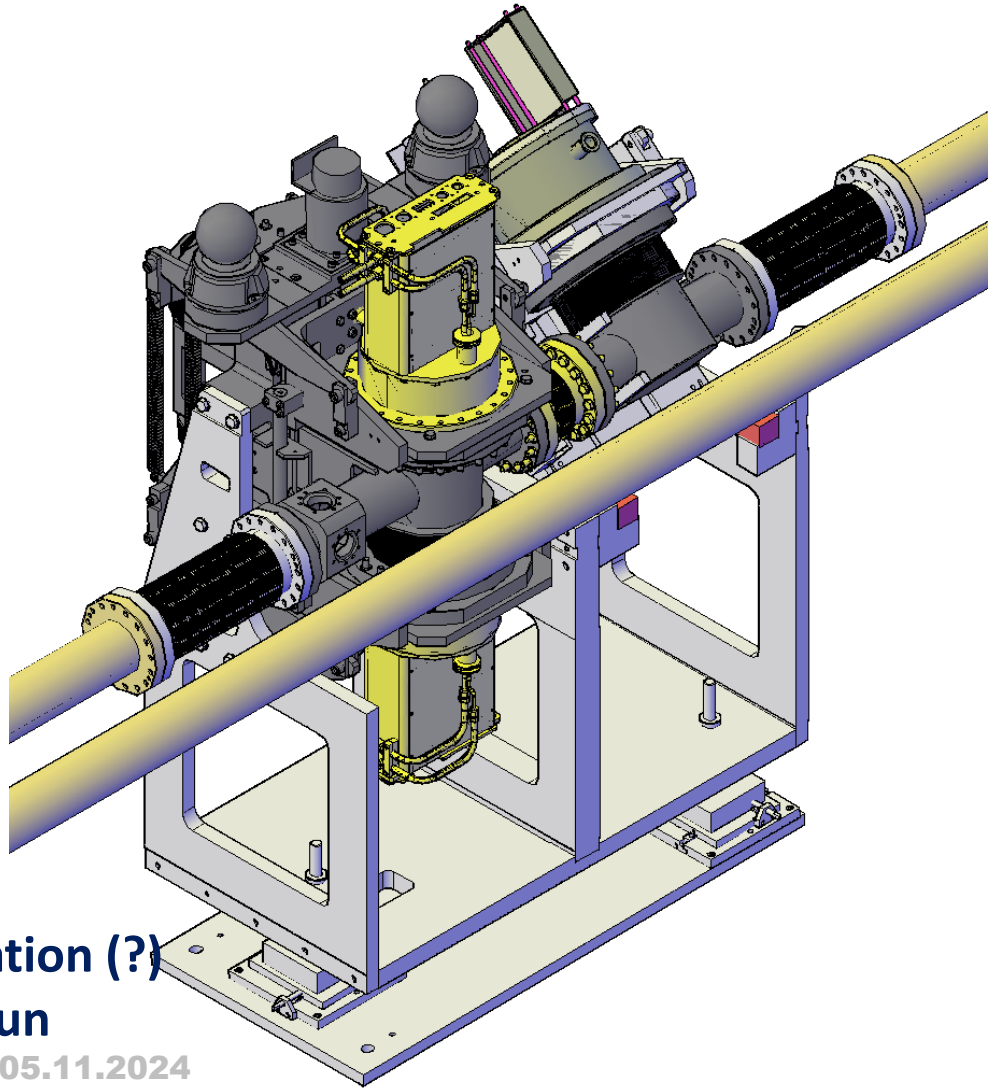
Sequence of operations with Triplet RPs: RP on the beam → removing connection bellows → removing RP Horizontal unit → installing RP Horizontal unit (with brackets) → RP on the beam



Final position

Timing		RPIX	RPIX	Timing
XRPTT.A6R5.B1	←LSS56→	XRPT2.B6R5.B1	XRPT2.A6R5.B1	XRPT1.A6R5.B1
XRPTT.B6L5.B2	←LSS45→	XRPT1.B6L5.B2	XRPT1.A6L5.B2	XRPT2.A6L5.B2
		RP210far	RP220far	RP220near

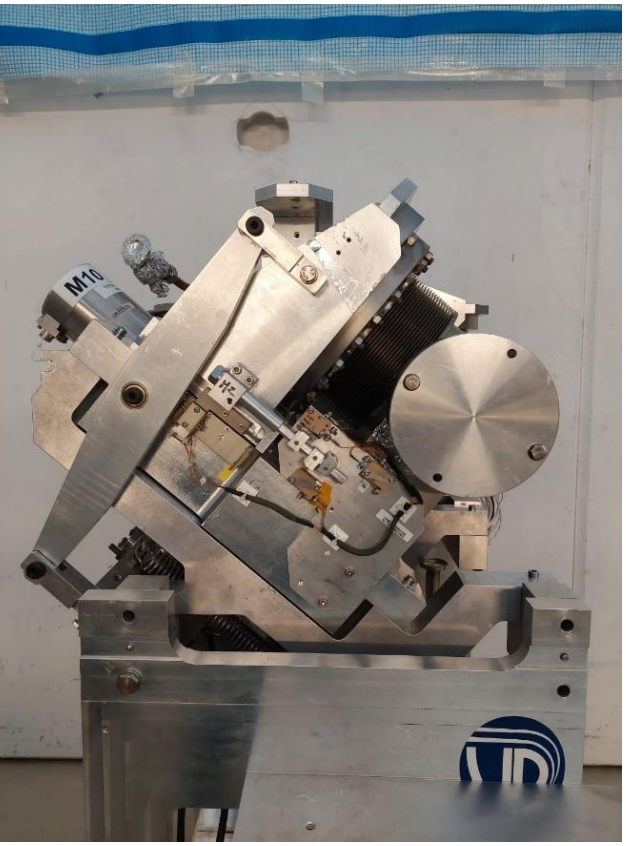


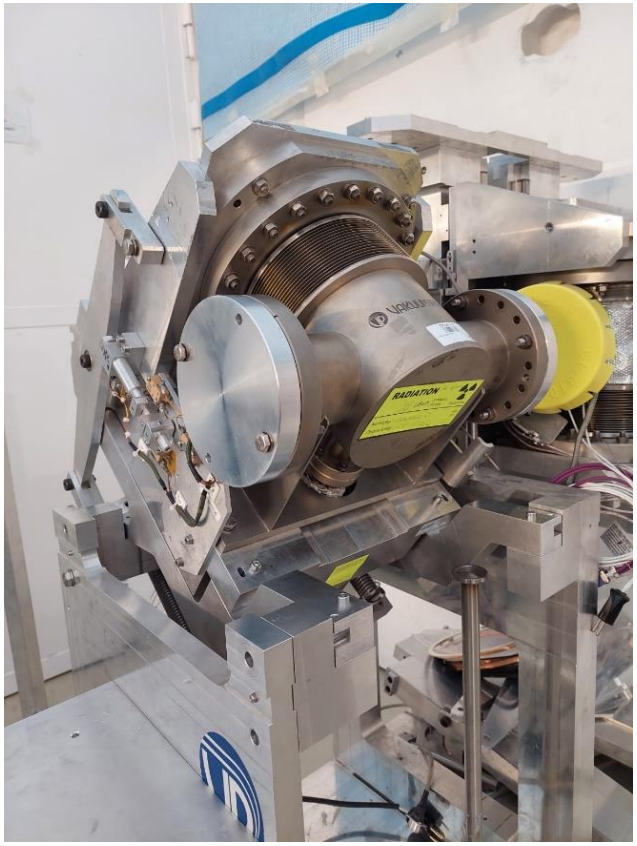


RP laser calibration (?)

RP alignment run

Test performance, April 2023
(*see also video*)

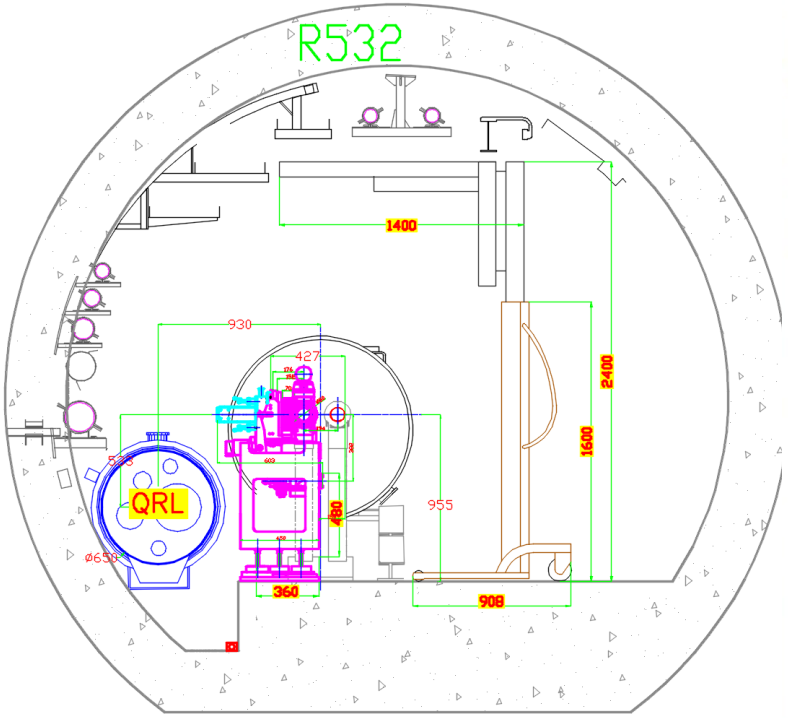




The PPS group carried out similar work twice:

- **first time in EYETS 2016 – 2017, when it was removed, converted and put in place 4 horizontal XRP units (all RP220m). Has been assembled new vacuum chamber, ferrite and faraday cage. Preliminary bake out and vacuum gas analysis test have been done in Prevessin lab.**
- **second in beginning of LS2 2018. Then it was removed from the tunnel two horizontal RP units (RP220near), and two others (RP210near) are rearranged.**

horizontal RP units on transport carriage



Hosting crane in the tunnel

CERN
CH-1211 Geneva 23
Switzerland

EDMS NO.	REV.	VALIDITY
2045055	1.0	RELEASED

REFERENCE
LHC-XRP-EC-0018

LHC

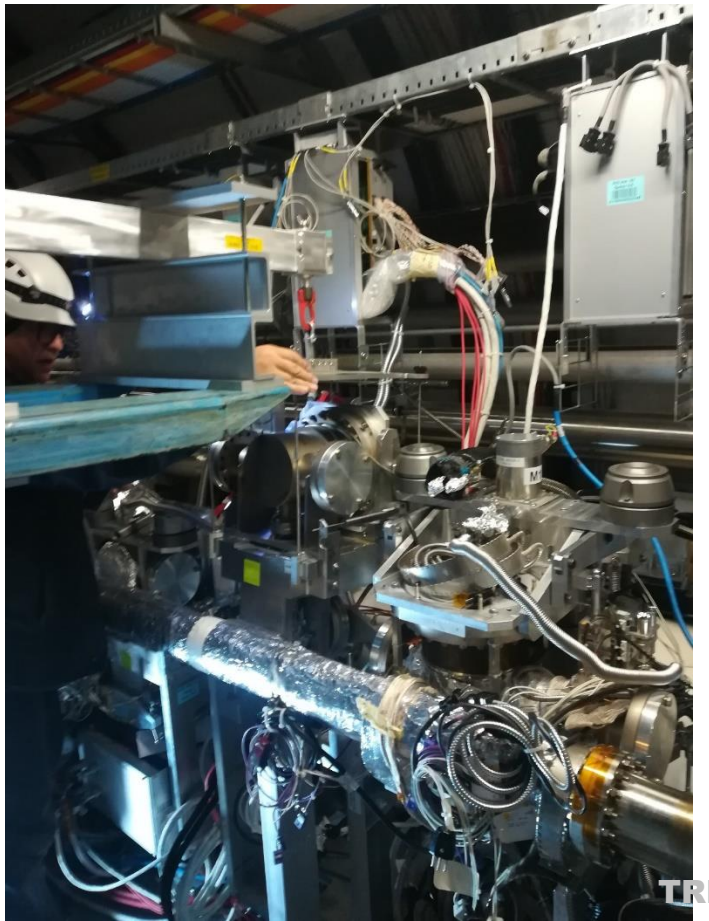
Date: 2018-11-28

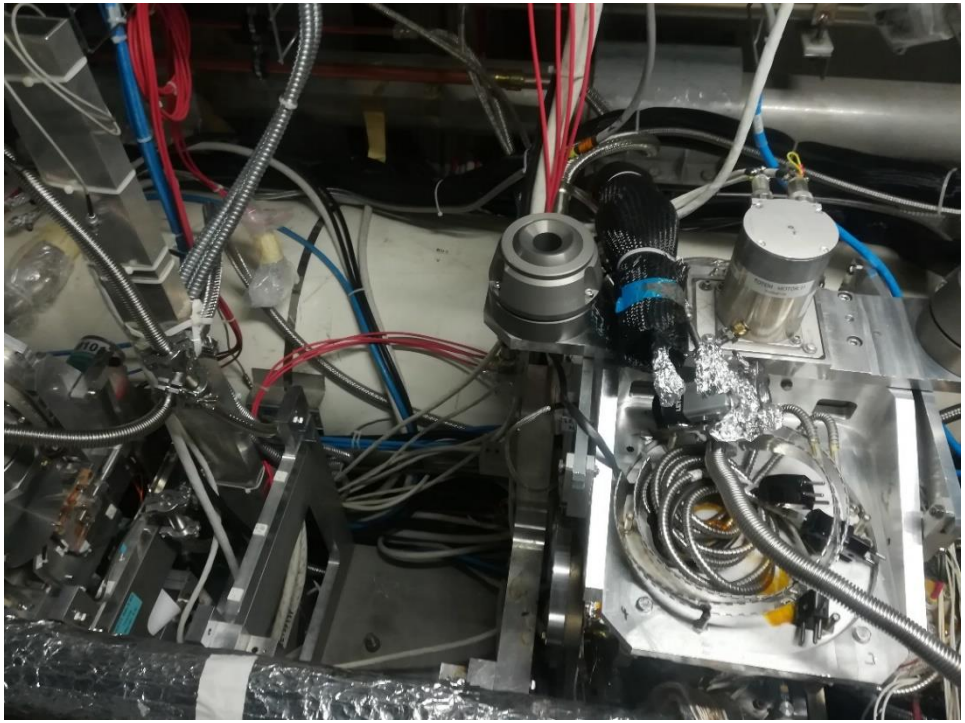
ENGINEERING CHANGE REQUEST

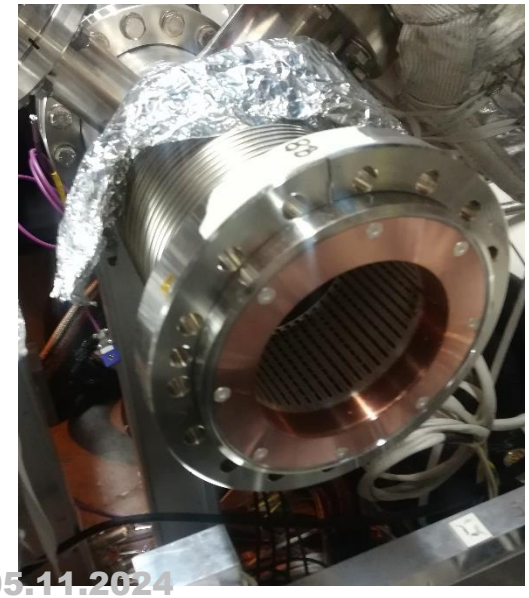
Removal of the PPS Horizontal Roman Pot 210 Near and Re-Installation at 220 Near

BRIEF DESCRIPTION OF THE PROPOSED CHANGE(S):

To improve the performance of the Proton Precision Spectrometer (PPS) during run3, we aim to install during LS2 in the RP220 near station a horizontal Roman Pot, which is validated for insertions at low beta *. The presently installed horizontal RP in the RP220 near station is not qualified for insertions at low beta * (TOTEM box RP, without RF shield). However, the horizontal RP installed in the 210 near station is equipped with the RF shield and validated for insertions at standard optics, but will not be used in future due to the





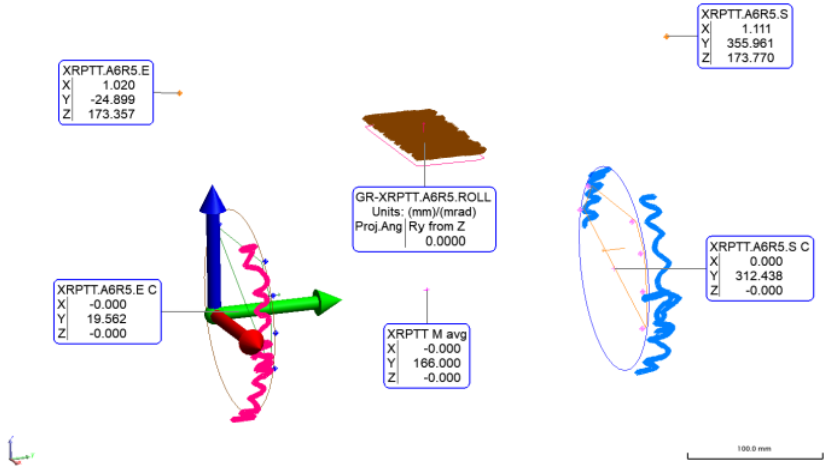


REPORT

TOTEM Roman Pots re-fiducialization

Accelerators Survey & Geodesy (EN-SMM-ASG)

DOCUMENT PREPARED BY:	DOCUMENT CHECKED BY:	DOCUMENT APPROVED BY:
Alban Vieille	Philippe Dewitte	



Beam	Element	Data	E (inlet) R	E (inlet) S	E (inlet) T	S (outlet) R	S (outlet) S	S (outlet) T
B1	XRPTT.A6R5.	*Géode (previous)*	*0.55*	*-24.86*	*173.25*	*1.04*	*356.02*	*173.75*
		Measured (new)	1.02	-24.90	173.36	1.11	355.96	173.77
		Δ	**0.47**	**-0.04**	**0.11**	**0.07**	**-0.06**	**0.02**

Roll ref angle = 0.000000 rad.

1. Measurement conditions

The instrument used was the Leica AT960-MR laser tracker #751135 in combination with the T-Probe.

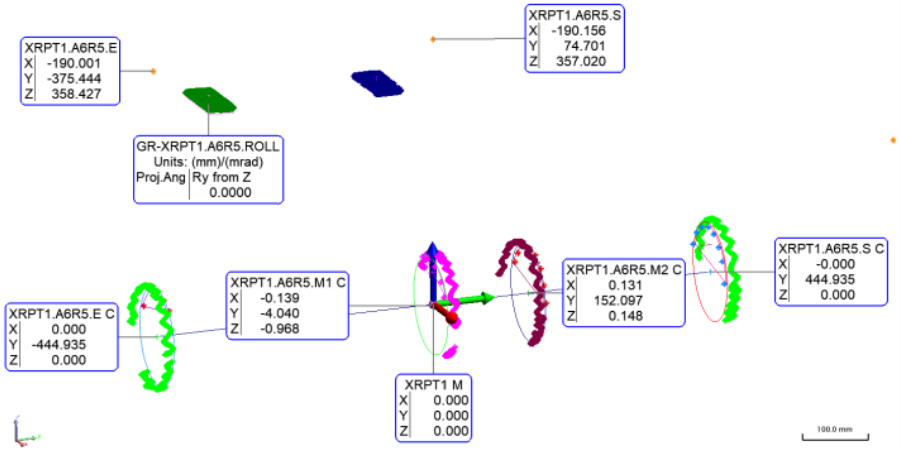
The measurement sequence was performed in such timing:

- 09/03/2020: LSS5R: B1.XRPT1.A6R5 and B1.XRPTT.A6R5
  Max instrument drift 0.02 mm, air temperature 23.9°C.
- 10/03/2020: LSS5L: B2.XRPTT.A6L5 and B2.XRPT2.A6L5
  Max instrument drift 0.05 mm, air temperature 23.2 to 23.5°C.

2. Results

2.1 LSS5R (B1)

2.1.1 XRPT1.A6R5



Beam	Element	Data	E (inlet) R	E (inlet) S	E (inlet) T	S (outlet) R	S (outlet) S	S (outlet) T
B1	XRPT1.A6R5.	*Géode (previous)*	*-190.11*	*-375.76*	*358.63*	*-190.71*	*74.36*	*357.53*
		Measured (new)	-190.00	-375.44	358.43	-190.16	74.70	357.02
		Δ	**0.11**	**0.32**	**-0.20**	**0.55**	**0.34**	**-0.51**

Roll ref angle = 0.000000 rad.

The coordinate system was created such as:

- The origin is the middle point between inlet and outlet flanges centers,
- Y+ oriented toward the outlet flange's center,
- Z+ oriented such as the normal of the roll reference plane is parallel to the YoZ plane.

PPS Roman Pot rotation for vertical crossing, proposed sequence

Proposed order	Roman Pot	Impact of vertical crossing on acceptance	Location-specific features and risks			
(Starting with 1 arm, then to be repeated on the other arm)			Triplet with vertical RPs occupying the adjacent slot of the frame?	Box RP with attached Faraday shield?	Radiation environment	Pre-existing tilt to be removed?
1	Timing cylindrical (~216m)	Almost complete loss of acceptance without rotation. From 2024 calibration runs, cylindrical-timing on both arms reduces bkg. by a factor of ~2 with both protons in acceptance	No	No	Moderate	No
2	Timing 220-near box RP	Almost complete loss of acceptance without rotation. From 2024 calibration runs, cylindrical+box-timing on both arms reduces bkg. by a factor of ~3 with both protons in acceptance	Yes	Yes	Moderate	No
3	Tracking 220-far box RP	Reduced acceptance at large ξ and large momentum transfer t without rotation.	Yes	Yes	High (proximity to collimator)	No
4	Tracking 210-far box RP	Mild loss of acceptance at large ξ and large momentum transfer t without rotation, due to existing 8 degree tilt.	Yes	Yes	Moderate	Yes (8 degree tilt of full frame)

Jonathan Hollar

Schedule

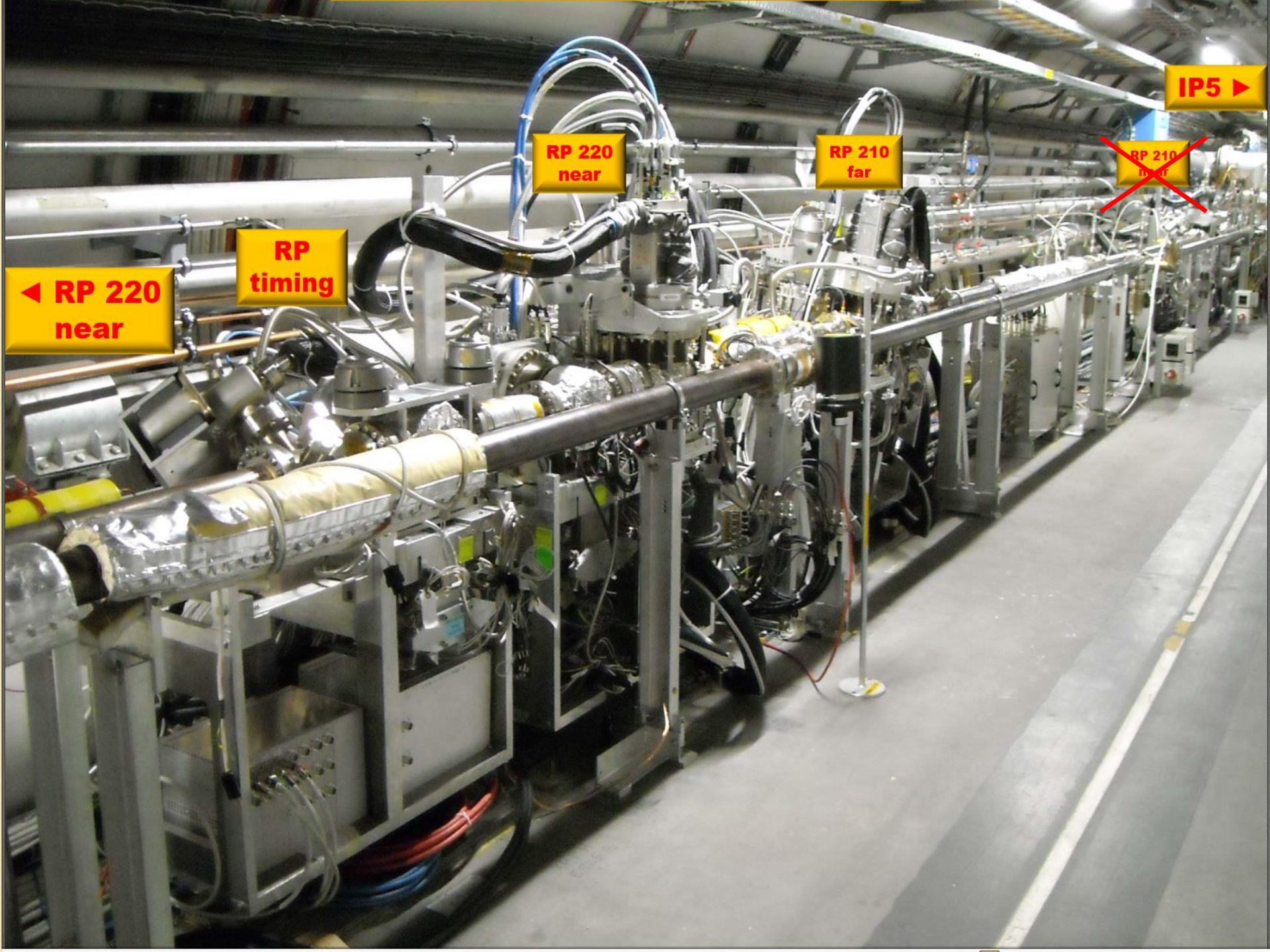
(tbd)

Option 1 (tbd): Start work in December with the reinstallation of 2 single cylindrical Roman Pots, evaluate the execution technology. Continue working with the remaining Roman Pots (with Faraday cages) in January.

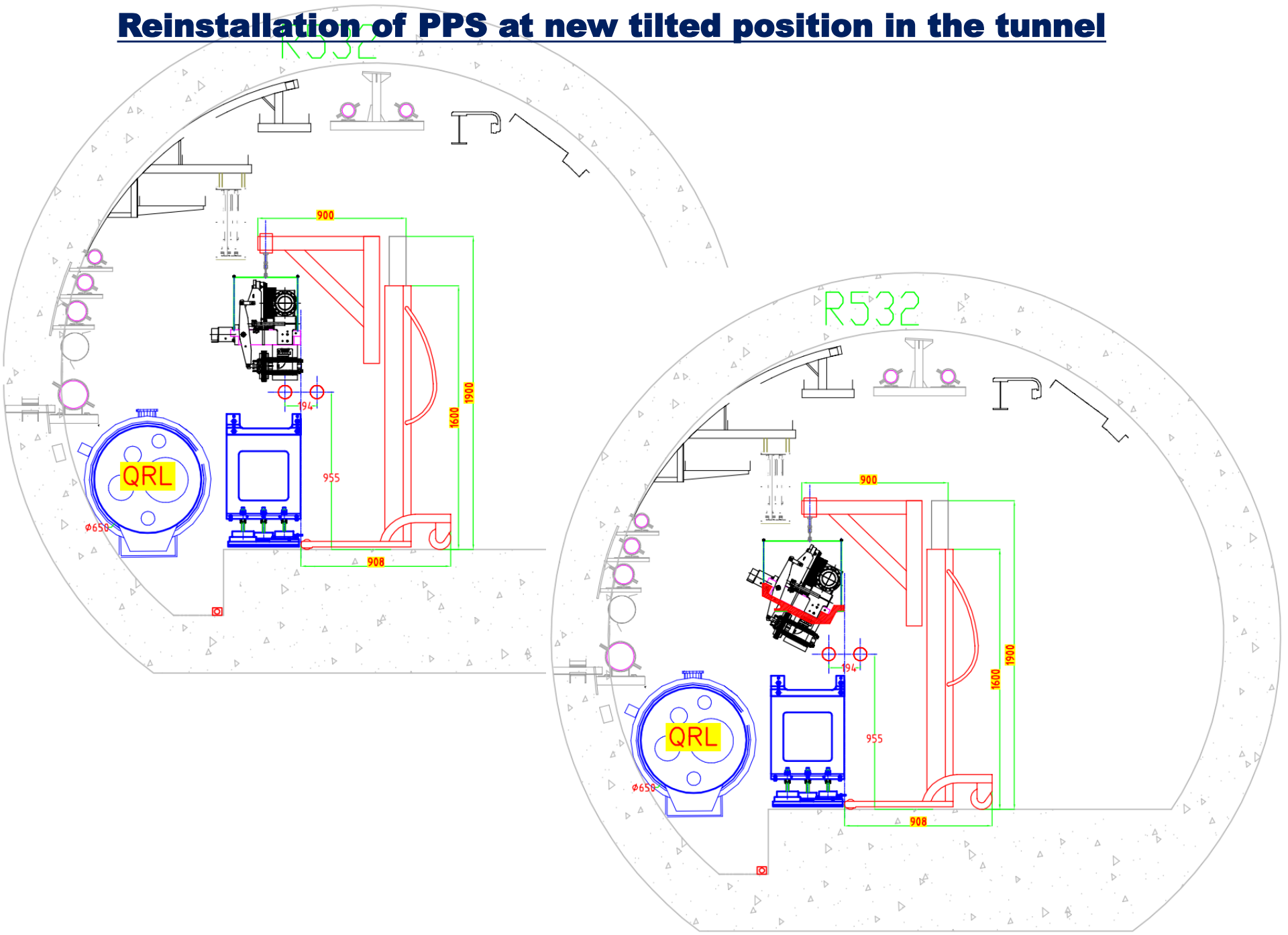
Option 2 (tbd): Start and complete all work in January - early February.

Radiation environment

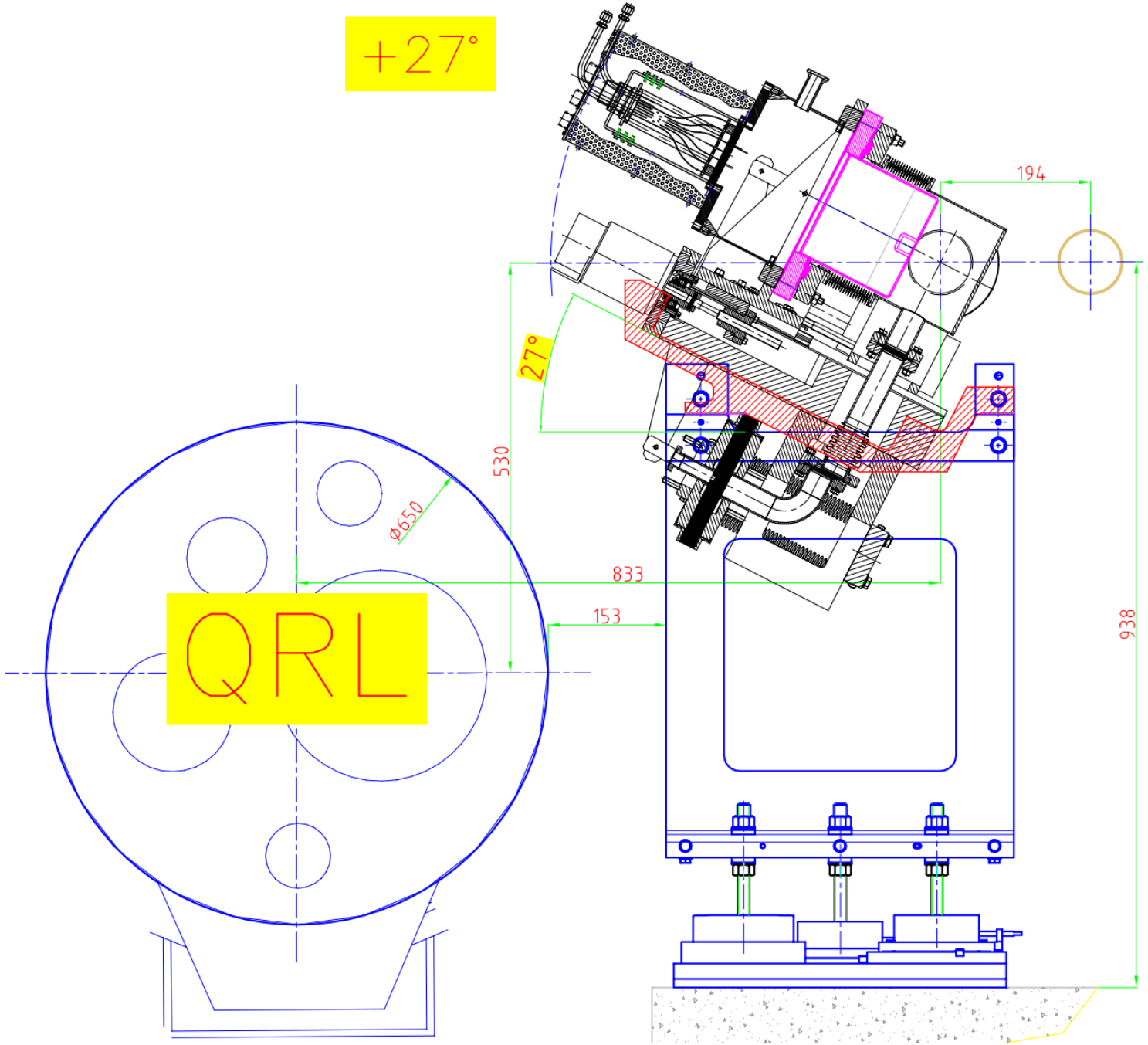
Back-up slides


IP5 ▶
RP 220 near
RP 210 far
RP 210 near
RP timing
◀ RP 220 near

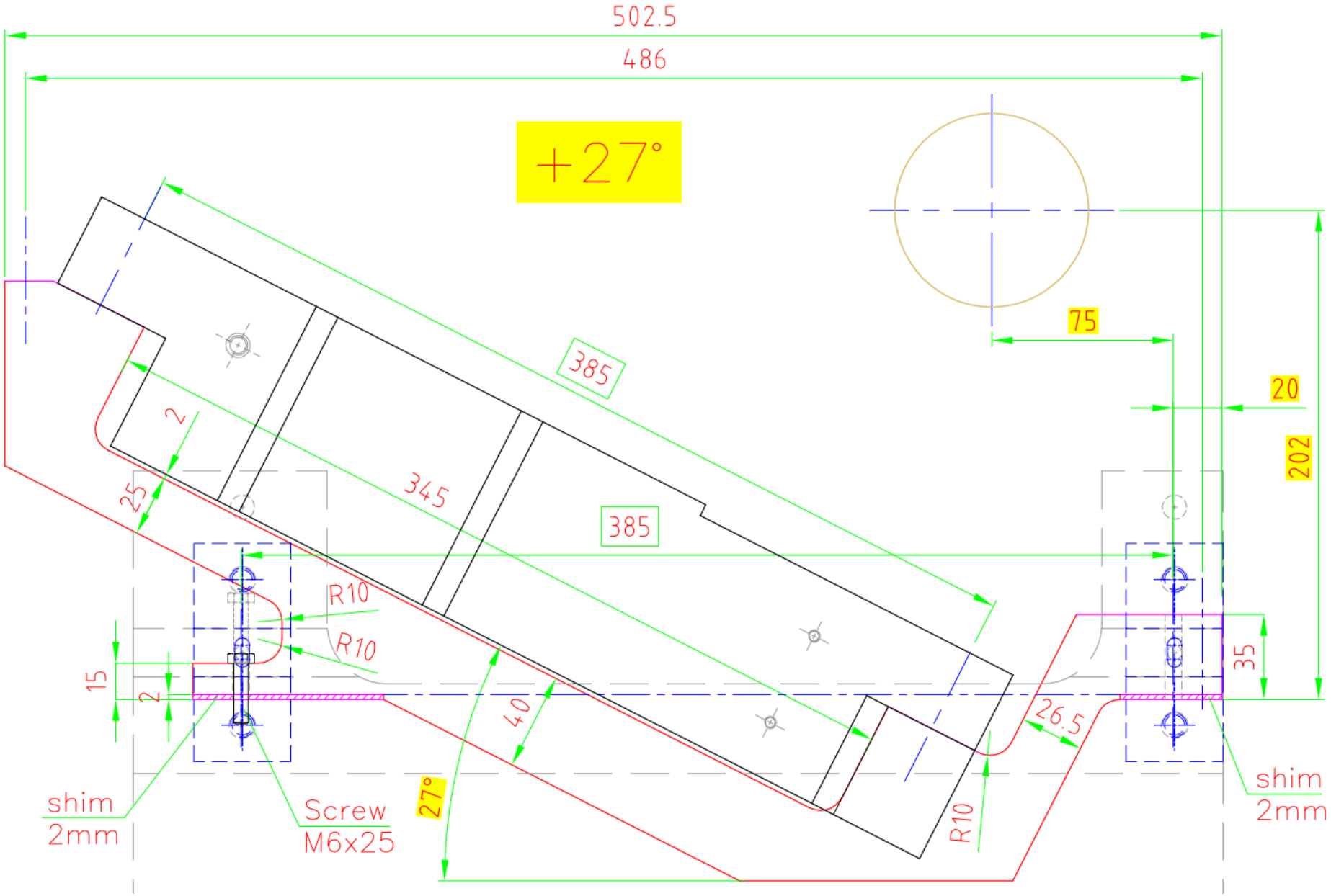
Reinstallation of PPS at new tilted position in the tunnel



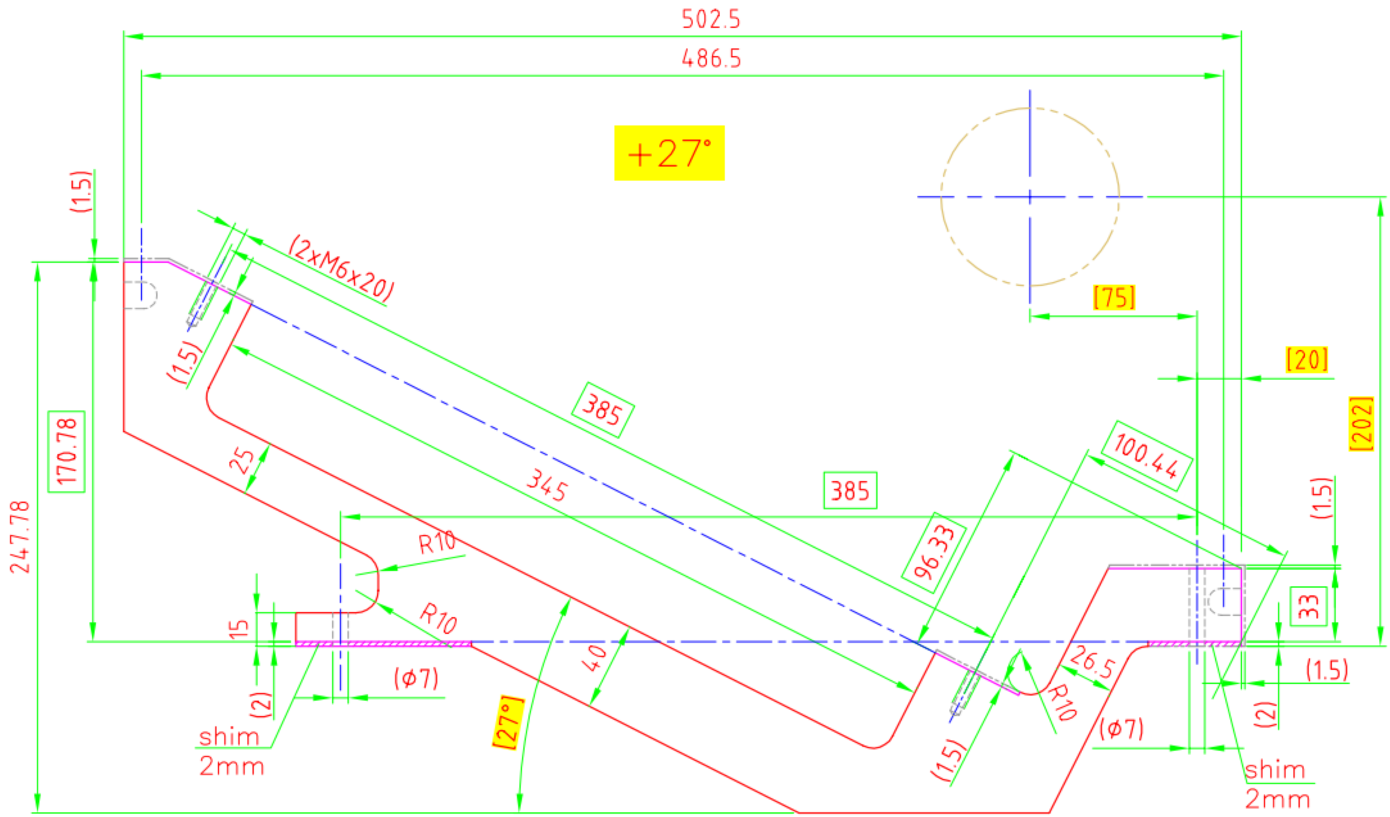
The Roman Pot station is tilted at 27 degrees and placed on LHC beam

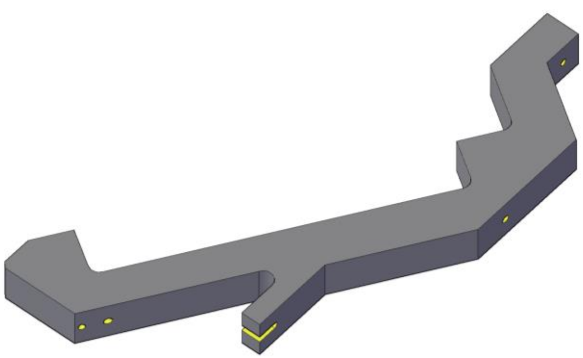


Checking geometric coincidence



INDICE	DATE	NOM	MODIFICATION

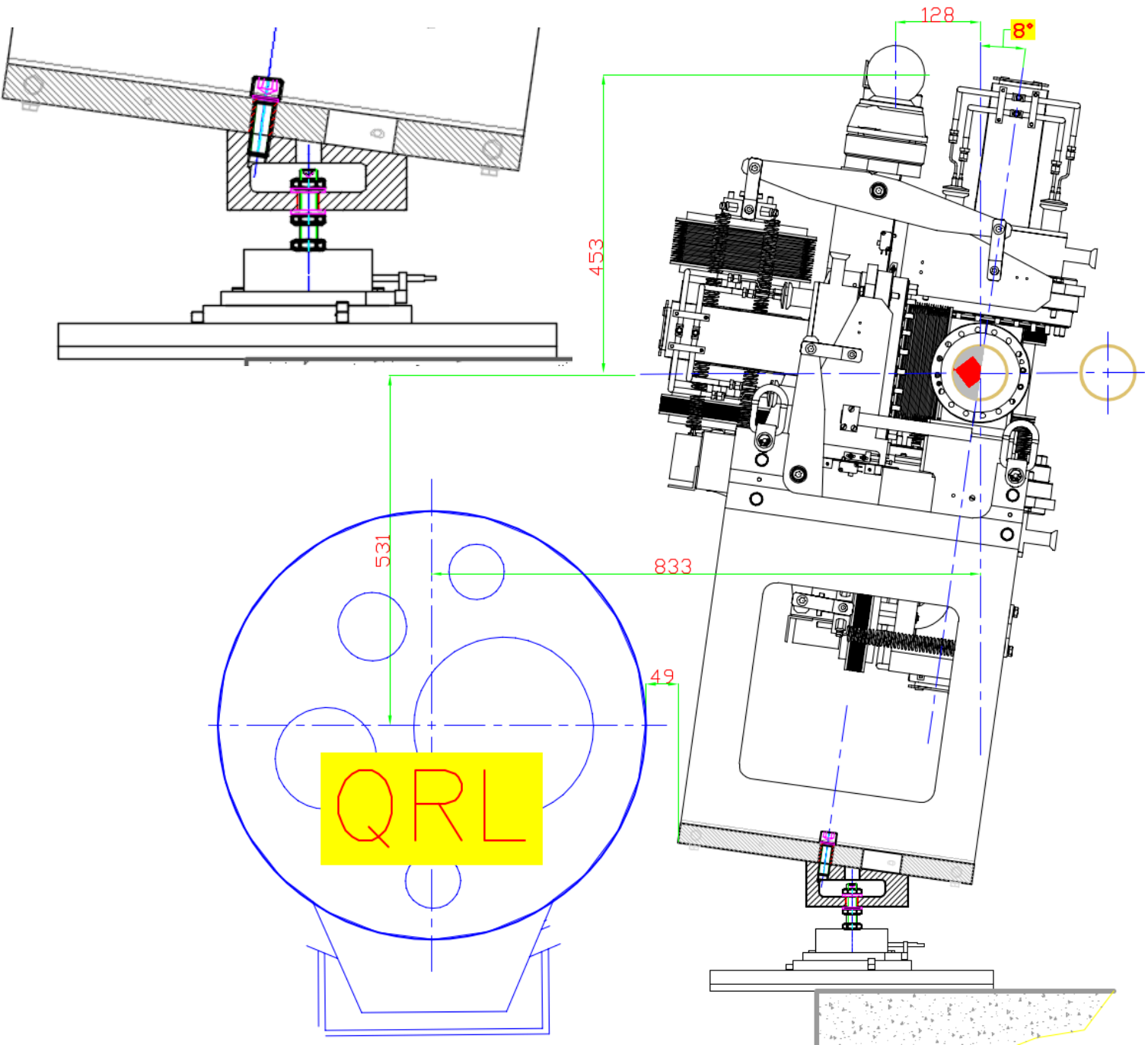


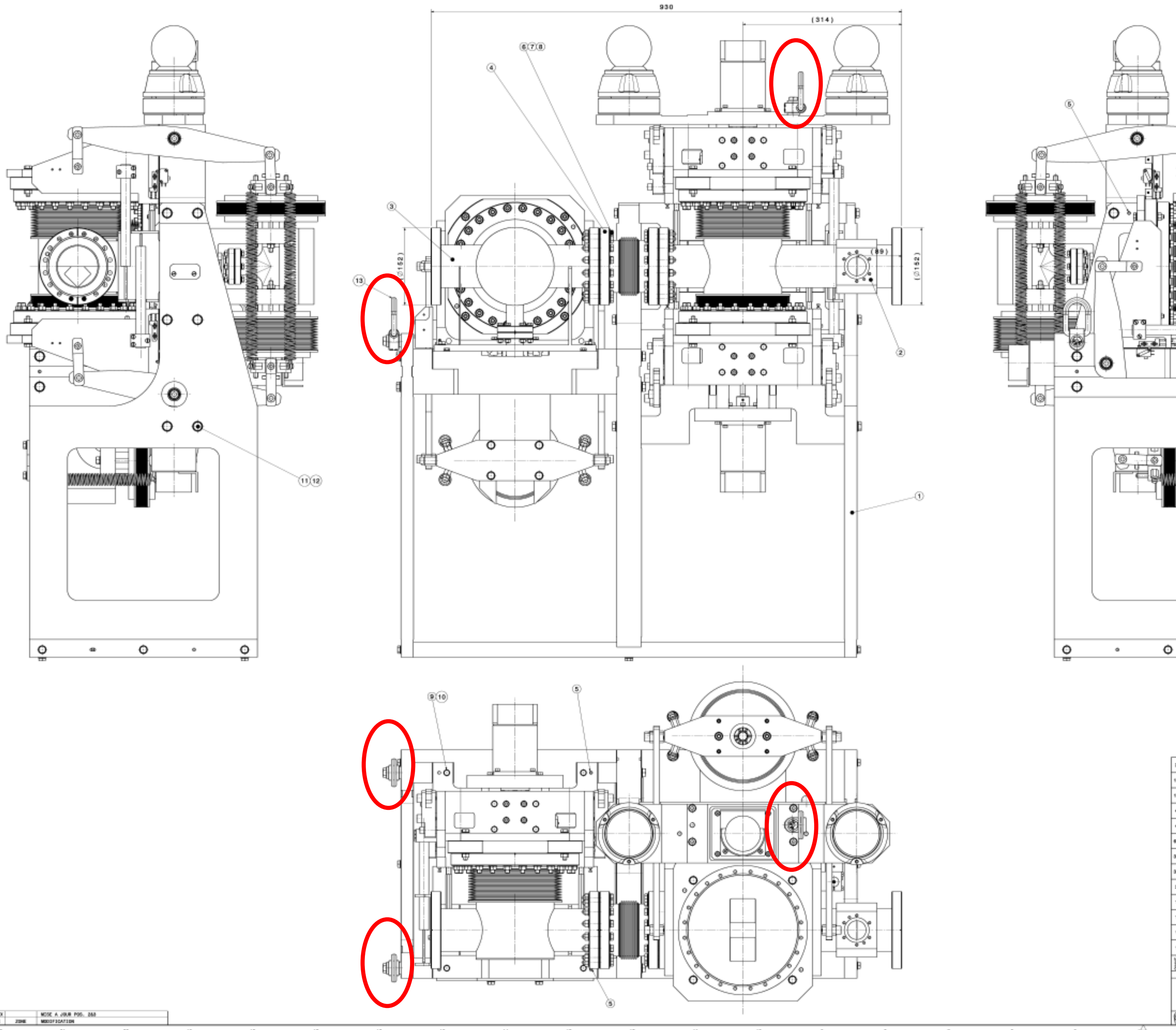


1. AW6082, 40mm plate;
2. (), [ ] – dimensions for processing;
3. h12; H12;
4. Other dimensions are for reference.

BRACKET	ECHELLE SCALE 1:2	DES/DRA. DRUZHKIN	17.10.2024
		CONTROLLED	
		RELEASED	
		APPROVED	
		REMPLACE/REPLACES	REMPLACE
CERN NON VALABLE POUR EXECUTION NOT VALID FOR EXECUTION	QAC	SIZE 3	IND.

The XRP210far station is already tilted by 8 degrees





MASS:300 Kg
MASSE:

QTY	DESCRIPTION	POS	MAT.	OBSERVATIONS	REF. GEN
3	Load ring VLBG 0,63t M10 VLBG 0,63 T M10 : anneau à étrier	13		RUD Kettenfabrik	
12	WASHER M10 RONDELLE M10	12	STAINLESS STEEL		47.78.15 810.4
12	HEXAGON SCREW M10x60 VIS H M10x60	11	STAINLESS STEEL A4 Ac INOX A4		47.62.82 367.8
4	PLAIN WASHER - M6 ROND.PLATE - M6	10	ST. STEEL A4-100 INOX A4-100		47.78.15 112.9
4	HEX. SCREW M6 x 45 VIS A TETE HEXAGONALE M6 x 45	9	STAINLESS STEEL		47.62.62 204.4
64	PLAIN WASHER M8 RONDELLE PLATE M8	8	ST. STEEL A4-100 INOX A4-100		47.78.15 116.5
32	HEXAGON NUT M8 ECROU HEXAGONAL M8	7	ST. STEEL A4-100 INOX A4-100		47.43.78 108.4
32	HEXAGON SCREW M8x55 VIS H M8x55	6	ST. STEEL A4-100 INOX A4-100		47.62.83 122.3
3	PIN Ø6h6 x 50 GOUPILLE Ø6h6 x 50	5	Steel Ac Trempé	DIN 6325 BOSSARD BN 858	
1	[illegible] -	4		LHCVBU__0036	
1	ROMAN POT - HORIZONTAL POT ASSEMBLY TYPE B POT ROMAIN - ENSEMBLE POT HORIZONTAL TYPE B	3		LHCXRP__0163	
1	ROMAN POT - VERTICAL POT ASSEMBLY TYPE B POT ROMAIN - ENSEMBLE POT VERTICAL TYPE B	2		LHCXRP__0162	
1	ROMAN POT SUPPORT - ASSEMBLY TYPE B SUPPORT POT ROMAIN - ENSEMBLE TYPE B	1		LHCXRP__0136	

Roman Pot (TOTEM) - Mechanical

ROMAN POT
ASSEMBLY TYPE B
POT ROMAIN
ENSEMBLE TYPE B

SCALE 1:2.5

J. LACROIX 2006-06-29

LHCXRP__0.LHCXRP__0164

REMPLACE/REPLACES

NON VALABLE POUR EXECUTION
NOT VALID FOR EXECUTION

FOR DISCUSSION
NOT FOR EXECUTION

LHCXRP__0164 0 A

IND.	DATE	NOM/NAME	ZONE	MODIFICATION
A	2006-[illegible]	J. LACROIX		MISE A JOUR POS. 2&3