# Status of AFP construction and plans for installation in the YETS

*presented by Petr Sicho of behalf of AFP collaboration*

# AFP approval milestones

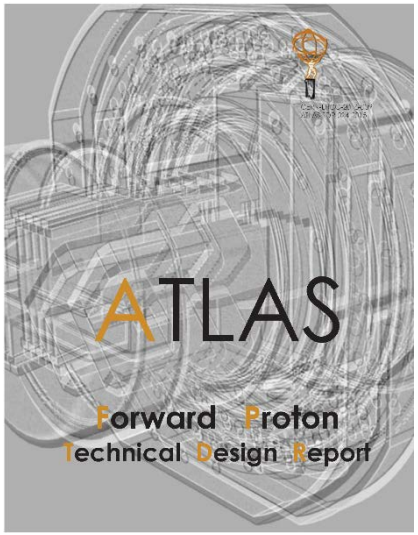
- **AFP TDR**

The ATLAS Collaboration ,

"Technical Design Report for the ATLAS Forward

Proton Detector", CERN-LHCC-2015-009 ; ATLAS-TDR-024;
url: https://cds.cern.ch/record/2017378/

Accepted by LHCC and ATLAS in June 2015

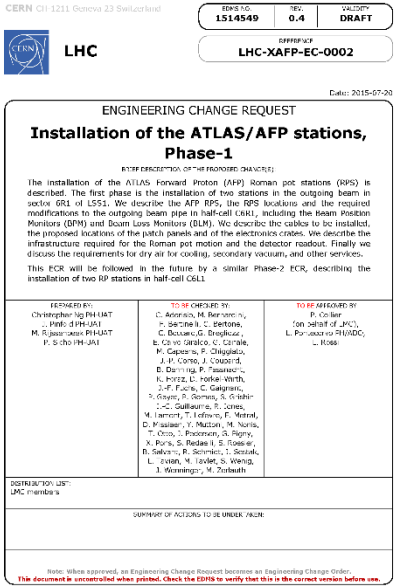



- **Engineering Change Request**

url: https://indico.cern.ch/event/440927/

Accepted at LHC Machine Committee meeting

26 August 2015


CERN CH-1211 Geneva 23 Switzerland

EDMS NO. 1514549 | REV. 0.4 | VALIDITY DRAFT

LHC

REFERENCE LHC-XAFP-EC-0002

Date: 2015-07-20

ENGINEERING CHANGE REQUEST

**Installation of the ATLAS/AFP stations, Phase-1**

BRIEF DESCRIPTION OF THE PROPOSED CHANGE(S):

The installation of the ATLAS Forward Proton (AFP) Roman pot stations (RPS) is described. The first phase is the installation of two stations in the outgoing beam in sector 6R1 of LSS1. We describe the AFP RPS, the RPS locations and the required modifications to the outgoing beam pipe in half-cell C6L1, including the Beam Position Monitors (BPM) and Beam Loss Monitors (BLM). We describe the cables to be installed, the proposed locations of the patch panels and of the electronics crates. We describe the infrastructure required for the Roman pot motion and the detector readout. Finally we discuss the requirements for dry air for cooling, secondary vacuum, and other services.

This ECR will be followed in the future by a similar Phase-2 ECR, describing the installation of two RP stations in half-cell C6L1

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TO BE APPROVED BY: P. Collier (on behalf of LMC), L. Ponce PH/ADC, L. Rossi

DISTRIBUTION LIST: LMC members

SUMMARY OF ACTIONS TO BE UNDERTAKEN:

Note: When approved, an Engineering Change Request becomes an Engineering Change Order.
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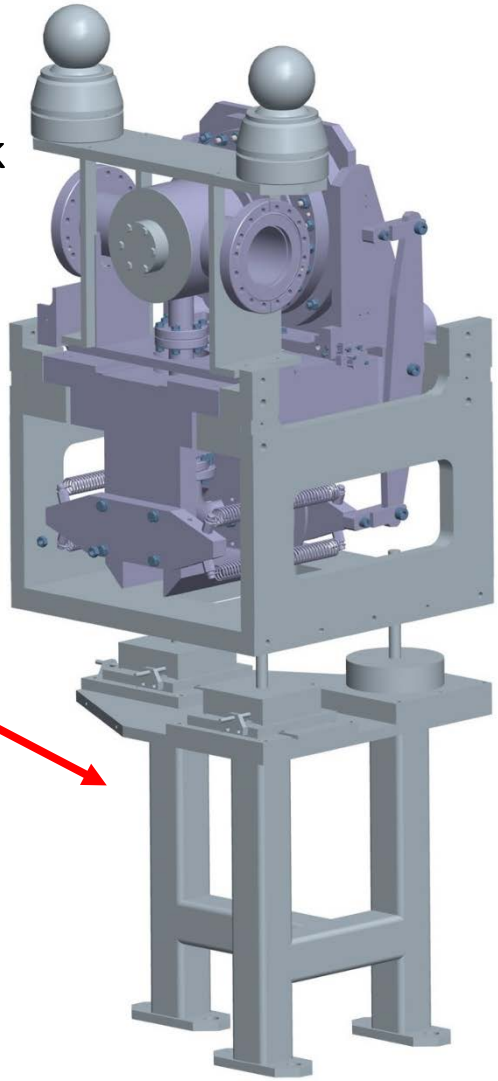
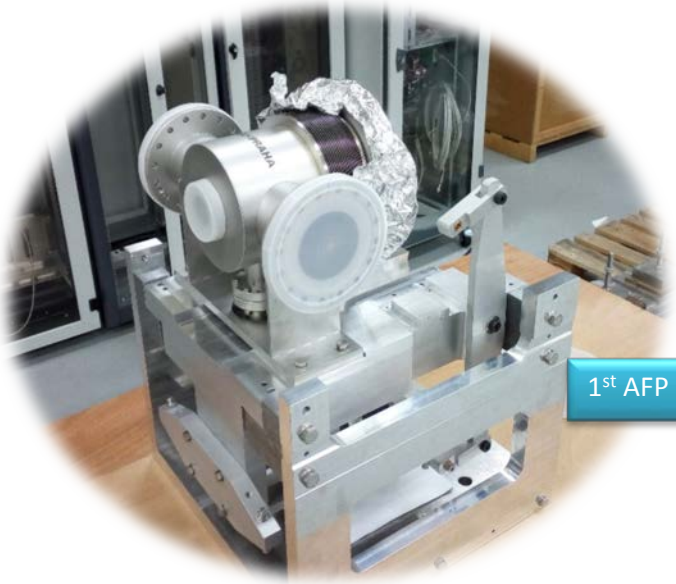
# AFP RP stations

- 5 Horizontal Roman Pot Stations ordered at Vacuum Praha (June 2015)
  - 2 RP Stations to be installed in YETS 2015/2016,
    First station was already delivered to CERN last week
  - 1 RP Stations for the lab
  - 2 RP Stations to be installed in YETS 2016/2017
    (expected delivery in spring 2016)



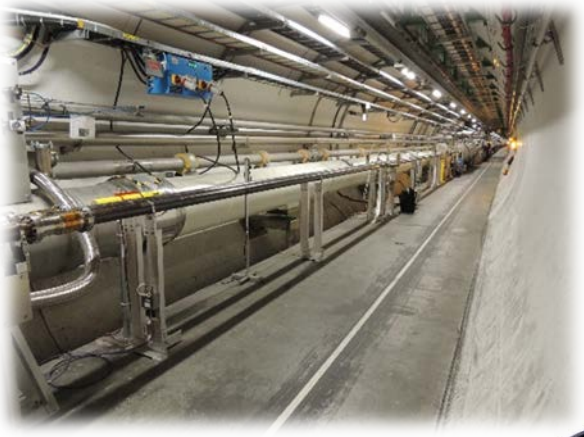
- Support tripod produced at CERN



1st AFP station delivered :-)

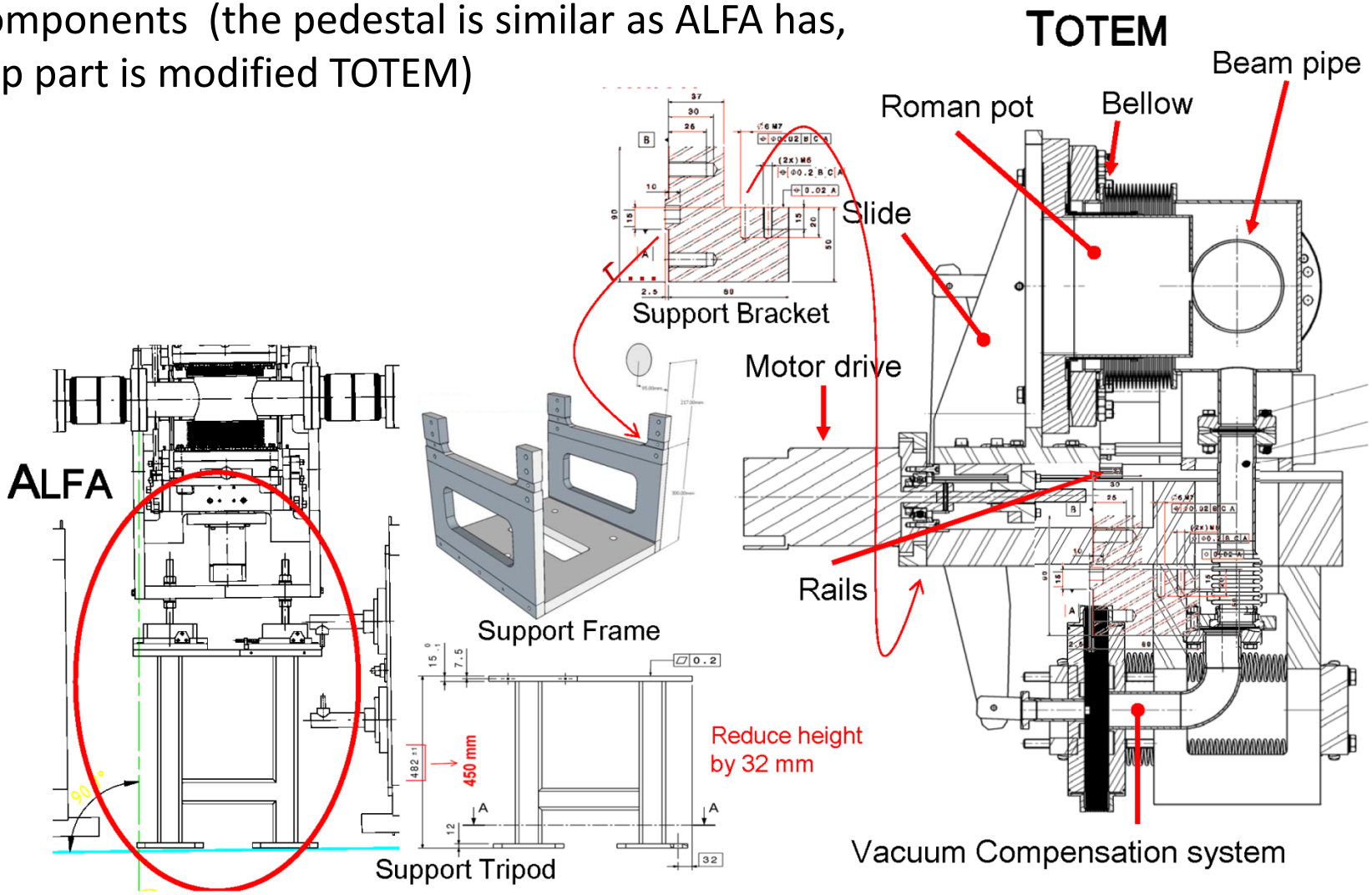
# Where we install?

- 2 first RP stations will be installed at right ATLAS arm (C6R1) at 205m and 217m far from ATLAS IP

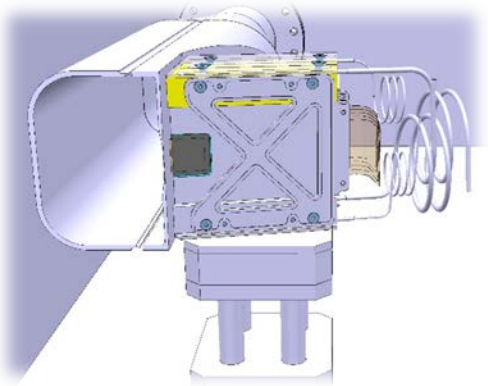


# RP station in more details

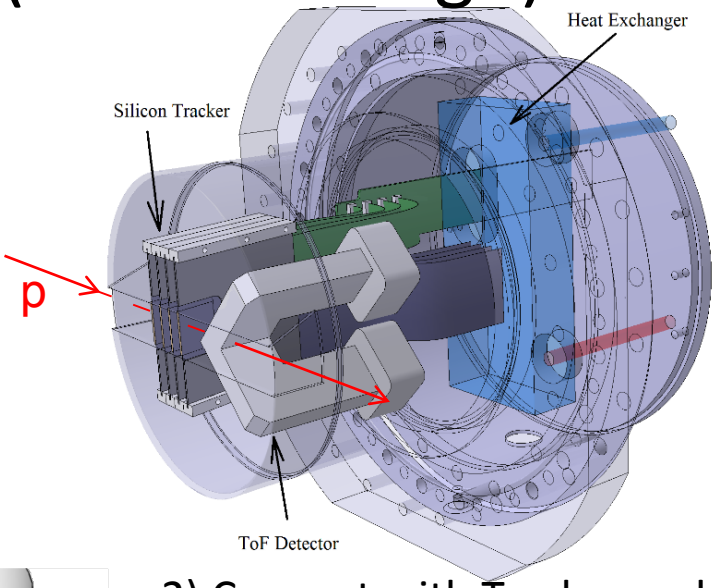
- AFP is using existing RP station mechanical components (the pedestal is similar as ALFA has, top part is modified TOTEM)



# Historical developments (Tracker design)

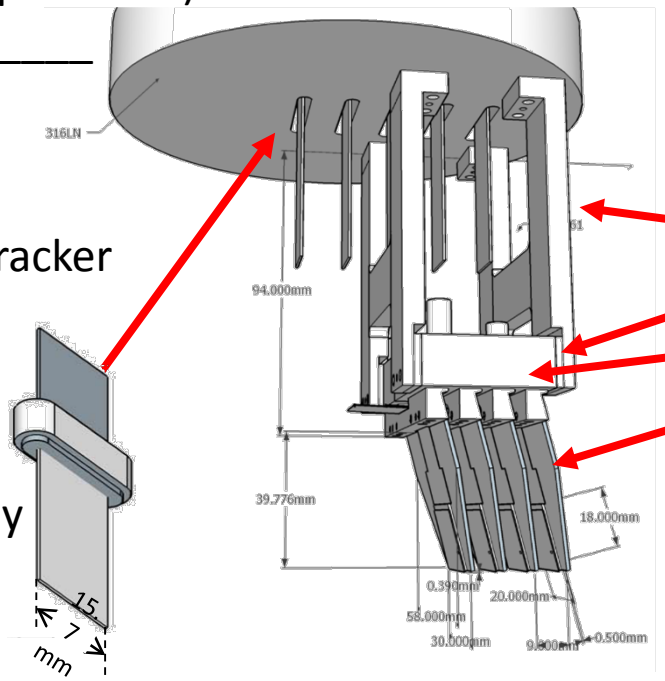


1) Moveable beam pipe, evaporative cooling (up to 2013)




2) Concept with Tracker and ToF in one pot, air-cooling (2014)

3) Construction of Tracker prototype,(2015)

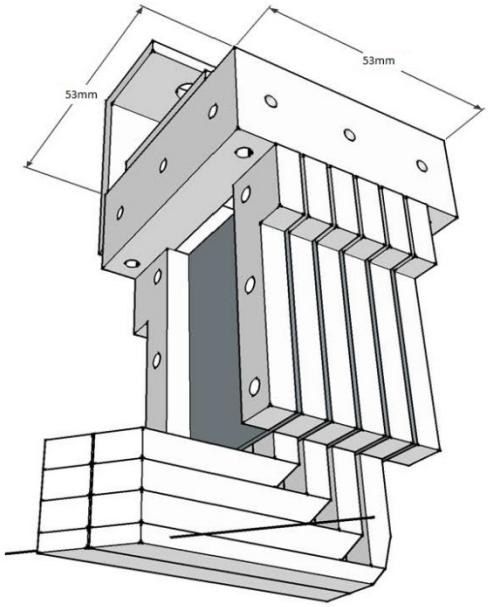



- Solid pillars
- PEEK insulation
- Heat exchanger
- Tracker planes (carbon fibre reinforced composite )

- Potted by Pave technology (sealed feedthrough connectors)

# Time of Flight detector

- ToF detector - not considered to be installed before the end of 2016
- ToF detector will be installed latter in the same Roman Pot as the Tracker at 217m (farther station)
- ToF related cables to be installed already in YETS 2015

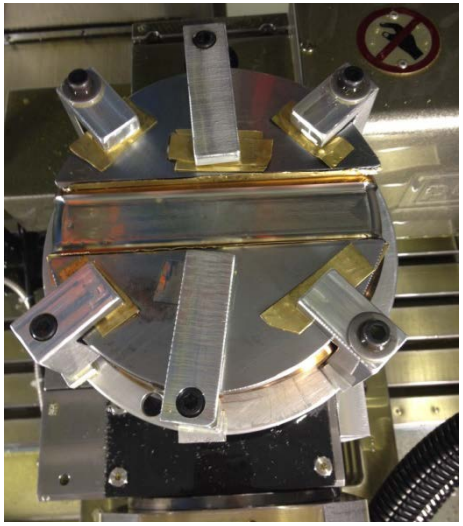



- Prototype shown here (not the final version)

# Roman Pot prototyping

- Pot production (University of Alberta), 2 pieces at CERN so far ✓
- Welding of pot parts (CERN workshop) ✓
- Mechanical and RF tests ✓
- Cleaning – etching, heating to 650 C in vacuum ✓
- Leak tests ✓
- Coating (0,1 µm NEG; 1,5- 2µm Cu; 0,5 µm NEG). Cu coating - to improve RF and have less heating, NEG –improve local vacuum and secondary electron emission - last step before installation (may be will be skipped for final pieces)

milling process



thin window ~300 µm

”model 0” shown here

# AFP installation plans in details

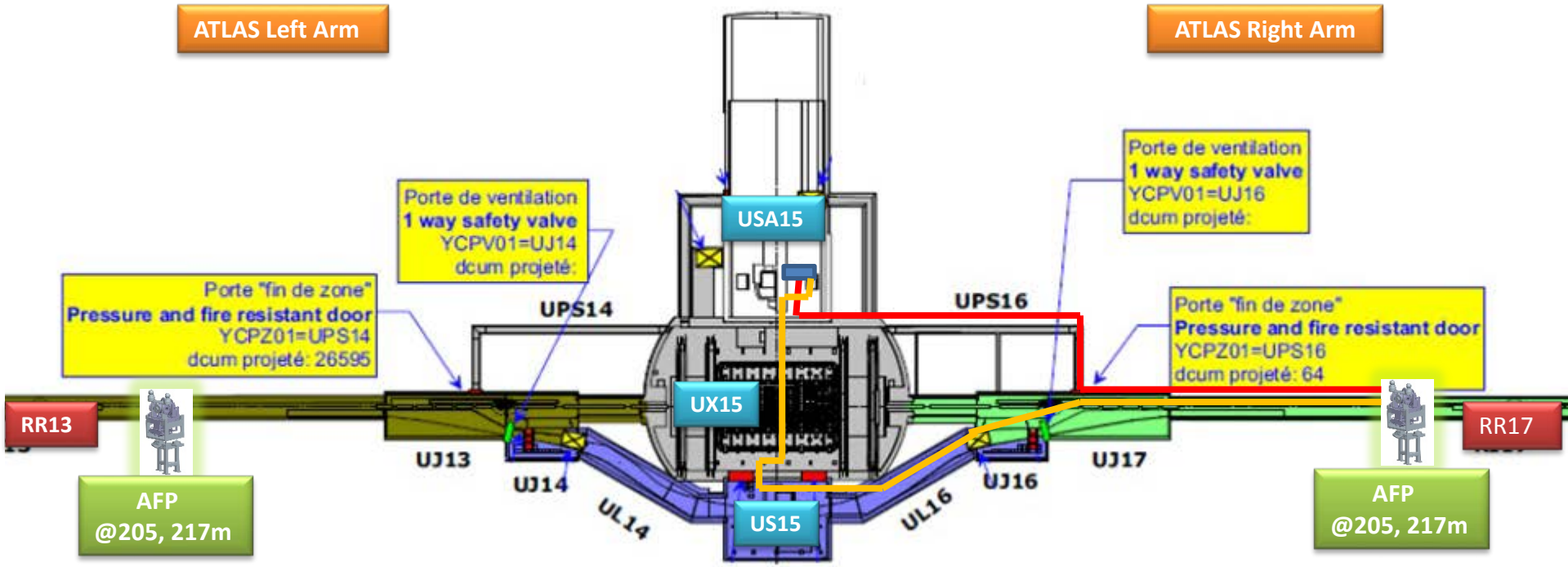
- AFP will install RP stations only at right ATLAS arm during YETS 2015/2016
- Infrastructure to be built and installed :
  - Cables and patch panels @212m
  - Control of station stepper motors (USA15)
  - Secondary vacuum system (pumps, control – alcove RR17, USA15)
  - Air-cooling infrastructure (tubes, valves, pressure regulators, sensors)
  - DCS and DAQ hardware in USA15
- 2 RP stations with Si Tracker (Tracker can be installed later over TS week) to be installed at the end of YETS

# List of AFP cables per ATLAS arm (includes ToF services)

| | Cable name | ATLAS Cable ID | Starting point | Destination | cable type | construction | ϕ [mm] | length [m] | Atlas side | Requested routing path |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AFP DATA/TTC | 3041000 | Y.24-05.A1 | Tunnel @212m | custom optical (FibreFab) | 8 x 12 fibres | 12 | 310 | A6R1 | shortest one (galleries) |
| 2 | Fast Trigger/Clock SiT | 3041001 | Y.24-05.A1 | Tunnel @217m | 7/8" Heliflex HCA78-50, | coaxial | 28 | 300 | A6R1 | shortest one (galleries) |
| 3 | Fast Trigger ToF | 3041002 | Y.24-05.A1 | Tunnel @217m | 7/8" Heliflex HCA78-50, | coaxial | 28 | 300 | A6R1 | shortest one (galleries) |
| 4 | LV cable SiT | 3041003 | Y.23-05.A1 | Tunnel @212m | TecniKabel | AWG10, 4 tw.pairs | 22 | 400 | A6R1 | standard one |
| 5 | LV cable SiT | 3041004 | Y.23-05.A1 | Tunnel @212m | TecniKabel | AWG10, 4 tw.pairs | 22 | 400 | A6R1 | standard one |
| 6 | LV cable ToF | 3041005 | Y.23-05.A1 | Tunnel @212m | TecniKabel | AWG10, 4 tw.pairs | 22 | 400 | A6R1 | standard one |
| 7 | LV cable ToF | 3041006 | Y.23-05.A1 | Tunnel @212m | TecniKabel | AWG10, 4 tw.pairs | 22 | 400 | A6R1 | standard one |
| 8 | LV cable spare(ToF) | 3041007 | Y.23-05.A1 | Tunnel @212m | TecniKabel | AWG10, 4 tw.pairs | 22 | 400 | A6R1 | standard one |
| 9 | VVDC | 3041008 | Y.23-05.A1 | Tunnel @212m | Novacavi 04.71.04.147.0 | AWG14, 7 tw.pairs | 18.7 | 400 | A6R1 | standard one |
| 10 | AuxPWR (Vreg) | 3041009 | Y.23-05.A1 | Tunnel @212m | Novacavi 04.71.04.147.0 | AWG14, 7 tw.pairs | 18.7 | 400 | A6R1 | standard one |
| 11 | HV cable SiT | 3041010 | Y.23-05.A1 | Tunnel @212m | TecniKabel 04.31.52.236.2 | AWG26, 18tw.pairs | 13.8 | 400 | A6R1 | standard one |
| 12 | HV cable ToF | 3041011 | Y.23-05.A1 | Tunnel @212m | TecniKabel 04.31.52.236.2 | AWG26, 18tw.pairs | 13.8 | 400 | A6R1 | standard one |
| 13 | Optoservices | 3041012 | Y.23-05.A1 | Tunnel @212m | NF8 04.21.52.160.0 | AWG18, 4tw.pairs | 12 | 400 | A6R1 | standard one |
| 14 | Environmental 1 | 3041013 | Y.23-05.A1 | Tunnel @212m | NE48; 04.21.52.150.2 | 0.5mm2, 24tw.pairs | 21 | 400 | A6R1 | standard one |
| 15 | Environmental 2 | 3041014 | Y.23-05.A1 | Tunnel @212m | NE48; 04.21.52.150.2 | 0.5mm2, 24tw.pairs | 21 | 400 | A6R1 | standard one |
| 16 | Air-cooler1 CTRL | 3041015 | Y.23-05.A1 | Tunnel @212m | NF12 04.21.52.170.8 | AWG18, 6tw.pairs | 14 | 400 | A6R1 | standard one |
| 17 | Air-cooler2 CTRL | 3041016 | Y.23-05.A1 | Tunnel @212m | NF12 04.21.52.170.8 | AWG18, 6tw.pairs | 14 | 400 | A6R1 | standard one |
| 18 | CANBUS | 3041017 | Y.24-05.A1 | Tunnel @212m | VG18CAN 04.21.60.491.2 | 1mm2, 9tw.pairs | 17.4 | 400 | A6R1 | standard one |
| 19 | Stepper motors | 3041018 | Y.25-05.A1 | Tunnel @212m | Intercond 04.71.04.167.0 | AWG 16, 7tw.pairs | 16.3 | 400 | A6R1 | standard one |
| 20 | LVDT, resolver | 3041019 | Y.25-05.A1 | Tunnel @212m | NE48; 04.21.52.150.2 | 0.5mm2, 24tw.pairs | 21 | 400 | A6R1 | standard one |
| 21 | microswitches | 3041020 | Y.25-05.A1 | Tunnel @212m | NE18; 04.21.52.130.6 | 0.5mm2, 9tw.pairs | 13.5 | 400 | A6R1 | standard one |
| 22 | general spare | 3041021 | Y.25-05.A1 | Tunnel @212m | Intercond 04.71.04.167.0 | AWG 16, 7tw.pairs | 16.3 | 400 | A6R1 | standard one |
| 23 | general spare | 3041022 | Y.25-05.A1 | Tunnel @212m | Intercond 04.71.04.167.0 | AWG 16, 7tw.pairs | 16.3 | 400 | A6R1 | standard one |
| | | | | | | | | | | |
| 24 | secondary vacuum | 3041023 | XYAFP01 RR17 | Tunnel @217m | NE18; 04.21.52.130.6 | 0.5mm2, 9tw.pairs | 13.5 | 46 | A6R1 | standard one |
| 25 | general spare | 3041024 | XYAFP01 RR17 | Tunnel @212m | NF12 04.21.52.170.8 | AWG18, 6tw.pairs | 14 | 46 | A6R1 | standard one |
| 26 | general spare | 3041025 | XYAFP01 RR17 | Tunnel @212m | NF12 04.21.52.170.8 | AWG18, 6tw.pairs | 14 | 46 | A6R1 | standard one |
| | | | | | | | | | | |
| 27 | secondary vacuum pipe | 3041026 | XYAFP01 RR17 | Tunnel @217m | pipe Assiwell | flexible vacuum pipe | ~25mm | 40 | A6R1 | standard one |
| 28 | Aircooler FS1 control pipe | 3041027 | XYAFP01 RR17 | Tunnel @217m | flexible plastic pipe | | | 40 | A6R1 | standard one |
| 29 | Aircooler FS2 control pipe | 3041028 | XYAFP01 RR17 | Tunnel @217m | flexible plastic pipe | | | 40 | A6R1 | standard one |
| 30 | Aircooler NS1 control pipe | 3041029 | XYAFP01 RR17 | Tunnel @205m | flexible plastic pipe | | | 46 | A6R1 | standard one |
| 31 | Aircooler NS1 control pipe | 3041030 | XYAFP01 RR17 | Tunnel @205m | flexible plastic pipe | | | 46 | A6R1 | standard one |

- We have 26 cables in total (per arm), in addition there are also BPM cables (~20 cables) which will be installed by LHC people

# ATLAS situation plan (top view)




Length od services:

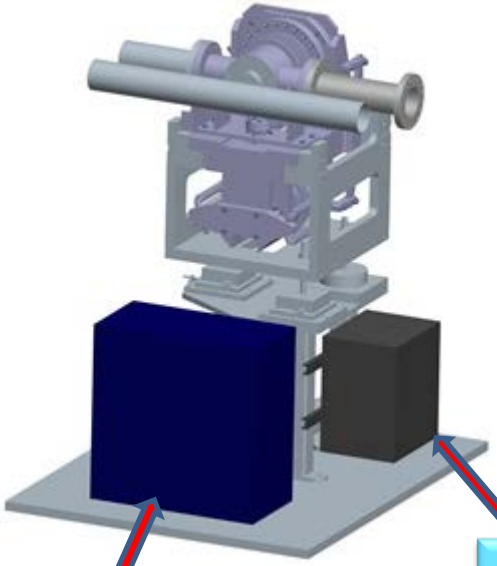
- Trigger and optical cables ~260m
- Standard cables ~360m

AFP Service areas:

- USA15 (off-detector electronics)
- US15 (BPM – DOROS data acquisition)
- Alcove RR13, RR17 (secondary vacuum)

# AFP Patch panels

@205m, 217m



Air-cooler

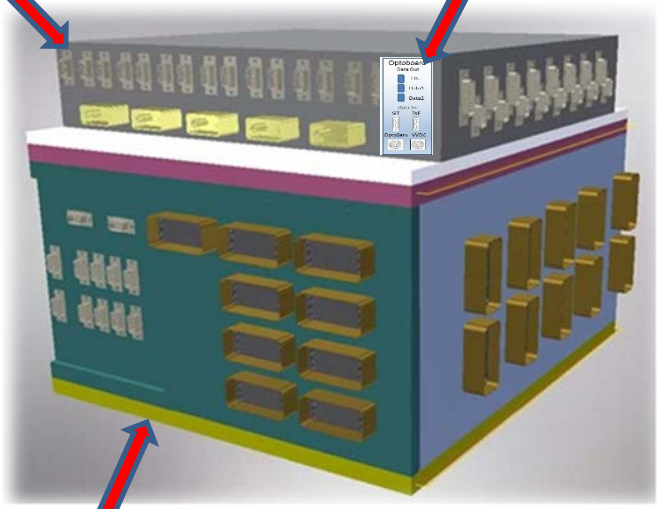
L1 Trigger Hitbus Board
Constant Fraction Discriminator
Constant Fraction Discriminator
ToF Trigger/2nd-stage ampl.
HPTDC Card
HPTDC Card
Reference Clock

ToF crate (@205m partly populated)

@212m

Passive patch panel (stepper motor control, NTC, HV distribution)

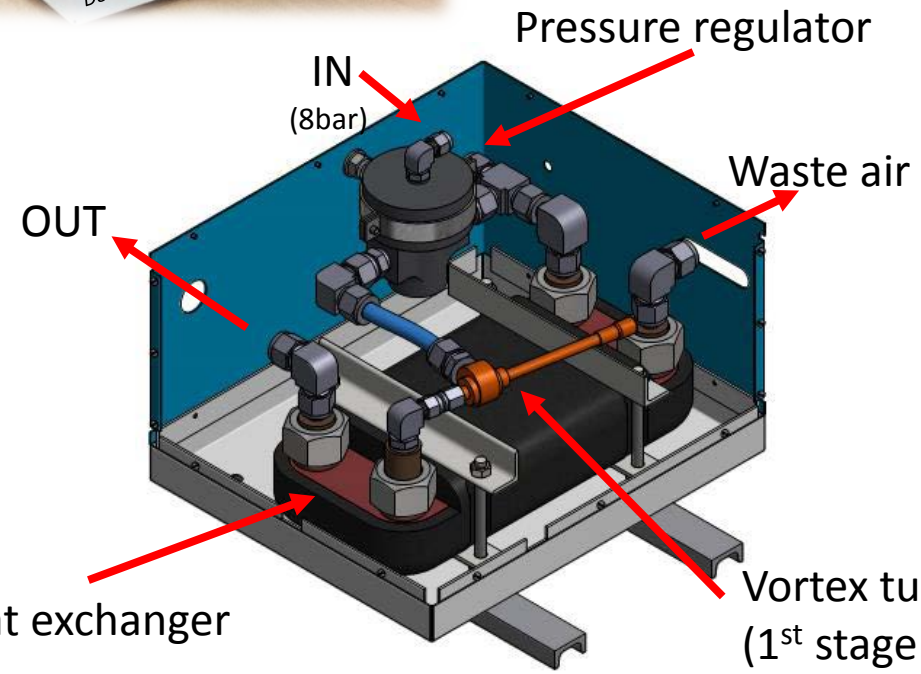
Opto module (optical interface, DATA, CMDs)



LV regulator crate (provides voltages for the Tracker and ToF electronics)

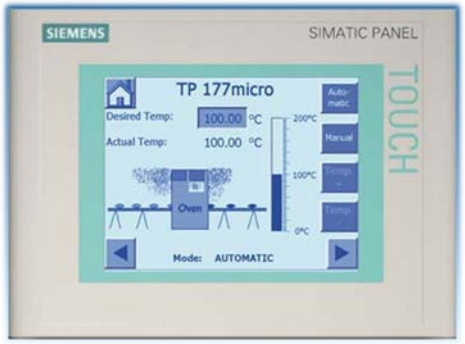
# Air-cooler infrastructure


- Silicon tracker requires cooling (sensors should be kept at temperature bellow 0 C)
- Power dissipation (5W the tracker), 10W roman pot
- The Air-cooler will be installed very close to RP station
- Regulation of output air temperature is considered

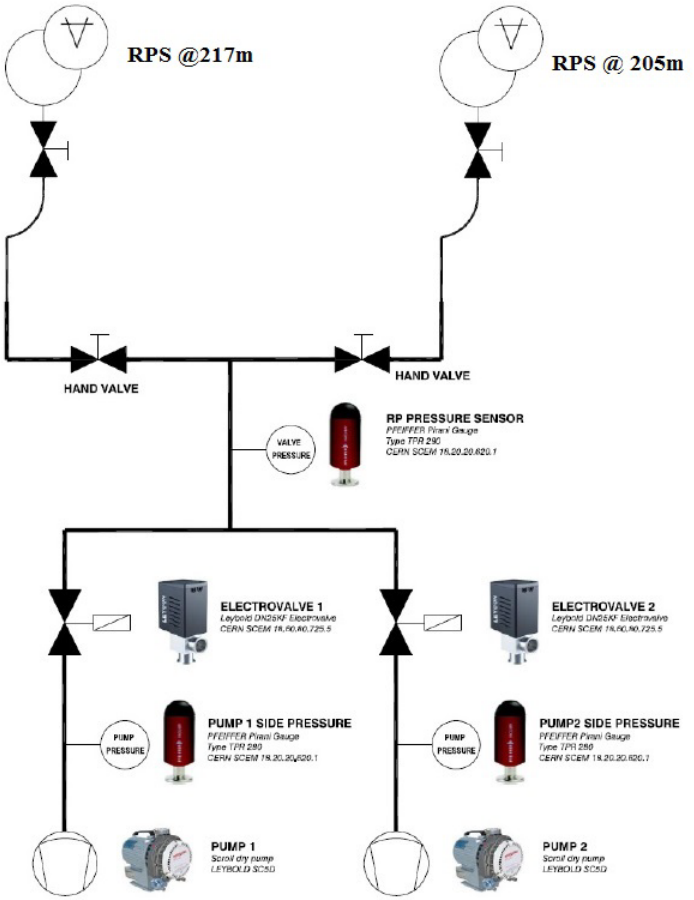



# Secondary vacuum

- Covered by WP *Roman Pot Instrumentation and Control system* (PH-DT X.Pons)
- Pums Scrollvac SC5D (0.05mbar), similar type as TOTEM
- Monitoring and control via PLC placed in rack in USA15 likely by Simatic S7-200 (Siemens).
- The same PLC could also be used for Air-cooler power control



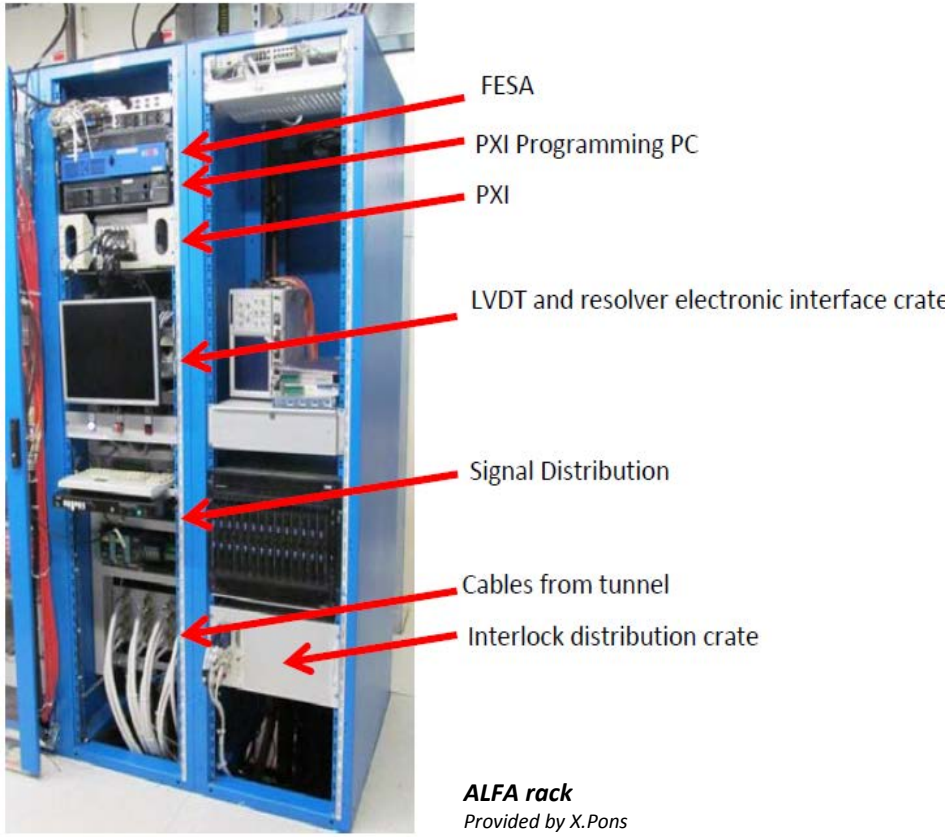

S7-200 front panel




***Secondary vacuum scheme***
*Provided by X.Pons*

# RP station Position Control System

- Covered by WP *Roman Pot Instrumentation and Control system* (PH-DT X.Pons)
- Proposed system will be very similar as ALFA or TOTEM has (original designed for the position control system of LHC collimators consequently modified by PH-DT group)
- FESA server provides interface between PXI control and LHC (LHC operator can always put RP to parking position)
- PXI crate - control of stepper motor
- LVDT & resolver (amplifies signals for primary circuitry of LVDT and resolver, receives secondary circuitry signals and provides them to PXI crate)
- Really great contribution of PH-DT…



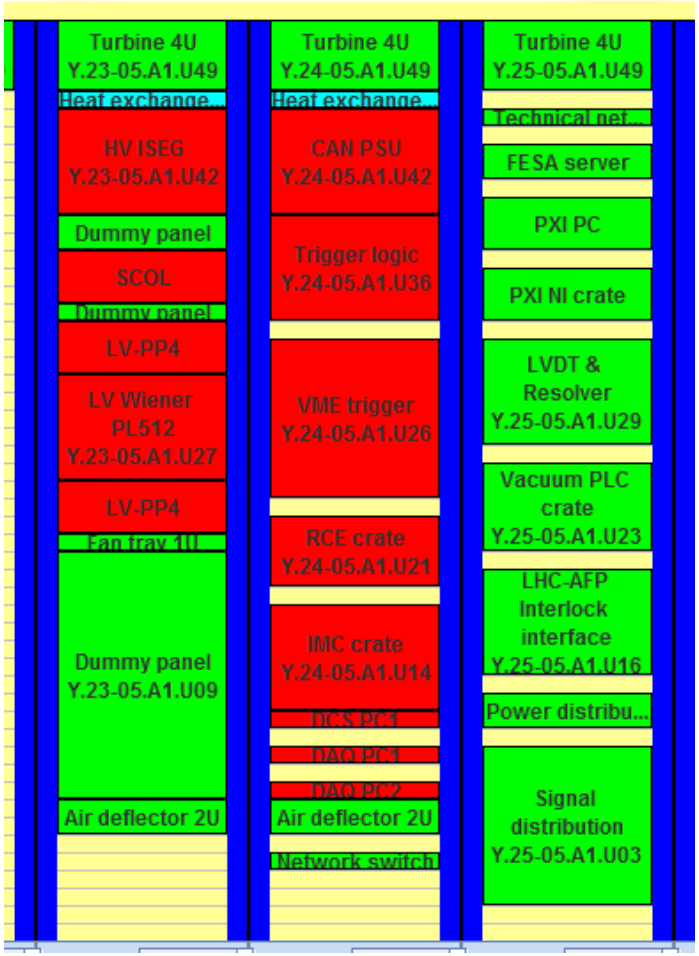

***ALFA rack***
*Provided by X.Pons*

# USA15 racks

LV & HV

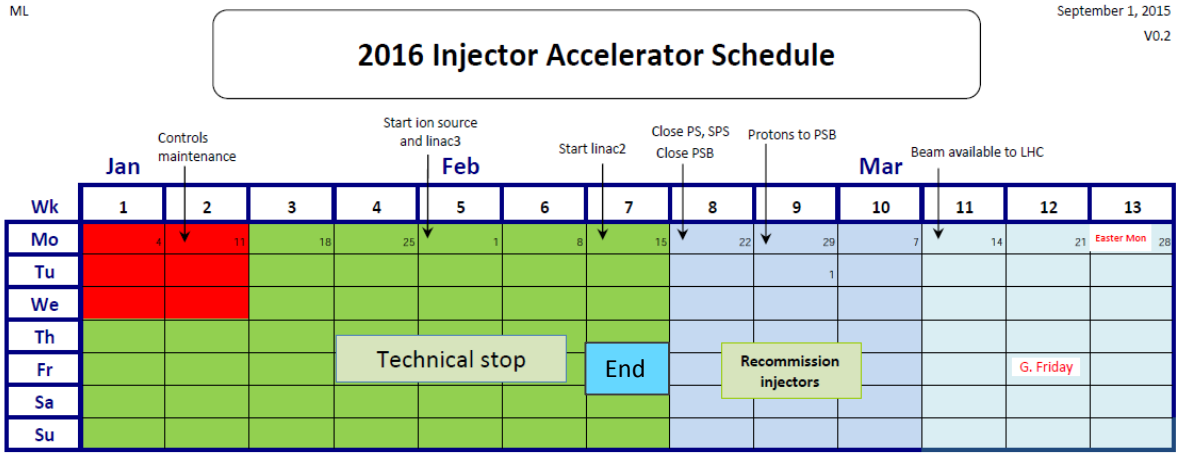
DAQ & DCS

Infrastructure




# AFP Installation schedule

- LHC accelerator schedule is driving AFP installation schedule
- YETS - 8 weeks of access




- Only preparation work can be done over LHC Technical Stops (3 in 2015)
- AFP installation will start in middle of December as soon as LHC is stopped. The geodetic survey equipment in UPS14 and UPS16 galleries will be partly removed and protected to allow installation of fast coaxial and optical cables
- Scaffolding is needed in the tunnel at entries to UPS14 and UPS16 galleries, some safety protection to be installed also in UX15 (the part between entry to UPS galleries and the wall to USA15) – to be done first week in January
- The cable installation should start with fast cables (4/1-25/1 including preparation) followed by other cables routed in standard way (25/1-10/2). Then termination of cables and testing can start.
- RP stations are scheduled for installation in the middle of February
- YETS ends on Friday 19th February

# Thank you for attention!

# Schedule of cable installation (draft created by Gianluca )

| ID | Task Mode | Task Name | Duration | Start | Finish | Predecessors | Resource Names |
|---|---|---|---|---|---|---|---|
| 0 | | **638 tirage AFP-ATLAS (YETS sem 51/2015->sem9/2016)** | **79 days** | **Mon 02/11/15** | **Thu 18/02/16** | | |
| 1 | | **Autorisations** | **79 days** | **Mon 02/11/15** | **Thu 18/02/16** | | |
| 2 | | Work above QRL | 1 day | Tue 15/12/15 | Tue 15/12/15 | | T OTTO |
| 3 | | VIC | 1 day | Tue 15/12/15 | Tue 15/12/15 | | OSS |
| 4 | | Authorization RP | 1 day | Tue 15/12/15 | Tue 15/12/15 | | RP |
| 5 | | LHC IMPACT | 1 day | Tue 15/12/15 | Tue 15/12/15 | | OSS |
| 6 | | IMPACT ATLAS | 1 day | Tue 15/12/15 | Tue 15/12/15 | | OSS |
| 7 | | Survey (drop wire) and development facility security | 5 days | Tue 15/12/15 | Mon 21/12/15 | | Survey |
| 8 | | Logging monorails | 1 day | Tue 15/12/15 | Tue 15/12/15 | | OSS |
| 9 | | making platform available in ATLAS (Nacelle) | 1 day | Mon 18/01/16 | Mon 18/01/16 | | ATLAS |
| 10 | | -test before pulling drum D1 OK | 0.67 days | Mon 02/11/15 | Mon 02/11/15 | | BE,MEF,SPIE |
| 11 | | tagout monorails | 1 day | Thu 18/02/16 | Thu 18/02/16 | | OSS |
| 12 | | reseal inspection | 1 day | Thu 18/02/16 | Thu 18/02/16 | | BE |
| 13 | | **HELIFLEX draw and LHC-USA15 fibers via UPS** | **16 days** | **Mon 04/01/16** | **Mon 25/01/16** | | |
| 14 | | scaffolding transport from surface (storage UJ) | 1 day | Mon 04/01/16 | Mon 04/01/16 | | HE |
| 15 | | scaffolding installation MBXW UJ17 (right side) | 2.5 days | Wed 13/01/16 | Fri 15/01/16 | 7 | Ouvaroff |
| 16 | | installing scaffolding MBXW UJ13 (left) | 2.5 days | Mon 18/01/16 | Wed 20/01/16 | 7 | Ouvaroff |
| 17 | | Drilling door UPS16 | 1 day | Mon 18/01/16 | Mon 18/01/16 | | SPIE |
| 18 | | laying path on vault 211m position and channel (right side) | 1.5 days | Tue 05/01/16 | Wed 06/01/16 | | SPIE |
| 19 | | UJ17 poses path L27A-XC (400mm) + vault | 1.5 days | Tue 05/01/16 | Wed 06/01/16 | | SPIE |
| 20 | | Drilling door UPS14 | 1 day | Wed 20/01/16 | Wed 20/01/16 | | SPIE |
| 21 | | installation path on vault pot novel position and gutter (left | 1.5 days | Wed 06/01/16 | Thu 07/01/16 | | SPIE |
| 22 | | installation path UJ13 | 1.5 days | Wed 06/01/16 | Thu 07/01/16 | | SPIE |
| 23 | | Transport 4 reels and cables scales from surface to UJ14 / UJ16 | 1 day | Wed 13/01/16 | Wed 13/01/16 | | HE |
| 24 | | test cable before pulling | 1 day | Mon 18/01/16 | Mon 18/01/16 | 23 | BE |
| 25 | | HELIFLEX draw fiber and right side | 3 days | Tue 19/01/16 | Thu 21/01/16 | 9,24,17 | SPIE |
| 26 | | test cables right | 1 day | Thu 21/01/16 | Thu 21/01/16 | | BE |
| 27 | | HELIFLEX fiber draw and left | 3 days | Thu 21/01/16 | Mon 25/01/16 | 9,24,20 | SPIE |
| 28 | | testing the left side cables | 1 day | Mon 25/01/16 | Mon 25/01/16 | | BE |
| 29 | | **LHC draw controls cables pos 211-> USA15** | **13 days** | **Mon 25/01/16** | **Wed 10/02/16** | | |
| 30 | | UX installing scaffolding 15 level 8 | 2 days | Mon 25/01/16 | Tue 26/01/16 | | Ouvaroff |
| 31 | | wall crossing seal opening UJ16 / EL16 and US15 / UX15 and partitions under USA15 | 1 day | Tue 26/01/16 | Tue 26/01/16 | | SPIE |
| 32 | | Cable pulling | 12 days | Tue 26/01/16 | Wed 10/02/16 | | SPIE |
| 33 | | **LHC draw controls cables pos 211-> RR17** | **5 days** | **Wed 13/01/16** | **Tue 19/01/16** | | |
| 34 | | poses L27A-XC path (48m) | 3 days | Thu 14/01/16 | Mon 18/01/16 | 23 | SPIE |
| 35 | | installation path vault before RR17 | 1 day | Wed 13/01/16 | Wed 13/01/16 | | SPIE |
| 36 | | cutting and grating RR17 poses Cablofil in rack | 1 day | Wed 13/01/16 | Wed 13/01/16 | | SPIE |
| 37 | | draw 2 cables and 2 tubes (lg ~ 50m) | 1 day | Tue 19/01/16 | Tue 19/01/16 | 36,34,35 | SPIE |
| 38 | | **Front yard** | **19 days** | **Wed 20/01/16** | **Mon 15/02/16** | | |
| 39 | | verification RR17 cables (identification, length) | 1 day | Wed 20/01/16 | Wed 20/01/16 | 37 | MEF,SPIE |
| 40 | | verification USA15 cables (identification, length) | 3 days | Thu 11/02/16 | Mon 15/02/16 | 32 | MEF,SPIE |
| 41 | | checking presence RR floor slabs, US15 and USA15 | 0.5 days | Mon 15/02/16 | Mon 15/02/16 | 32,37 | MEF,SPIE |
| 42 | | **construction decline** | **16 days** | **Wed 27/01/16** | **Wed 17/02/16** | | |
| 43 | | dismantling scaffolding UJ 13/17 | 3 days | Wed 27/01/16 | Fri 29/01/16 | 26,28 | Ouvaroff |
| 44 | | recovery sealing doors and 16 UPS14 | 1 day | Wed 17/02/16 | Wed 17/02/16 | 26,28 | GS |
| 45 | | recovery sealing wall crossing UJ16 / EL16 | 1 day | Wed 17/02/16 | Wed 17/02/16 | 40 | GS |
| 46 | | recovery sealing wall crossing US15 / UX15 | 1 day | Wed 17/02/16 | Wed 17/02/16 | 40 | GS |
| 47 | | recovery partition crossing under seal USA15 | 1 day | Wed 17/02/16 | Wed 17/02/16 | 40 | GS |
| 48 | | cleaning and disposal equipment | 1 day | Wed 17/02/16 | Wed 17/02/16 | | SPIE |