Requirements for UT assembling, testing and commissioning

LHCb upgrade electronics meeting

April 13, 2017

Burkhard Schmidt for the UT group

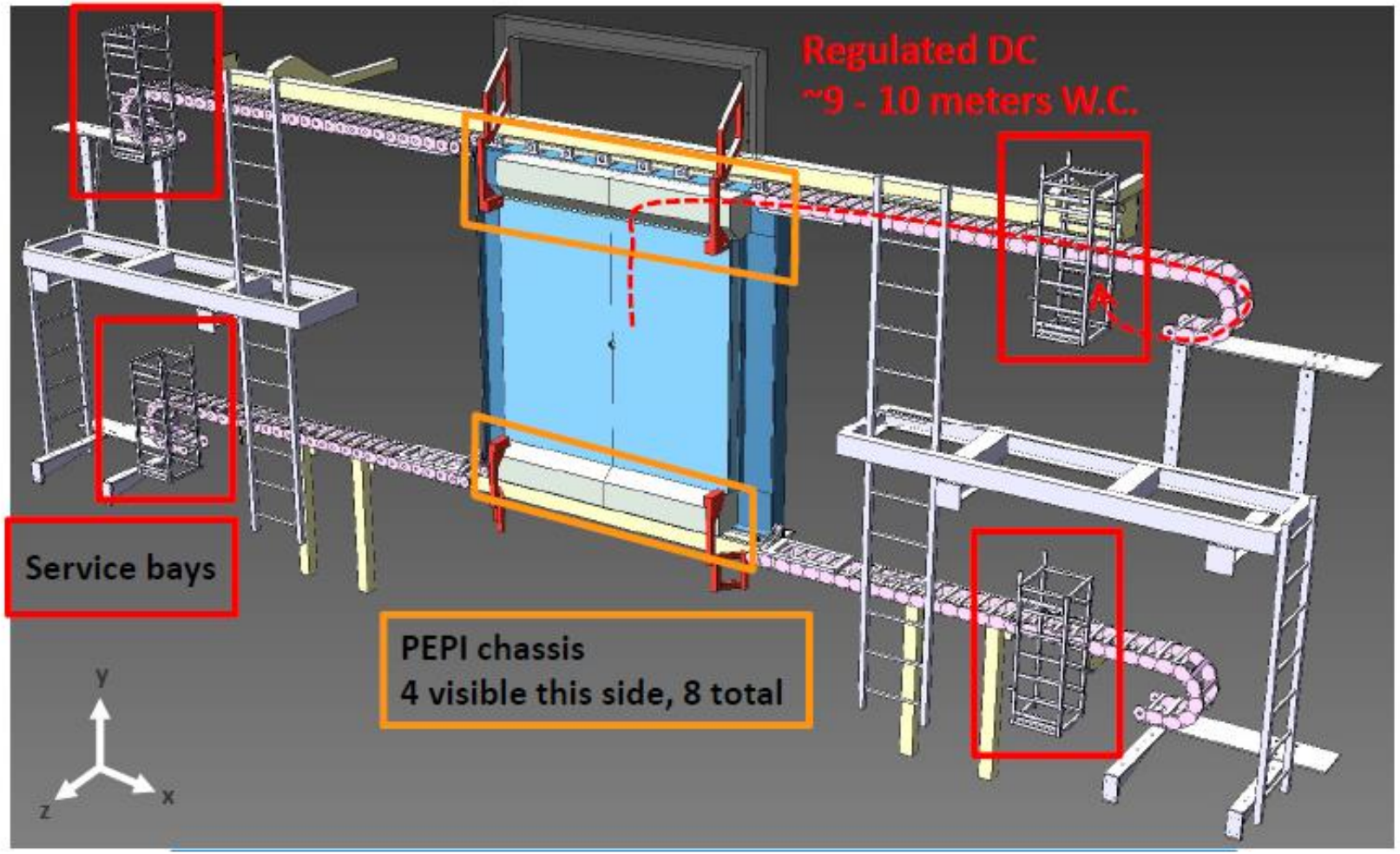
General Questions

1. Do you need centralised support for a test-system, or will you do it yourselves?
   - **YES**

2. Where will you do the tests?
   - **In the new assembly hall 3852**

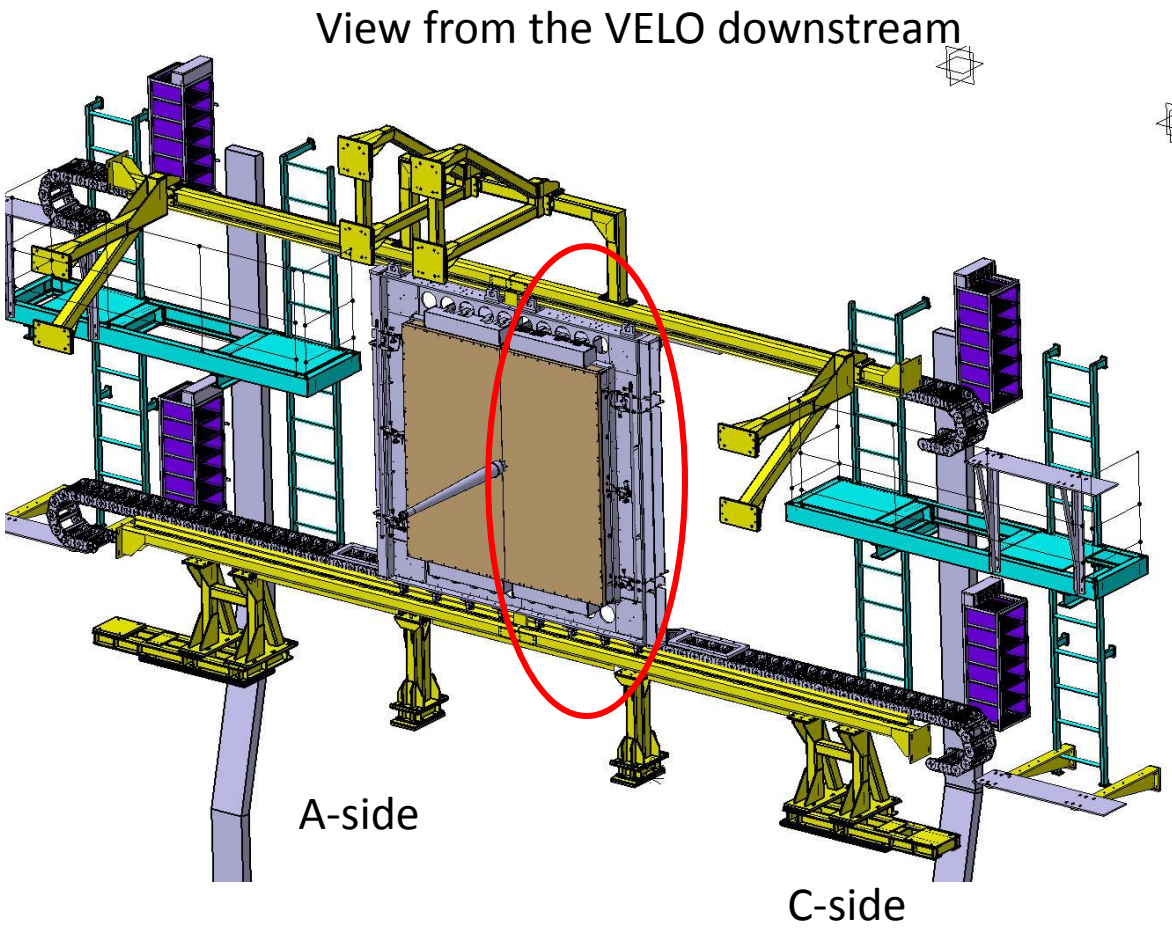
3. When do you need the test infrastructure to be ready?
   - **Last quarter of 2018 (cooling) and 1st quarter 2019 (DAQ)**

UT and its infrastructure

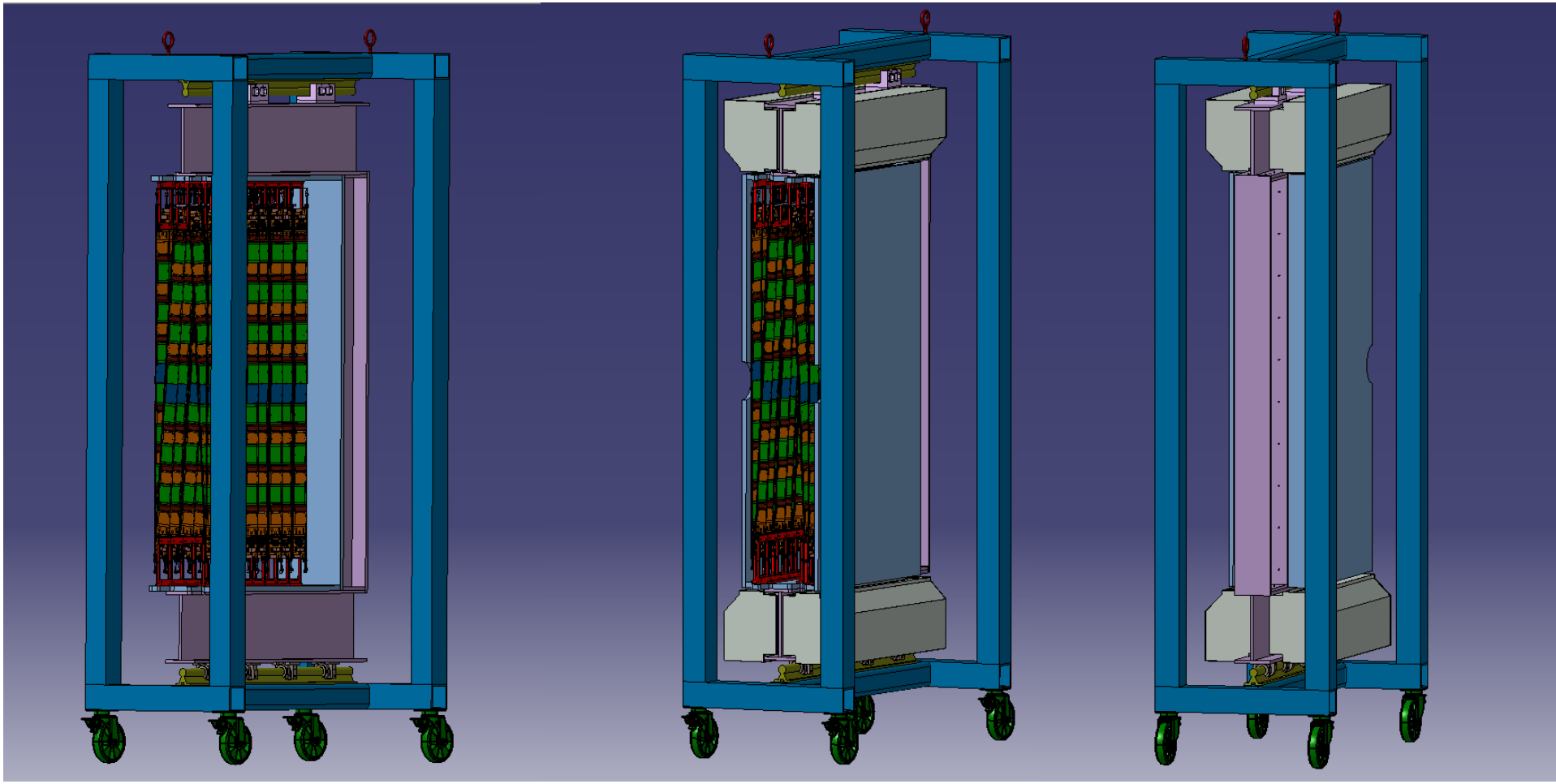


UT assembly sequence

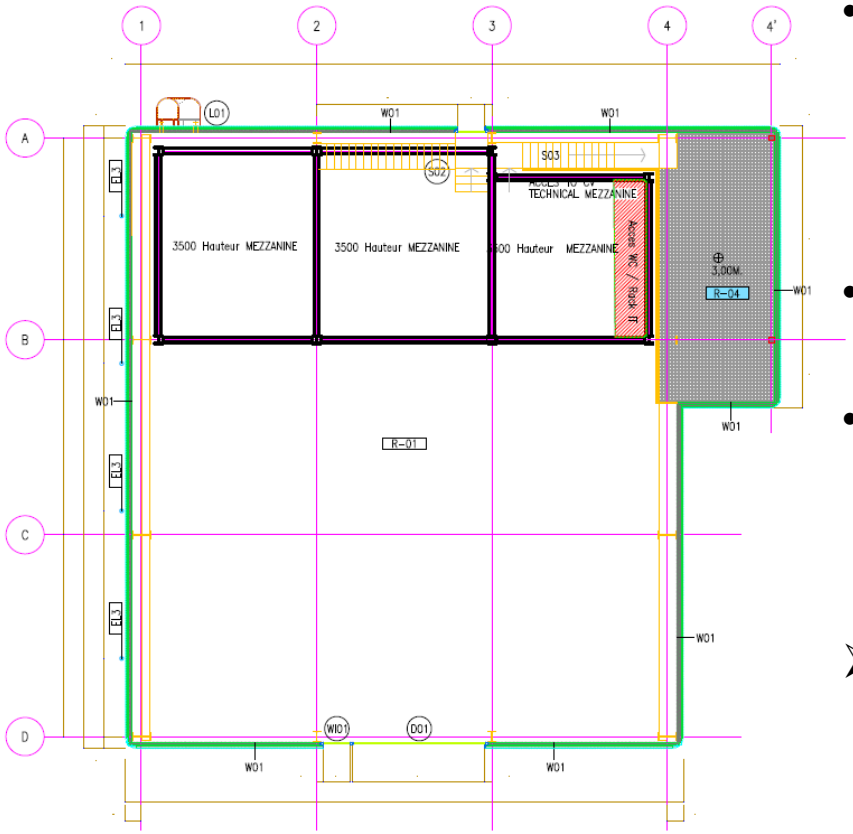
- The installation sequence will be as follows:
  1. Put the infrastructure on the C-side in place (racks, chain, services etc.)
  2. Installation of the C-side detector box
  3. Installation of the A-side detector box
  4. Install/connect the infrastructure on the A-side
- The beam-pipe will be installed after 2 is completed



First design of cart for UT assembly



Area for UT assembling



- The area between 1-2 and A-B (7m x 7.6m, 3.5m high) is considered for UT
  - It will be prepared as a semi-clean room for detector assembling, with slight overpressure, filters and an airlock to enter.
- Additional space for UT will be needed between 2-3 A-B for surveys (as we assemble from 2 sides).
- Further space will be needed for:
  - The LUCASZ cooling plant
  - Material storage
  - Control room space outside the clean room
- We need about ~7kW of cooling power for the tests we want to do (see next slides).
  - We count on the TC for support/resources

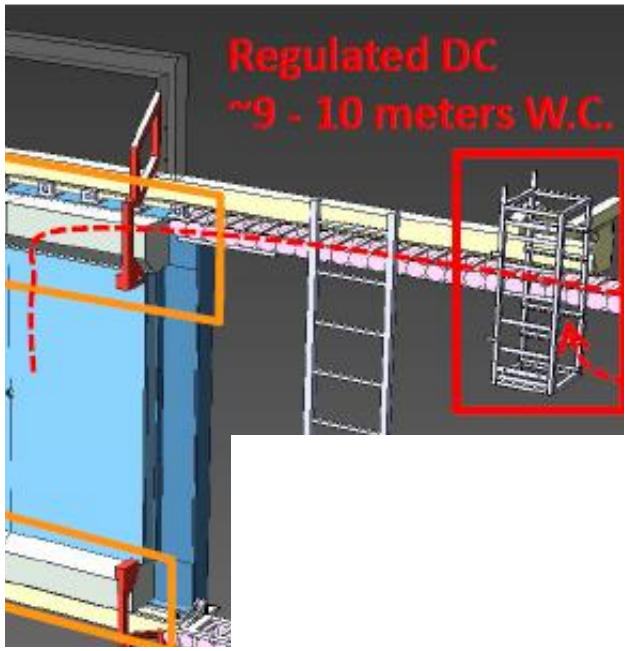
Electronics infrastructure

Power (UT contact is Carlos):

1. What type of Low Voltage system?
   - Wiener Maraton (could be part of the final setup/spares)
   - High Voltage will taken care for by us
2. How many power supply channels are required?
   - Next slide
3. What copper-cabling is required?
   - Discussion is still ongoing within the UT group
   - We count on help for powering up to the Maratons and the related infrastructure: PFCs, RCMs, cooling, WinCC panels, network

Infrastructure needs

- We intend to simultaneously power ½ of one detector side (thus ¼ of the full system) in the assembly area in 3852
  - This requires one complete service bay of power boards and cable sets planned for the cable trays.
  - The 4 PEPI chassis are an integral part of the detector half to be moved/installed as such
  - We need 3 Maratons to power ¼ of the full system
- The thermal cooling of ~7kW is needed for a service bay, 3 Maraton chassis and 2 (out of 4 total) active PEPI chassis



Infrastructure: Cooling

1. Do you need cooling systems in building 3852?
   - **YES**
2. If yes, please
   i. Specify coolant,
   - **We need both water and CO_2 cooling**

   ii. Temperature and power
   - **For water: 7kW at bout 150C**
   - **For CO_2: 1.5kW (LUCASZ cooling plant)**

   iii. when these cooling systems are needed
   - **End of 2018**
3. Do you need compressed air or gas in the assembly areas?
   - **YES**
4. Please give an estimate of the total power of the equipment used in the assembly areas
   - **See previous slide**

Cooling option in the UT assembling area

LAUDA WK class WKL 7000
Circulation chiller

Description:

- Circulation chiller
- 1-line LED display for display of actual or set temperature and analogue pump pressure indication
- User-friendly menu guidance with simplest 3-key operation
- Electronic 2-point temperature control with hysteresis
- Safety elements for refrigerant pressure, coil temperature. Level indication
- Extremely powerful pressure pump
- Additional pump for internal circulation
- Filler opening at the front, drain tap
- Cooling capacity adjustment by solenoid valve control
- Air-cooled version

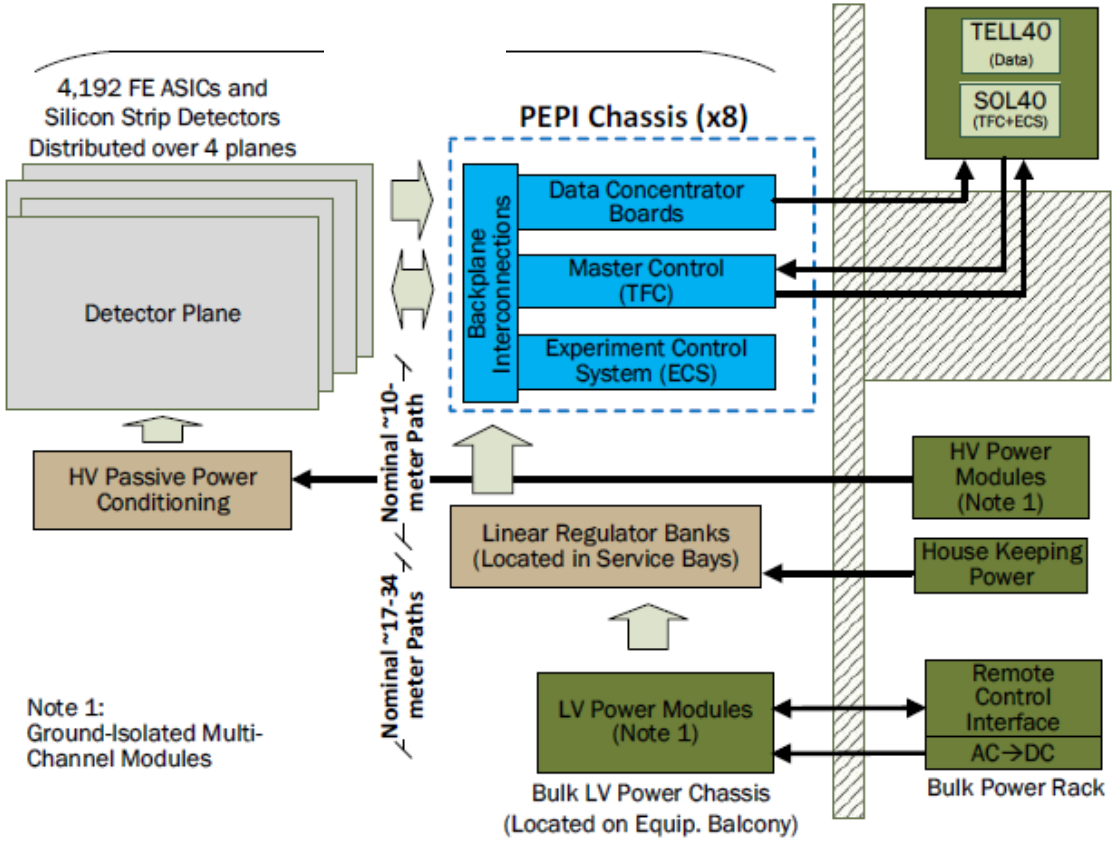
Technical Data:

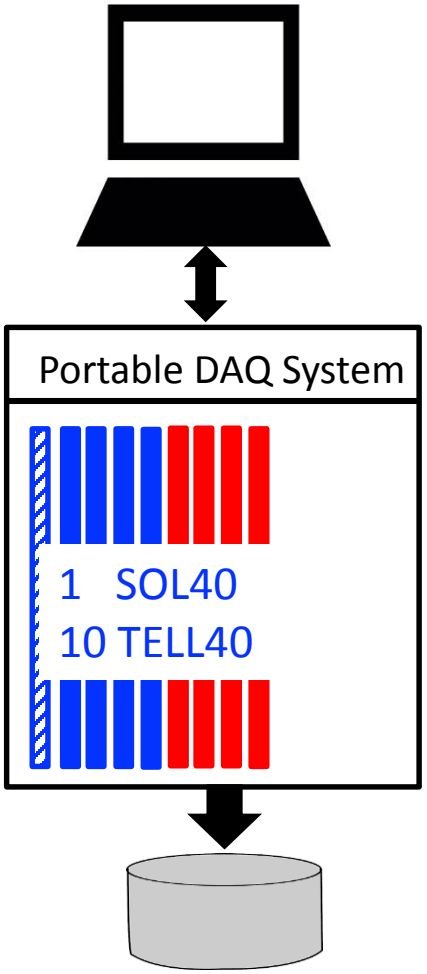
Working temperature range	-30 °C ... 40 °C
Ambient temperature range	5 °C ... 40 °C
Temperature control	± 0.5 °C
Cooling output at 20 °C	7.0 kW
Pump pressure max.	6.0 bar
Pump flow max.	60 L/min
Filling volume max.	45 L
Overall Dimensions (W x D x H)	850 x 670 x 970 mm

Cost:

- not known yet, but smaller unit with 2.2kW cooling output costs ~8.5kCHF
- Expect about 15kCHF for the larger unit

Readout infrastructure





UT Optical Connection Needs

- Data concentrator boards (DCB) in the PEPI chassis.
  - Transfer event data out:

    SALT ➔ DCB (GBTx, VTTx) ➔ TELL40

- Master control boards (MCB) in the PEPI chassis.
  - Generate master clocks for DCBs & SALT ASICs,
  - Distribute TFC to SALT,
  - Configure & read back SALT registers via ECS,
  - Read out temperature, voltage, humidity etc via ECS.

    MCB(GBTx, GBT-SCA, VTRx) ⬅➔ SOL40

- LV monitor board in the service boxes.
  - Monitor LV parameters.

    LV monitor board (GBTx, GBT-SCA, VTRx) ⬅➔ SOL40

Readout infrastructure

Optical fibres:

1. How many fibres are required?
   - **We need 218 fibres for a single UT PEPI chassis**
   - **We intend to readout two chassis at the same time**
2. What lengths are needed?
   - **To be decided where to place a portable DAQ system**
   - **30 m might be a reasonable estimate**
3. What types of connectors & patching are required?
   - **We need 24 MPO connections to the TELL40/SOL40.**

Readout infrastructure

DAQ (the following is just a first iteration) :

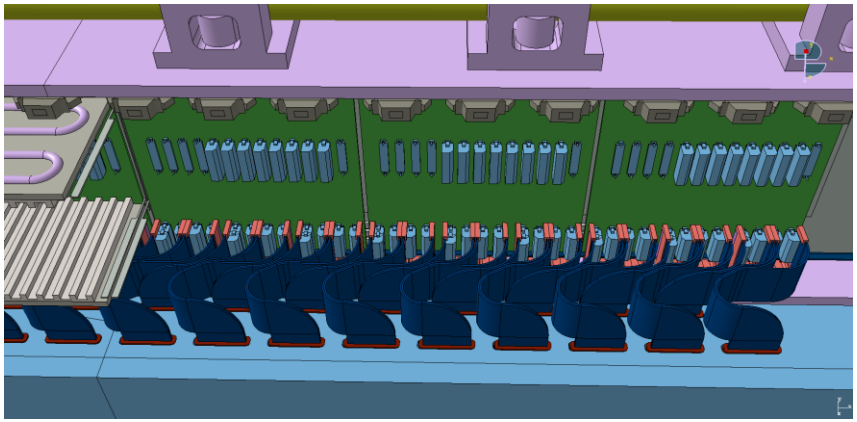
1. Number of PCIe40s? **11**
2. event-building required? **No**
3. Data need to be stored? **Yes, temporarily**
4. Data need to be processed? **To be decided**
5. In the FPGA? on the PC? What kind of processing? **On the PC**
6. Does data need to be monitored? **Yes**
7. At what granularity ? **single channel**
8. Do you have an existing data monitoring system that you intend to integrate? **No**
9. How many work-places/screens required on site? **3**
10. Remote access? **Yes**
11. Are you interested in a small-scale miniDAQ2 reference system being available at CERN in the near-future? **Yes**

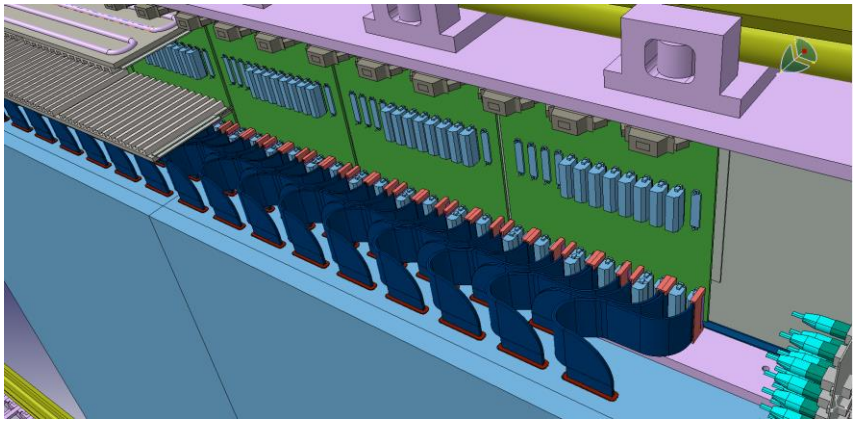
Backup

UT Assembly & Testing Plan

- Tentative stave assembly procedure:
  - Fully-populated staves shipped to CERN
  - C-frame with box, backplane pigtails assembled and ready.
  - Box has removable cover panels on open sides and dry air flush
  - Mont frame and stave, connect pigtail, connect cooling, etc.
  - Power up, cool down, and read out in order to qualify staves for operation
  - Repeat for all staves in four half-planes, working from beampipe region outward, populating planes U,V,X,X in order
  - Frequency of tests with cool-down to be decided
  - ➢ **Ideally, test everything possible before lowering half-UT into pit**
- Proposed DAQ assembly:
  - DCBs will be housed in crates above the detector box.
  - They should be considered as part of the detector halves assembled on the surface
- Installation of LV and HV distribution:
  - LV and HV modules will be in the racks on the side of the detector or further away on the 'balcony' and installed independent on the detector halves
  - Some LV and HV will be needed on the surface for testing
  - Use some modules first there before installation in the cavern

Pigtail installation





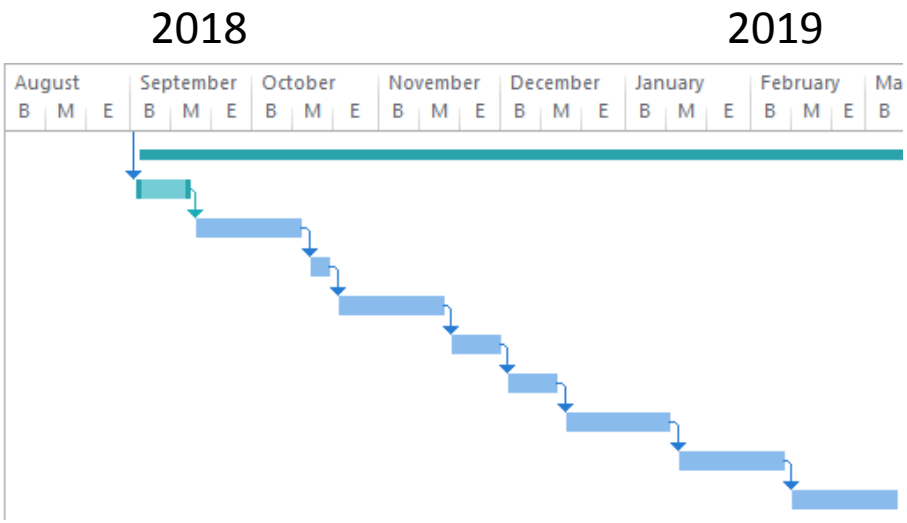
- Given the available space all pigtails have to be installed prior to the mechanical support and the cooling plates for the PEPI
- We plan to do thorough testing on connectivity before and after mounting of the pigtails in the detector box.
- A gasket is foreseen at the interface to the box to ensure proper tightness to the interior of the box.

Some milestones assumed in the following

- First batch of staves arrives at CERN — February 2019
- Second batch of staves arrives at CERN — October 2019
- C-side detector half ready for installation — November 2019
- A-side detector half ready for installation — June 2020

Preparatory work for stave mounting

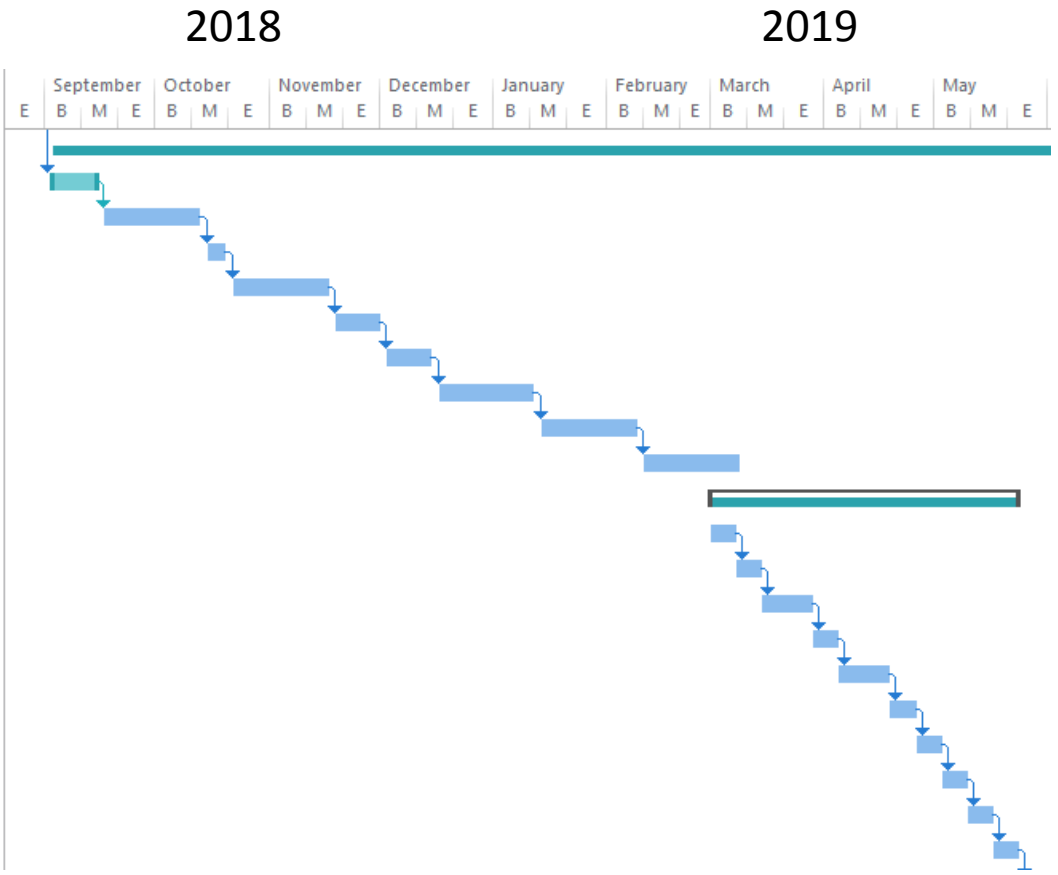
Task Name	Duration
Preparation of UT C-side on the surface	
Installation and alignment of C-frame	2 wks
Test assembly of UT-box in C-frame	1 mon
Alignment of top/bottom plate	1 wk
Installation and alignment of rails for frames/staves	1 mon
Installation of 4 chassis for PEPI (top/bottom; front/back)	2 wks
Installation of PEPI backplanes	2 wks
Installation of pigtails	1 mon
Electrical tests of pigtails after installation	1 mon
Mouting of PEPI boards and testing	1 mon



- Some tasks could be anticipated, if material arrives early enough

Mounting and Testing of UT C-side

Task Name	Duration
Preparation of UT C-side on the surface	
Installation and alignment of C-frame	2 wks
Test assembly of UT-box in C-frame	1 mon
Alignment of top/bottom plate	1 wk
Installation and alignment of rails for frames/staves	1 mon
Installation of 4 chassis for PEPI (top/bottom; front/back)	2 wks
Installation of PEPI backplanes	2 wks
Installation of pigtails	1 mon
Electrical tests of pigtails after installation	1 mon
Mouting of PEPI boards and testing	1 mon
Installation and testing of U-layer	**12 wks**
Mouting of first frame and stave of U-layer (back)	1 wk
Test of first stave and the electronics chain (without HV)	1 wk
Complete installation of the 4 staves in the back of the U-layer	2 wks
Test of staves and electronics chain of the U-layer back	1 wk
Full test of stave of the U-layer back with HV on sensors	2 wks
Survey/alignment of 4 staves in the back of the U-layer	1 wk
Mount 4 staves in the front of the U-layer	1 wk
Test of staves and electronics chain of the U-layer front	1 wk
Full test of stave of the U-layer back with HV on sensors	1 wk
Survey/alignment of staves in the front of the U-layer	1 wk

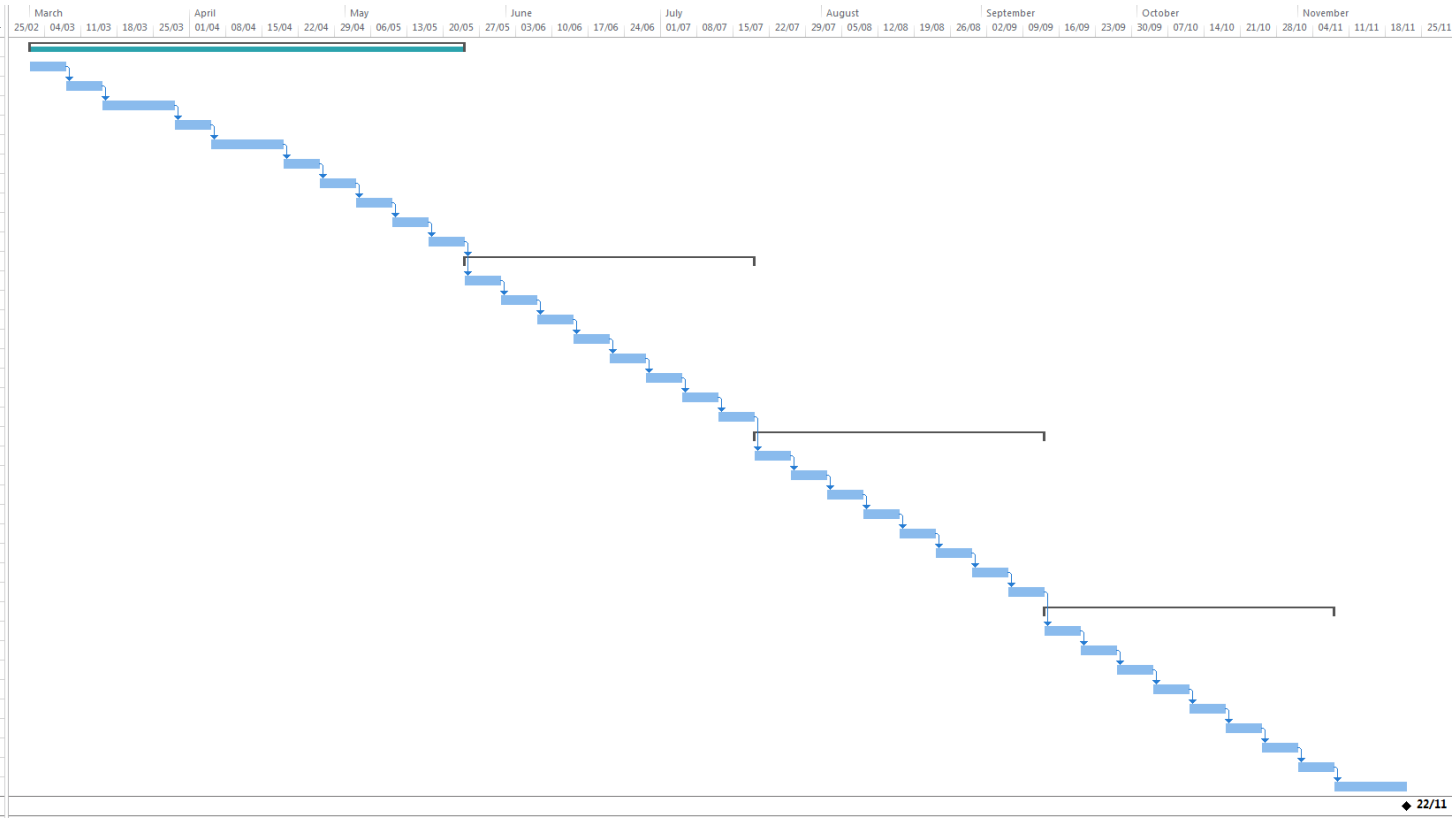


- Schedule assumes start of stave mounting in March 2019
- We foresee to do electronic tests in 2 steps
  1. Check of full electronics chain without HV on sensors
  2. Test with HV on sensors, which requires closing of the box etc.

Mounting and Testing of UT C-side

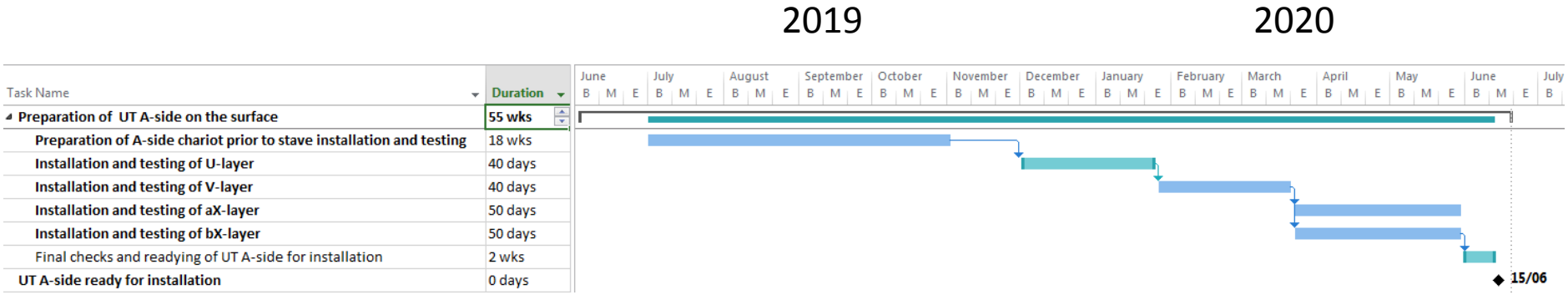
2019

Task Name	Duration
Installation and testing of U-layer	**12 wks**
Mouting of first frame and stave of U-layer (back)	1 wk
Test of first stave and the electronics chain (without HV)	1 wk
Complete installation of the 4 staves in the back of the U-layer	2 wks
Test of staves and electronics chain of the U-layer back	1 wk
Full test of stave of the U-layer back with HV on sensors	2 wks
Survey/alignment of 4 staves in the back of the U-layer	1 wk
Mount 4 staves in the front of the U-layer	1 wk
Test of staves and electronics chain of the U-layer front	1 wk
Full test of stave of the U-layer back with HV on sensors	1 wk
Survey/alignment of staves in the front of the U-layer	1 wk
Installation and testing of V-layer	**40 days**
Install 4 staves in the back of the V-layer	1 wk
Test of staves and electronics chain of the V-layer back	1 wk
Full test of stave of the V-layer back with HV on sensors	1 wk
Survey/alignment of staves in the back of the V-layer	1 wk
Install 5 staves in the front of the V-layer	1 wk
Test staves and electronics chain of the V-layer front	1 wk
Full test of stave of the V-layer front with HV on sensors	1 wk
Survey/alignment of staves in the front of the V-layer	1 wk
Installation and testing of aX-layer	**40 days**
Install 4 staves in the back of the aX-layer	1 wk
Test of staves and electronics chain of the aX-layer back	1 wk
Full test of stave of the aX-layer back with HV on sensors	1 wk
Survey/alignment of staves in the back of the aX-layer	1 wk
Install 4 staves in the front of the aX-layer	1 wk
Test staves and electronics chain of the aX-layer front	1 wk
Full test of stave of the aX-layer front with HV on sensors	1 wk
Survey/alignment of staves in the front of the aX-layer	1 wk
Installation and testing of bX-layer	**40 days**
Install 4 staves in the back of the bX-layer	1 wk
Test of staves and electronics chain of the bX-layer back	1 wk
Full test of stave of the bX-layer back with HV on sensors	1 wk
Survey/alignment of staves in the back of the bX-layer	1 wk
Install 5 staves in the front of the bX-layer	1 wk
Test staves and electronics chain of the bX-layer front	1 wk
Full test of stave of the bX-layer front with HV on sensors	1 wk
Survey/alignment of staves in the front of the bX-layer	1 wk
Final checks and readying of UT-C-side for installation	2 wks
UT C-side ready for installation	0 days



- Schedule assumes start of stave mounting in March 2019
- C-side would be ready for installation in LHCb in November 2019
- The installation and testing of aX and bX could go on in parallel which provides a contingency of about 40 days

Mounting and Testing of UT A-side



- Schedule assumes start of stave mounting in December 2019 (after completion of the C-side)
- A-side would be ready for installation in LHCb in June 2020
- The installation and testing of aX and bX is assumed to go on in parallel.
- More parallelism could be foreseen for U and V layers.
- This would provide a contingency of about 40 days.