INSTALLATION OF THE LHC EXPERIMENTAL INSERTIONS

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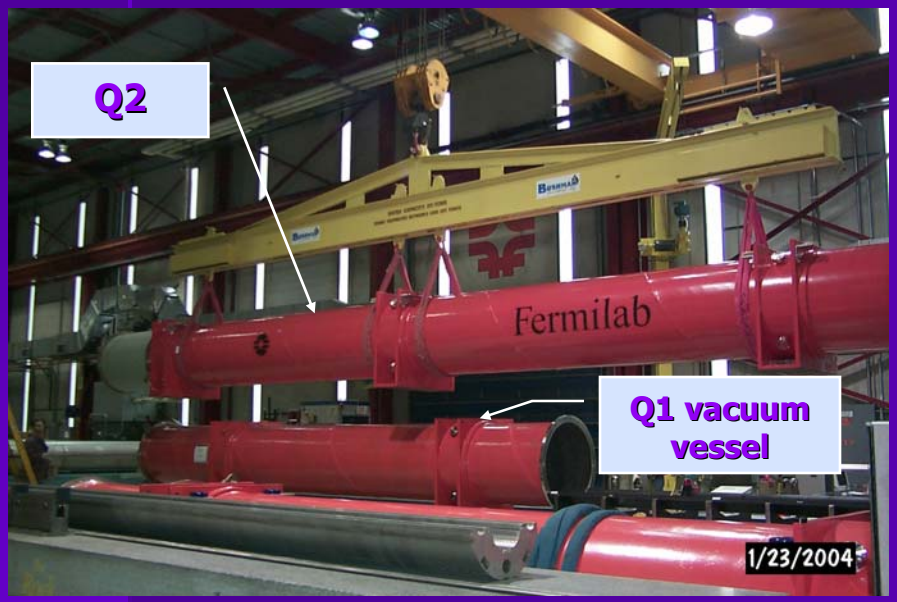
Acknowledgments

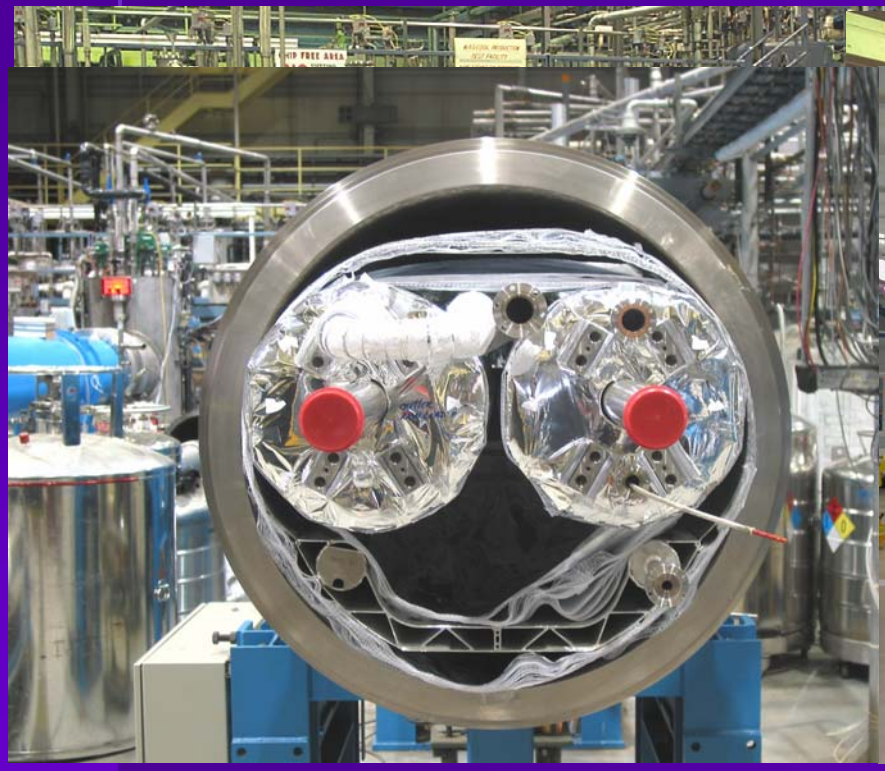
1. Elements provided in the frame of the LHC-US collaboration

- Low-beta quadrupoles (IP1/2/5/8):
  - FERMILAB: LQXA (Q1), LQXB (Q2), LQXC (Q3)
    - KEK: MQXA, C
  - 8 inner triplets + 1 spare

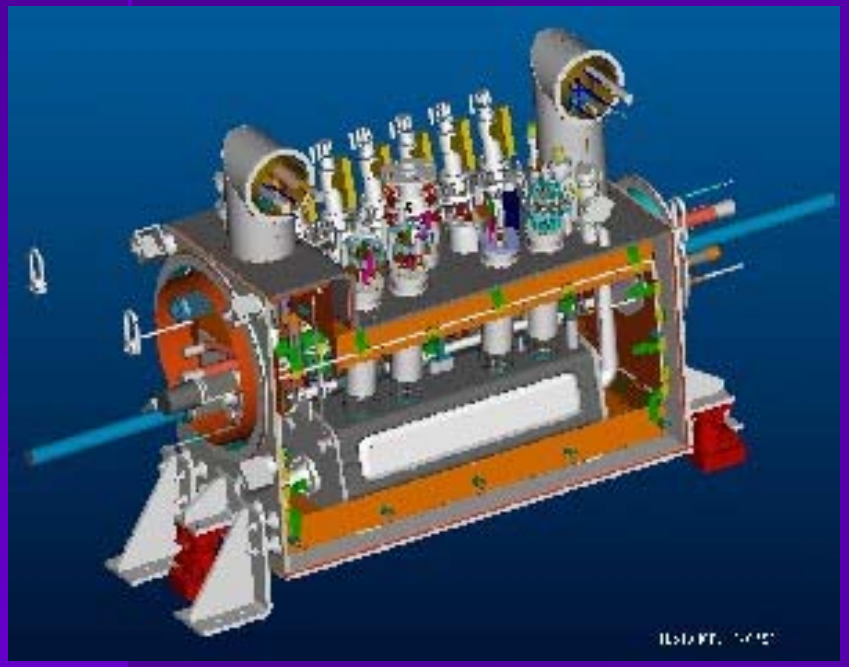


- CERN supply: correctors, BPM, beam screens…

- Separation dipoles (Brookhaven National Laboratory):
  - LBX (D1) → 4 units (IP2/IP8)
  - LBRC (D2) → 8 units (IP1/2/5/8)
  - LBRSA/C (D3a) → 2 units (IP4)
  - LBRSB/D (D3b) → 2 units (IP4)
  - LBRA/B (D4a/b) → 4 units (IP4)



- Distribution Feed Box (**DFBX**) (Lawrence Berkeley National Laboratory):
  - Connection of the superconducting magnets to the LHC cryogenic, electrical and vacuum systems
  - Interface for the instrumentation wires for diagnostics and control
  - 8 units (IP1/2/5/8)
  - Compact (L=2.5m, H=2.25m, W=0.983m) and heavy (6.6 tons)
  - Twin jumpers!!
  - Main manufacturer: Meyer Tools (Chicago)
  - 7.5kA HTS leads from Pirelli (UK)
  - Vapour cooled leads (600A & 120A) from Ami (US)



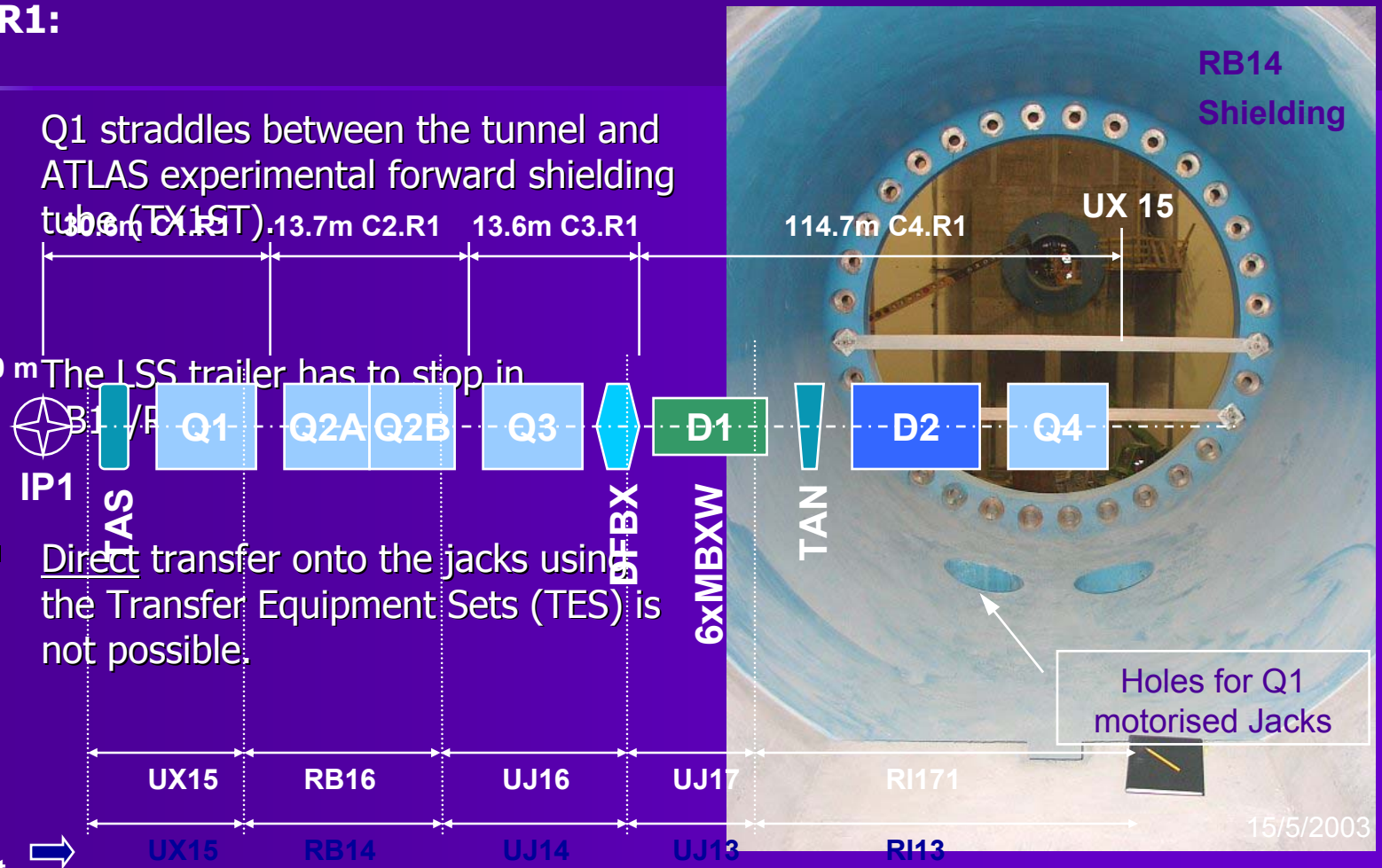
- Neutral Beam Absorbers (**TAN**) (Lawrence Berkeley National Laboratory):
  - 4 units (situated at 140m from and IP1 and IP5)
  - 33 Tons

- Front quadrupole absorbers (**TAS**) (Lawrence Berkeley National Laboratory): installation coordinated by TS/LEA.

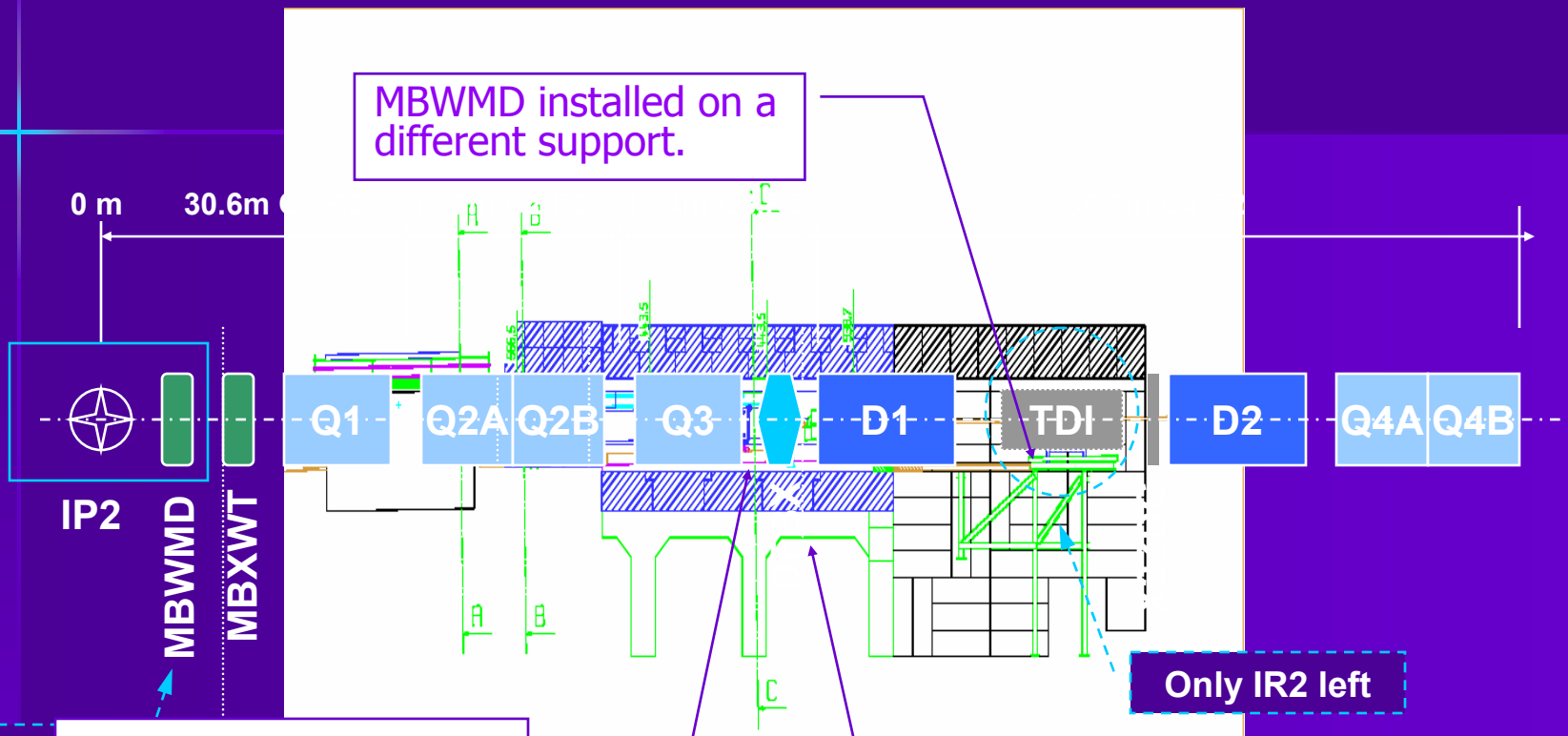
2. Main installation constraints

IR1:

- Q1 straddles between the tunnel and ATLAS experimental forward shielding tube (TX1ST).
- The LSS trailer has to stop in front of Q1.
- Direct transfer onto the jacks using the Transfer Equipment Sets (TES) is not possible.

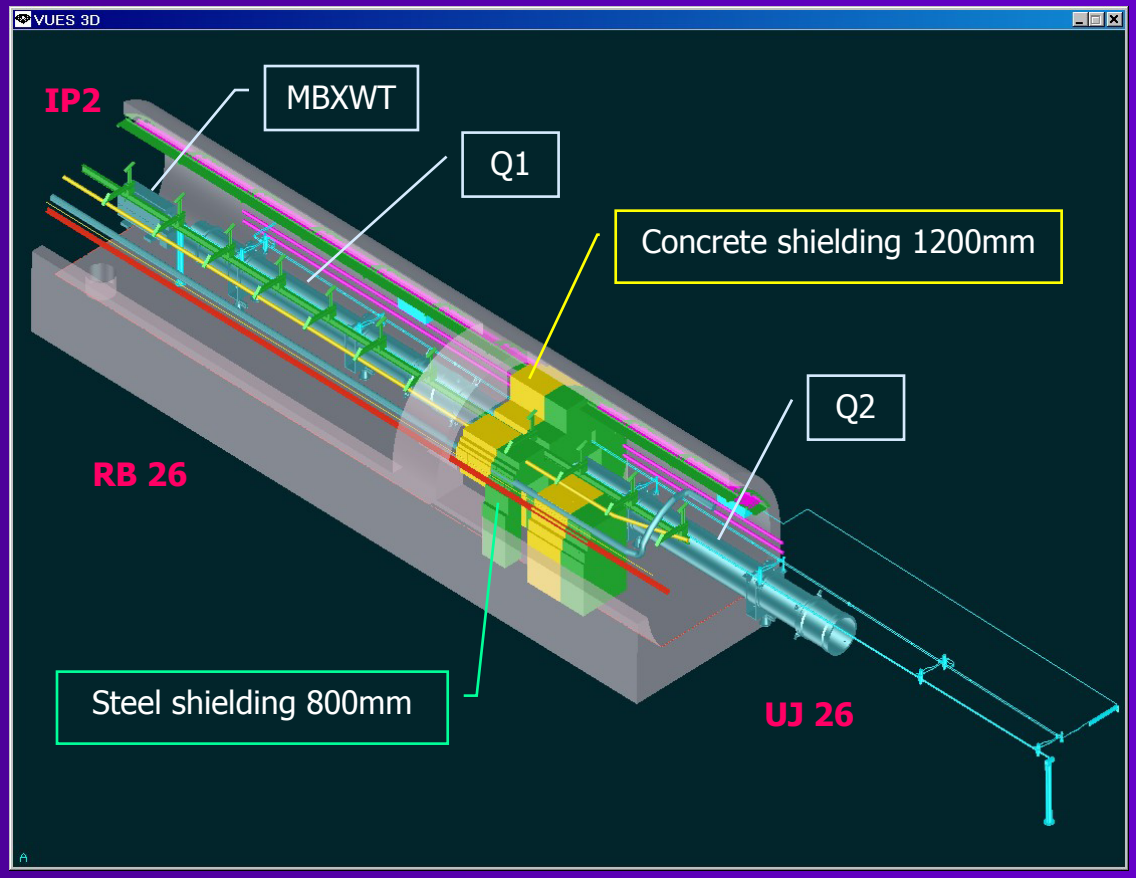


IR2 (PX24-RB24):



IR2 (RB26-UJ26):

- Concrete/steel shielding plug of about 90 tons around Q2 (R.Valbuena-TS/IC). Main shielding blocks should be installed before Q1 and Q2.
- Access to MBXWT through a chicane.
- Neither Q1 nor Q2 can be directly installed using the LSS trailer and TES.

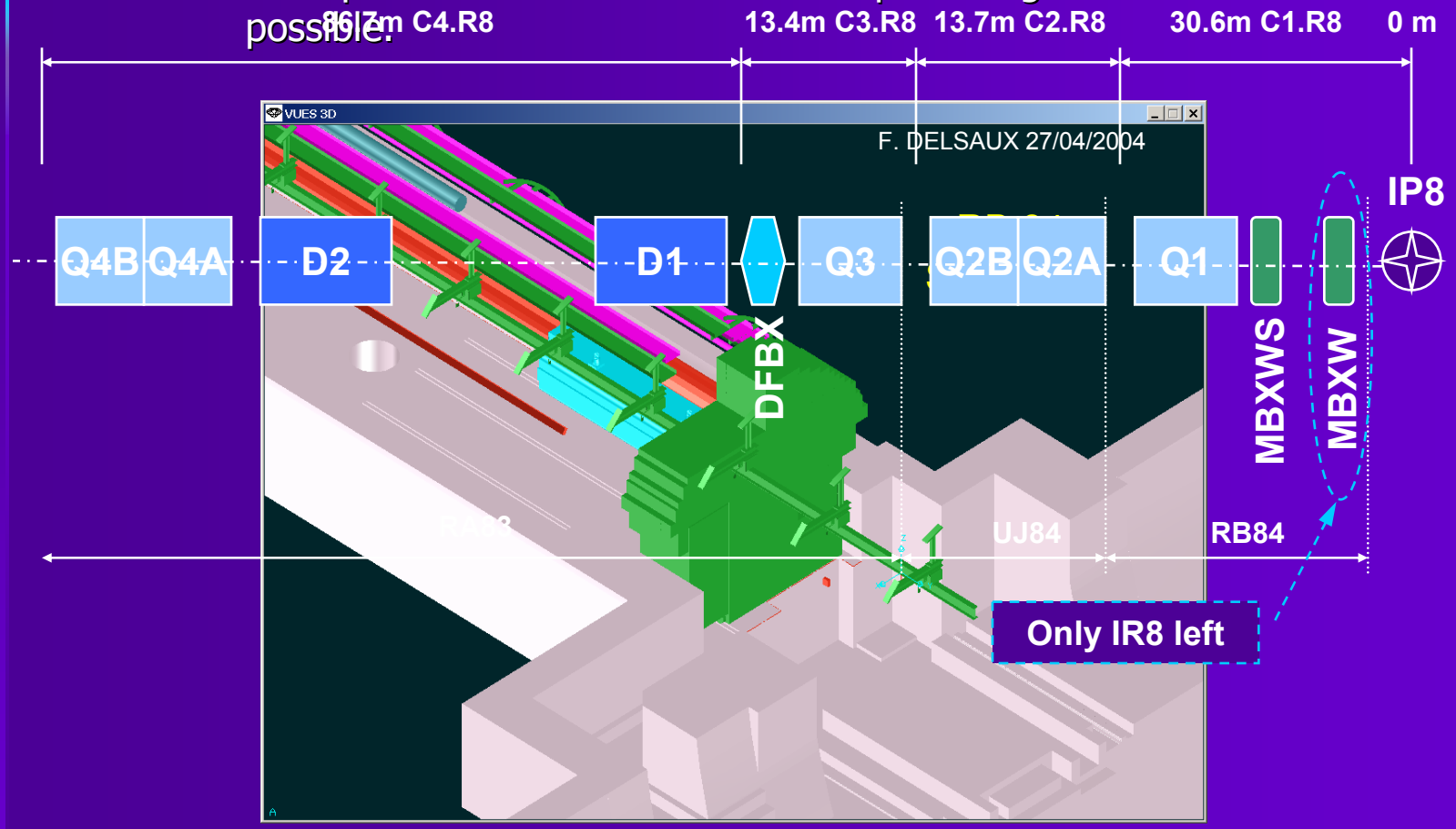


IR5:

- Q1 straddles between the tunnel and CMS forward shielding.
- The three motorised jacks are in this confined area 2x2(m^2).
- The LSS trailer has to stop before, in UJ56 and R542. Direct transfer with TES is not possible.

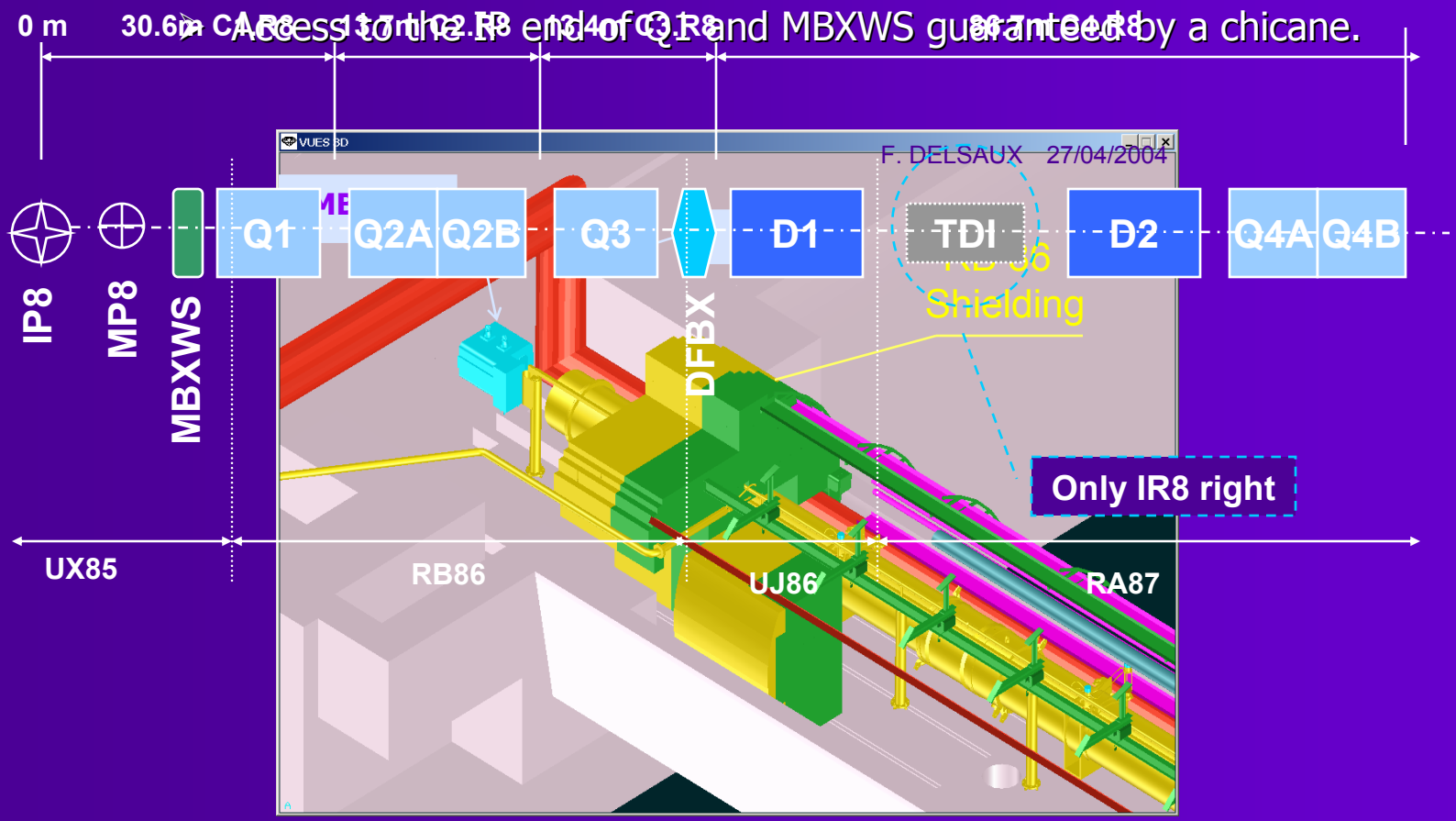
IR8 (RB84-UJ84-RA83):

- Shielding plug in RB84, in front of MBXW.
- For security reasons, the shielding should be installed before the magnets.
- Transport and installation of inner triplet using the LSS trailer and TES is possible.



IR8 (RB86):

- The shielding plug is situated in RB86, around Q1.
- Q1 cannot be transported and installed at once using the LSS trailer and TES.
- Main shielding blocks to be installed before the quadrupoles.
- Access to the IP end of Q1 and MBXWS guaranteed by a chicane.



3. Technical solutions & Installation procedure overview

IR1, IR2 right, IR5, IR8 right:
the installation of Q1 and sometimes Q2 is **not** possible with LSS trailer and TES

Technical Solution

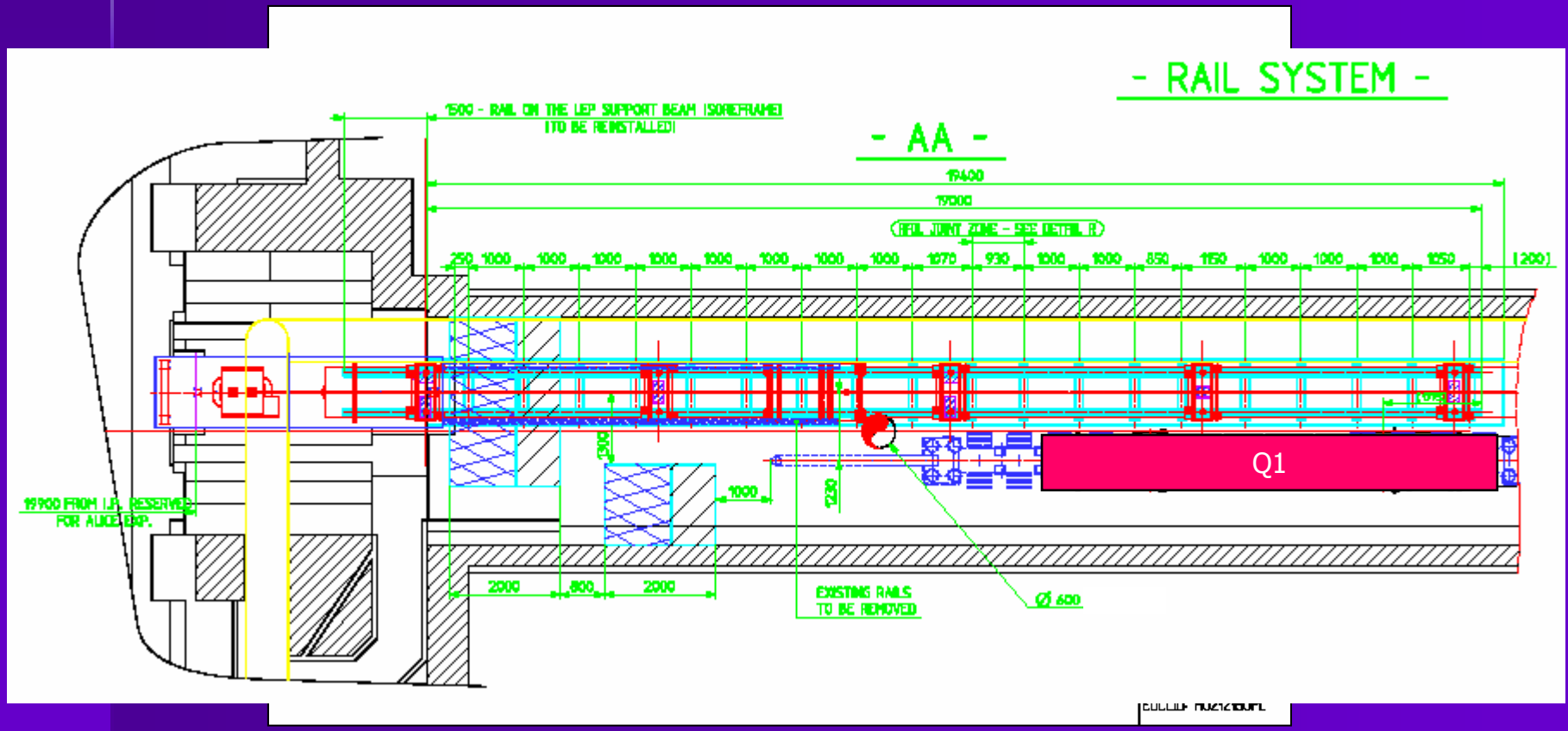
Rails + motorised bogies for longitudinal transfer

Sector 7-8 (RB86):

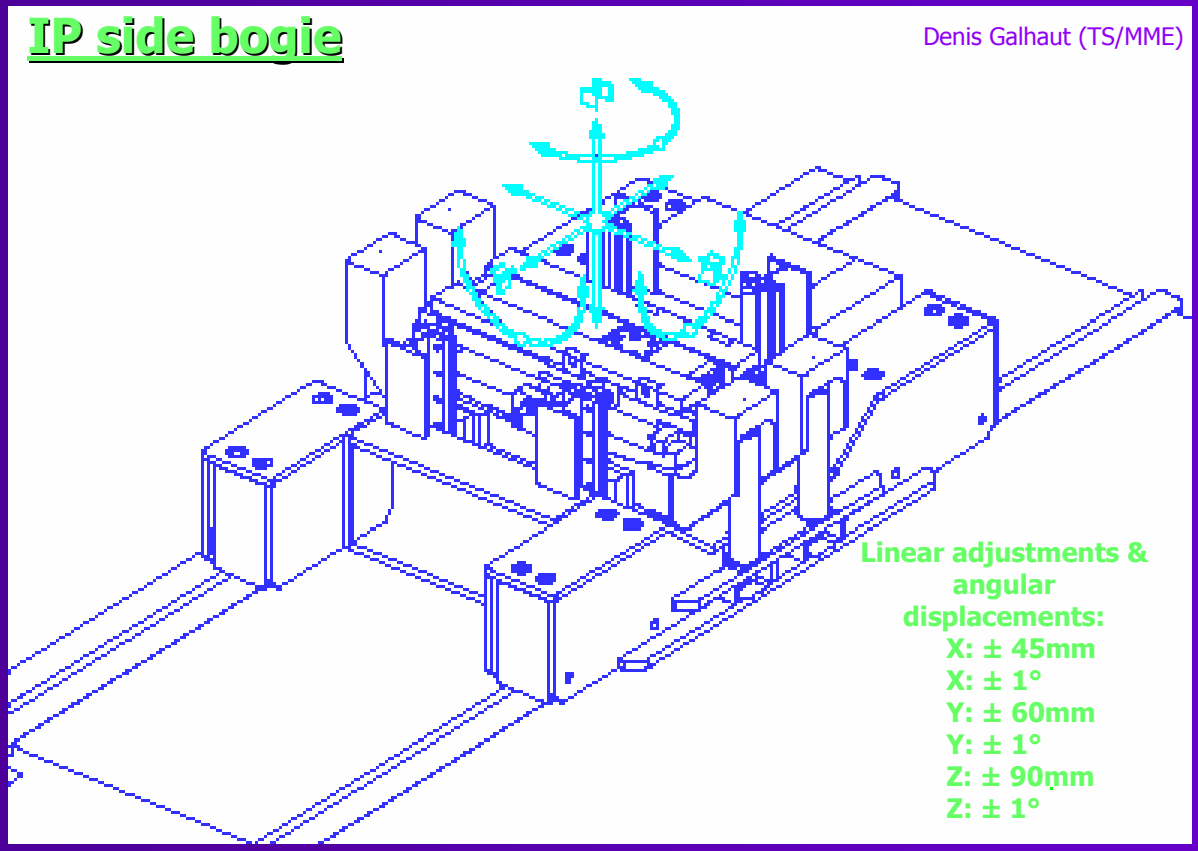
- ✓ **First rails (L=19.4 m, W=0.730m) already installed!**
- ✓ **The installation of the support for Q1 and compensator magnet able to start from the 6th September 2004.**

RB 86 (28 April 2004)

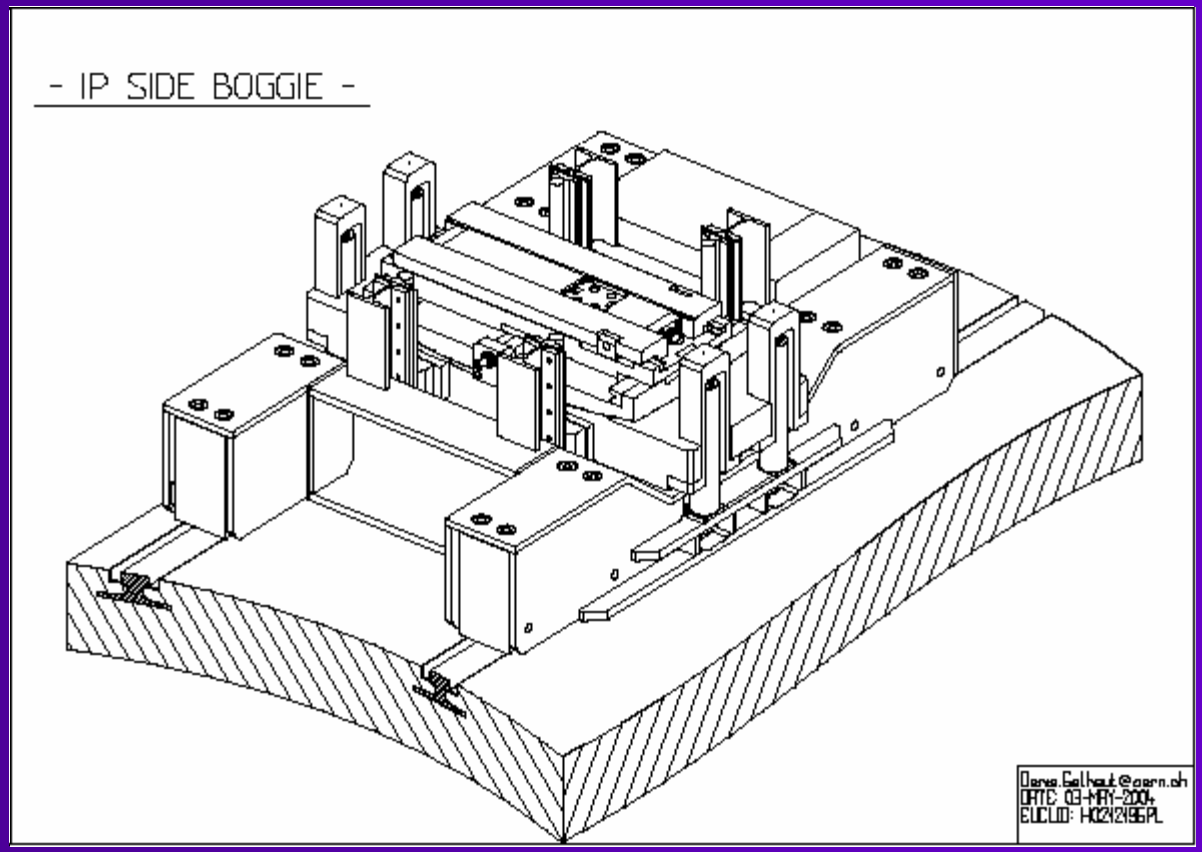
- The general installation sequence of Q1 (and Q2 in RB26) consists of approximately 15 operations. The main ones are:
  - Transport with LSS trailer.
  - Download onto the TES using the Unloading Equipment.
  - Transfer with the TES onto 2 motorised bogies (already prepared with shims).
  - Longitudinal transfer with the bogies.
  - Downloading onto the motorised jacks (H. Mainaud-TS/SU).



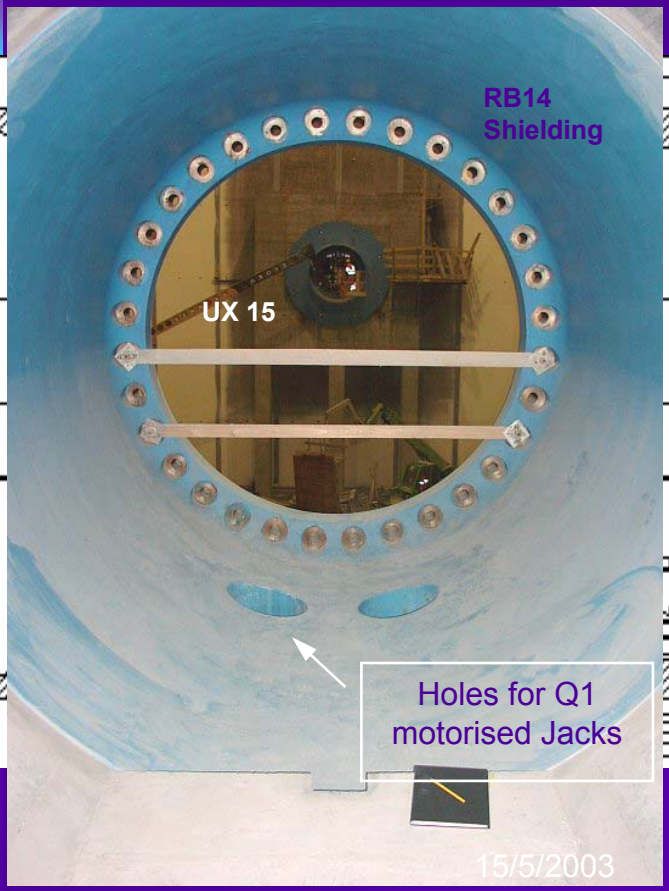
- Bogies characteristics:
  - Compatible with both beam axis positions: 950mm and 1100mm.
  - Both bogies are motorised.
  - The forward bogie is adjustable in x, y, z independently.
  - The rear bogie is adjustable in x and z and free in y (±60mm).
  - Rotation about x, y, z is possible.

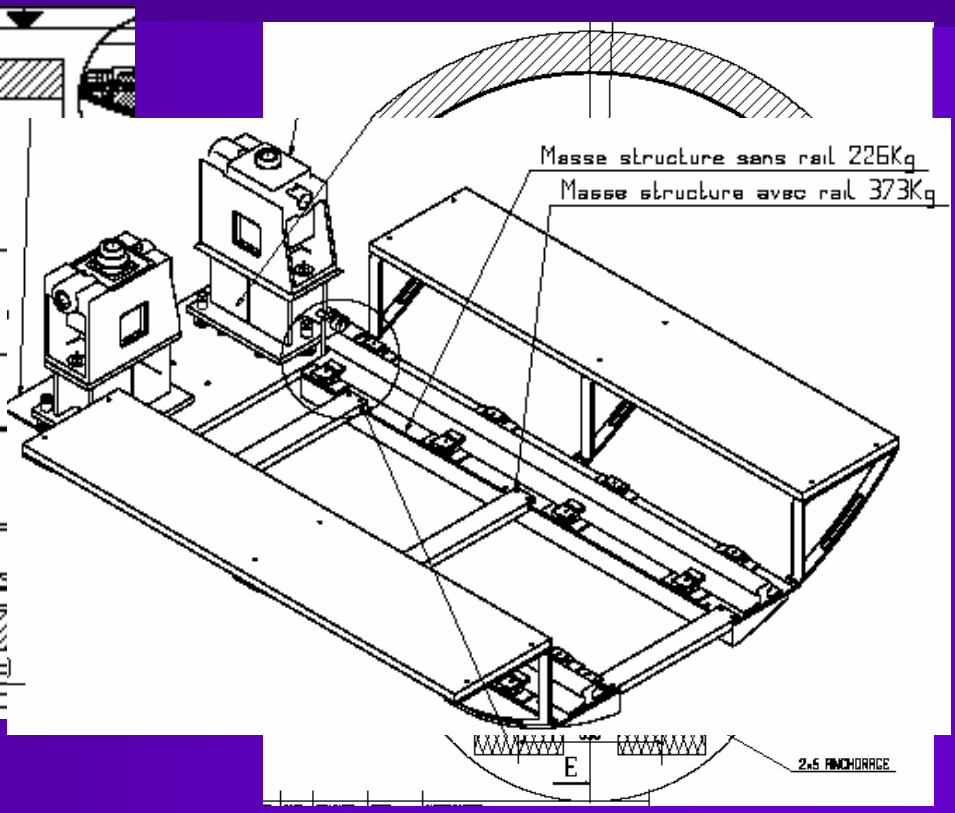


- Bogie components:
  - Motorised translation unit (DEMAG)
  - Main frame
  - Vertical guiding and spherical cradle
  - Hydraulic jacks
  - x-y table



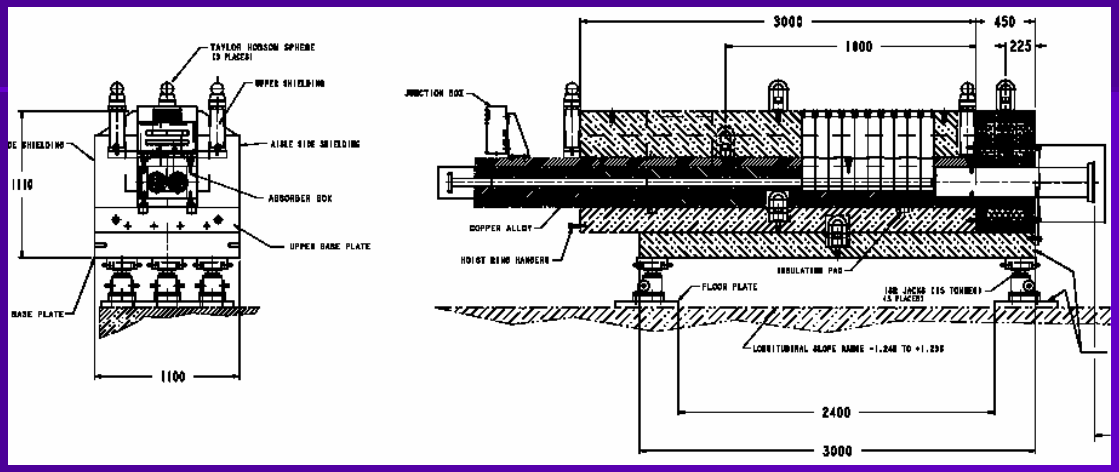
- Special case: ATLAS forward shielding tube TX1ST
  - Steel-welded structure for continuing the rails and allowing personnel access inside the tube.





- TAN underground transportation possibilities:

i. Option 1: TAN fully assembled (weight=33 tons).
ii. Option 2: Underground assembly from 8 single pieces (below 5 tons).



OPTION 1 preferred:

1. Assembly carry out on the surface where more handling means and space facilitates the activity. An assembly in the tunnel demands preparing the area with special structures & the operations would be costly & complicated.
2. Removal during LHC dismantling (radioactive unit).

CERN does not have a transport unit able to carry this item.

➔ **Motorised transport trolleys (rollers)**:

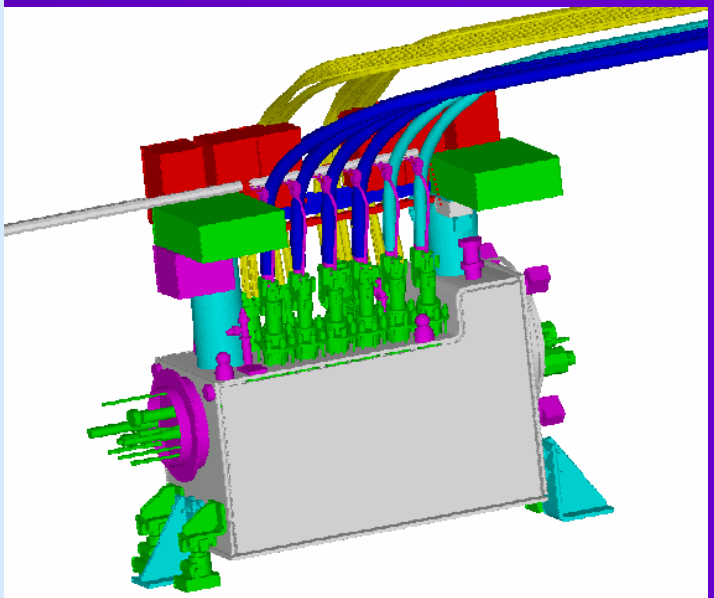
-Dimensions: H=230mm, W=1412mm (to be optimised)

-Speed=4km/h

- If TES are proved compatible to transfer TAN and the motorised trolleys are chosen, the following installation sequence is foreseen:
  1) Transport with special motorised trolley device.
  2) Downloading onto the TES.
  3) Transfer onto the ISR jacks with the TES.

DFBX installation studies status:

- In IR5, DFBXE and DFBXF have to be lowered down from Point 4 and Point 6 respectively and transported through the R tunnel (Ø=3800mm). Then installed in in RZ54 and UJ56 caverns in pits 150mm deep.
- Integration studies are going on: first results show main instrumentation and transformers should be mounted *in situ* due to tunnel access constraints.
- Transport equipment has to be defined.

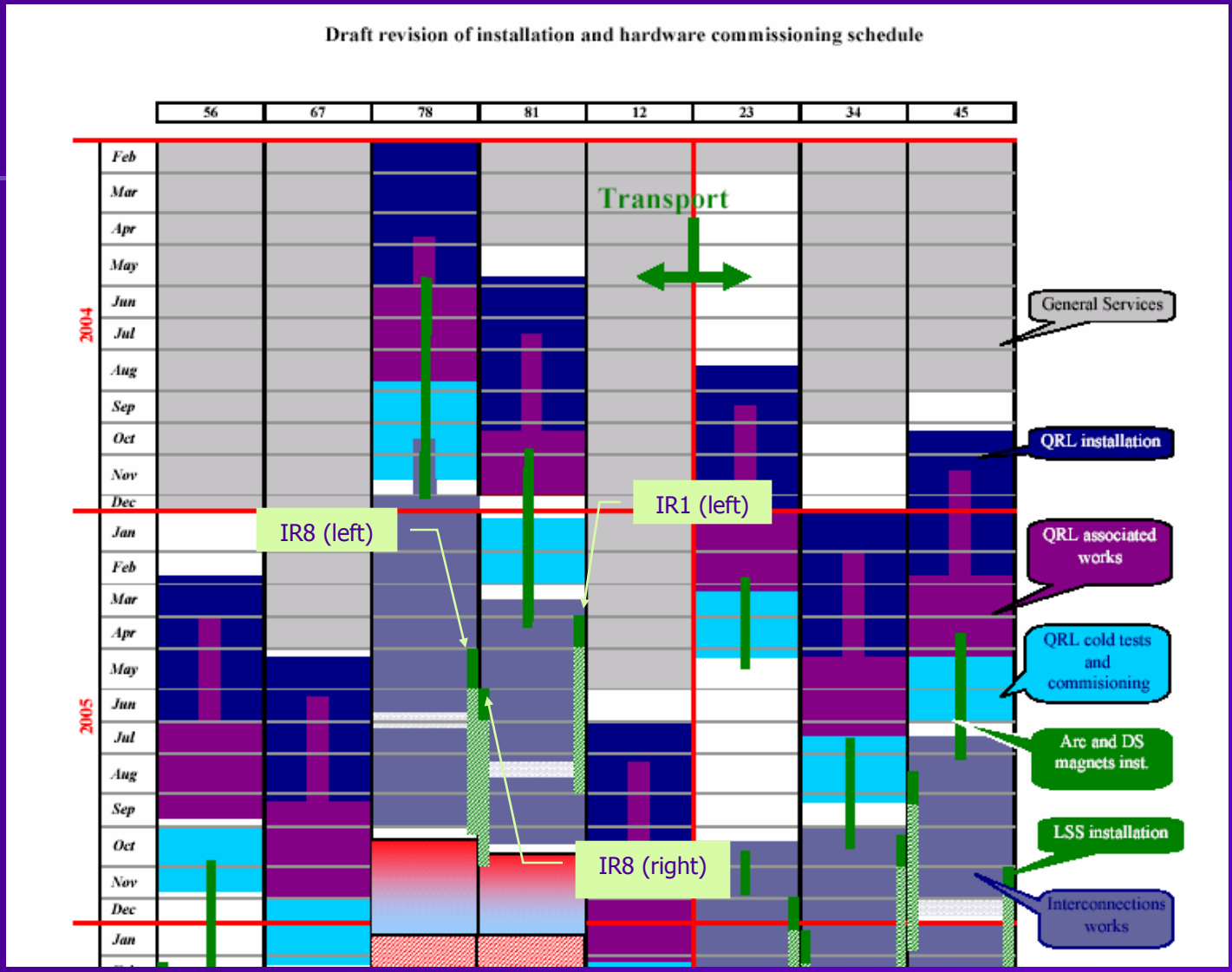


4. Chronological sequence of installation

General pattern

•Prior to the LSS installation, the following tasks have to be completed:		-General services -QRL installation -DC liaisons installation and test (depending on the zones) -Signal and control cabling installation -Rails for transfer of Q1 and/or Q2 (when required) -Mounting of shielding plugs (main components) -Marking on the floor of the machine elements (if required) -Partial installation of the HLS and WLS (in points 1 and 5)
•T0 (time 0)	•Supports installation (jacks and vacuum):	•Drilling, positioning, aligning, fixation. -Special case for Q1, Q2, TAN and collimators
•Installation (transport and positioning) of magnetic elements:		-Resistive magnets (on the experiment side) -Low-Beta triplets -Stand-alone cryomagnets -Other resistive components
•Beam instrumentation installation		
•Alignment of beam elements		
•Installation and connection of jumpers		
•Interconnecting work		
•Installation and connection of vacuum equipment		
•Finalize installation of Hydrostatic Leveling System (HLS) and Wire Leveling System (WLS)		
•Hydraulic connections		
•Signal and control connections		
•DC connections (resistive elements)		
•Vacuum and leak detection tests		

- Experimental insertions installation planning (2005…):



5. Budget

- The cost of the hardware described required for the installation of these LHC-US collaboration equipment is not included in the LHC-Cost To Completion.
- An ECR (LHC-KRB-EC-0002) has been prepared and approved to cover the cost of the hardware and the related design office work.

Acknowledgements

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