

FITTING ELECTRON RF AND POWER SOURCES INTO THE LHC

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RF and beam parameters

- Energy loss / turn @ 70 (50) GeV = 707 (184) MeV
- Beam current $I_b = 74$ mA
- Beam energy $E_b = 54$ (14) MW
- Total RF voltage V_{rf} (lifetime) = 900 (250) MV
- (Assume) $F_{rf} = 1002$ GHz, $h = 89100$
- $F_s = 1406$ (1124) Hz, $Q_s = \sim 0.125$ (0.1)

RF design electron ring (tentative)

- SC system 1.9 °K (1000 MHz)
- RF Power coupler max./cavity 500 kW CW
- 50(14) MW beam power → 100(28) cavities
- 100(28) cavities for 900 (250) MV
→ 9(9) MV /cavity
- 6 MV / m (beam line) → each cavity 1.5 m
- 100(28) cavities → 150(42) m beam line
- 100(28) cavs. @ 500 kW → 100(28) klystrons @ 500 kW
- or → 50(14) klystrons @ 1 MW
- 100(28) klystrons @ 4 m → horizontal, 400(112) m
→ (stack double? 200(56) m)
- 4 klyst. / HV bunker 2 m → 50(14) m
- 1.5 racks (0.6m)/(klyst.) → 90(25) m
- Cavity diameter 1 GHz → 50 cm

Total floor space for RF system

- Beam line 70(50) GeV → 150(42) m
- RF power (klystron gallery) → 540(151) m
- stack (difficult replacement) → 340(95) m

For the present exercise assume 70 GeV

→ 150 m beam line, 540 m klystron gallery

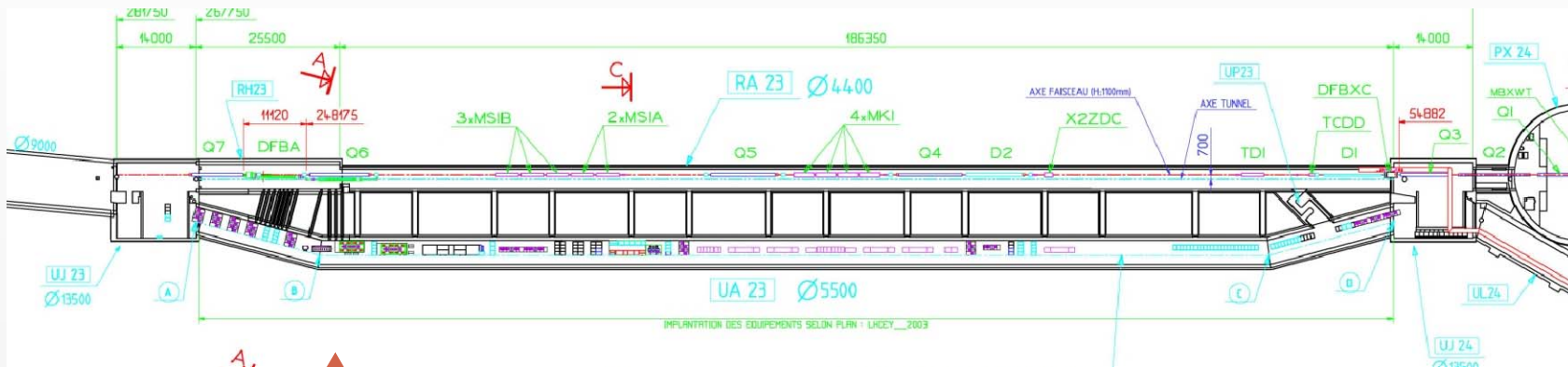
Distribute in 2(4) areas

Installation of electron RF – possible in point 4?

- Where to put electron ring – bypass?
- Very crowded at entry to tunnels New electron RF point 2 or 8 (but also injection area)



Installation of electron RF – left/right points 2,8



Point 2 left	168 m
Point 2 right	168 m
Point 8 left	210 m
Point 8 right	210 m
(avoid dfba, dfbx)	
TOTAL	756 m

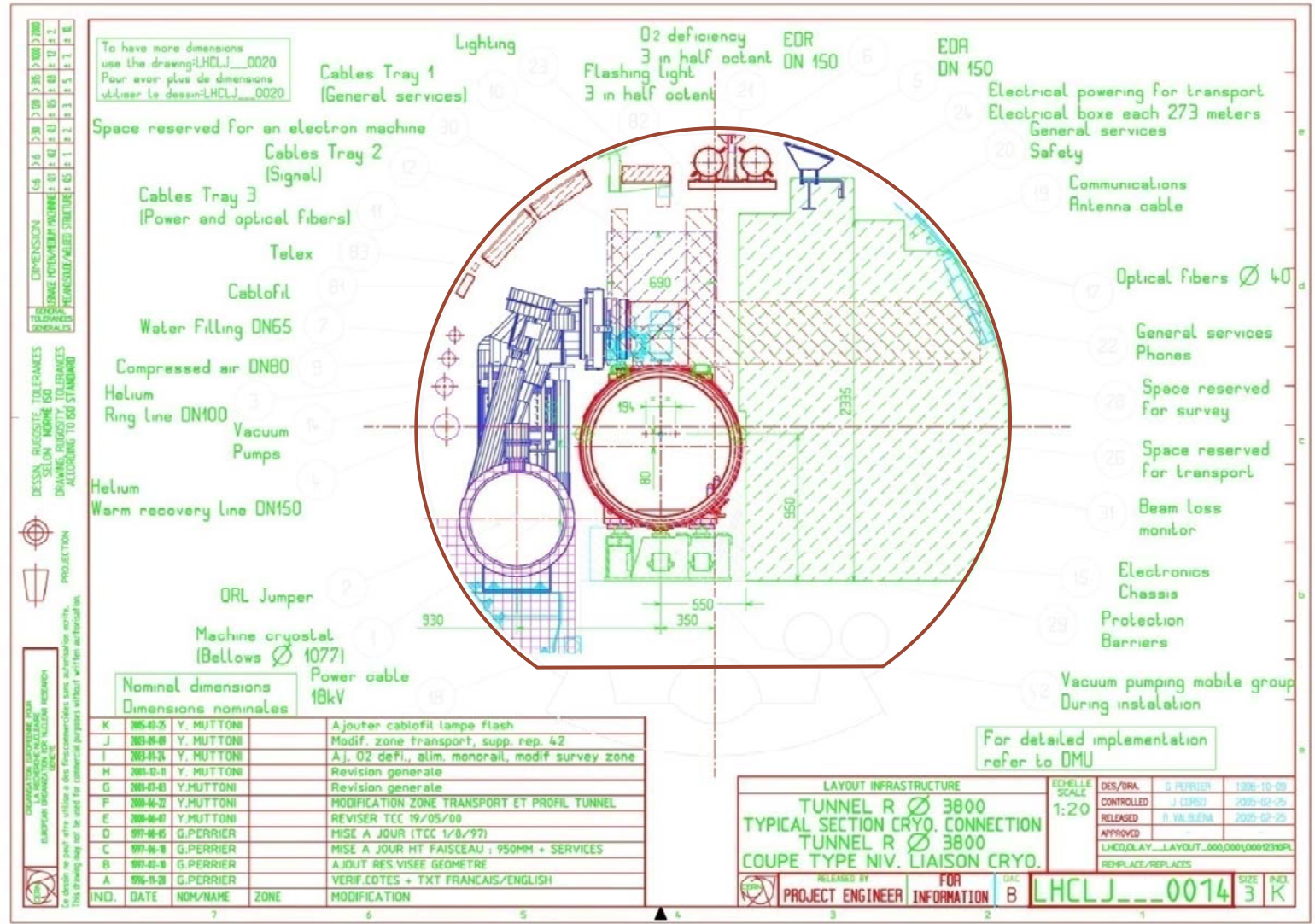
RF Beam-line 150 m : filling factor 20%

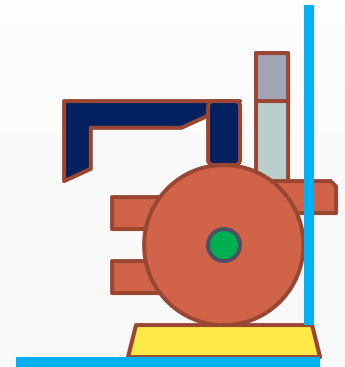
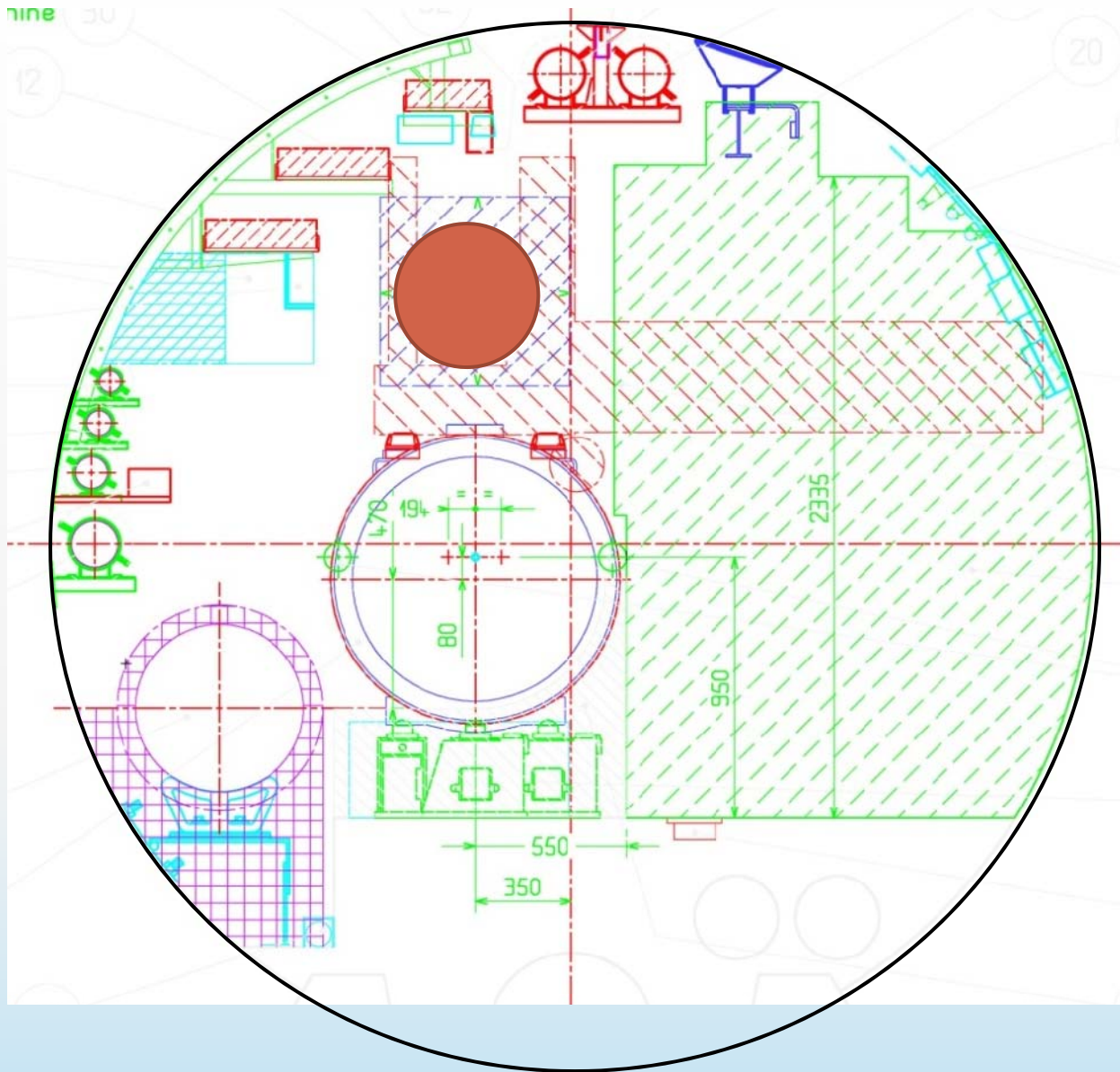
RF Klystron gallery 540 m : filling factor 71%

Does this leave enough room for power convertors, kicker supplies?

Installation of electron RF – point 2,8

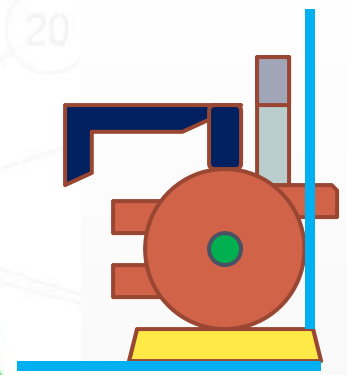
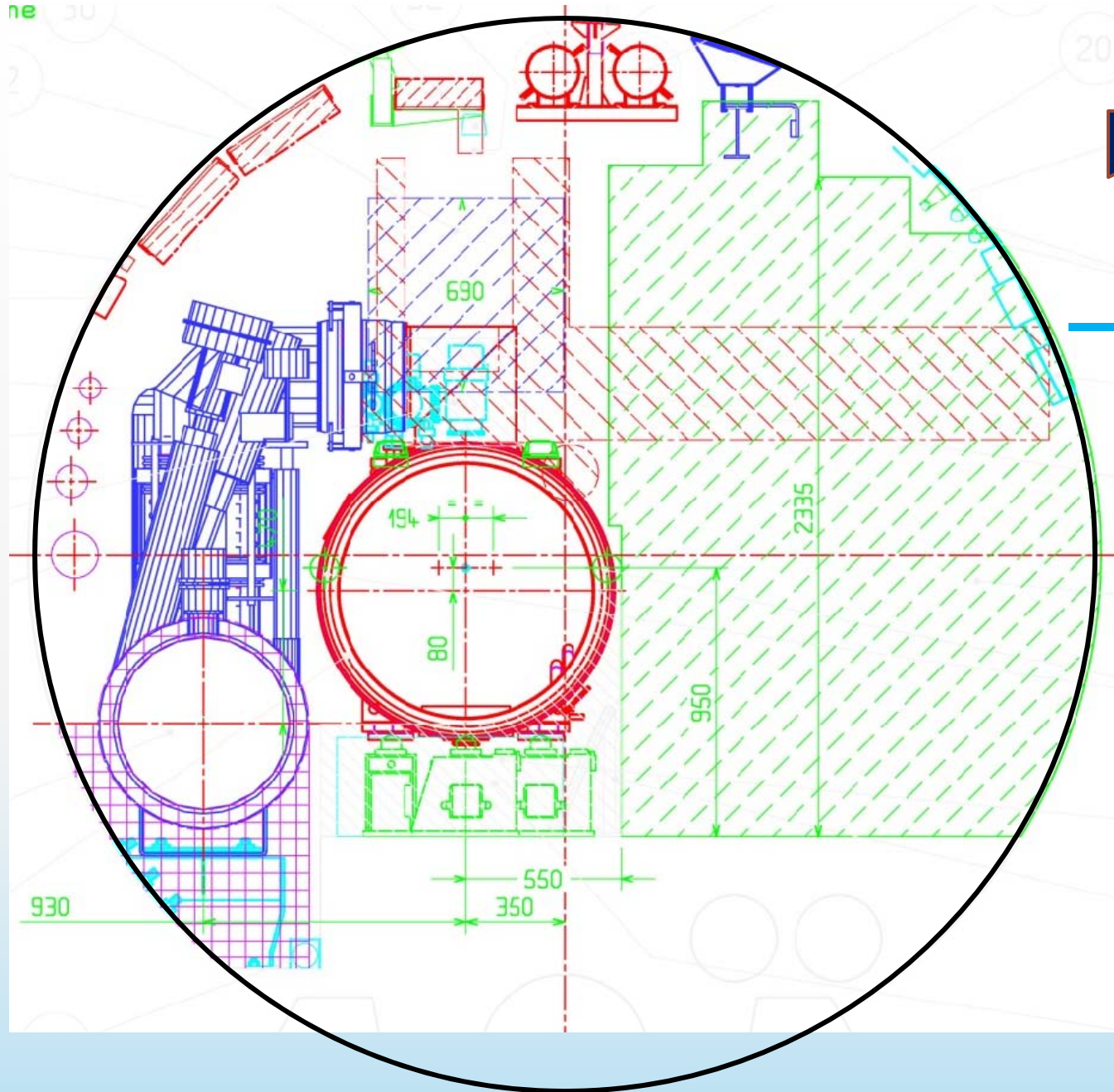
Typical cross section – cryo. Connection – could we use this?





Connections to 1.9°K cryo-line

50 cm diameter cavity

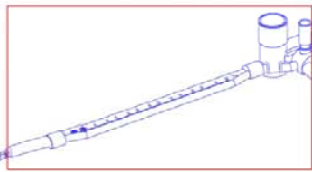


Klystron galleries RF Power, feedbacks and control

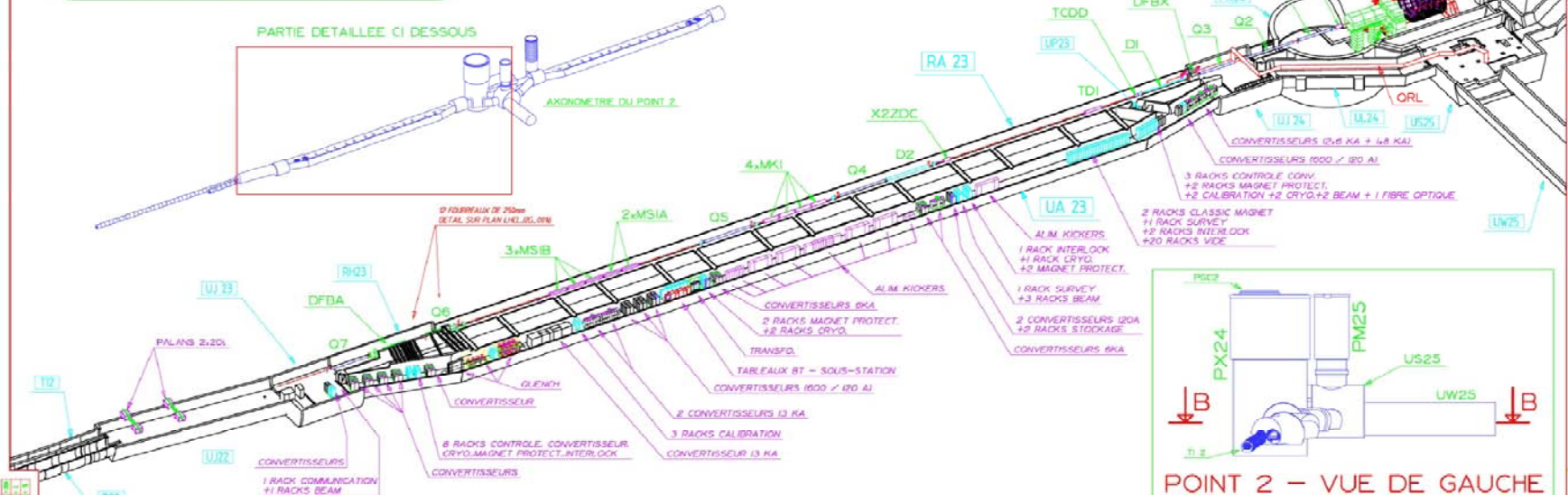
- Equipment local for fast RF feedback
- Radiation shielding – for fast electronics, FPGAs, slow control PLCs (results from CNGS and soon from LHC), etc.
 - X-rays from cavities
 - Beam-gas radiation (proton beams)
- Need klystron gallery or equivalent
- N.B need space for new power converters for electron ring magnets, kicker supplies etc.

POINT 2 - ALICE

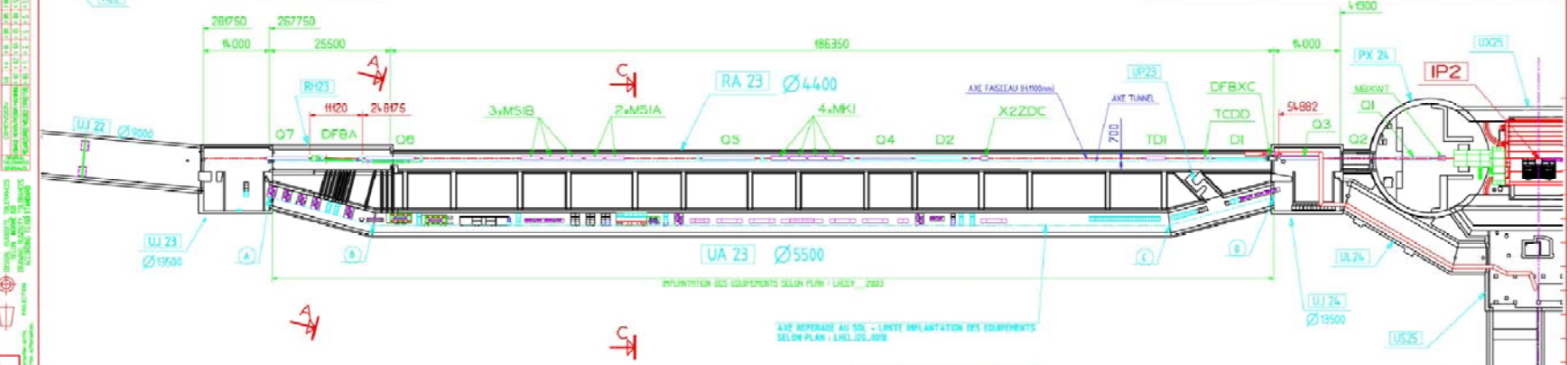
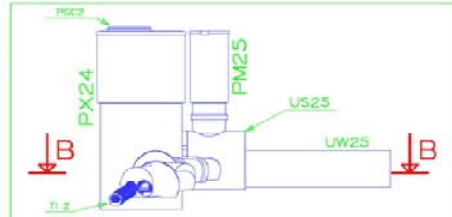
PARTIE DETAILLEE CI DESSOUS



AXONOMETRIE DU POINT 2



POINT 2 - VUE DE GAUCHE



COUPE B-B VUE NORMALE PARALLELE A L'AXE FAISCEAU

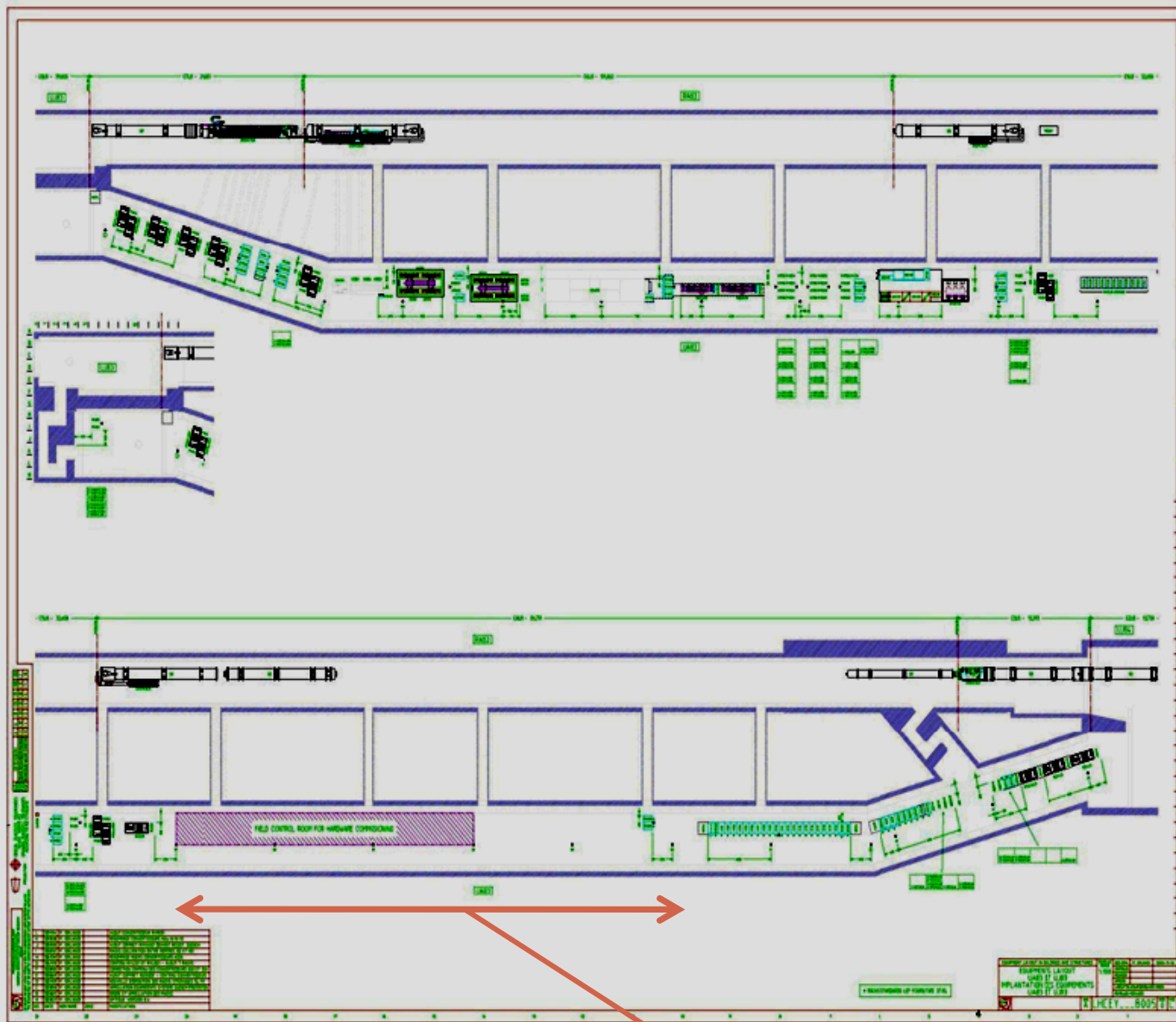
Ce dessin donne la forme et les dimensions du tunnel pour LHC. Les éléments de la machine sont donnés à titre indicatif et correspondent à la version 6.4 de l'optique.
This drawing shows the shape and dimensions of the tunnel for LHC. Machine elements are only indicative they have been drawn in accordance to the optics version 6.4.

1	MBR 2	BOULARD	PROP 2	2004/07/05	SC - V2.0
2	MBR 1	COSSARD	PROP 1	2004/07/05	SC - V1.0
3	MBR 1	ALLOMBRO	POSTING	2004/07/05	SC - V1.0
4	MBR 1	ALLOMBRO	PROP 1	2004/07/05	SC - V1.0
5	MBR 1	ALLOMBRO	PROP 1	2004/07/05	SC - V1.0

GENERAL	REVISION	DATE	BY	CHKD
SCHEMATIC LAYOUT	1	2004/07/05	MBR 2	MBR 2
POINT 2 - LEFT - VERSION 6.4	2	2004/07/05	MBR 1	MBR 1
IMPLANTATION SCHEMATIQUE	3	2004/07/05	MBR 1	MBR 1
POINT 2 - GAUCHE - VERSION 6.4	4	2004/07/05	MBR 1	MBR 1

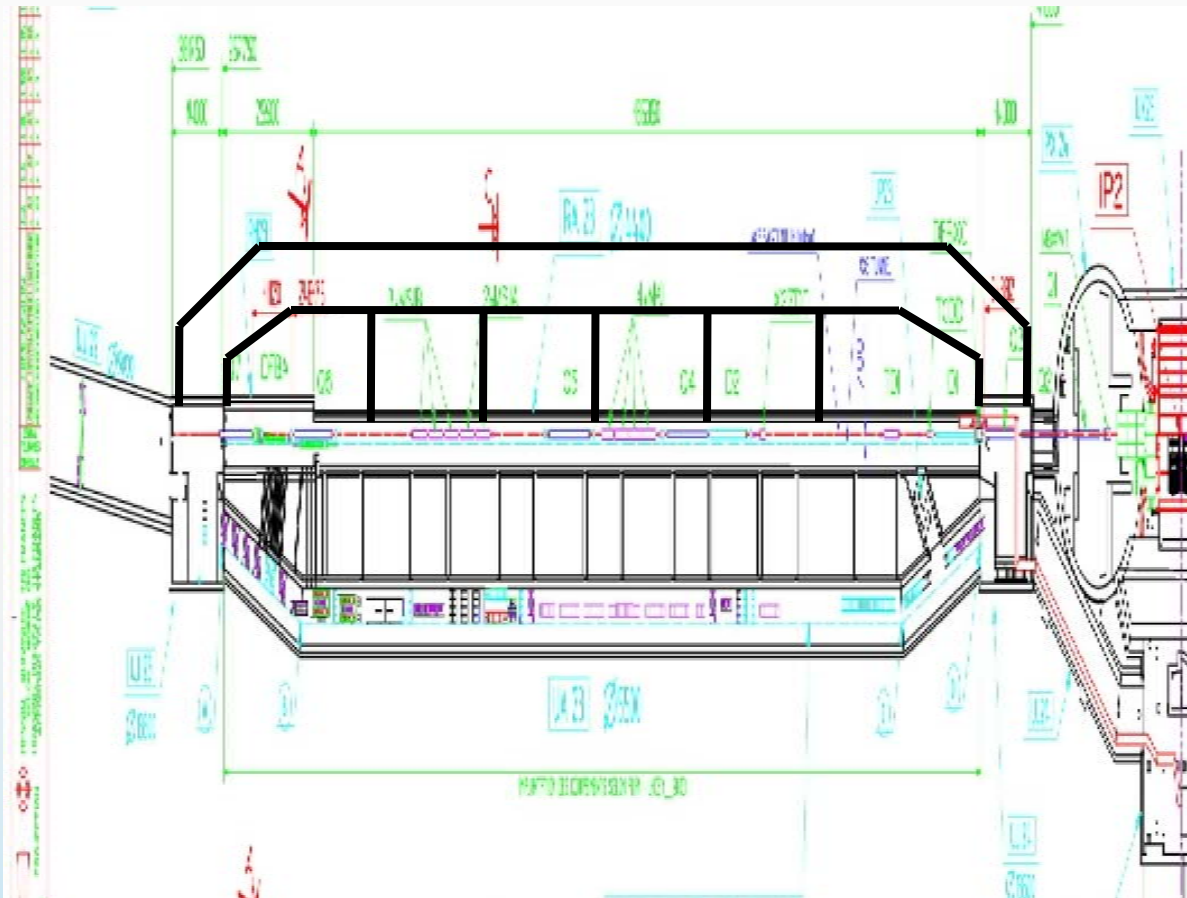
Point 8

Is this drawing up-to-date?



Free space ? – in any case not much!

Need a radical solution:



Much better would be to clear out as much of the proton power convertor equipment as possible and re-use the existing klystron gallery for RF and electron ring power convertors.

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Superconducting link to put main proton power convertors on the surface – need R & D, especially D

Summary

- Electron RF should fit in ring
 - Many things will have to be modified anyway
 - Make a list of these?
 - Points 2 and 8 look OK at first sight
 - But- injection regions for p, and e also in 8
- Klystron galleries
 - Need to occupy at least 4 regions for 70 GeV (much easier at 50 GeV)
 - No room in galleries at present
 - Two possibilities envisaged
 - superconducting link – R&D now
 - excavate 4 bypass tunnels
- For consideration in medium term
 - Cryogenic connection
 - Waveguide distribution – existing holes in tunnel
 - Space for power convertors for e-ring
- R & D for power coupler 500 kW CW @ 1 GHz
- Cavity structure design – confirmation 6 MV / m beam line
- Klystron design – confirmation, 500 kW or 1 MW, 4m or shorter length