EN Engineering Department

EN STI

PSB Upgrade
LIU Project

NEW PSB DUMP

PROJECT STATUS

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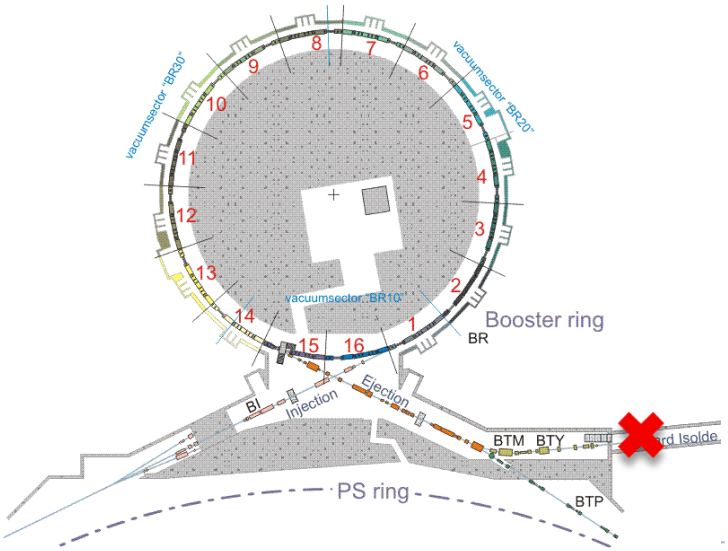
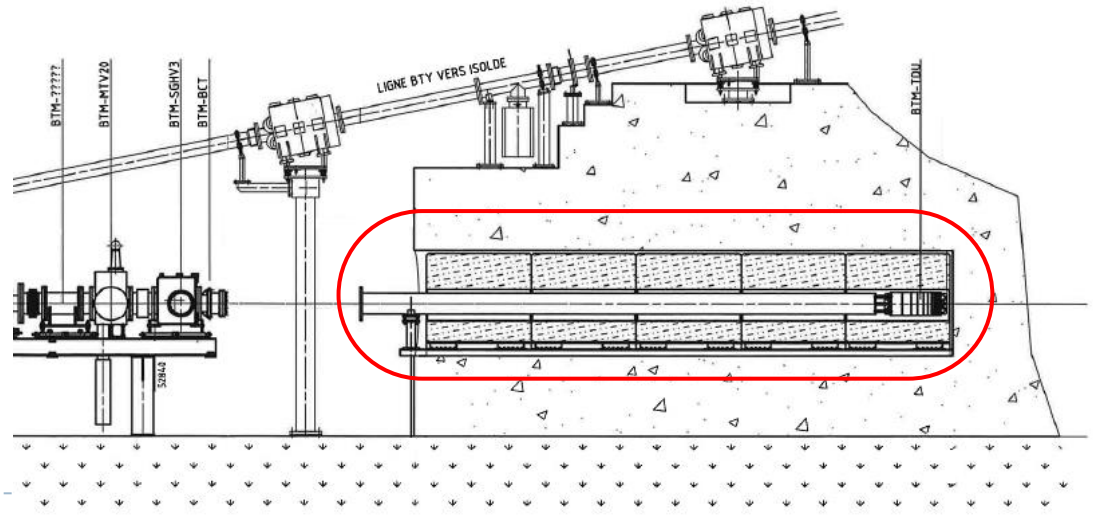
Presentation Layout

- Requirements and constraints
- Material considerations
- Final conceptual design
- Simulations: Fluka, CFD and FEA
- Final detailed design
- Monitoring, safety
- Conclusions

Requirements

- **Installation**: October 2013
- **Location**: same location as old dump
- **Space limitations**: 5^{+}m-long, 1m-diam cavern → for dump + new shielding





Constraints

- **Maximize reliability**:
  - → Implement simple design (facilitate manufacturing, installation and future extraction)
  - → Minimize the risk of failure (robust design)
  - → Include monitoring and inspection in the design

- **Difficult access**:
  - → Limited space in the area
  - → Installation. Partial dismantling of optical line

Material considerations

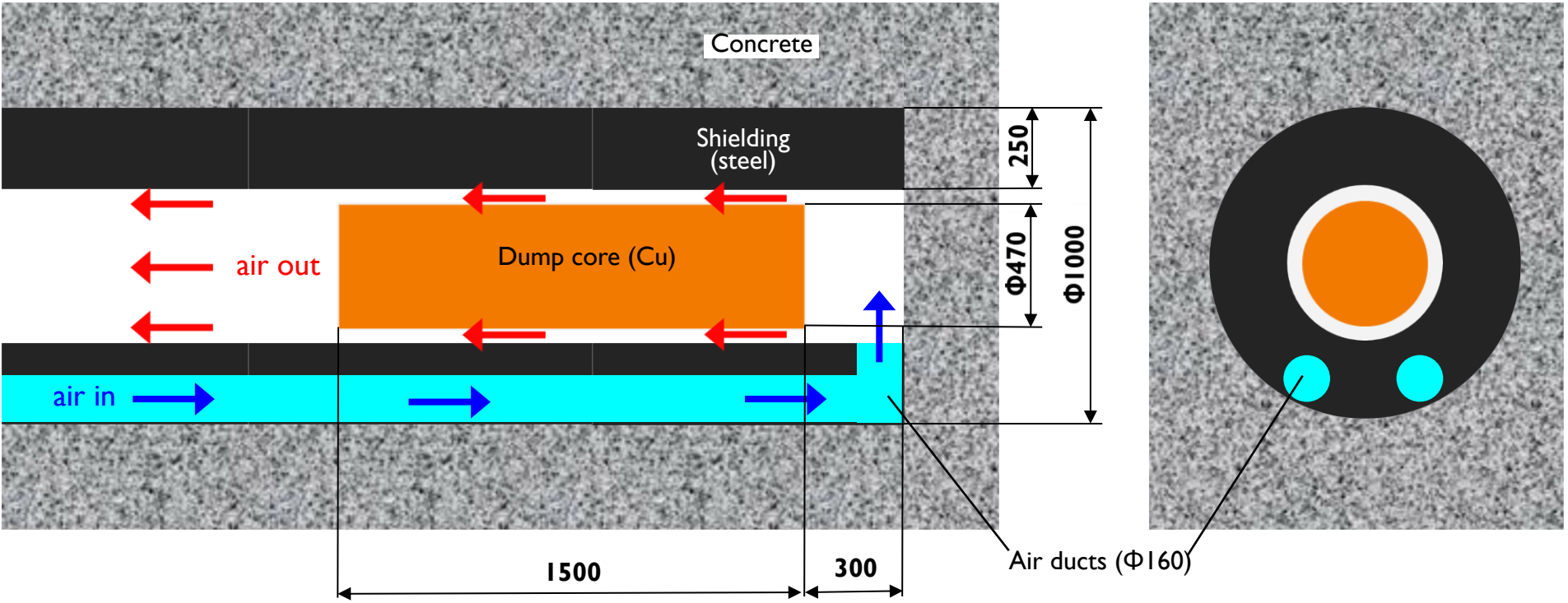
- High conductivity required for core
- High density to maximise efficiency and shielding
- Good mechanical properties at high temp.
- Aging effects
- Corrosion resistance

Material Properties

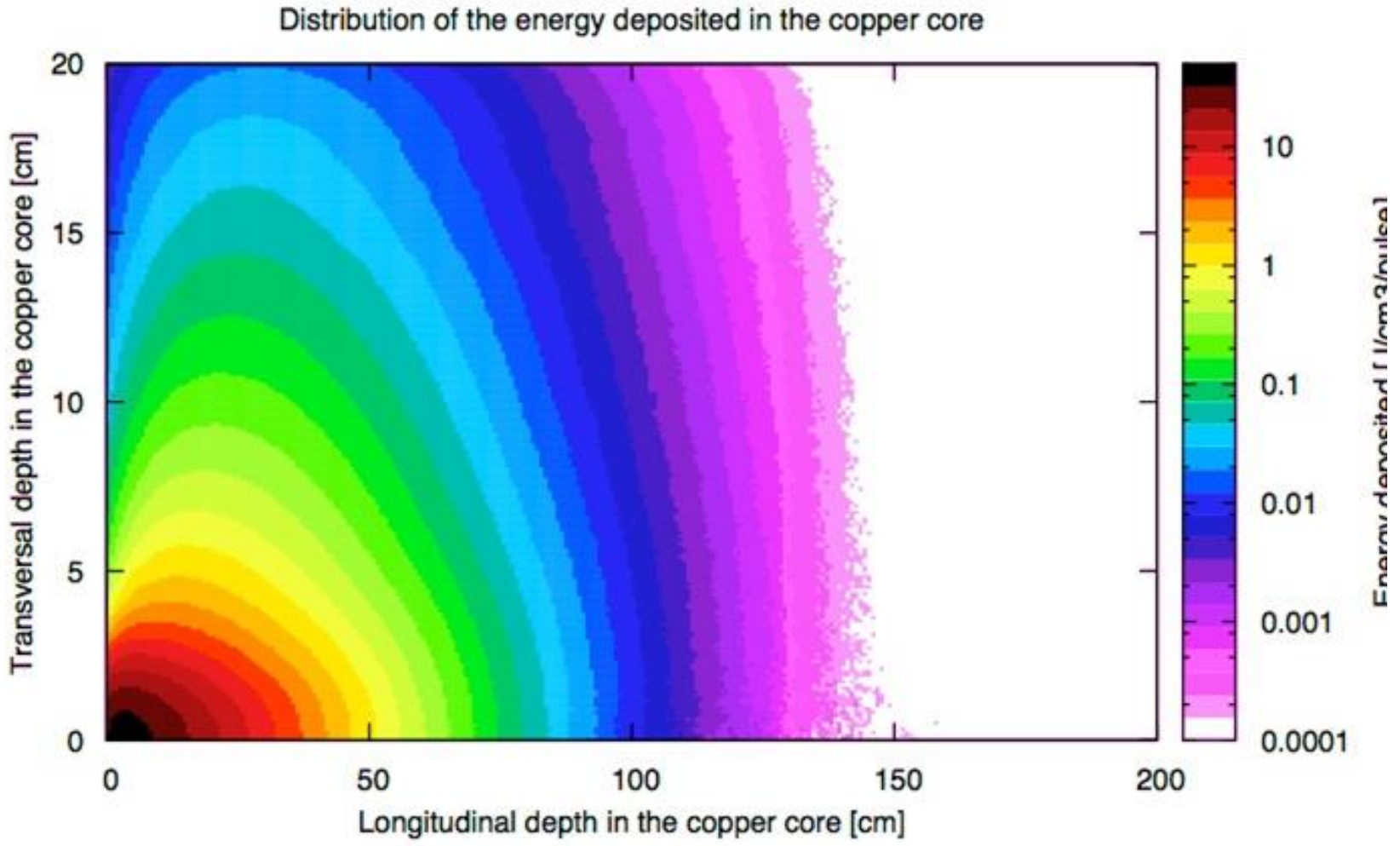
Properties @ RT	Units	Copper C18150 (CuCrZr)
Density	g/cm^3	8.9
Yield Strength @ RT	MPa	270
Young Modulus E	GPa	108
Max Service Temperature	°C	300*
Thermal Conductivity	W/m °C	320
Specific Heat	J/kg °C	376
Thermal expansion	10^{-6}/°C	17

*Value taken from similar coppers

Conceptual Design



FLUKA Simulations



FLUKA Simulations

	Deposited Energy [GeV/pr.]	Deposited Energy [J/pulse]	Average Power [kW]
Cu core	1.415	22640	9.433
Shielding (energy escaping dump)	0.220	3521	1.467
Total	**1.635**	**26161**	**10.900**

The total energy deposited in the PSB dump is equal to: 22.667 kJ/pulse, and relevant total deposited power is equal to 9.444 kW.
11.0% of the total energy escapes from the dump (radially), which corresponds to the average escaping power of 1.467 kW.

16.7% missing (binding) energy
1.4% - discarded energy (neutrino..)

Cooling
CFD Simulations

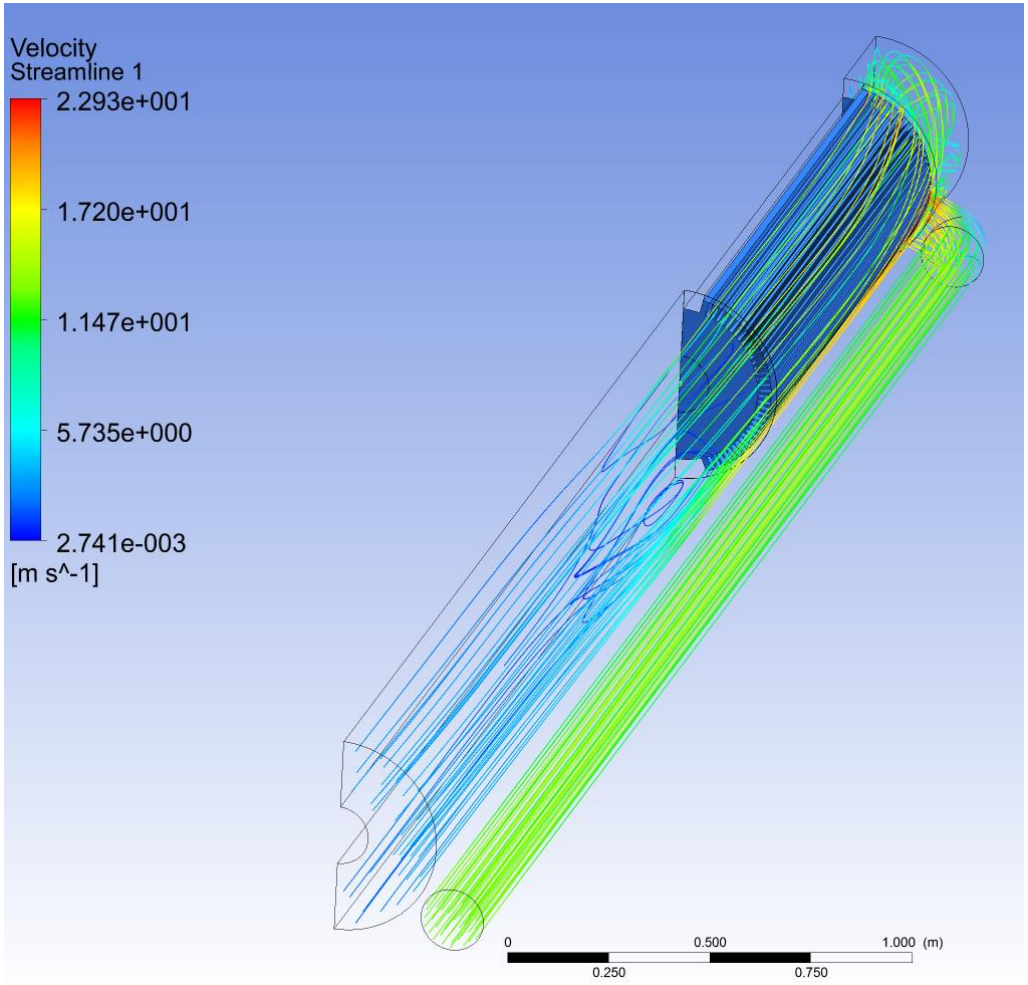
Calculation Parameters :

- Heat source = 9.4 kW
- Air Flow = 1800 m^3/h
- Inlet air temp. = 20 °C

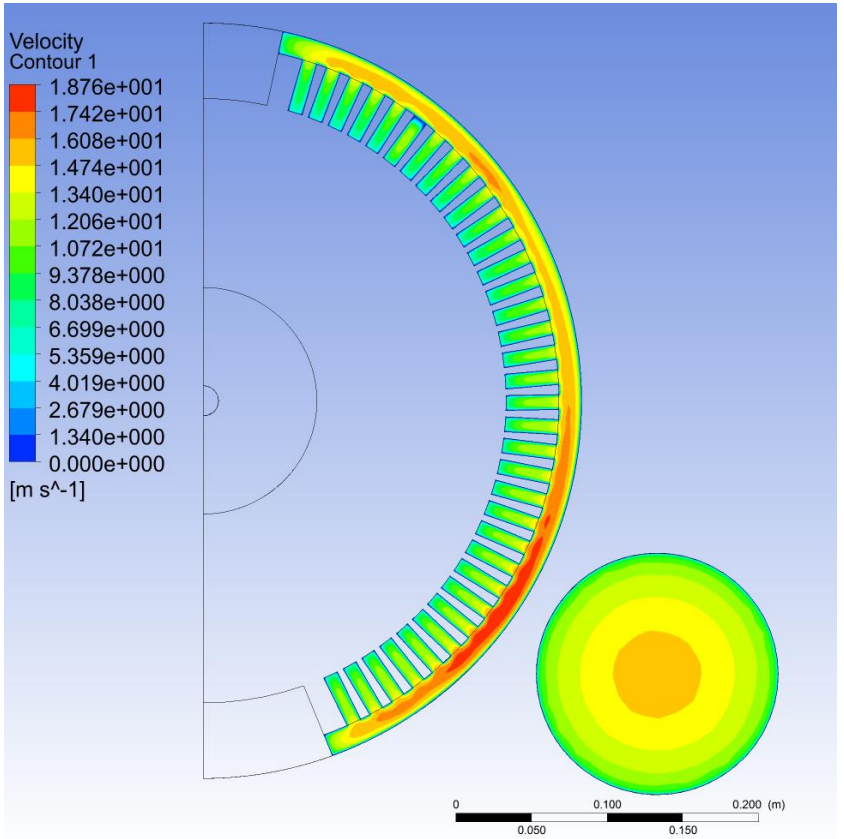
Results:

- Average HTC = 73 $W/(m^2.K)$
- Outlet Air temp. = 33 °C
- Pressure drop = 445 Pa

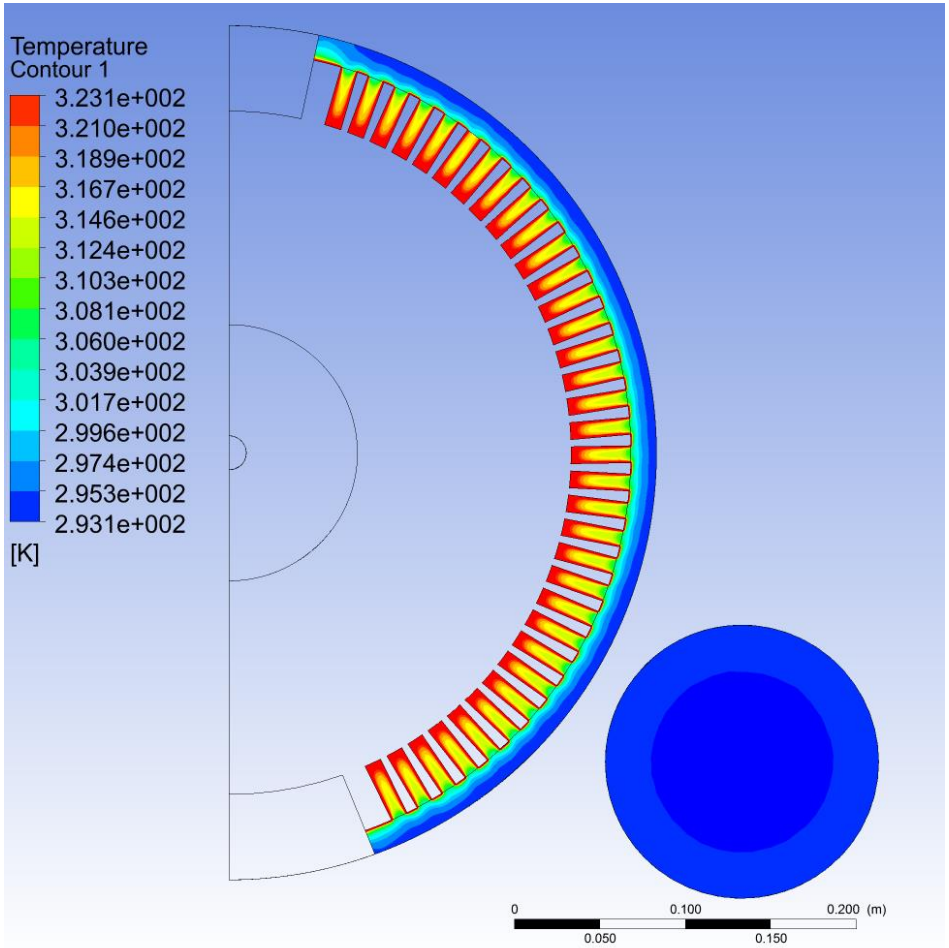
Cooling CFD Simulations



Air Velocity

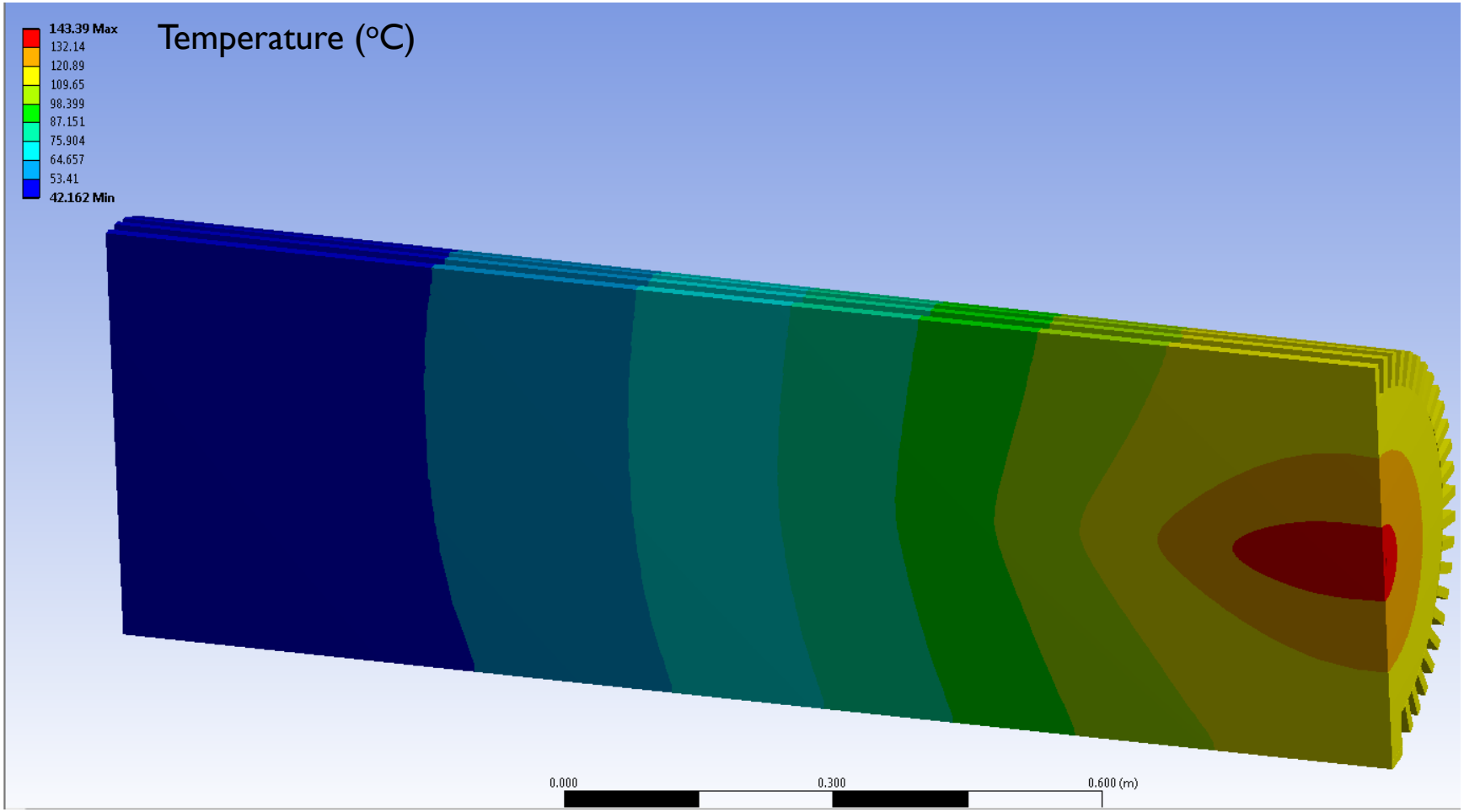


Cooling
CFD Simulations



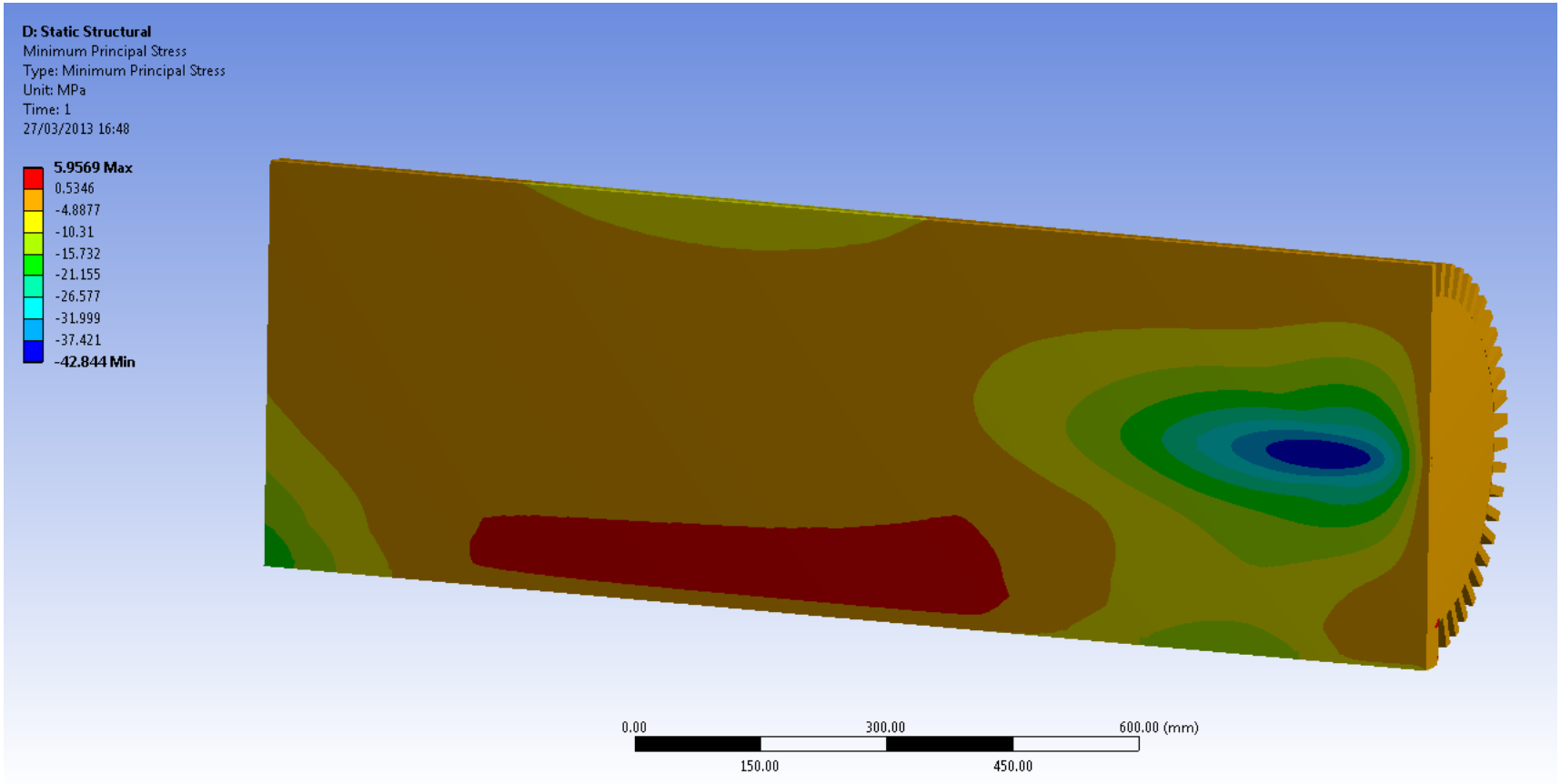
Air Temperature

Thermal Analysis

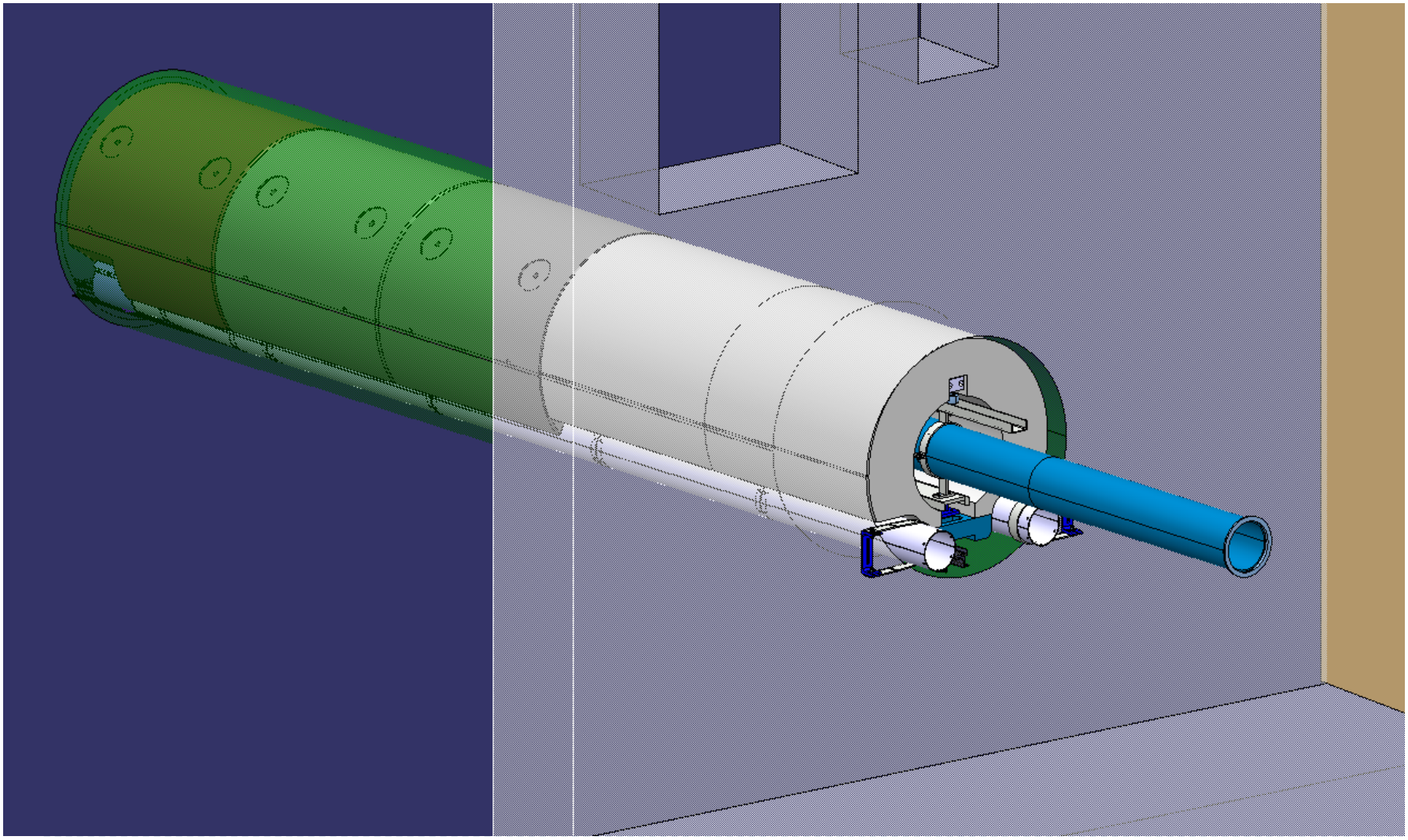


Stress Analysis

Compressive Stresses



Detailed Design



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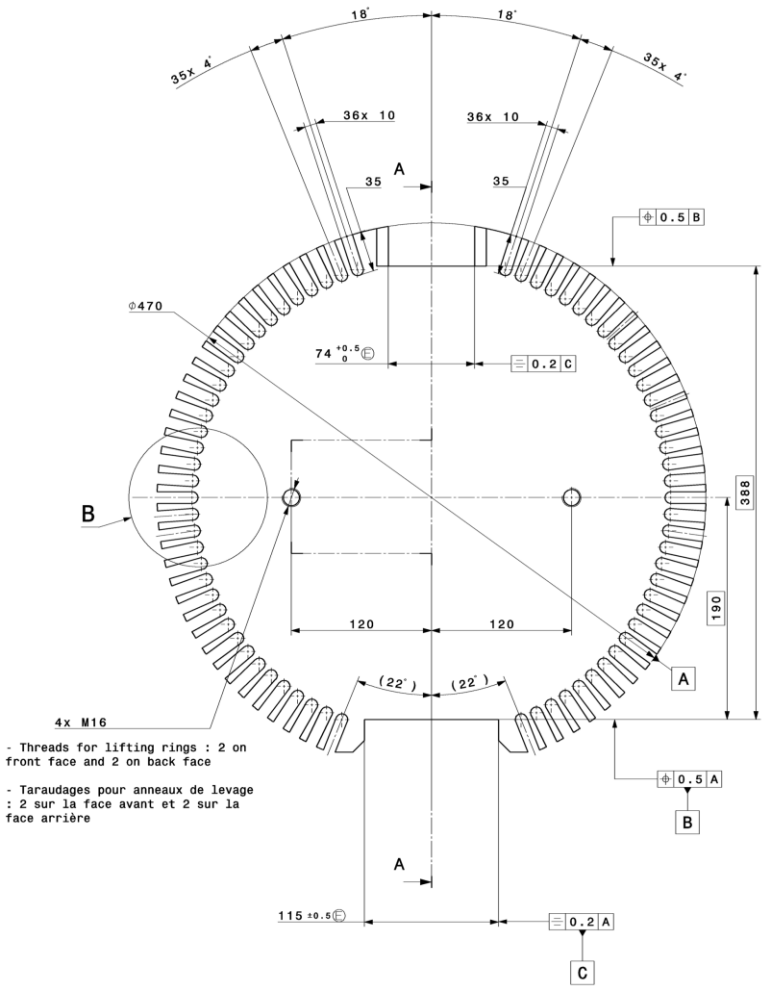
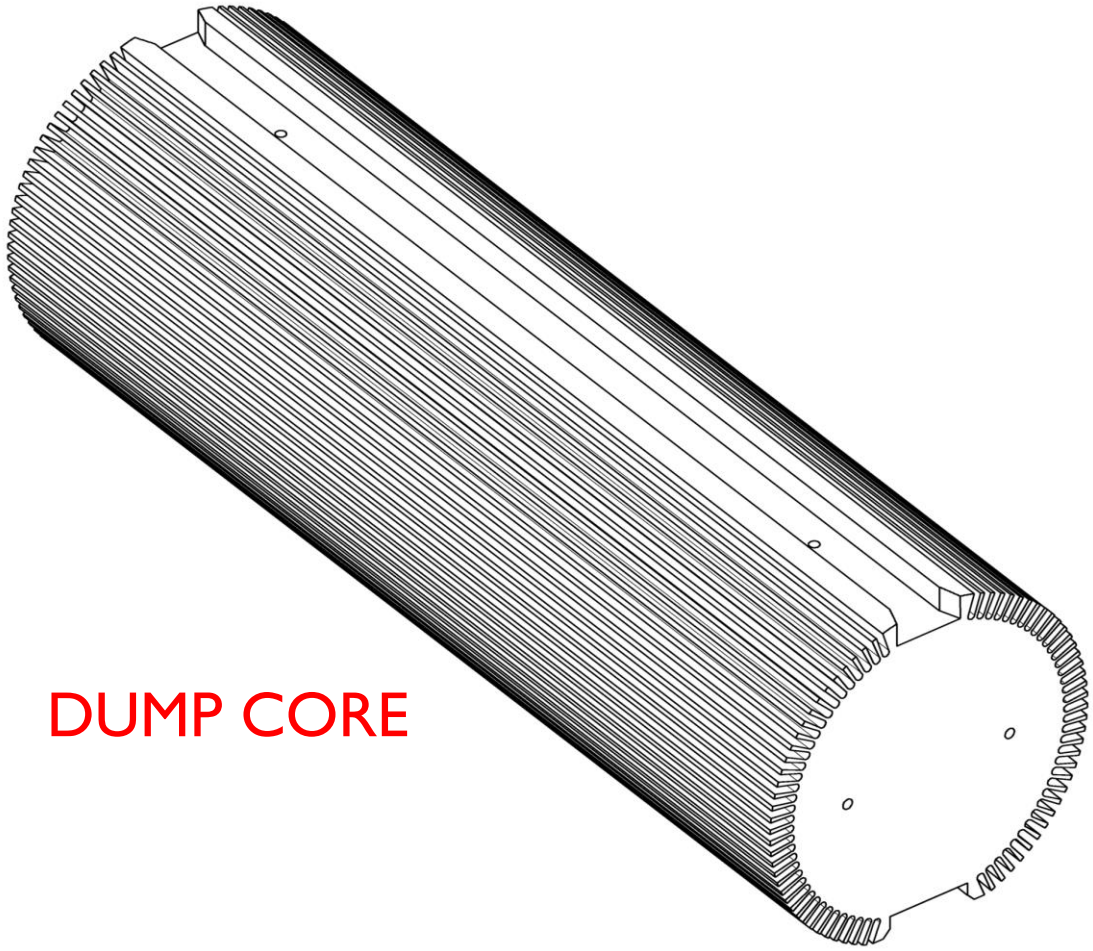
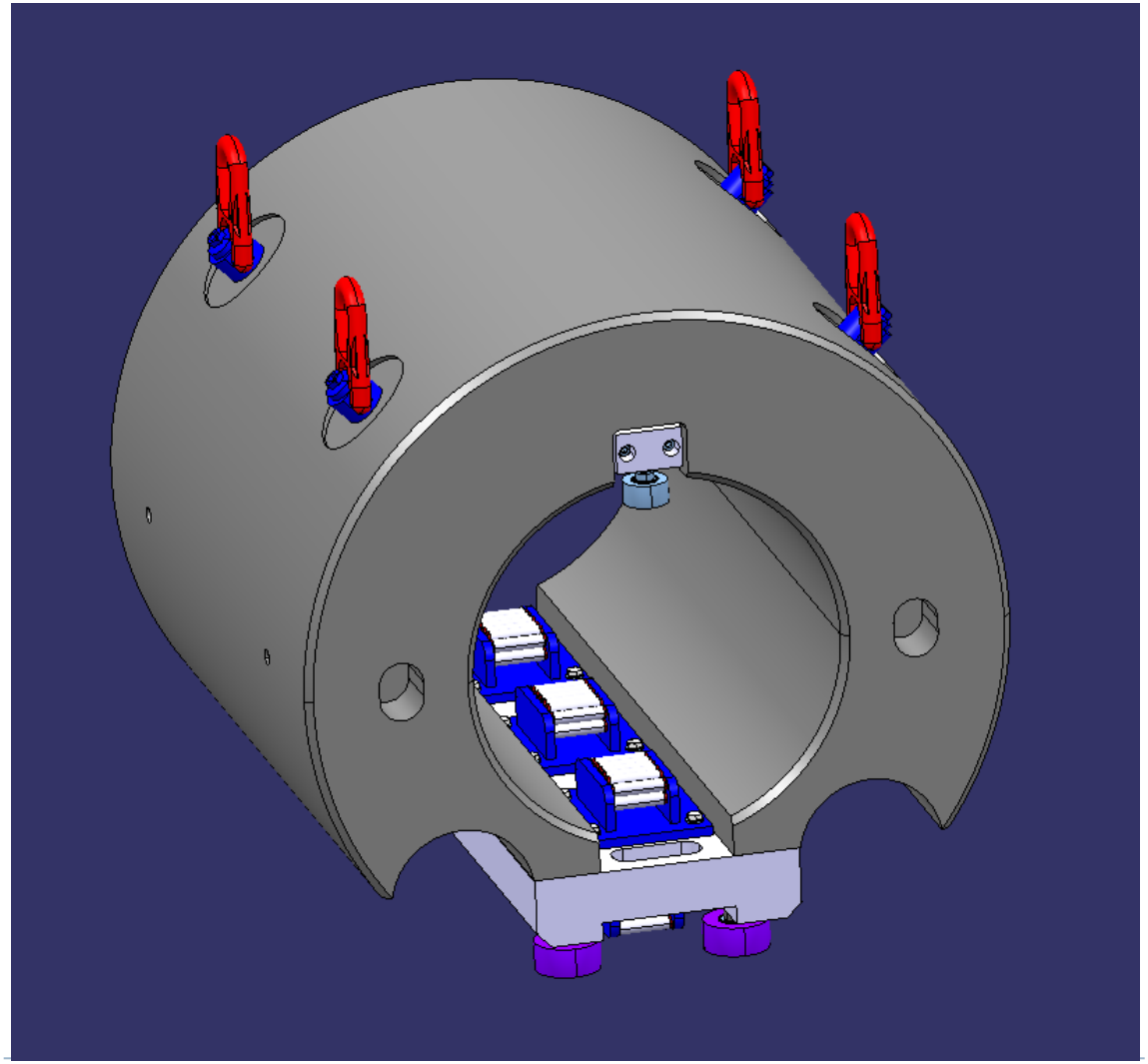




DUMP CORE

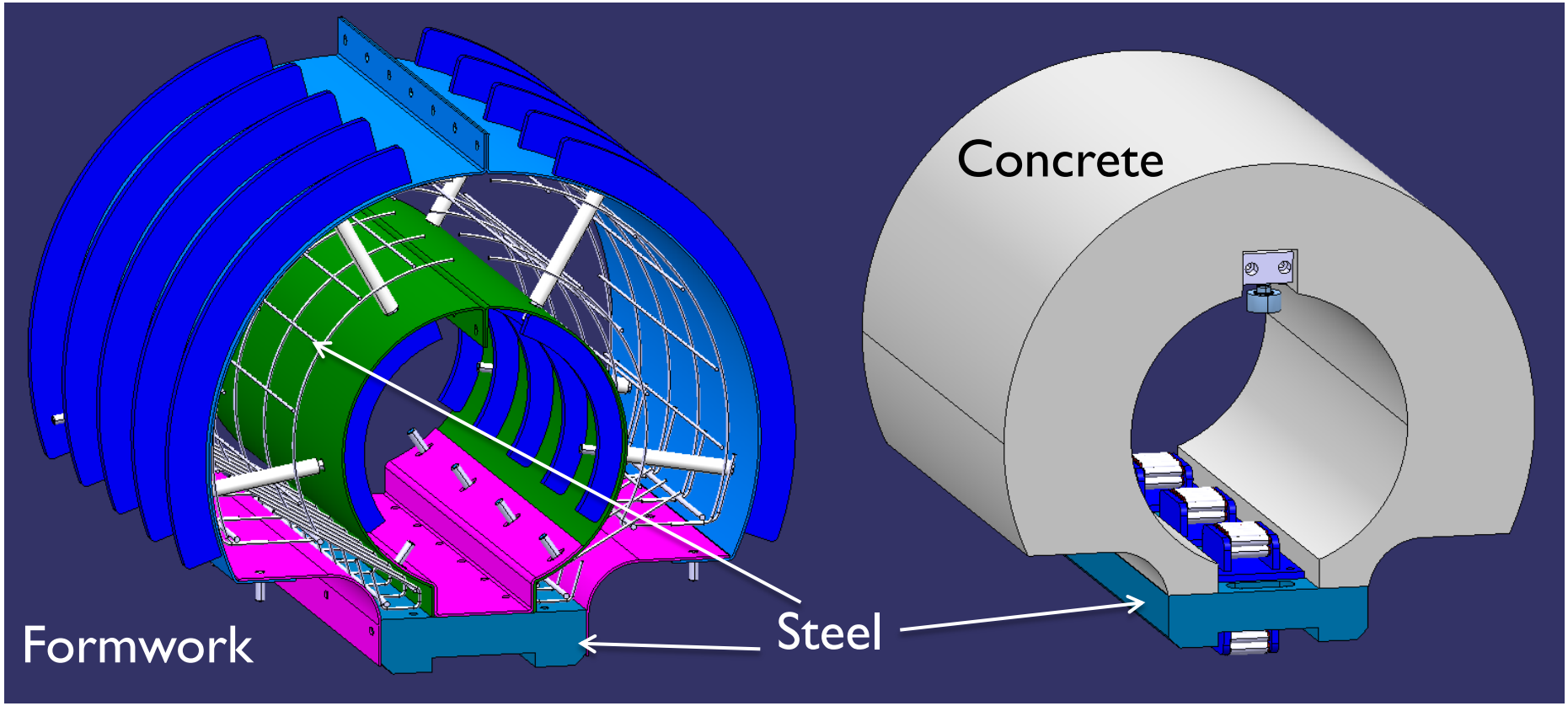
Detailed Design



Carbon Steel Shielding

Detailed Design

Concrete Shielding



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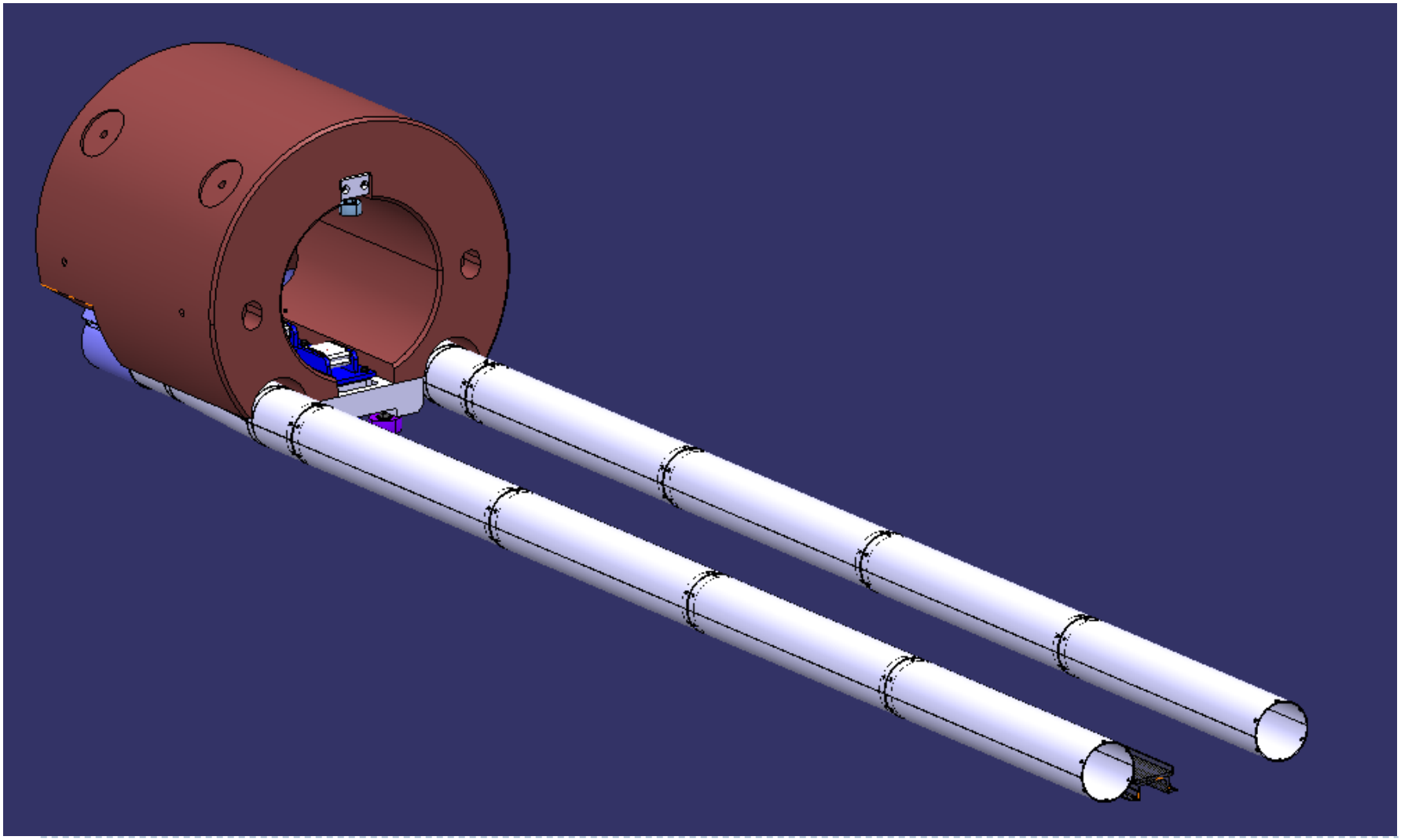

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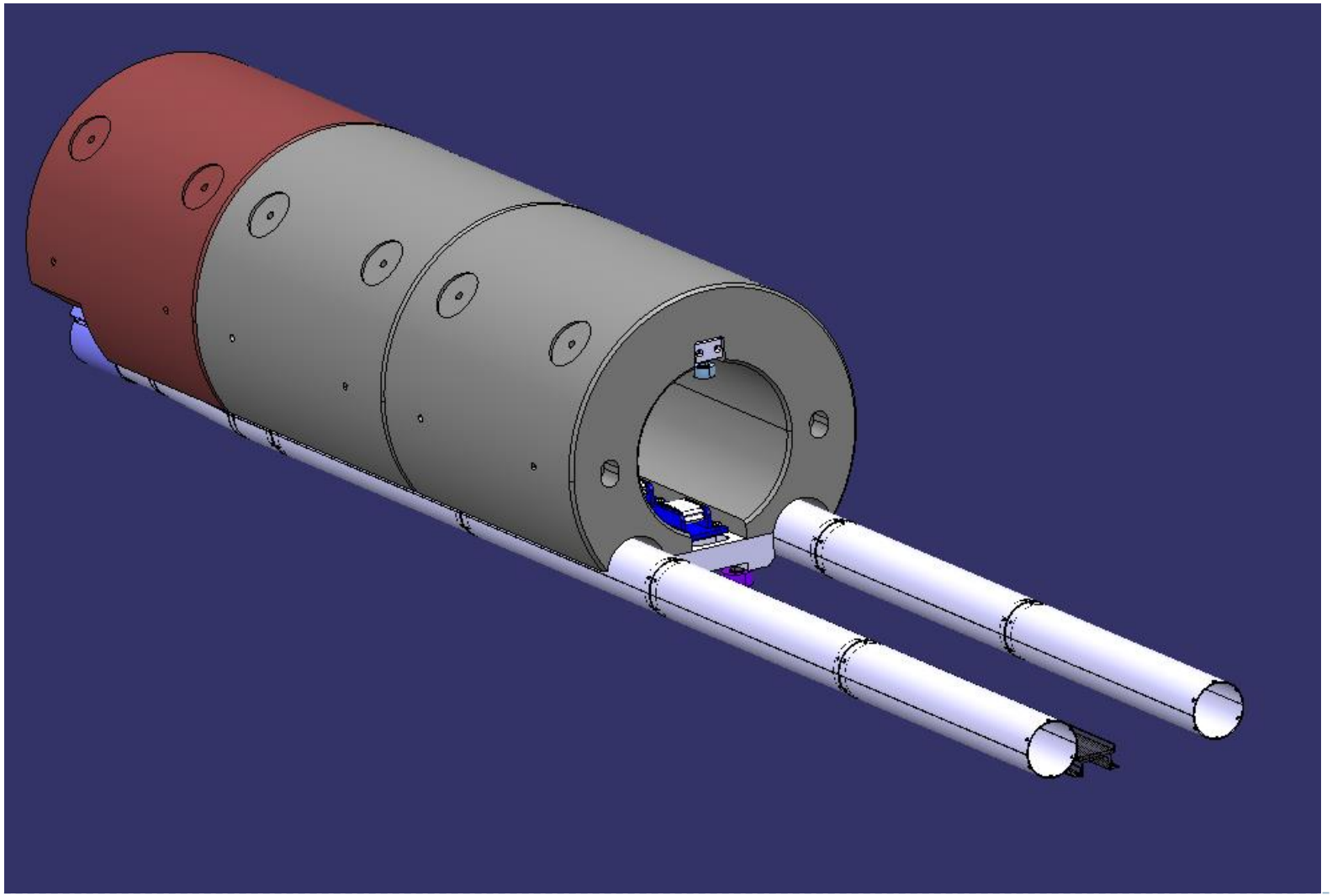

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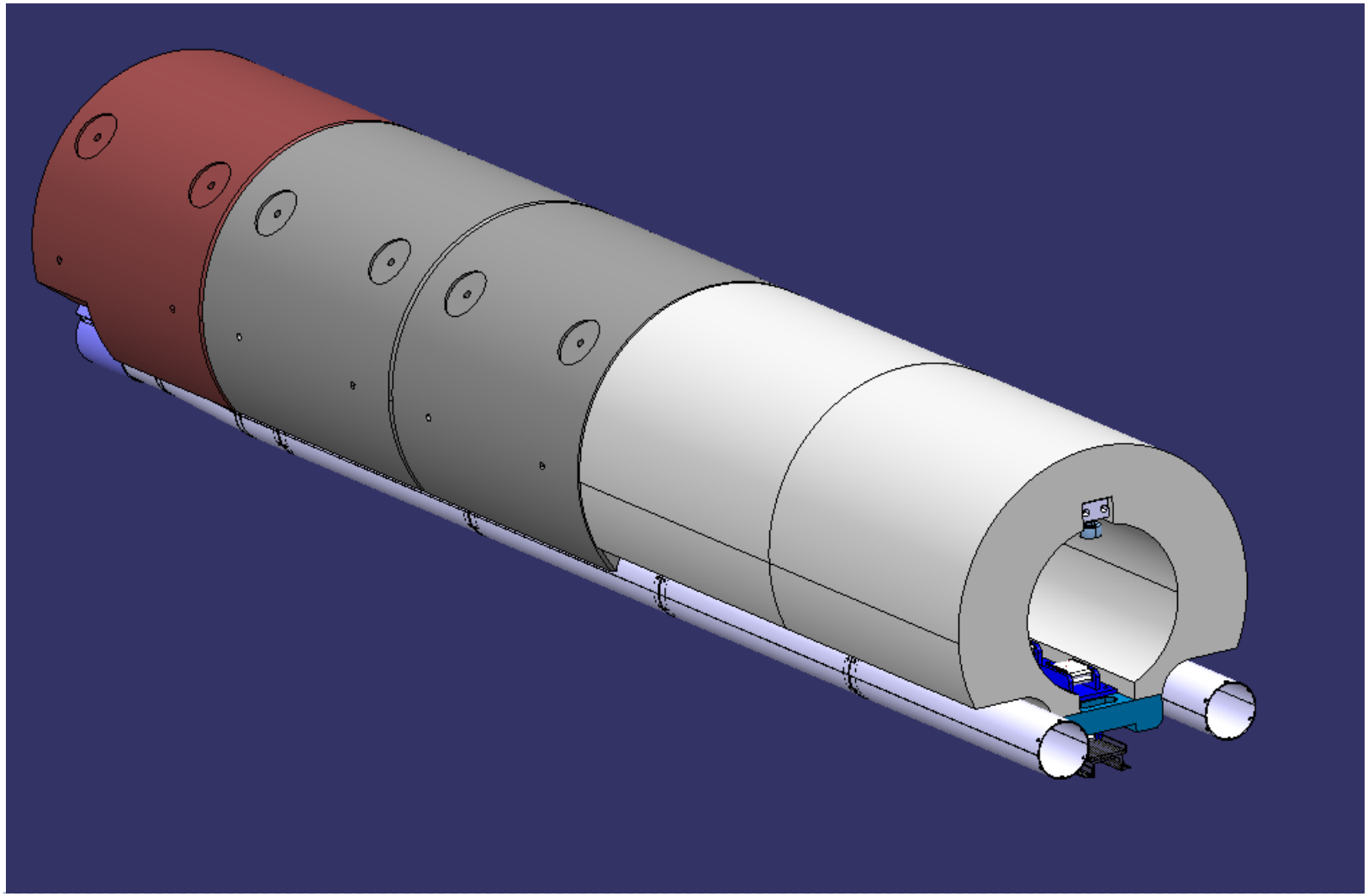

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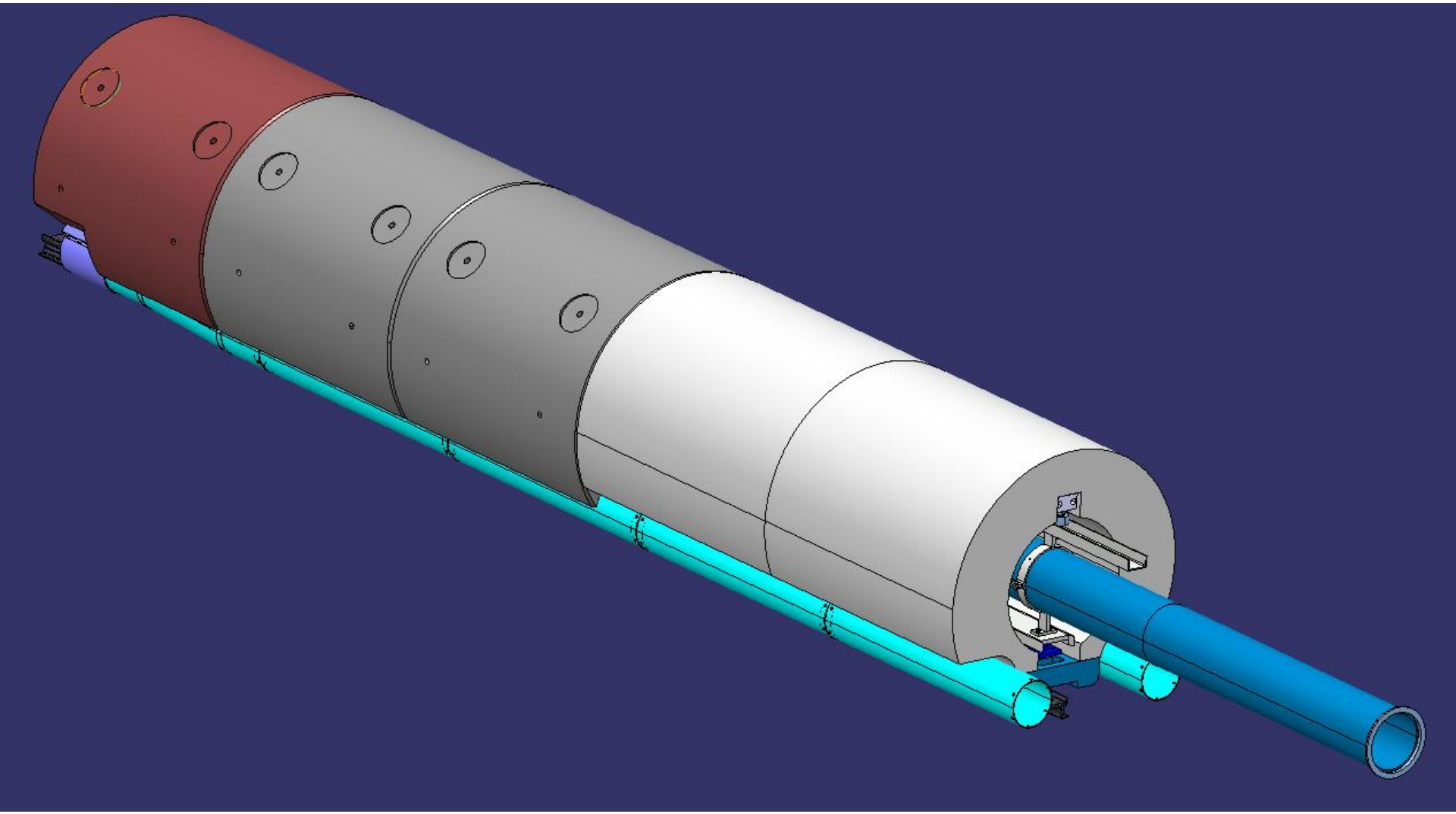

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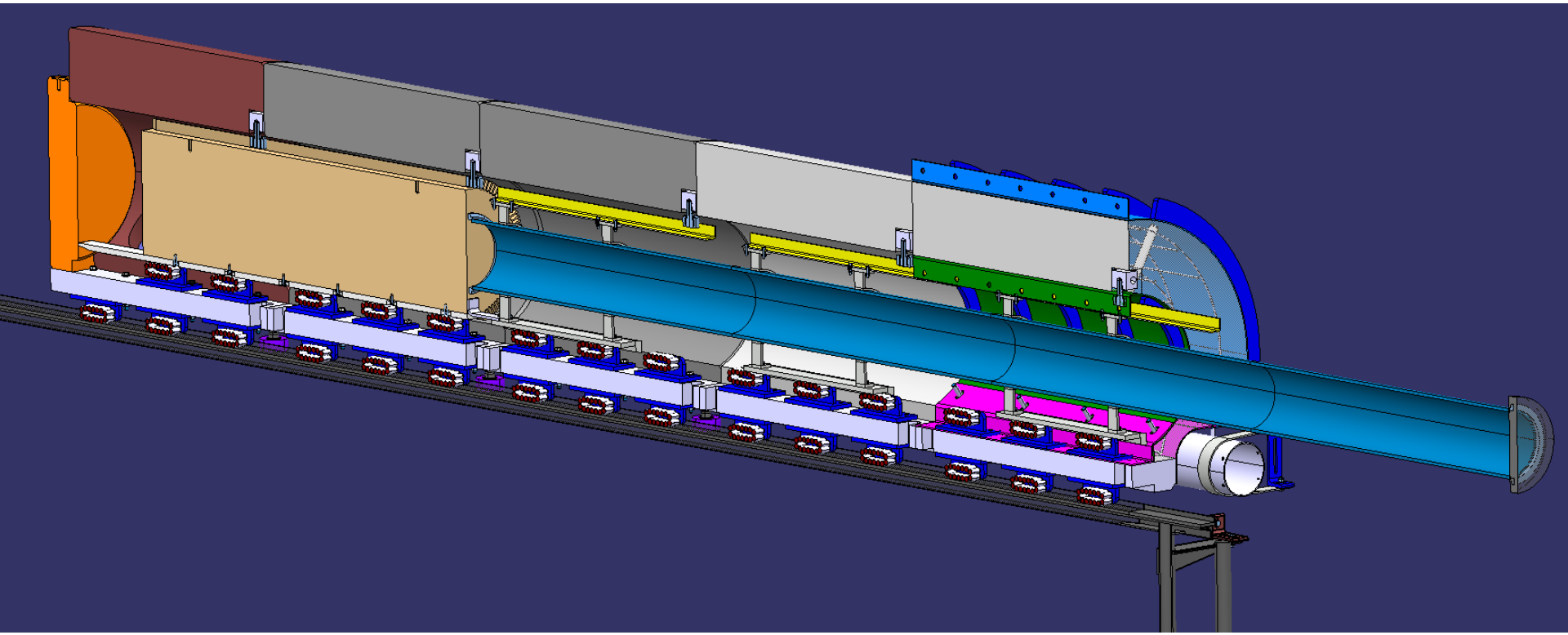

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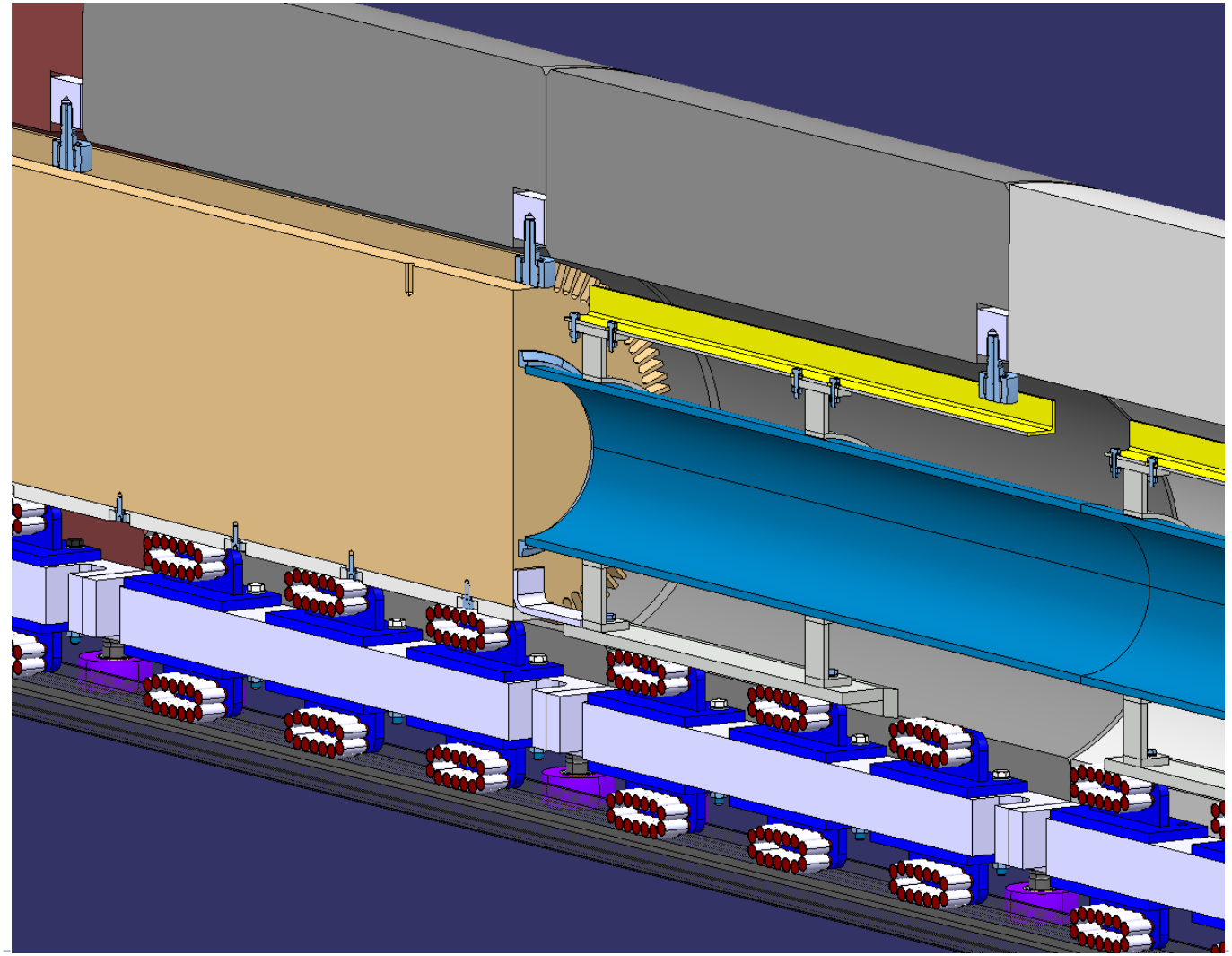


Monitoring

- Temperature of dump
- Temperature of air (inlet and outlet)
- Flow rate of air (interlocking)
- Possibility to perform endoscopy inspections

Progress Status

- Steel Shielding: In manufacture. Delivery June
- Concrete Shielding: Detailed design not finished.
- Dump: Research of suppliers due to large size.
- He Chamber: Order in April. Manufacture in-house.
- Cooling Ducts: Order in April (CERN Stores)

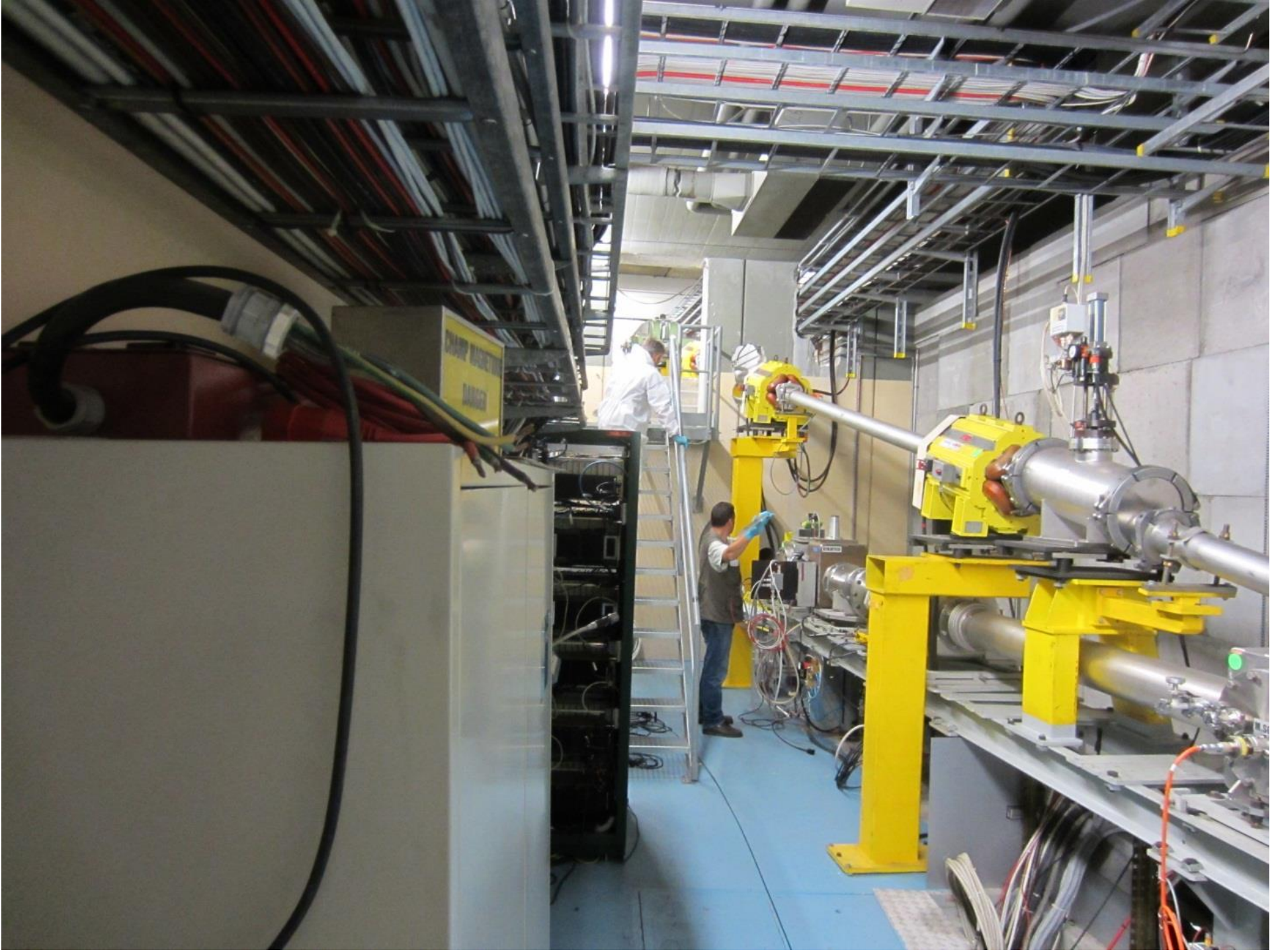
Goal: All parts manufactured by end of August.

Conclusions

- All parts designed according to specifications
- Robust, reliable materials and components
- Design near completion or finished for most elements
- Dump ordering delayed due to unforeseen manufacturing limitations. Research of alternatives under way.


BTM.MTV20
Danger Radiation

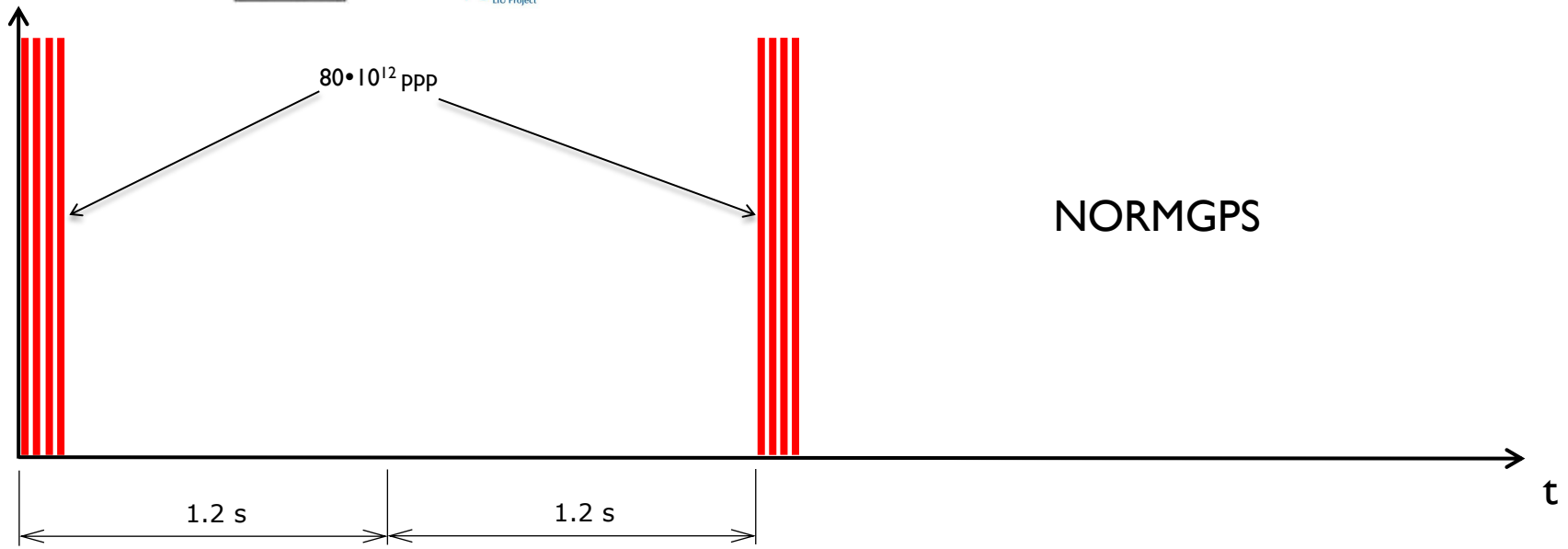

DANGER
BTM.MTV20
15/12/2011

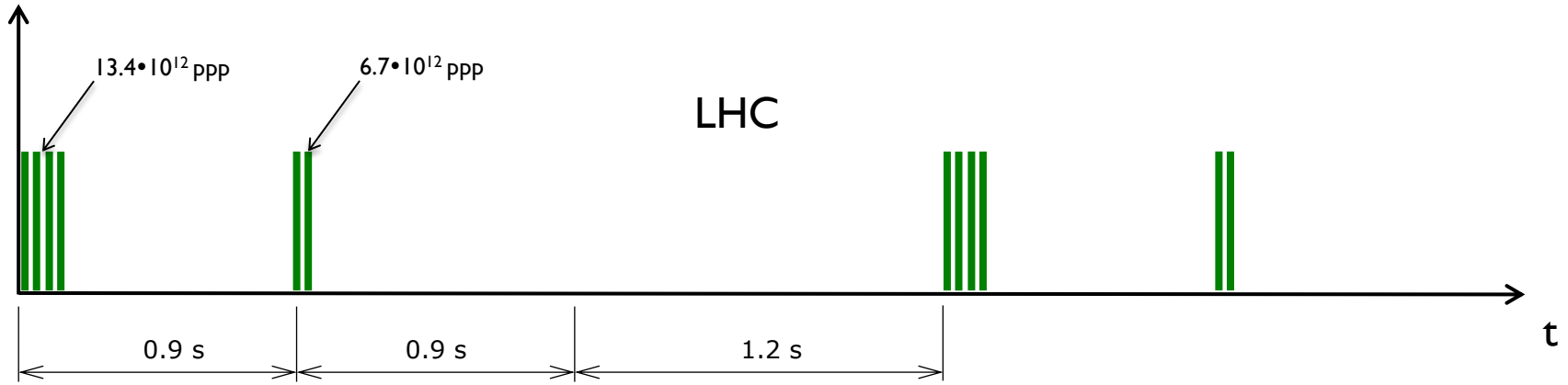


Beam Parameters

USER	Intensity [10^{13} ppp]	σ_x [mm]	σ_y [mm]	Beam Density $I/(\pi \sigma_x \sigma_y)$ 10^{10}
LHC25ns	1.3	5	6	14
CNGS-like	4.0	11	10	12
NORMGPS	8.0	13	13	15
TOF	4.0	11	10	12

Beam pulses


80•10^12 ppp
NORMGPS
1.2 s
1.2 s
t


13.4•10^12 ppp
6.7•10^12 ppp
LHC
0.9 s
0.9 s
1.2 s
t

Beam Parameters for Design

- **Design parameters (NORMGPS):**
  - Max beam intensity: 1E14 particles per pulse
  - Beam energy: 2 GeV
  - Pulse length: 0.94 μs
  - Pulse period: 2.4 s (1.2 s per cycle but dumped one out of two cycles)
  - Total Average beam power: 13.35 kW
  - Min beam size (1σ, H x V): 13 x 13 mm
  - Max beam size (5σ, H x V): 169 x 177 mm (@ 1 GeV)
  - Yearly dose: 5E19 particles
  - Life time: 25-30 years