Longitudinal integration of a cold collimator

January 25, 2013

Presented at ColUSM by D. Ramos on behalf of the Cold Collimator Feasibility Study Working Group

https://espace.cern.ch/CCFS/default.aspx

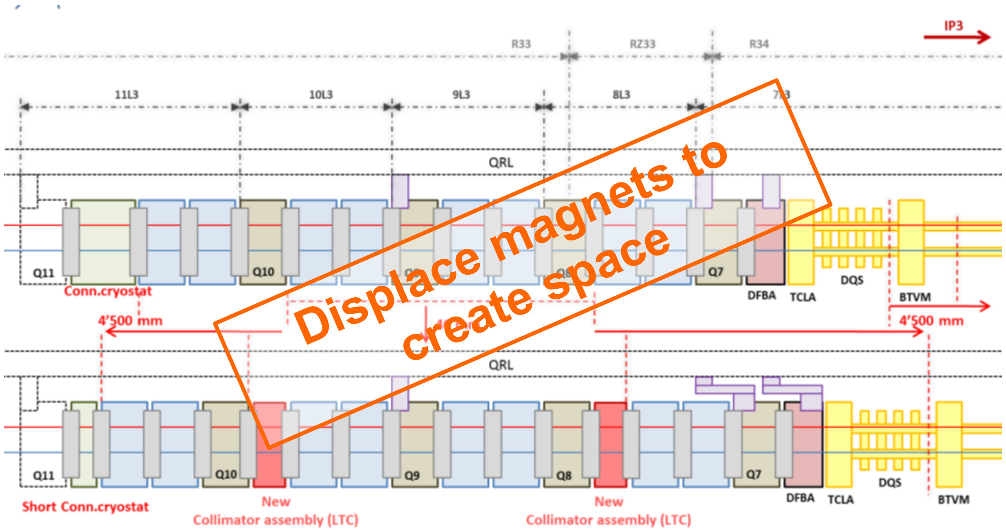
How can we integrate a collimator in the LHC continuous cryostat?

1. **Move magnets** and DFBA’s to create space for a cryogenic module and collimator

2. Create space by replacing LHC dipoles with shorter **high field magnets** (minimum impact on installed equipment)

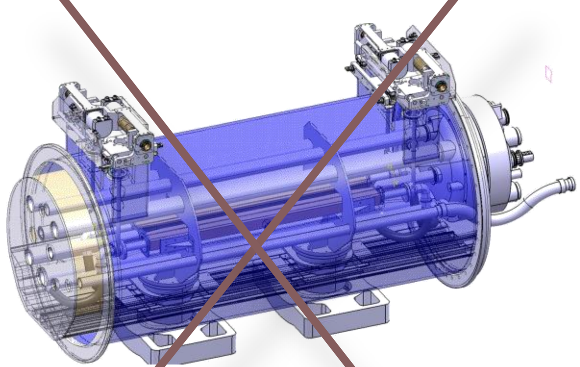
1. Move magnets and DFBA's to create space

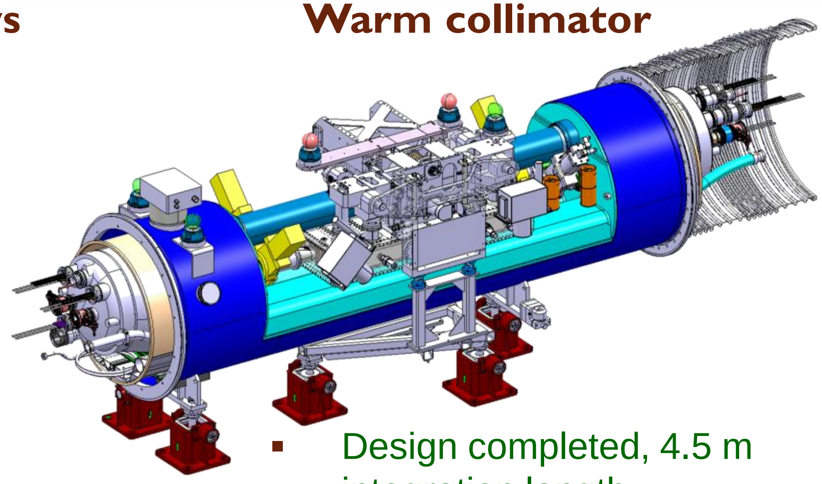
See last status report by V. Parma



Design started in 2010 aiming for installation in LS1 (schedulled for 2012 at the time)

Cold collimator vs **Warm collimator**

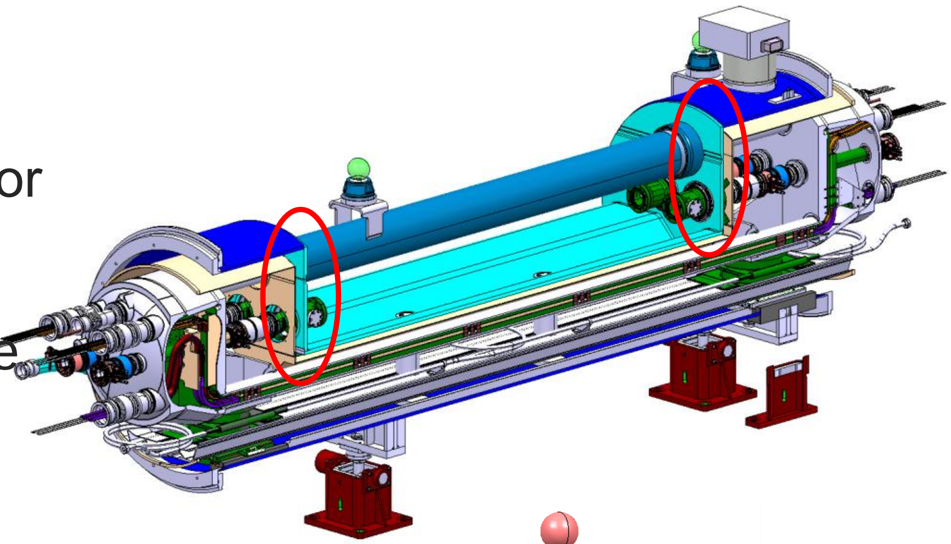




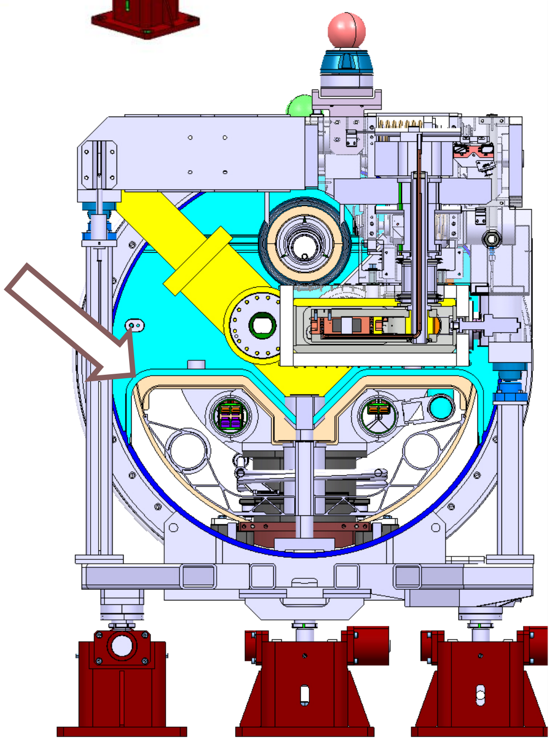
- ~~Potentially shorter but not feasible within schedule~~
- ~~Many open issues, possible showstoppers~~

- Design completed, 4.5 m integration length
- Prototyping of collimator actuation and cryostat

Why considering a cold collimator?

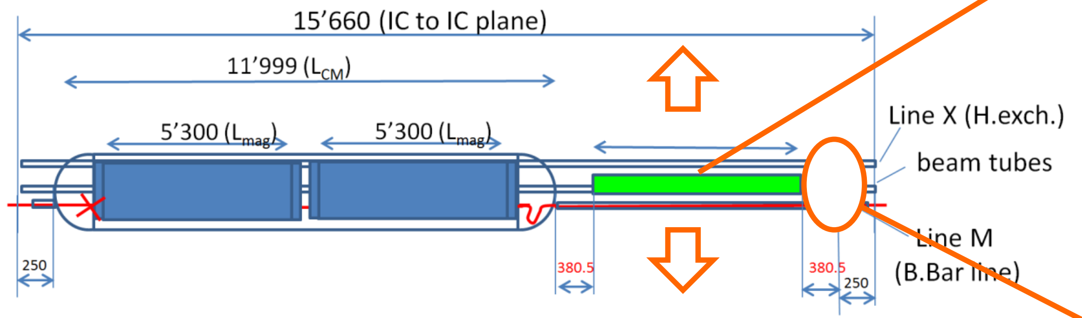


- Since it's cold, no need for cold to warm transitions, hence the overal installation length may be **shorter**.
- If placed in the insulation vacuum, possibly **more compact** in cross section.
- Could it be enough to get away without moving all those magnets and DFBA's?



2. Replace LHC dipole with high field magnet

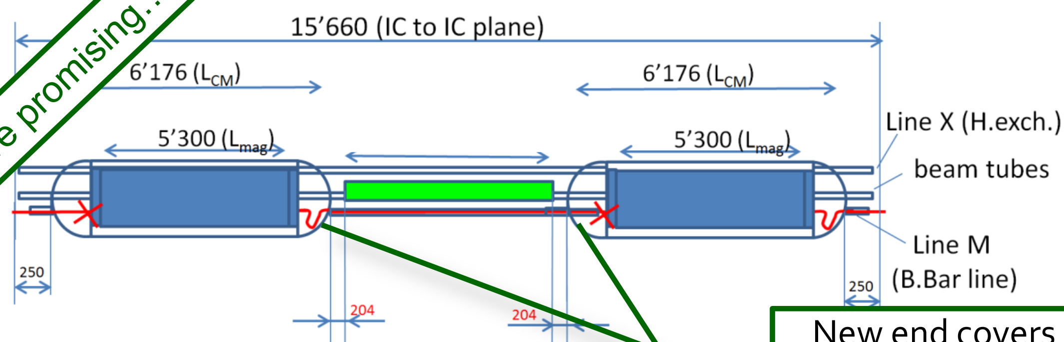
Possible layout options as presented last time:



Most likely not possible to fit netiher the collimator nor sector valves between standard bus bar lines. New routing needed to make vertical space for the collimator

Additional module needed to create a standard interconnect interface and thermal compensation. Interference with W sleeve.

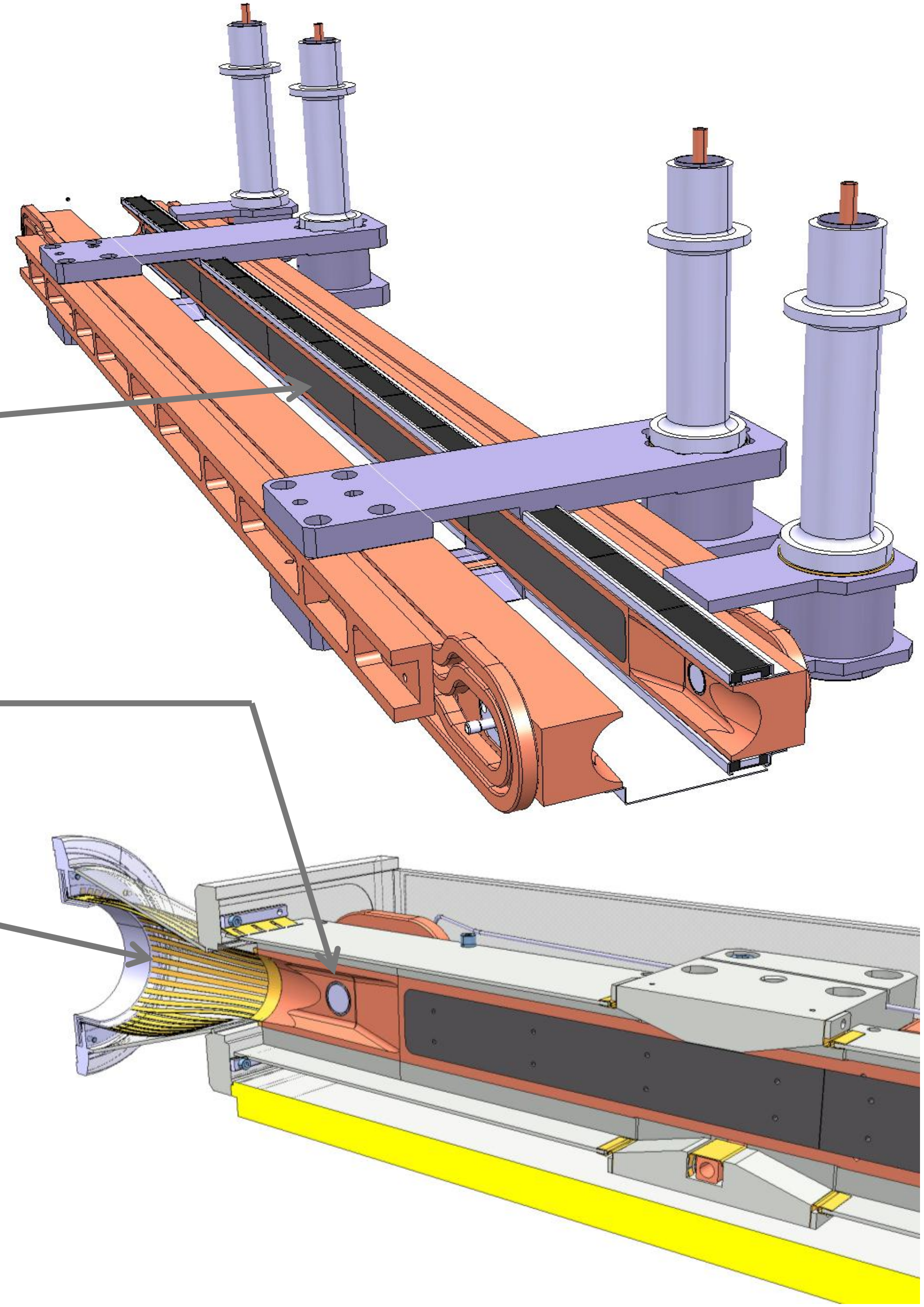
Looks more promising…



New end covers may be made to route the bus bars in a way to provide enough space for the collimator. The cost is loss of interchangeability betwen cold masses…

Collimator length

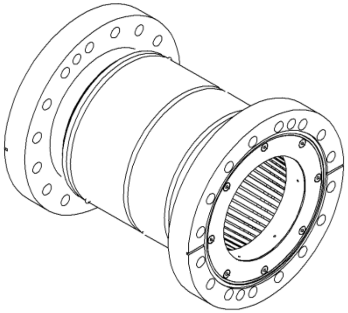
- 1000 mm tungsten active length: (*should it be re-evaluated?*)
- 2x100 mm for tapering and pick-ups
- 2x140 mm for RF transitions
- Total: **1480 mm**



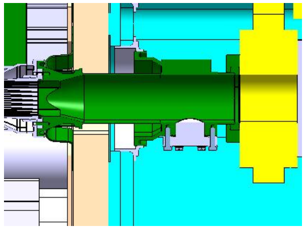
Mechanical and vacuum decoupling

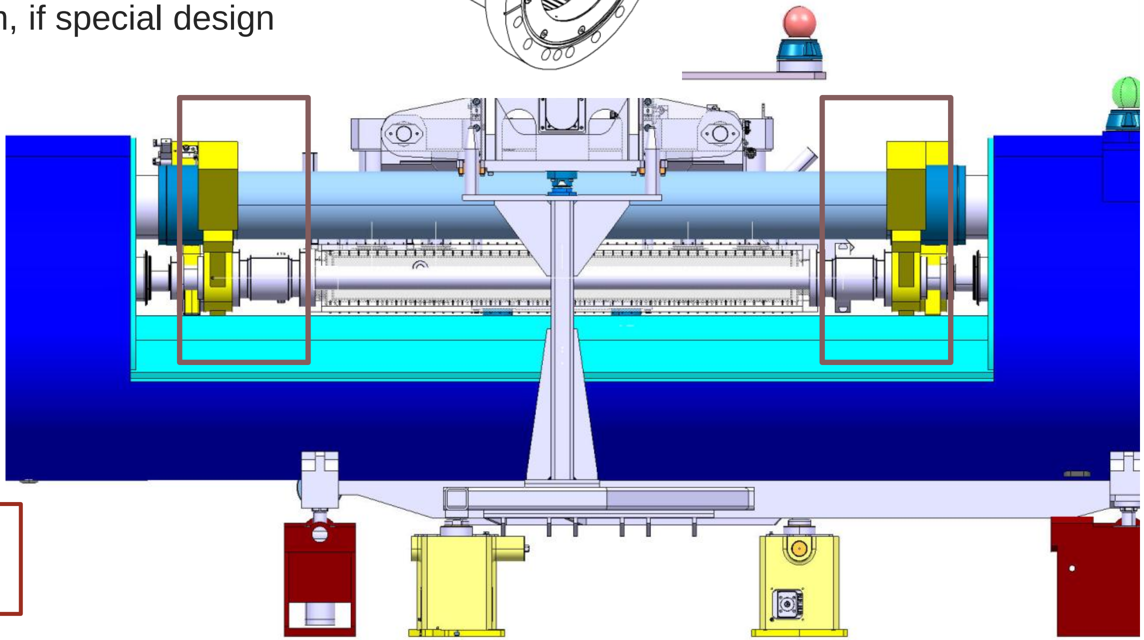
- RF shielded gate valves
  - For independence of vacuum operation
  - Must be staggered: 2x75 mm
  - Do not exist for low temperature operation! External actuator with long stem. Lets assume stationary wrt vacuum vessel.

- RF shielded expansion joint modules for:
  - Installation and removal
  - Thermal compensation
  - Independent alignment of the collimator:
  - Possibly down to 100 mm, if special design



- Port for RF ball plug-in module test after LHC warm-up: 100 mm

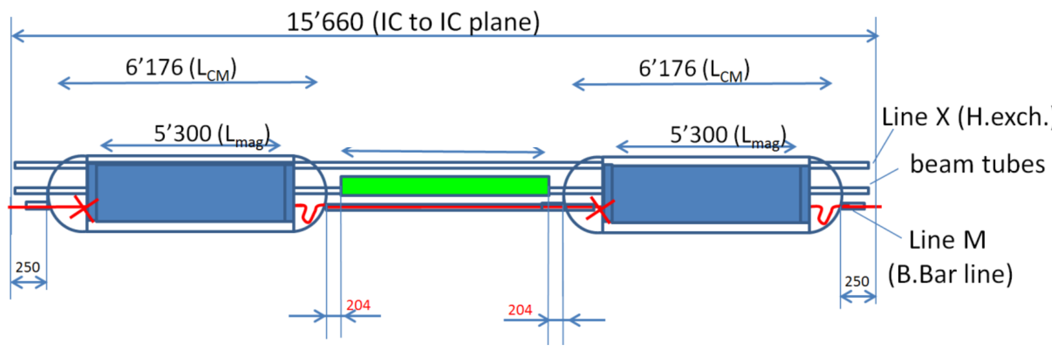




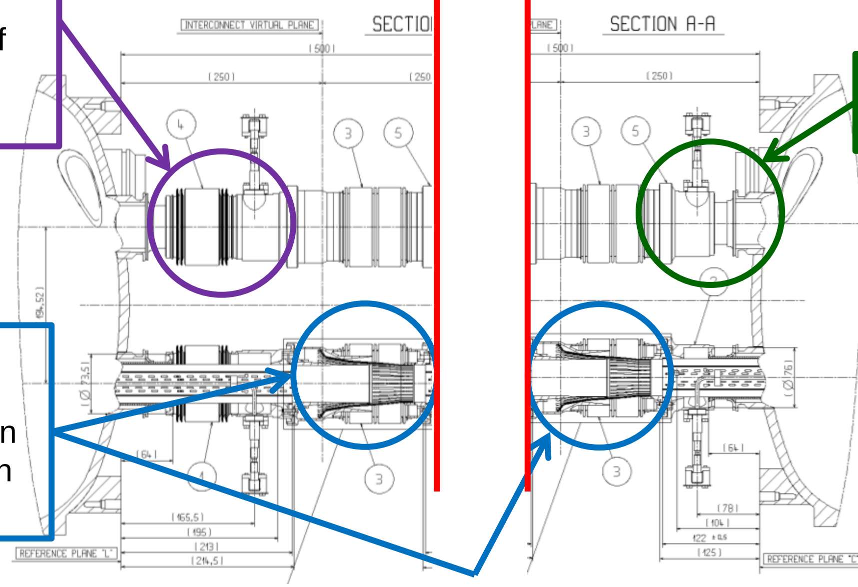
Total length
2x(100+2x75+100) = **700 mm**

Magnet cold mass and beam lines

Assuming cold bore diameter 50 mm



Sector valve interface fixed to the vacuum vessel



Beam screen termination with compensation for differential displacements: 213 mm if standard; eventually 181 mm if optimised with a short nested bellows

Beam screen termination, fixed side: 122 mm

RF bellows module for magnet thermal contraction: 165 mm if standard; 147 mm if new design with shorter stroke in proportion to cold mass length

“Standard” length scenario;
6176+213+165+165+122+ 6176 = **13017 mm**

If optimisation proves feasible:
6176+181+147+147+6176 = **12949 mm**

High field magnet + cold collimator length

	Length (mm)
Collimator	1480
Decoupling (bellows, sector valves, RF ball)	700
Magnet, beam screens, bellows	13017 (12949)
Interconnect	500
Total length	15697 (15629)
LHC dipole	15660
Margin	**-37** **(31)**

To think about…

- Very tight longitudinal integration: **already searching for the mm and haven’t even started the design!**
- In the **transversal plane** the task will not be easy either: volume for sector valves; additional cooling pipes and feedthroughs; mechanical feedthroughs, supports, thermal shielding…
- The impact on LHC machine availability: **introduction of moving parts into the LHC continuous cryostat**, **machine warm-up for interventions**
- **The amount of R&D**: beam vacuum dynamics; sector valves; collimator mechanics,vacuum chamber and cooling; support and alignment…
- Since vacuum operation and thermo-mechanics require anyway beam screen terminations and bellows on either side of the sector valves, adding cold to warm transitions represents about 2 x 165 mm, i.e **330 mm** (2% of 15660 mm…)