Longitudinal integration of a cold collimator

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Presented at CoIUSM 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

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

Design started in 2010 aiming for installation in LSI (scheduled for 2012 at the time)

Cold collimator vs Warm collimator

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

See last status report by V. Parma
Why considering a cold collimator?

- Since it’s cold, no need for cold to warm transitions, hence the overall 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:

- 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 between cold masses...
- Additional module needed to create a standard interconnect interface and thermal compensation. Interference with W sleeve.
- Most likely not possible to fit neither the collimator nor sector valves between standard bus bar lines. New routing needed to make vertical space for the collimator.

Looks more promising...
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

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

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.

Sector valve interface fixed to the vacuum vessel.

Beam screen termination, fixed side: 122 mm.

"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

<table>
<thead>
<tr>
<th>Component</th>
<th>Length (mm)</th>
</tr>
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<tbody>
<tr>
<td>Collimator</td>
<td>1480</td>
</tr>
<tr>
<td>Decoupling (bellows, sector valves, RF ball)</td>
<td>700</td>
</tr>
<tr>
<td>Magnet, beam screens, bellows</td>
<td>13017</td>
</tr>
<tr>
<td></td>
<td>(12949)</td>
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<tr>
<td>Interconnect</td>
<td>500</td>
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<tr>
<td>Total length</td>
<td>15697</td>
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<td></td>
<td>(15629)</td>
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<tr>
<td>LHC dipole</td>
<td>15660</td>
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<tr>
<td>Margin</td>
<td>-37</td>
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<tr>
<td></td>
<td>(31)</td>
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</table>
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…)