Machine Detector Interface for the HL (MDI)

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Project definition

- For this new phase of the LHC project (HL) we need a well organized interface between the LHC machine (and its services) and the experiments
- The experiments are very sensitive to backgrounds and radiation originating in the collisions and the accelerator. It took many years of optimization to arrive to the present design of the last 200 m of beam line, TAS/TAN region included
- When entering the new era of high luminosity, activation and the ALARA strategy related to it will be a new very important ingredient which need a new culture of engineering

- Good for the machine:
  - large aperture
  - quadrupoles close to IP
  - possibility if proven necessary of an early separation scheme
  - excellent vacuum conditions
  - components mechanical stability
  - radiation tolerance or hardness for all active components in the beam
- Good for the experiments:
  - Smaller central beam pipe, maximal angular acceptance
  - Beam pipes made out of light material (Al, C, Be) to control backgrounds and activation
  - Beam operation at 25 ns, luminosity leveling
  - Symmetrical material distribution around IP
  - Precise survey of the various components
  - Possibility of a major re-alignment of the last ~300 m of beam line in case of major movements
  - Decoupling of the experimental caverns and the tunnel, point of view of safety, ventilation, radio protection and magnetic fields

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requires overall optimization

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Common activities or needs

- Optimize beam pipes and vacuum. Remove all Fe components in favor of lighter materials (at least Al)
- Redefine the various apertures as a function of the new quadrupoles: TAS and experimental beam pipes
- Optimize the collimation and machine protection systems for safe operation of the detector. Analyze all possible failure scenarios and provide estimates for beam-gas and beam halo backgrounds
- Re-design the TAS and the region in front of the last quadrupoles, also in the optics of ALARA
- Establish methods and procedures for opening, closing and eventually re-aligning the IR region
- Improve, upgrade the beam diagnostic and monitoring in the IR region
- Re-optimize all shielding elements around the beam pipe in the detector forward region including the TAS
- Re-optimize the TAN (absorber and detector region)
- Re-optimize the experimental region from the point of view of electron cloud over the last few hundred m of beam line
- Re-optimize the ventilation aspects of the tunnel regions around the IRs, to fully decouple machine and experiment safety (i.e. the region around Q1-Q2 is today critical)
- Revisit the needs of the experiments for additional detectors (forward physics) in the tunnels
- Re-evaluate the need of LHCb and ALICE for all the points above. Not clear what is needed!
- Provide, organize and monitor resources for all the projects above

ATLAS EXPERIMENT

Past and ongoing activities

1) Central beampipe design, manufacture and installation: including optimisation of dimensions for physics and for machine aperture

Endcap & forward beampipe & vacuum design, manufacture & installation, including optimisation of dimensions for physics and machine aperture:

Experiments, TE-VSC, EN-MEF, LEB working group

2) Simulation maps of received dose, activation and dose rate in the experimental area.
Simulation of beam-induced backgrounds and their influence on trigger and physics capability

Experiments, DGS-HSE, BE-ABP, LBS working group

3) Specialised beam condition monitoring in the experimental area and exchange/development of BI technologies with LHC.

Experiments, EN-MEF, BE-BI

4) TAS and forward shielding design and construction, including interface shielding between the cavern and the tunnel including remote alignment and remote opening procedures and fire/ventilation compartmentalisation.
(For HL-LHC, this will include optimistion of L*):

Experiments, EN-MEF, LTEX working group

5) Mechanical structures in the forward region: design and construction consistent with physics objectives, beampipe support, shielding requirements and rapid opening requirements (with beampipe in place), taking account of ALARA constraints.

Experiments, EN-MEF, LTEX working group

6) Survey and remote position monitoring for initial installation, opening/closing and movement under magnetic field, including application/development of new techniques or instruments, taking account of ALARA constraints:

Experiments, BE-ABP.

ATLAS EXPERIMENT

Past and ongoing activities

7) Application and Development of improved sensing techniques for temp, field, humidity, stress, radiation dose-rate and integrated dose under harsh conditions.

Experiments, EN-MEF, LTEX working group

8) Remote handling gear for installation of personnel protection shielding, access to activated detectors and installation of heavy ion physics detectors with beampipe in place and at vacuum. (eg ZDC, CASTOR), taking account of ALARA.

Experiments, EN-MEF, LTEX working group

9) Simulation of magnetic fields and forces in the forward regions (and extending into the nearby LSS) design and construction of magnetic shielding.

Experiments, TE-MSC

10) Exchange of luminosity, background, status and other monitoring data between experiments and LHC

Experiments, LBS working group

→ All these relations ad activities must be protected and avoid to restart from zero

Possible additional goals:

- Integrated simulations: to allow to study and optimize optics, geometry, background and radiation together, with a full description of the geometry of the IRs and beginning of the arcs

- Benchmarking simulations and improving monitoring and corrections using the actual LHC

MDI definition

- MDI as a sub-project of the HL-LHC project and probably also of today's LHC project
- It reports to the HL-LHC steering group
- It operates through a dedicated steering committee where all activities are represented
- It define where necessary ad-hoc working groups for specific activities and issues
  - Experimental beam pipe, TAS/TAN engineering, survey activities, beam monitors, …
  - Link to existing groups : collimation, optics and backgrounds simulation, ….
- It promotes R&D in fields like : beam monitors, vacuum chambers, survey technologies, radio-protection, simulation, ….
- It allows continuity for the works/relations already ongoing
- Resources for MDI are organized as for any other HL-LHC project