Introduction and Requirements

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for the collimation team

Basic constraints

- Have a collimation system produced and **installed for 2007**, with a **reasonable cost**.
- The system must be a **robust and flexible tool** for operation.
- **Nominal performance** must be achievable.
- The layout of cleaning **insertions must be finalized** by the end of 2003.

Collimation project

- Started in last October.
- Team and individual responsibilities set up by January.
- **Half a year of intense work** to arrive at a coherent proposal.
- Final **consensus** was built in the collimation team over the last month (collimation WG, collimator project meeting, ABP+ATB meetings).
- Proposal is presented now, as we must **enter into the detailed engineering phase**.

Ideas/comments/work by many different people

- E.g. 23 persons presented their work at the CWG or CPM in 2003 (see web).
- Strong support from **AB/ABP, AB/ATB, AB/BDI, AB/BT, AB/CO, AB/OP, AB/RF, AT/MTM, AT/VAC, EST/ME, MPWG, TIS/RP** + collaborators at **IHEP** and **TRIUMF.** Thanks for the support!
- Proposal refers to work mostly done in AB/ABP, AB/ATB, AB/BT, AT/VAC, TIS/RP groups (1000's of CPU and "man" hours).
- Not one revolutionary idea but **many ideas in an evolutionary process**.
- The result has been achieved by the **whole team** and would not have been possible without relying on the past work.

Driving beam impact requirements

450 GeV:

- **1 full p batch** (4 PS batches) on 1.2 mm × 1.2 mm.

7 TeV:

- **8 p bunches** over 1 mm × 0.2 mm (irregular dump after factor 2.5 improvement due to AB/BT efforts). Severe: 2 full Tevatron beams.

- **4×10^{11} p/s** for 10 s, **8×10^{10} p/s** continuously in 200 nm surface. 10 times less for secondary collimators. ***(slow case)***

Note:

- Only one failure at a time is assumed.
- Almost any jaw can be hit (keep flexibility for the LHC tune).
- Transfer line collimation protects the LHC arcs but not always the LHC collimators.
- Corresponding requirements defined for ions.
- Collimators should withstand these impact scenarios (expected problems, not worst-case: collimators will be destroyed in worst case: dump failure).

Choice of appropriate materials/cooling! (V. Vlachoudis + O. Aberle + N. Hilleret).

Irregular and regular scenarios

* Multi turn failures are not included, as they should result in beam dump before the beam impacts on collimators.
* Full failure of beam dump is not included ($0.01y^{-1}$). Collimators will be destroyed.

Location	Energy	Plane	Type	Impact	Frequency
IR7	.45 TeV	H V	Large injection oscillation from transfer line, SPS, injection elements.	**1 full batch**	unknown
	.45 TeV	V	Kicker flash over.	0.8 batch	0.1 y-1
	.45 TeV - 7 TeV	H	Asynchronous dump (number for 7 TeV)	5 bunches	≥ 1 y-1
	.45 TeV - 7 TeV	H	Dump single-module prefire (number for 7 TeV)	**8 bunches**	≥ 1 y-1
	.45 TeV - 7 TeV	S	Fraction of H/V impact for similar cases. Skews are often not fully skew. 7 sigma S can catch above 8.5 sigma for secondaries?	fraction of above	see above
	.45 TeV - 7 TeV	H V primary	Drop in beam lifetime to 0.2 h for 10s.	4e11 p/s	0.5 d-1
	.45 TeV - 7 TeV	H V primary	Drop in beam lifetime to 1 h for longer times.	0.8e11 p/s	1 d-1
	.45 TeV - 7 TeV	H V secondary	Drop in beam lifetime to 0.2 h for 10s.	0.4e11 p/s	0.2 d-1
	.45 TeV - 7 TeV	H V secondary	Drop in beam lifetime to 1 h for longer times.	0.08e11 p/s	0.5 d-1

Location	Energy	Plane	Type	Impact	Frequency
IR3	.45 TeV - x TeV	H	Irregular dump can affect momentum collimators when they sit at 8/9.3 sigma (TCDQ at 10 sigma)	1-2 bunches?	≥ 1 y-1
	.45 TeV	H	Large injection oscillation from transfer line, SPS, injection elements.	1 full batch	unknown
	.45 TeV	H	Loss of 5% uncaptured beam at start of the ramp (within 1 s). This is 1 MW for this 1 s.	1.5e13 p/s	2-3 d-1

Still trying to identify a few safe locations for metallic collimators.

Other requirements

- **Mechanical tolerances** can be met (~ 25 μm surface flatness, …)
- Collimator opening **gap can be guaranteed** at all times (error < 50 μm)
- Collimators can be **moved by small steps** (~ μm, ~μrad)
- Settings must be **reproducible** to < 20 μm
- **Vacuum** is manageable (for C: T<50˚C, small surface, good outbaking)
- **Local e-cloud** is manageable (installing clearing electrodes, solenoids?)
- Collimators can be **serviced and exchanged** in high-radiation area
- **Downstream equipment** is OK for considered cases
- **Reliability** must be sufficiently good

- **Impedance** is manageable (~ 110 MΩ/m) for the overall system
- **Operational tolerances** (orbit/beta beat) are manageable
- **Cleaning efficiency** is sufficient
- **Loss rates** are acceptable (no quenches, acceptable background)

Choice of appropriate technology (O. Aberle) and impedance (F. Ruggiero).

Presentations

Several 10 min presentations on particular aspects of LHC collimation followed by the proposal:

- Energy desposition in different materials (V. Vlachoudis)
- Mechanical robustness, choice of material, and mechanical design (O. Aberle)
- Vacuum issues for the collimator jaws (N. Hilleret)
- Impedance issues (F. Ruggiero)
- Proposal (R. Assmann)