Plan for future Collimation studies

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for the FLUKA Team

CWG 7/7/2006

Outline

- FLUKA team
  - Composition
  - Available manpower
    - July-December
    - 2007
- Calculations for Phase I
  - Completed
  - Ongoing
  - To be done
  - "Brennan"
- Phase II
- Next iteration

FLUKA team: composition

Alfredo Ferrari (staff)
Vasilis Vlachoudis (staff)
Markus Brugger (staff ***new***)
Francesco Cerutti (staff ***new***)
Mario Santana-Leitner (fellow ***end***)
Lucia Sarchiapone (fellow)
Marco Mauri (fellow, ***from december 1st***)

I would like to thank

Mario

and

Matteo

For the huge amount of work and enthusiasm they put into all collimation related issues in the last 2 ½ years and wish them the best for their future carriers at SLAC and CERN respectively

FLUKA team: manpower available

	July-December 2006	2007
Alfredo Ferrari	25%	25%
Vasilis Vlachoudis	20%	25%
Markus Brugger	50%	80%
Francesco Cerutti	30%	50%
Mario Santana-Leitner	0%	---
Lucia Sarchiapone	100%	100%
Marco Mauri	0%	80%
Total	225% (11.25 man months)	360% (39.6 man months)

Alfredo and Vasilis are also heavily involved in other activities connected with LHC (heavy ion physics and collimation, DPA, energy deposition etc)

FLUKA team: recent topics completed

MBW, MQW5 and Passive Absorbers:

- Several configurations and materials tested and compared in terms of dose in MBW's and MQ5 (documented)
- ***MISSING!*** Refined iterations with cooling channels in passive absorbers ***(2-3 weeks depending on geometry complexity)***
- ***MISSING!*** Energy deposition in support of MBW's to estimate deformation ***(2-3 weeks depending on geometry complexity)***

BLM's

- Radiation effects on the optical fibres for BLM's (Matteo)
- Deposited energy in BLM's and cross-talk (documented)
- Energy spectra. (documented)
- ***PENDING!*** Phase space of particles entering the BLM's ***(1-2 weeks + a lot of CPU, does it really make sense??)***

Collimators:

- ✓ Accident scenario with 60 cm long primary collimators at IR7 (Andy. Documentation?)
- ✓ Shock heating of water in collimators (heat map inserted in documentation)
- ✓ Heating of front and end plate in collimator tank. YES, heat map was provided for the collimator. (To be included in reports)
- ✓ Heat load to springs in the collimator jaws: Equilibrium temperature & radiation resistance YES, it was given. (To be included in reports)

FLUKA team: topics completed (2ND part)

- Ozone Production at IR7 (Andy)
- Radiation in the RR's of IR7 and required shielding (Done, Katerina)
- Energy deposition to vacuum pipes in complete insertions.
  - Map computed in certain locations. (Documentation in progress...)
  - Heat in flanges was provided. (Documentation in progress...)

Study of other scenarios:

- ✓ Dose in MQW and heat in Q6 at injection energy. ***IT NEEDS CHECKING!!*** (TO BE PRESENTED in next CWG meeting) ***(it could require up to 2-3 weeks for proper checking and consolidation)***
- ✓ Commissioning failure scenarios
  - All TCS retracted. DONE. (TO BE PRESENTED in next CWG meeting)
  - ***PENDING!*** Other scenarios
- ✓ Beam 2.
  - Radiation in the straight section done (Katerina)
  - ***PENDING!*** All machinery must be adapted for arc + upgrade changes ***(1-2 months minimum of work including debugging, plus time for running and analyzing results, 1-2 extra months?)***
- ✓ Energy balance (TO BE PRESENTED in next CWG meeting)

FLUKA team: ongoing activities ("Brennan" excluded)

- Documentation of IR7 activities: ***UNDER LAST EDITING ITERATIONS***. (***1.5 Months required***) Now adding:
  - commissioning cases
  - injection results
  - power deposition maps in collimators, flanges, pipes...
- BLM studies
  - Individual events (**TO BE PRESENTED in next CWG meeting??**)
- Injection energy:
  - Verification of results and scripts (***particularly optics)***
- TCDQ/S studies (Lucia, see later)

Examples of result summaries (Mario next CWG)

1	2	3	4	5	6	7	8	9	
E[GeV] beam / TCS	**7000** **ON**	7000 ON	7000 **OFF**	7000 ON	7000 **OFF**	**450** ON	450 **OFF**	450 OFF	1 2
TCL	**OFF**	**ON**	ON	ON	ON	ON	ON	ON	3
Beam	**Hori**	Hori	Hori	**Vert**	Vert	**Hori**	Hori	**Vert**	4
MQ6	0.77	1.4	29.9	0.3	39.3	~0.1	2.5	5.7	5
MQ7	*0.46*	*0.4*	*2.4*	*~0.1*	*2.6*	*~0.01*	*0.3*	*<0.4*	6
MBA8	0.10	0.2	1.7	~0.5	2.6	~0.09	0.1	<0.05	7
MBB8	0.32	0.2	0.5	~0.1	~1	~0.01	<0.05	~0.02	8
MQ8	*0.88*	*1*	*0.4*	*~0.01*	*~5*	*~0.03*	*~0.05*	*~0.03*	9
MBA9	0.60	0.60	0.8	0.35	1.5	~0.02	~0.03	~0.03	10
MBB9	0.54	1	1.0	~0.5	1.5	~0.01	~0.03	~0.05	11
MQ9	*0.35*	*1.8*	*2.4*	*~0.4*	*1.7*	*~0.01*	*~0.03*	*<0.03*	12
MBA10	0.08	0.4	0.3	~0.03	~0.5	<0.01	<0.02	<0.03	13
MBB10	4E-3	~0.03	~0.1	~0.3	~0.02	~1E-3	<0.02	<0.03	14
MQ10	*0.16*	*0.5*	*0.3*	*~0.02*	*~0.5*	*~0.01*	*~0.03*	*<0.03*	15
MBA11	0.37	0.9	1.3	0.2	1.8	~5E-3	~0.02	-	16
MBB11	0.38	1.0	1.02	<0.6	2	~5E-3	~0.02	~0	17
MQ11	*2.56*	*5.0*	*3.8*	*3.5*	*≈7*	*~0.02*	*~0.03*	~0	18
MBA12	0.10	~0.4	~0.3	0.14	0.7	~1E-3	~0	~0	19
MBB12	1E-3	~5E-3	<0.1	~0.02	~1E-3	~0	0	~0	20
MBC12	-	~0	~0	~0.005	0	~0	0	~0	21
MQ12	*0*	*0*	*0*	*0*	*0*	*0*	*0*	~0	22

Table 2: Peak energy densities $[\frac{mW}{cm^3}]$ in the DS for injection and top energy (*row 1*), with horizontal or vertical beam losses (*row 4*). Five *active* absorbers (**TCL**), $A6_vC6_hE6_vF6_hA7_h$ (chosen in sec. 2, 3) are on or off (*row 3*) with the *passive* absorbers (**PA**, see ch.??). *Row 2* distinguishes a failure mode where the TCS are retracted. The loss rate was $4 \cdot 10^{11} \frac{p}{s}$.

1	2	3	4	5	7	8	8	
TCPjaws / **TCLjaws**	**20 cm** **Cu**	20 cm Cu	20 cm **Cu+W**	**60 cm** Cu+W	60 cm Cu+W	60 cm Cu+W	60 cm Cu+W	1 2
TCS	**ON**	ON	ON	ON	ON	ON	**OFF**	3
5thAbsor.	$B7_v$	$B7_h$	$A7_h$	$A7_h$	$A7_h$	$A7_h$	$A7_h$	4
PA:	**OFF**	OFF	OFF	**ON**	ON	ON	ON	5
Source: TC.	**P+S**	P+S	P+S	P+S	**L**	**P+S+L**	**P+L**	6
MQ6	0.77	1.10	0.22	0.45	0.35	0.80	29.9	7
MQ7	*0.46*	*0.50*	*0.18*	*0.12*	*0.21*	*0.33*	*2.4*	8
MBA8	0.10	0.39	0.05	0.07	0.09	0.16	1.7	9
MBB8	0.32	0.38	0.09	0.11	0.04	0.15	0.5	10
MQ8	*0.88*	*0.82*	*0.35*	*0.29*	*5E-3*	*0.29*	*0.4*	11
MBA9	0.60	1.39	0.35	0.63	3E-3	0.63	0.8	12
MBB9	0.54	1.56	0.55	0.67	1E-3	0.67	1.0	13
MQ9	*0.35*	*1.67*	*0.88*	*1.14*	*2E-3*	*1.14*	*2.4*	14
MBA10	0.08	0.32	0.12	0.18	~0	0.18	0.3	15
MBB10	4E-3	7E-3	0.02	0.03	~0	0.03	0.1	16
MQ10	*0.16*	*0.57*	*0.24*	*2.34*	*~0*	*2.34*	*0.3*	17
MBA11	0.37	1.81	0.48	0.65	1E-3	0.65	1.3	18
MBB11	0.38	1.02	0.49	0.60	1E-3	0.60	1.5	19
MQ11	*2.56*	*3.10*	*1.55*	*~0*	*~0*	*~0*	3.7	20
MBA12	0.10	0.28	0.14	0.18	~0	0.18	0.2	21
MBB12	1E-3	0.08	0.01	0.03	~0	0.03	~0	22
MBC12	-	3E-3	~0	0.01	~0	0.01	~0	23
MQ12	*0*	*0*	*0*	*0*	*0*	*~1E-3*	~0	24

Table 4: Peak energy densities $[\frac{mW}{cm^3}]$ in the DS for the horizontal beam loss scenario at 7 TeV (**lwb**). Five *active* absorbers (**TCL**) are on, $A6_vC6_hE6_vF6_h$ (chosen in sec. 2) + 5^{th} absorber (row 4), and sometimes also the *passive* absorbers (**PA**, see ch.??), row 5. As for the loss source (row 6), simulations were first computed for losses originated in the TCP and TCS only. Then the contributions from the TCL were included, i.e. Column 7 = Column 5 + Column 6. Column 8 represents an accident case without TCS.

FLUKA team: "Brennan" topics (Lucia at present)

DONE: Results presented at the 69th CWG, May 08, 2006

- Energy deposition on LHC dumping system elements (IR6), beam 2, 7 TeV (vertical and horizontal losses).
- Peak energy and quench limits in quadrupole (MQY) and corrector dipole (MCBY), IR6.
- Magnetic field modulation in the MCBY.

TO BE DONE (High, Medium, Low priority):

- TCDQ secondary halo: 3 cases with same geometry (injection case, 7 TeV – TCS retracted, 7 TeV– 1-sided cleaning); 1 case with new geometry (nominal cleaning, +TCLA).
  Order of 1 month per case
- TCLIB+TCLIM+Q6 in IR2/8 (new geometry using TCS model,…): protection of Q6; halo load for quench.

It can require a significant amount of work anywhere between 1 month and several months

- TCDQ beam sweep case for Finite Element analysis of dynamic thermal stresses (possibly already existing data?)
- TDI+TCDD+D1 secondary halo load + quench risk in IR2/8 (existing geometry – need halo distribution from CWG).
  Order of 1 month ? Not fully clear the amount of work
- Beam dump entrance window WDWB – 1 bunch: energy deposition with final design – 450, 2000, 7000 GeV. ?? Joachim ??

FLUKA team: to be done

- MBW, MQW5 and Passive Absorbers:
  - Simulations with cooling system? (***setup+simulations+analysis ~ 2-3 weeks***)
  - Energy deposition in support of MBW's to estimate deformation. (~1.5 weeks)
- Upgraded automatic FLUKA model of IR7 for beam 2 including cold part ***(1-2 months for the setup and debugging + xxx for results)***
  - Upgrade the scripts
  - Computation of heat loads in Q5 and Q6.
- Cross-check FLUKA and IHEP simulations (model IR3 with FLUKA and IR7 with MARS) ***(minimum 2 months for setting up and >= 2 months for results, is it really a priority??)***
- Crystal studies - deposited energy by channeled halo particles ***(George Smirnov is working on this, difficult to predict if and how much can be done, no timescale)***
- Direct proton losses versus deposited energy in the cold magnets of IR7 first look by checking the TWISS and loss data **?? Do you really want this ??**
- Validation of passive absorber and active absorber final set up for skew halo loss case **Proposal: low priority, just at the end**

FLUKA team: items to be clarified/better defined

- Heating of components in case of accident ***INPUT NEEDED (no way to define a timescale without further details, proposal =< 2 man-months?)***
- More failure scenarios at injection ***DEFINE LIMITED NUMBER OF CASES (no way to define a timescale without further details, proposal =< 3 man-months?)***
- Showering studies at specific locations of beam loss ***INPUT NEEDED (no way to define a timescale without further details)***
- (Showering studies for tertiary collimators at IR1, IR2, IR5 and IR8 ***Nikolai***)
- Implications of final IR7 layout on the bake-out system: ***no further work for us***
- Operational studies (different configurations of collimation) ***INTENSIVE CPU CONSUMPTION! MAYBE SHOULD FIND ANOTHER APPROACH, AT LEAST A MINIMAL SET OF CONFIGURATIONS MUST BE DEFNIED***
- Tuning studies with shower maps (beam loss measurements) ***NEED MORE INFORMATION***

FLUKA team: phase II

- Different materials
- Different collimators
- New layout
- ....

Very hard to make any definite prediction about the required manpower (CPU power).

Extrapolating from IR7, phase I, at least 12-20 man-months are required, depending on the complexity. If also IR3 must be accounted for, an overhead of 50% in manpower (an 100% in CPU power) could be a reasonable assumption

It is critical to define more exactly a plan for Phase II calculations

Do we have to postpone their start to 2007, or run them in parallel with the other studies (hence slowing down the other studies)?

FLUKA team: proposal

- Not all (future) tasks are precisely defined. The required man (and CPU…) power is sometimes difficult to define
- Define in a detailed way (written memo) the calculations required for the next months including which input is required
  - Stefano and Markus ?
  - Lucia and Brennan ?
- After cross check in one of the next CWG, a precise (???) timetable could be setup
- Meanwhile we go on with those calculations which are already clear enough


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