Cryogenic BLMs

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Congratulations to Peter Higgs and Francois Englert!



Outlook

- Motivation for Cryogenic BLMs.
- Results of beam-test and irradiation studies.
- Motivation for LS1 installation on the cold mass.
- Proposed locations.
- Installation setup.
 - Safety considerations.
- Who is on the project (now).
- Conclusions.



Motivation for Cryogenic BLMs - reminder

- On September 4, 2012, at this meeting installation of Cryogenic BLMs on Q7R3 was proposed, discussed and accepted.
- But for technical reasons Q7R3 will not be installed in the machine (and this was a very good location!)
- The case is well documented (see next slides).
- Idea is simple: measure signals closer to the coil.
- Difference debris/losses:
 - Different loss pattern.
 - Different particles (e.g. debris: 1 TeV pions).
 - As a result different ratios S_{BLM}/E_{coil}



Motivation – existing documentation

FLUKA Simulations for Assessing Thresholds of BLMs Around the LHC Triplet Magnets

> <u>A. Mereghetti¹, on behalf of the FLUKA Team</u> M. Sapinski², on behalf of the BLM Team

For current BLMs and preliminary study for CryoBLMs

 $^{1}\mathrm{EN}/\mathrm{STI}/\mathrm{EET}$

 $^{2}\mathrm{BE/BI/BL}$

October 18^{th} , 2011

http://indico.cern.ch/event/CryoBLM2011

CERN-ATS-Note-2012-014 TECH , CERN-ATS-2012-093, IPAC12



Motivation – loss scenario

FLUKA Simulations

Aim Relate the energy deposited in the superconducting coil of the *inner triplet* to the signal read by BLMs all around: assessment of the signal thresholds. FLUKA simulations of the *Inner Triplet* presently installed on the right side of Point 1 of LHC (ATLAS). Considered scenarios:

pp-collision debris

- $L_0 = 10^{34} \text{ cm}^{-2} \text{ s}^{-1} [1];$
- 80 mb as pp inelastic cross section at 14 GeV centre-of-mass energy;

direct losses in Q2B (MQXB.2BR1)

7.0 TeV protons on Q2B magnet, due to wrong settings of collimators;



For other scenarios: EDMS doc in preparation.



Motivation – loss versus debris



- For HL-LHC luminosity losses in triplets will be close to quench limit.
- Now BLM thresholds are factor 3 below quench level.
- It will not be possible for HL-LHC. Need more precise measurement.
- CryoBLMs give 2-3 times better separation debris/loss.
- Similar need for other losses: collimation, injection...



New simulations - ongoing

- Work of Francesco Cerutti and Luigi Esposito.
- Real new triplet geometry.
- For debris: done.
- For loss scenario: ongoing investigation, probably new Sixtrack studies needed.
- Motivation for CryoBLMs not expected to change.





Results of beam-tests

Detectors were studied and tested on the beam

• Rich documentation:

•Ch. Kurfuerst et al., Radiation Tolerance of Cryogenic Beam Loss Monitor Detectors, Proceedings of IPAC13

• M. Bartosik et al., <u>Characterisation of Si Detectors for the</u> <u>Use at 2 K</u>, Proceedings of IPAC13, MOPME071, CERN-ATS-2013-058

- Ch. Kurfuerst, PhD thesis, November 2013
- In LHe: shorter signals, higher amplitude

Good radiation hardness



Investigated technologies:

- x He3 chamber
- ✓ Silicon
- x scintillators
- x scintillation in LHe
- Diamond
- ✓ LHe ionization chamber
- x thermal equilibrium cal
- x transition edge sensors





Motivation for LS1 installation on the cold mass

- Beam-test studies will continue, but:
- We want to investigate as well:
 - Long-term performance of the system (stability, reliability, availability as the current system).
 - Relation between current detectors and new ones (see the advantages).
 - Radiation hardness of other elements (holder, cables).
- Proposal:
 - Install test detectors on cold masses in two locations: 11R1 and 9R7.
 - Triplet magnets not accessible during LS1.
 - MQ cold mass is difficult to access, so use MBs.
 - In each location install 4 detectors (probing the radiation field).
 - Connect them to standard BLM electronics (but special crates, not affecting the current system).
 - Keep possibility of measuring fast signals (bunch-by-bunch).
 - Make sure this test installation will not affect magnets.



Location R7



BLM signals during 4 TeV loss map 2012-09-25.

 Monitor
 loss rate [Gy/s]

 BLMQI.08R7.B1E30_MQ
 4.6·10⁻⁵

 BLMEI.09R7.B1E30_MBA
 4.3·10⁻⁵

- Purpose: observation of collimation losses.
- Maybe particularly interesting for next quench test.
- Choice made based on dose measured during collimation loss maps (data from Belen Salvachua, collimation).
- Normal signals scale down, small differences between various loss maps.
- Two locations seem to be equally good: MBA and MBB between Q8 and Q9 – in both cases end cap facing the IP



Location R7 – cell 9R7







Location R1 – cell 11R1



- Connection cryostat end cap facing the IP is proposed.
- Choice made based on total dose due to luminosity production measured by current BLM system.
- BLMEI.11R1.B1E30_MBB integrated dose of 2.5 Gy
 (in November 2012 largest in the area)
- Expected about 5 times larger rate because closer to beam



Installation setup

- Support plates attached to the front of the magnet
- (see LHCQQA_S0273 by Thierry).
- Detectors on special holders screwed to the plates.



drawing by Thierry



Installation setup

- In each location: one diamond and 3 silicon detectors
- Materials:
 - Cables the same as for BPMs (vacuum, cryogenic),
 - Ceramic PCBs (Diamond), FR-4 for Silicon
 - SMA connectors with ceramic instead of teflon.
- HV: maximum 500 V (Diamond)
- Each detector is independent (separate HV)
- Heat dissipated by working detector ~ 1 mW





Who is on the project

- CERN: Bernd Dehning, myself
- PhD students:
 - Christoph Kurfuerst finished
 - Marcin Bartosik
- External collaborators:
 - Vladimir Eremin (IOFFE, St. Petersburg, Si detectors, holders)
 - Erich Griesmayer (CIVIDEC, Diamond detectors, holders)
 - Chris Fabjan (expert for LHe chamber not for LS1 test)
- FLUKA simulations: Francesco Cerutti, Luigi Esposito
- Many people from CERN to help: Vittorio Parma, Nicolas Bourcey, Jean-Phillipe Tock, Thierry Renaglia, CryoLab team, Christian Boccard - thank you!



Conclusions

- An installation of beam loss detectors on the cold mass of LHC magnets is proposed in two locations.
- It is an important development towards HL-LHC.
- Materials and detectors have been carefully chosen.
- Most of the elements are produced.
- ECR will be finished soon.
- Vittorio will present the details of the installation and the proposed schedule.

Thank you for your attention!



Additional slides



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2013/10/03

Loss map data

. <u>Monitor</u>	dcum [m]	loss RS09 [Gy/s]
BLMQI.06R7.B1E10_MQTL	20219.17	0.000484443
BLMQI.07R7.B1E10_MQ	20257.2	0.000333014
BLMQI.06R7.B1E20_MQTL	20223.47	0.0001299324
BLMQI.06R7.B2I20_MQTL	20222.27	0.0001057081
BLMQI.07R7.B1E20_MQ	20259.77	9.27885E-05
BLMQI.06R7.B2I10_MQTL	20226.9	8.08849E-05
BLMQI.07R7.B2I30_MQ	20253.23	7.88157E-05
BLMQI.09R7.B1E10_MQ	20335.33	5.54319E-05
BLMQI.07R7.B1E30_MQ	20264.32	4.98616E-05
BLMQI.11R7.B1E10_MQ	20428.58	4.67632E-05
BLMQI.08R7.B1E30_MQ	20303.42	4.5806E-05
BLMEI.09R7.B1E30_MBA	20319.16	4.32588E-05
BLMEI.09R7.B1E21_MBA	20311.16	3.00738E-05
BLMEI.09R7.B1E22_MBA	20314.16	2.73749E-05
BLMQI.07R7.B2I20_MQ	20258.57	2.716E-05



Luminosity data

. Monitor	dcum [m]	loss RS09 [mGy]
BLMEI.11R1.B1E22_MBB	413.9	1189.962
BLMEI.11R1.B1E23_MBB	415.65	1108.671
BLMEI.11R1.B1E24_MBB	417.7	1283.256
BLMEI.11R1.B1E30_MBB	420.073	2549.128
BLMQI.11R1.B2I30_MQ	431.326	1574.25
BLMEI.11R1.B1E21_LEHR	431.34	3073.741
BLMQI.11R1.B1E10_MQ	434.416	2634.265









Pictures from installation on Q7



