Radiation Monitoring in LHCb

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University of Dortmund, July 11, 2006

Outline: Plans for the LHCb (and possibly ALICE) beam-condition monitor (initiated by D. Eckstein)

Passive Sensors (Alanine, RPL, TLD)

The LHCb Beam Condition Monitor (BCM)

Purpose of the LHCb BCM:

provide real-time radiation monitoring within LHCb / ALICE to detect and initiate protection procedures for detector subsystems (such as the VELO) at the onset of beam instabilities and accidents

Goal:

provide monitoring information in the time scale of the LHC turn (89 μs, possibly also sub-orbit time scale) → beam dump request, detector HV ramp down, moving out of the VELO (larger time scale, suitable only for slow failures)

no bunch-by-bunch measurement

Sensor:

CVD diamond close to beam, at a distance of about 1.5 m from the interaction points. First stage: BLM electronics (tunnel card → optical link → DAB6 board)

BCM: Possible Location within LHCb

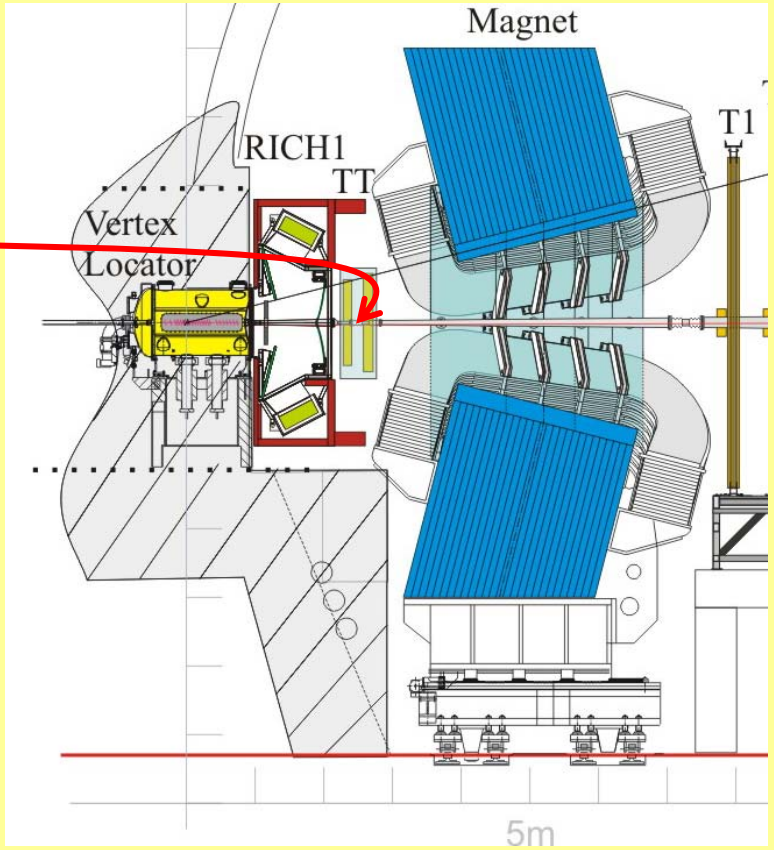
- space in fwd direction at 2.25m between RICH and TT (to be confirmed – low B field might be a problem)

- as close to beam pipe as possible

- coincidence (2 times 4 sensors), another sensor set “upstream” LHCb

- space coincidences

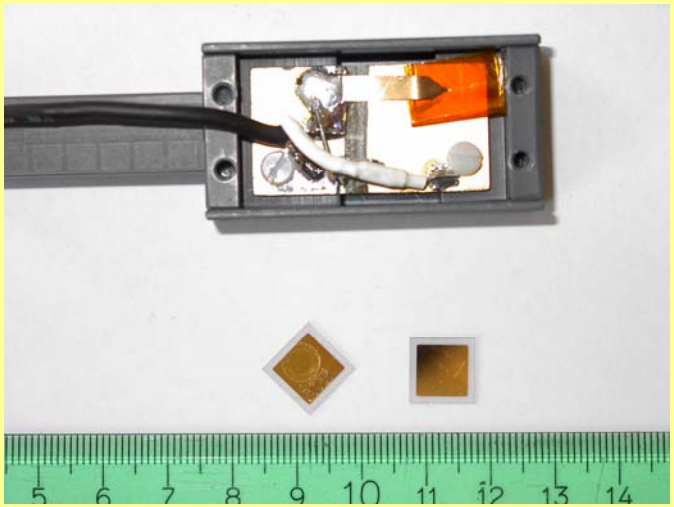
- simulation on this in preparation



BCM sensor test housing

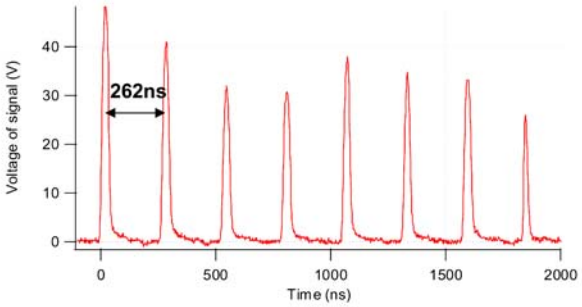
CVD (chemically vapor deposition) diamond:

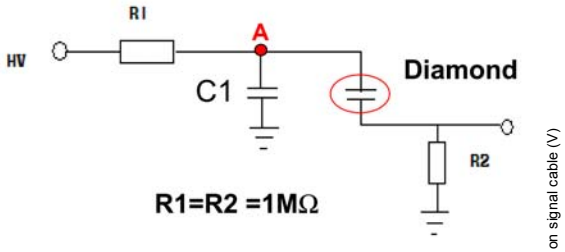
- 1 x 1 cm polycrystalline pieces, 500 µm thick
- operation similar to Si, but charge traps need to be filled up
- radiation hard
- B-field tests in the coming days



sensors: courtesy of the ATLAS BCM group, H. Pernegger, A. Gorisek

CVD diamond response (CMS tests)

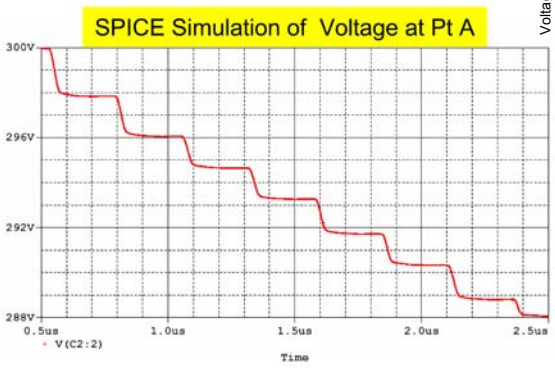


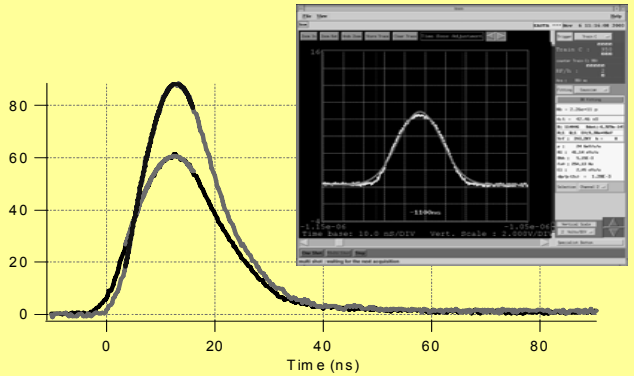


C1 acts as a reservoir capacitor
=>The larger the value the longer the bias field on the can be maintained.
=>Bunch amplitude variation is real

C1(CDS126)=15 nF
C1 is sufficiently large to maintain bias across the diamond for the 8 bunches.

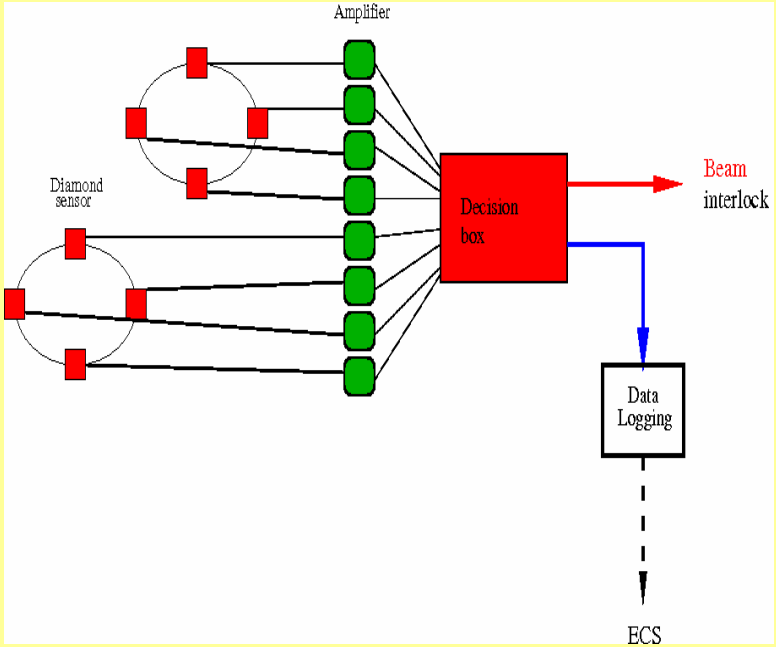
C1R1 time constant ~15 ms
⇒ recharging of C1 is slow compared to bunch structure

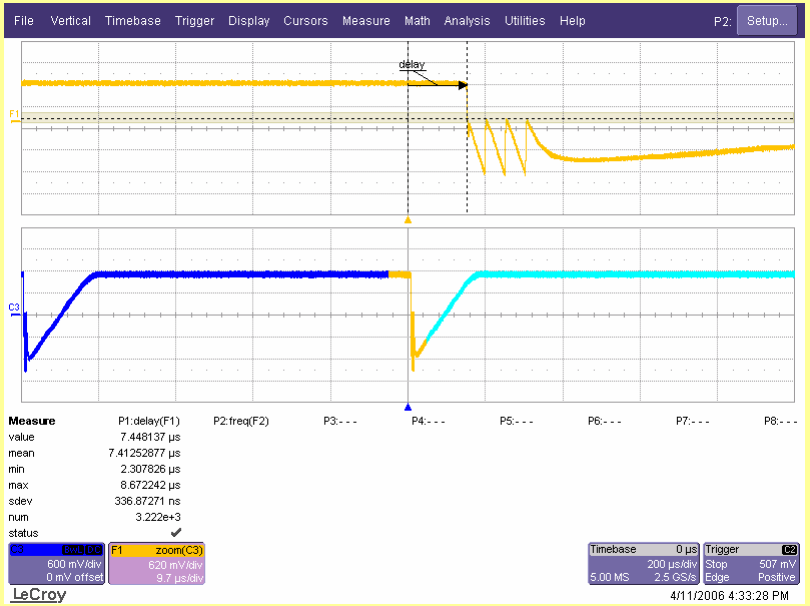




(A. Macpherson, T. Pritchard)

Readout scheme

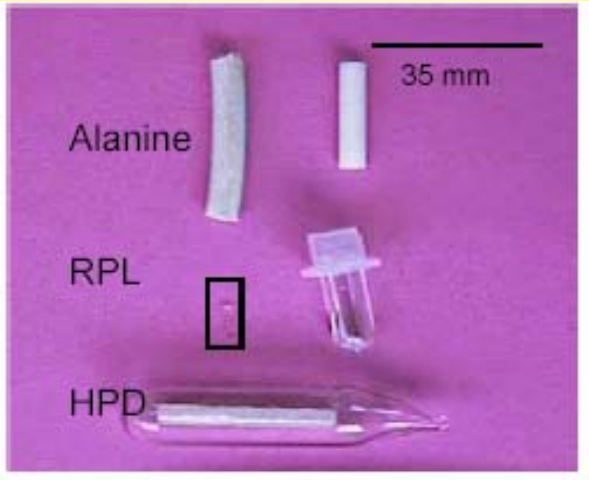


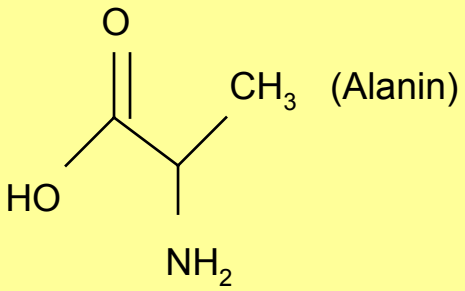


preliminary design: BLM tunnel card and DAB6 boards for fast current integration(readout every 40 µs) (E. Effinger and Ch. Zamantzas, AB-BI)

in a later stage: commercial rad-hard amplifiers (ex. FOTEC)

passive dosimeters



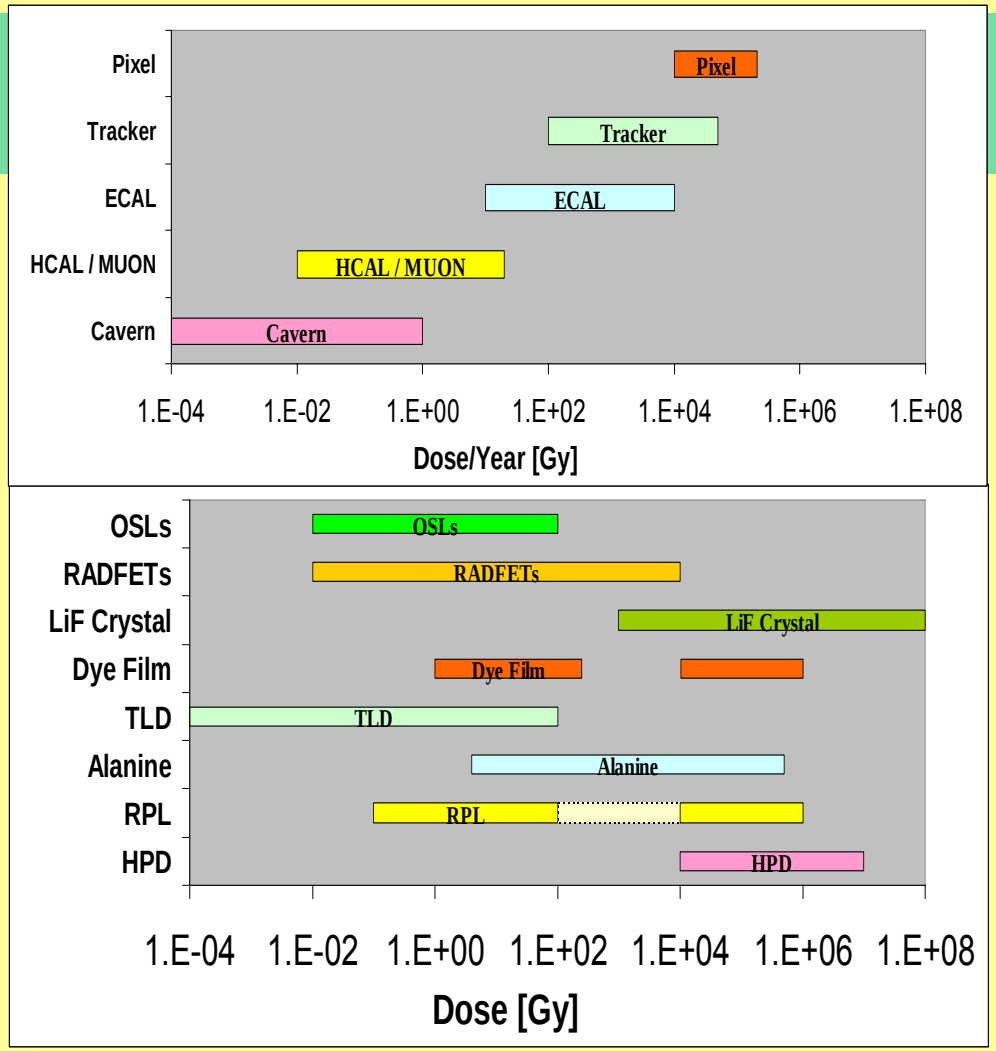


courtesy: I. Floret

	TLD	LiF crystal	PAD (Alanine)	Dye films	RPL	HPD
Dose Range	10 mGy to 100 Gy	1KGy to 100MGy	10Gy to 1MGy	1-250Gy 10KGy-1MGy	100mGy to 1MGy	10 KGy to 10MGy
readout method	heating	heating	EPR	densitometry	UV light exposure	pressure measurement

(after M. Moll)

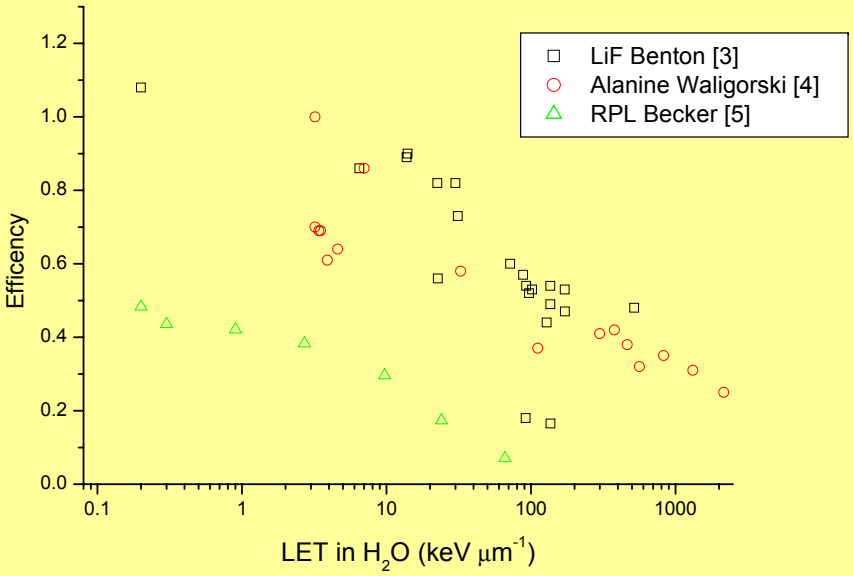
passive dosimeters



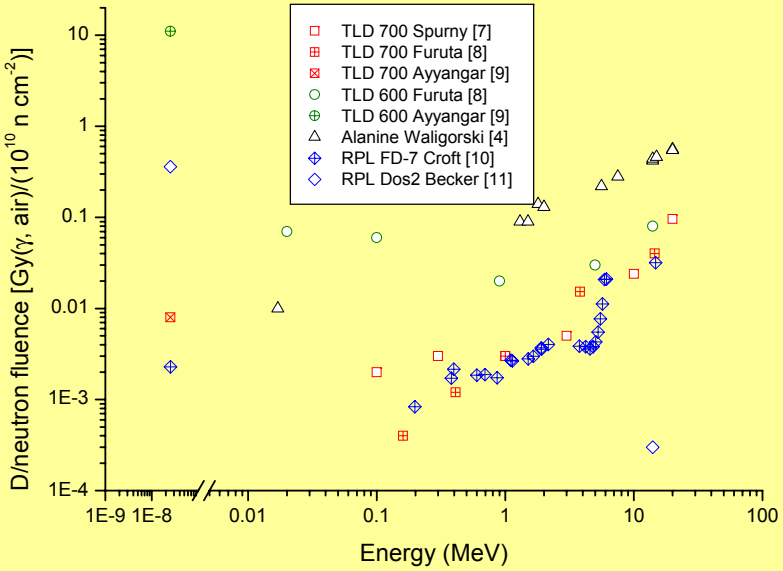
expected doses in CMS

(after I. Floret/M. Moll, A. Macpherson)

Passive sensor response



response to protons/ions as a function of their linear energy transfer



response to neutrons

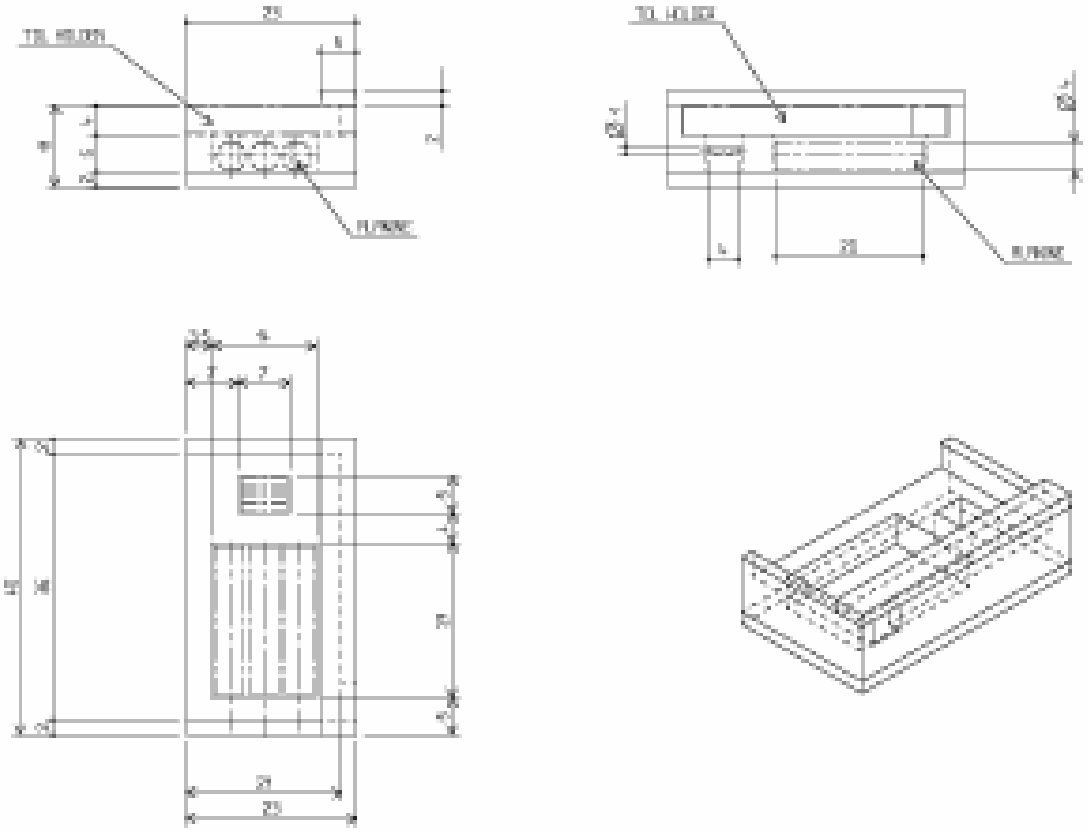
(data compiled by M. Fürstner, SC-RP)

Passive sensor housing

proposed material:

polymethyl methacrylate (PMMA, i.e. Plexiglas/Perspex)

ALNOR TLD slide with unique coding serves as the cover



conclusion

A simple Beam-Condition Monitor system is currently under development in LHCb and ALICE.

A variety of active and passive sensors is being used for monitoring the LHC machine and is available to the experiments upon request.

For passive sensors a writeup on their properties is in preparation, including a proposal for a housing.