Notes by M.Moll
(draft 001 - 22.7 – circulated for comments)
(draft 002 - 23.7 – included comments from H.Vincke)
(draft 003 – 30.7 – included comments from R.Lindner,I.Brunner)

Radiation Monitors for the LHC experiments
Thursday, 22.7, 9:30-12:00

Present:
PH-TA1 - Maurice Glaser, Michael Moll
CS-RP - Marco Silari, Helmut Vincke
Alice - Marc Tavlet
ATLAS - Per Grafstroem, Francis Anghinolfi
CMS - Alick MacPherson
LHCb - Doris Eckstein, Rolf Lindner, Sergey Barsuk, Gloria Corti, Andreas Schopper

Purpose of the Meeting:

The aim of the meeting is to understand which and how many passive dosimeters will be approximately needed by the LHC experiments in order to possibly launch a common purchase of dosimeters respectively a common activity leading to the set-up of the required infrastructure to read them.

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Presentations:
(All transparencies and these minutes will be made available on the RADMON homepage http://cern.ch/lhc-expt-radmon/)

(1) Michael Moll
Michael points out the aim of the meeting and briefly summarizes the PH-TA1-SD proposal to work on the radiation monitor project which was presented in the last meeting in April 2004.
Federico Ravotti is since July 2004 a doctoral student attached to the TA1-SD section and working on dosimeter developments. The quota was taken from the TS-LEA group while the financing is shared between the LHC experiments.
The following radiation monitoring contact persons have been appointed by the LHC experiments:

Alice : Marc Tavlet
ATLAS : Marko Mikuz
CMS : Alick MacPherson
LHCb : Doris Eckstein

(2) Maurice Glaser
Maurice gives a brief overview of the activities on active radiation monitor developments within TA1-SD since last April. The most relevant news are:
(1)The development of the OSL detectors has run into unforeseen radiation hardness problems which were unexpected since this technology

is used in satellites in space. The used LED and the optical filter for the photodiode can not withstand LHC radiation levels. Therefore further development is needed which leads (at least) to a delay in the work plan for OSLs proposed in April.
(2) A new source for forward biased p-i-n diodes has been found which in principle should allow to measure displacement damage starting from a 1 MeV-equivalent fluence of 10^8 cm^{-2} (For the presently used OSRAM BPW34F devices the minimum fluence that can be measured is 10^{12} cm^{-2}). The availability and price for these diodes are presently under investigation.

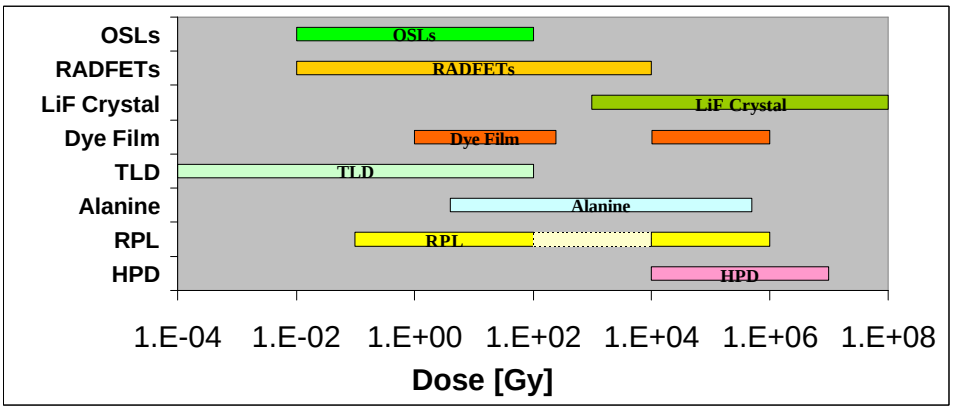

Figure indicating the dose ranges of various passive dosimeters

(3) Helmut Vincke
Helmut presents the high level dosimeters available within the CS-RP group and their working principle. The presentation is focused on RPLs and PADs. In 2003 about 2000 dosimeters have been measured by the high level dosimetry group (mainly RPLs, which are e.g. used to measure doses in the SPS). An experiment performed at CERF showed an excellent agreement between the dose measured in RPLs and PADs and a preliminary simulation predicting the energy deposition in air, indicating that these dosimeters are well suited for dose measurements in LHC detectors.

→ **Discussion RPL**
- The RPL system is very old and the UV lamp needed for it is no longer available. Only one spare lamp exists at CERN and 14 at DESY. RPL systems are not commercially available (market survey done by M.Tavlet). Also the dosimeters itself are difficult to get and the only commercially source so far found asked for about 23 euros per piece. Further investigations are currently ongoing. These facts are making the availability of these kind of dosimeters over the full LHC lifetime presently questionable.
- CS-RP is investigating the possibility to build a new readout system as well as ordering the dosimeters (silver doped glass) from a glass producer (Schott, Germany).
- CS-RP is also investigating the possibility to use transmission measurements in parallel to the photoluminescence measurements in order to cover the ‘peak region’ of the RPL response curve (see transparencies).

→ **Discussion PAD (Alanine)**
- Commercial sources for PAD reader and Alanine exist.
- Linear response over main part of the measurement range.
- Accuracy of the read out system is in the range of some percent.

(4) Marco Silari
Marco presents the use of TLDs dosimeters(Lithium Fluoride) at CERN and their working principle. They offer a wide dose range response(10µGy to 100Gy) and have an almost negligible fading at room temperature. They can be made sensitive to neutrons if Li-6 enriched dosimeters are used. At CERN commercial TLDs (Harshaw) are used. The dose range in practice at CERN is 10µGy to a few mGy and only little experience exists on measurements at higher doses. Two TLD readers exist: One automatic reader (Alnor, 10mGy to 2 Gy) and one semi-automatic reader (Harsaw, high doses). In 2003 about 12200 TLD measurements have been performed by SC-RP. Marco points out that the outsourcing of the TLD service at CERN is under discussion.

→ **Discussion TLDs**
- Seems like the best solution for most regions in the experiments, however some questions remain:
- Why is it difficult to measure the response at high dose levels (1 to 100 Gy)?
- What would be the price per dosimeter?
- What is the absolute sensitivity to thermal neutrons?
- Sensitivity in dependence of particle type and particle energy?
- Will this technology be supported in CS-RP in the future?

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Discussion (Dosimeters needed by the Experiments)

It is stressed by all LHC experiments that the indicated numbers and type of dosimeters are a very rough estimate which might change in the future. However, these numbers will serve as a first guess to estimate the needed infrastructure and manpower to read these dosimeters.

Alice (Marc Tavlet)
Alice will need only a few 10ths of dosimeters. These will most probably be TLDs and RPLs that easily could be provided and read out by CS-RP using the present infrastructure.

ATLAS (Per Grafstroem, Francis Anghinolfi)
(see also transparencies by Per)
Passive dosimeters will be needed only outside the inner detector. A change of dosimeters once per year is planned. A few hundred measurement points will be needed. At full luminosity no measurement point will see more than 100 Gy/year or 1e11 neutrons/cm^2/year. This makes TLDs a very interesting option, especially taking into account the low luminosity running over the first years of operation.

CMS (Alick MacPherson)
The Beam Condition Monitor will cover the inner detector area. Only outside the tracker passive dosimeters will be needed. The number will depend on the choice of additional active dosimeters. However, a first guess is that, like in ATLAS, a few hundred dose measurement points (TLDs) will be needed. The monitoring could be completed by putting RPLs in some locations.

LHCb (Rolf Lindner, Doris Eckstein)
In the calorimeters doses in the range of 50 to 2KGy/year are expected. Therefore, Alanine could be a good choice for these sub-detectors and

about 50 measurement positions are foreseen. Requests will be sent to other subdetectors to get a full view of needs in LHCb. TLDs will be an option for monitoring area in the outer parts of LHCb. The number of TLDs should not exceed 100.

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Conclusion:
At this stage it is difficult to give exact numbers. However, interpreting the indicated “few hundred” measurement positions stated by ATLAS, CMS and LHCb as 200 and taking into account that redundancy is needed for TLDs (information gets lost during the reading) by using e.g. 3 dosimeters fore each measurement point, a total amount of 1800 TLDs would be needed.
Furthermore, about 100 PAD and 100 RPL dosimeters might be needed.

Questions arising from this meeting:

- What are the costs per dosimeter (TLD, RPL, Alanine)?
- Could 1800 dosimeters be read in the SC-RP infrastructure, and if so, what would be the requirements by SC-RP in terms of investment and man power?
- Would these requirements change significantly if less (e.g. only 1000 dosimeters) are needed?
- After presenting the available dosimeters at CERN in this meeting, did the number/type of needed dosimeters change?

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Next Meeting:
Tentative date (to be confirmed): Thursday, October 21