

High-Level Dosimetry systems used at CERN

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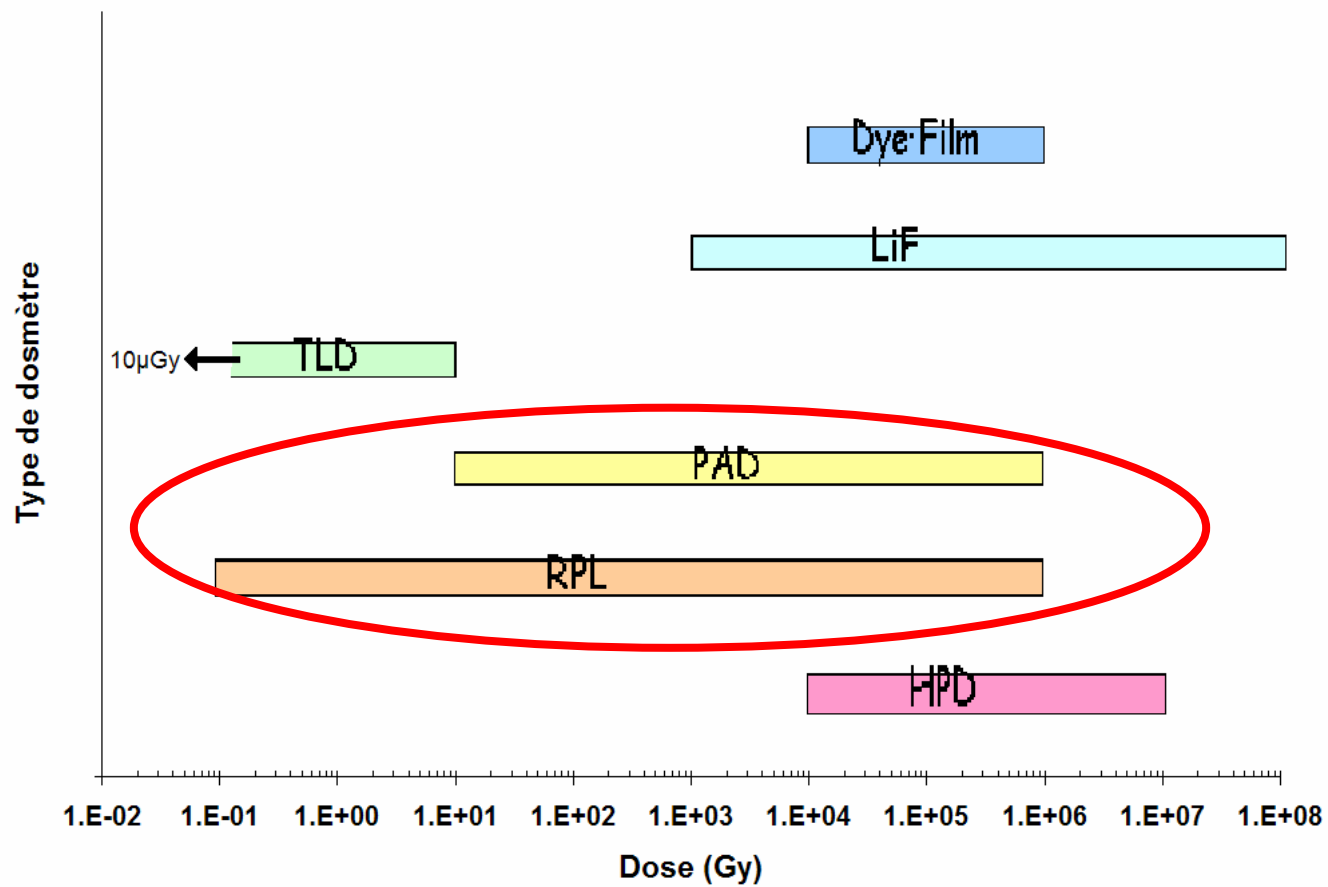
- Overview of HLD systems
- HLD systems used at CERN
- Further development of the systems
- HLD measurement campaigns in mixed radiation fields
- Conclusion

Types of dosimeters

Commercial available passive dosimeters:

- Hydrogen Pressure Dosimeter (HPD)
- LiF Crystal
- Thermo Luminescent Dosimeter (TLD)
- Dye Film
- Radio Photo Luminescent (RPL)
- Polymer-Alanine Dosimeter (PAD)

Dose range of various dosimeters



RPL and alanine dosimeter systems

- For both systems a gamma calibration exists up to a dose of 1MGy.
- The dosimeter response in a gamma irradiation field is well understood

Two main goals need to be achieved within the next years

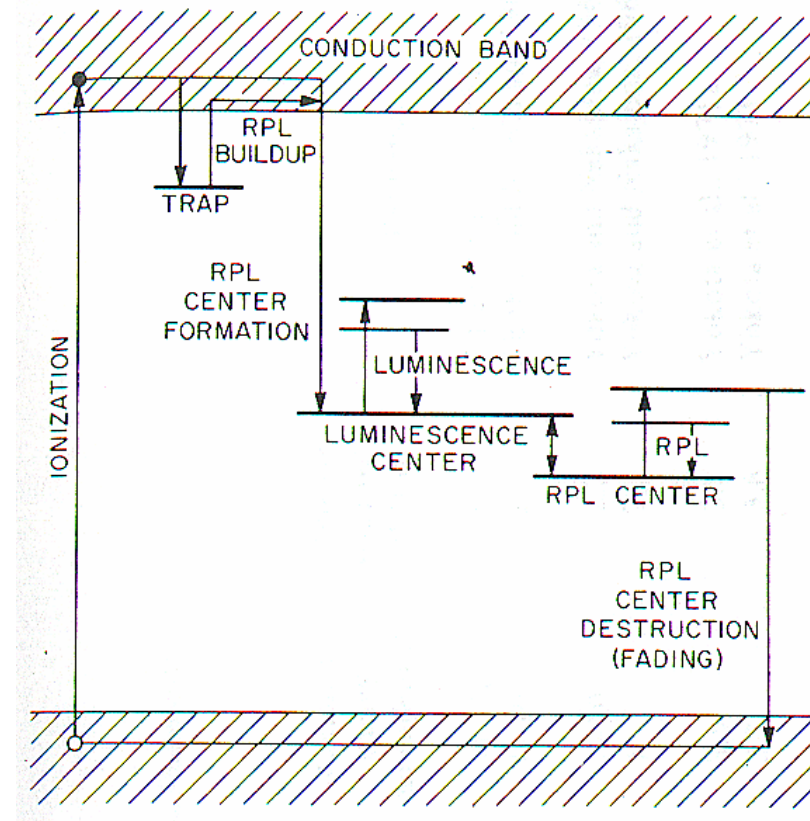
1. Better understanding of detector response to mixed radiation fields
2. Improvement of the current detector readout systems

Principle of physics of RPL

100 Gy 10^5 Gy 10^6 Gy

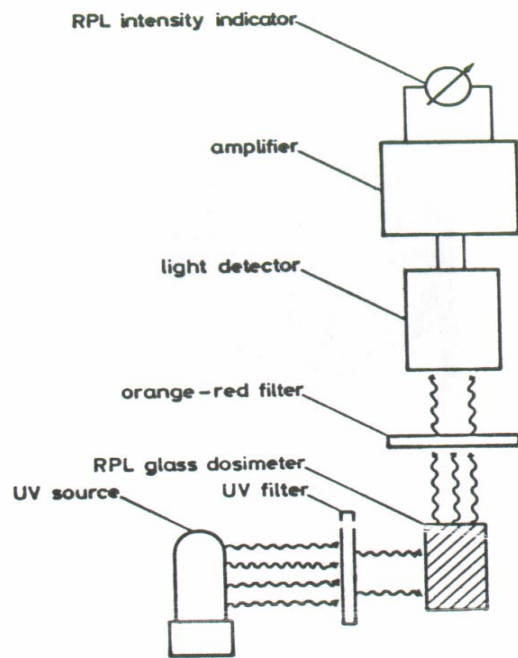


- Very small (~ 6 mm length) silver doped glass cylinder
- Radiation creates
 - RPL centres
 - Colour centres

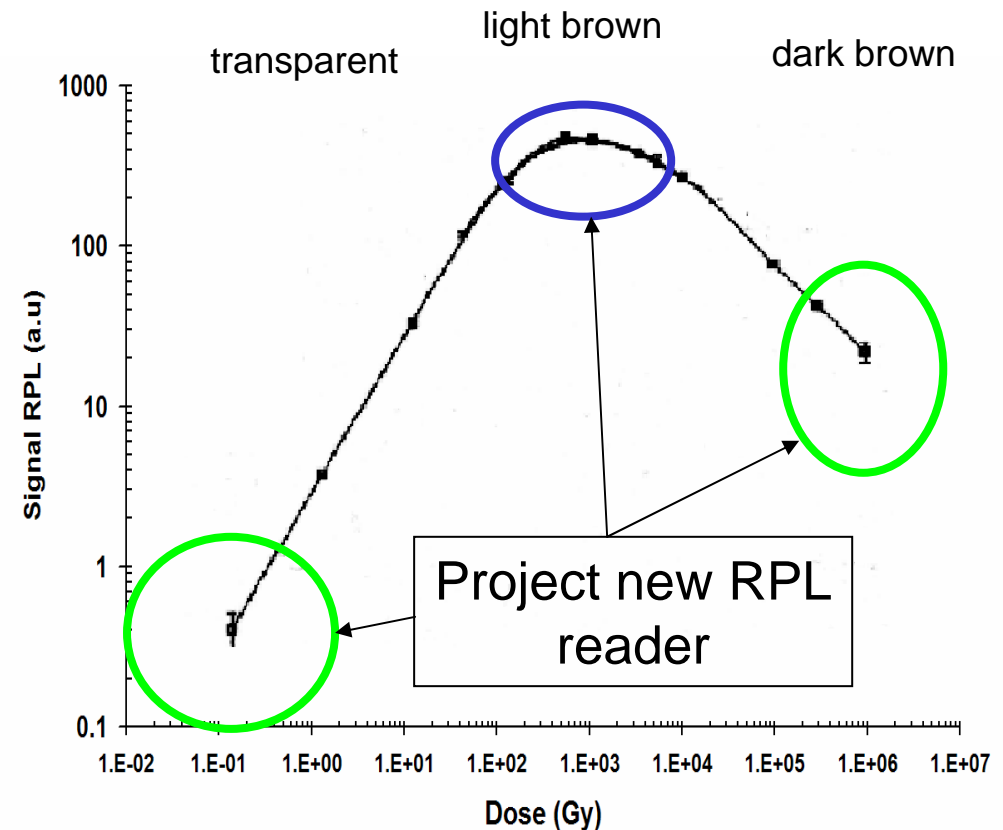


Readout of dosimeter

- spectrometry
 - UV light
 - Luminescence
 - Signal RPL

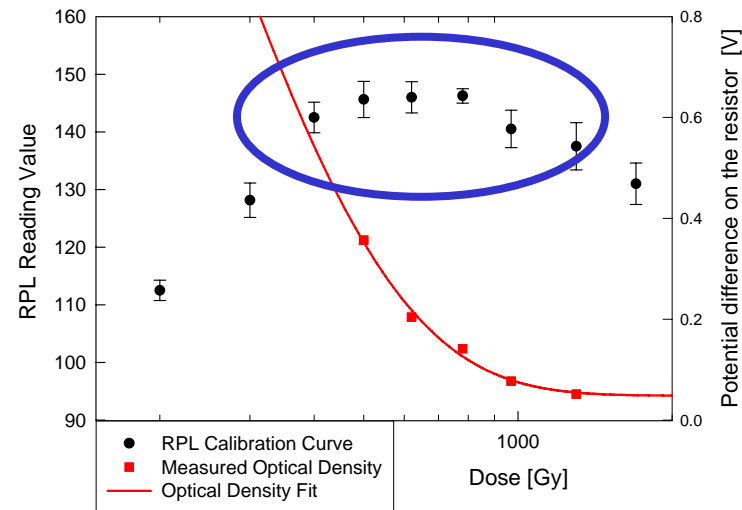
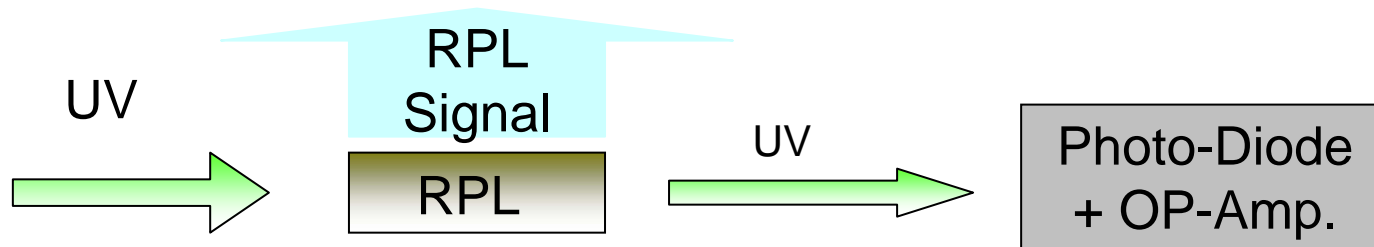


- Relation between dose and RPL signal



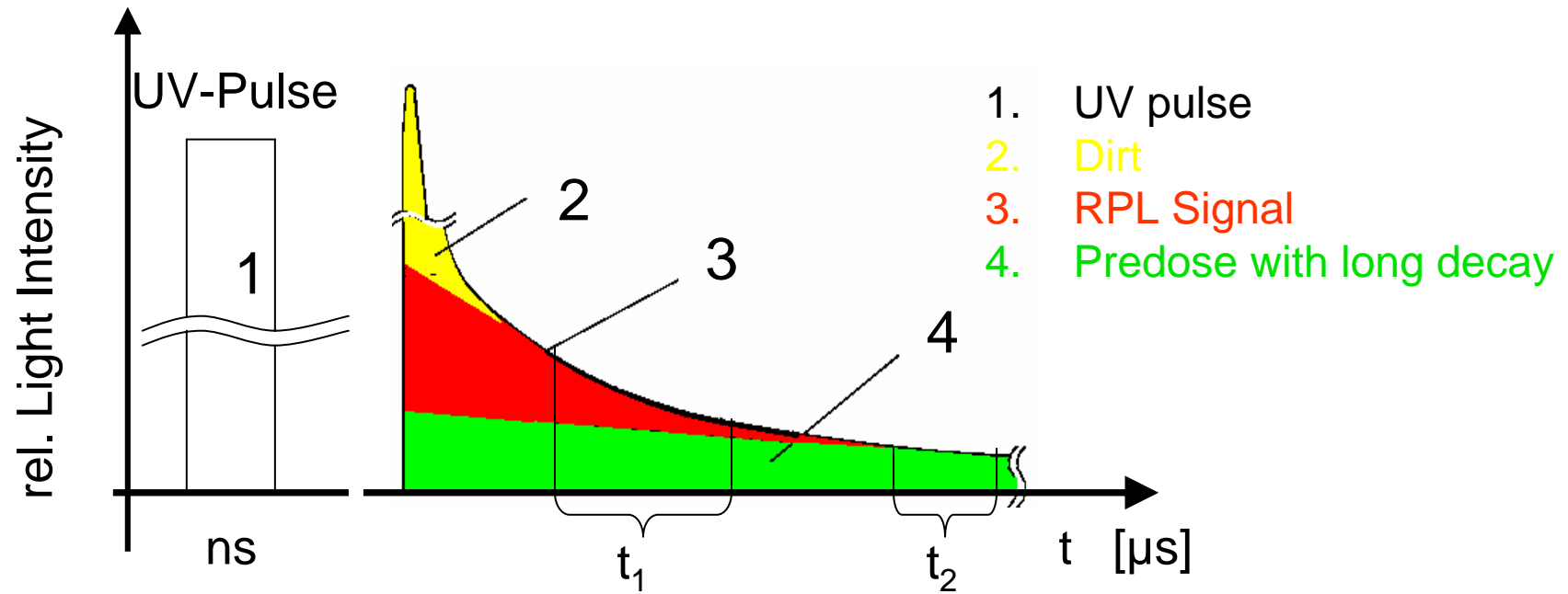
Project new RPL-Reader

1. Feasibility Study: Measurement of the optical density of the Dosimeter



Project new RPL-Reader

2. UV-Pulse Excitation [1]



Dose $\star A(t_1) - f(A(t_2))$

Project new RPL-Reader

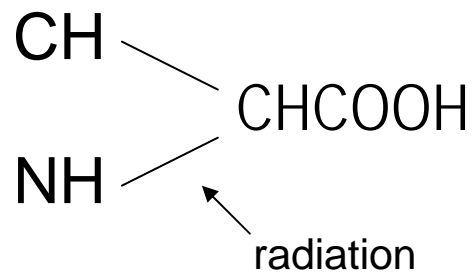
Advantages:

- measurable dose range 1 μ Gy (*) – 1MGy...
12 decades (before 7 decades)
- well defined reading in the plateau
- no washing (for low dose)

(*) According to the brochure of the FGD-1000 Reader
from Chioda Technol Coporation
<http://www.c-technol.co.jp/>

Principle of physics of alanine

- Alanine = amino-acid molecule



100 Gy

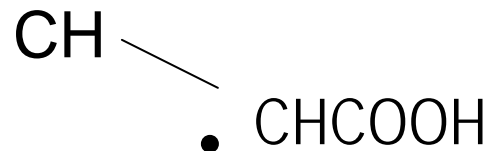
10^5 Gy

10^6 Gy



Cylinder (~ 3 cm length) consisting of alanine/polymer

- Radiation causes formation of free radicals



Experiments in mixed radiation fields

- CERF 2003
- CERF August 2004
- CERF October 2004
- p^+ Calibration Curve (IRRAD1)
- Radiation Source TT40 Beam dump

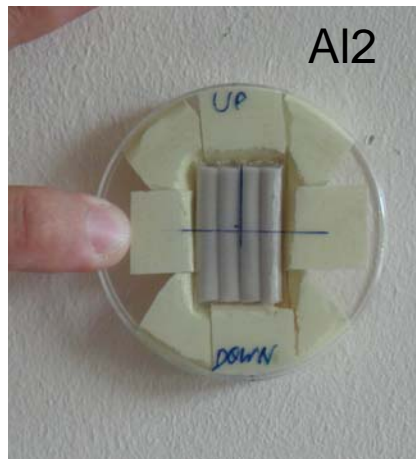
Aim of the irradiation campaigns: Collecting data in high-energy mixed radiation fields before the PS and the SPS are switched off.

Experiment at CERF in 2003

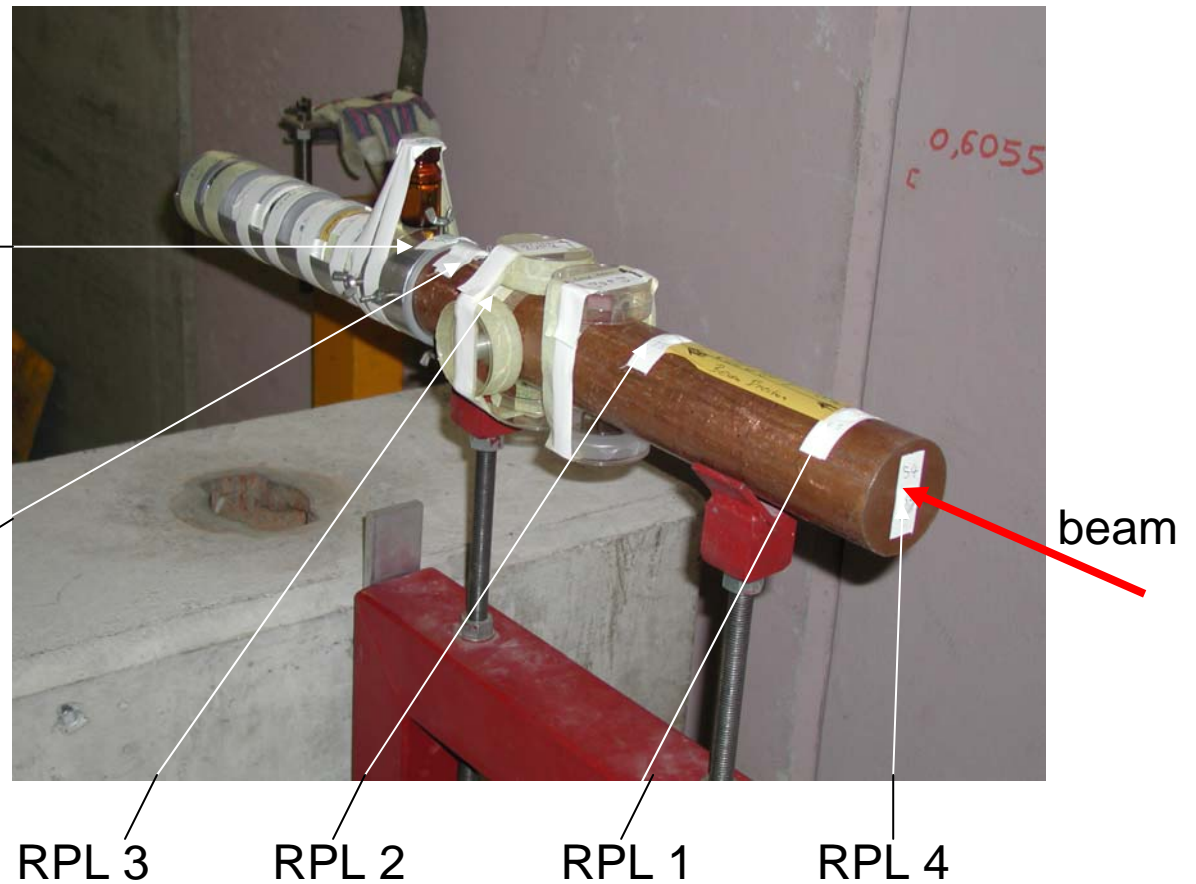
Mixed hadron beam
60% π^+ , 35% p, 5% K^+

Momentum
120GeV/c

Total intensity
 1.55×10^{12}



AI1

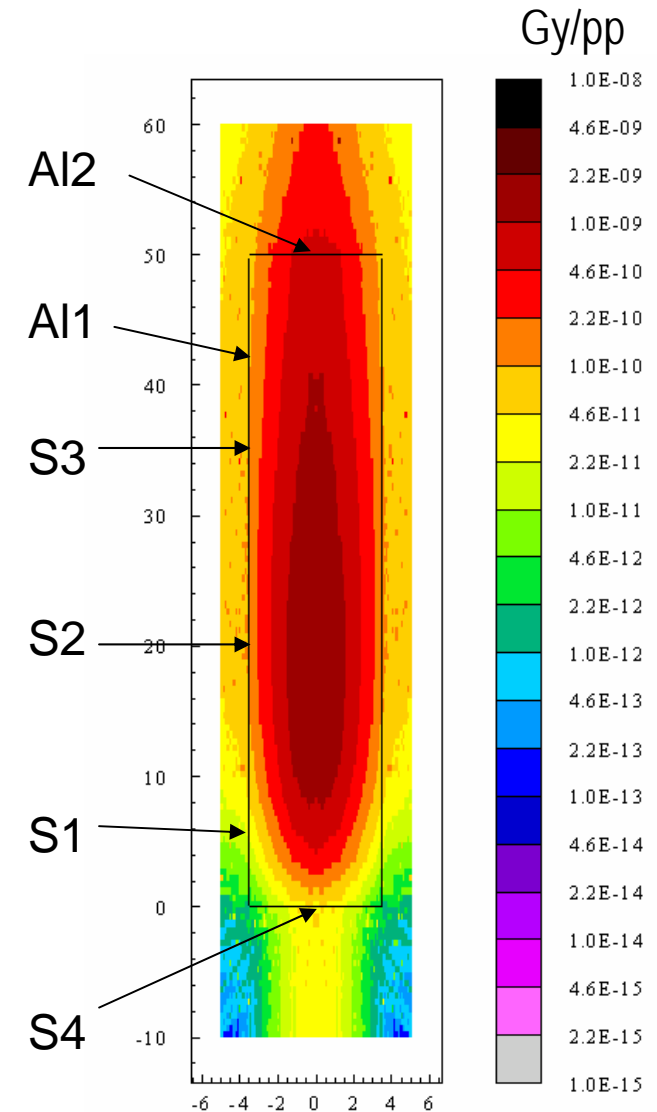


Preliminary results

Comparison: simulation vs. experiment

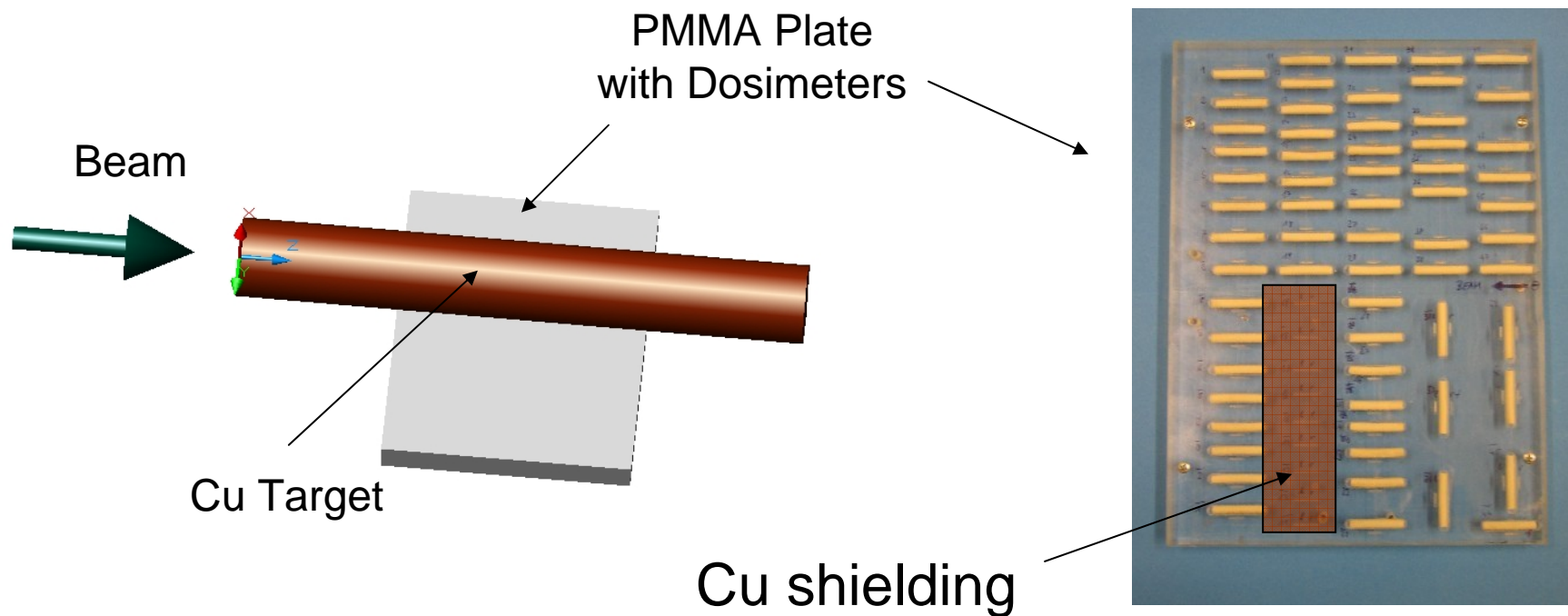
Simulation results give Gy in air

	Simulation	Stat. σ	measured	Measurement σ	Sim/Meas
RPL 1	30.3	4.4	29	1	1.04
RPL 2	168	5	182	6	0.92
RPL 3	169	4	183	6	0.92
RPL 4	75	7	76	2	0.99
AI1	130	10	127	7	1.02
AI2_a	724	15	854	40	0.85
AI2_b	862	17	879	40	0.98
AI2_c	958	21	879	40	1.09
AI2_d	861	17	789	40	1.09



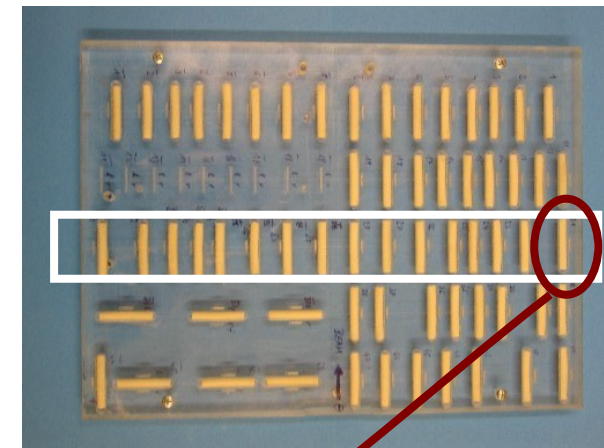
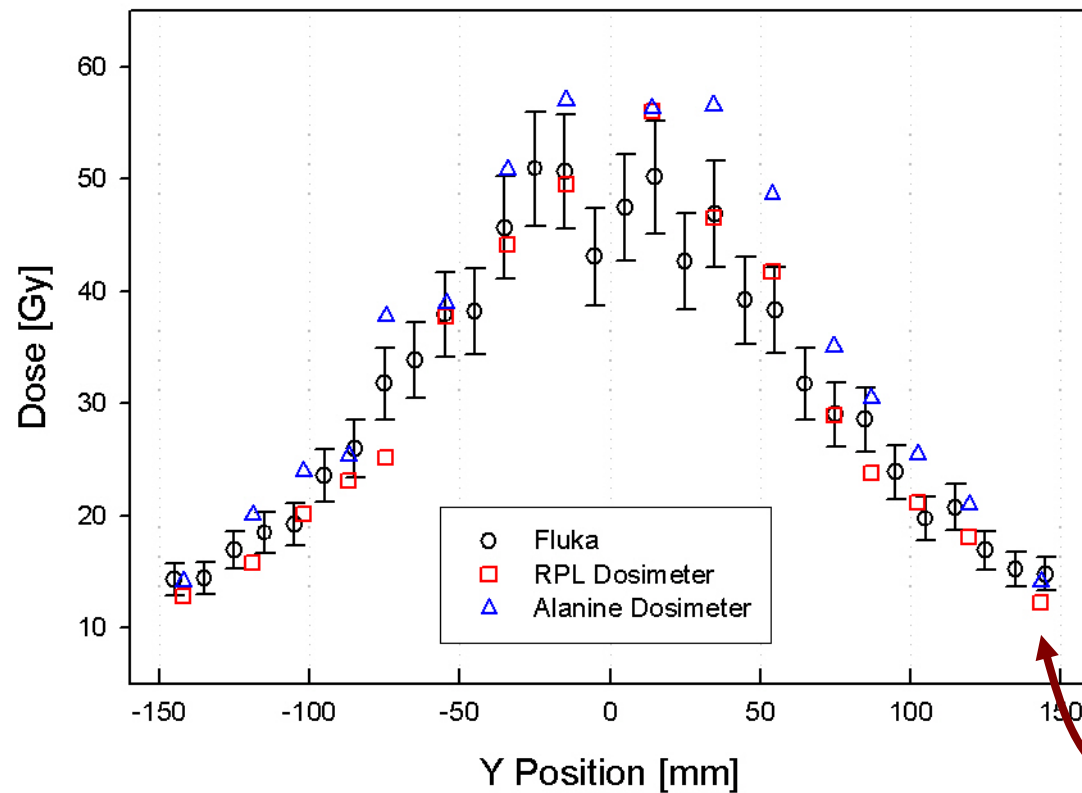
CERF August

Motivation: Investigation of the response function of Alanine and RPL Dosimeter (e.g. according to the direction of the dosimeters)



CERF August

Preliminary results: Comparison between simulation and RPL/Alanine dosimeter measurements



Conclusion

- Various measurement campaigns in mixed high-energy radiation fields were performed in order to improve the knowledge of the HLD systems.
- Measurements at IRRAD1 were performed to build up a proton calibration curve.
- RPL and Alanine dosimeter are well suited for High Level Dosimetry at CERN .
- First simulations were performed allowing a better understanding of the behavior of the HL dosimeters in mixed radiation fields.
- An upgrade of both systems is under way.
- Further analysis of the measurements and simulations is under way.
- Preliminary results look very promising.

Acknowledgment

- Glaser Maurice¹ PH/TA1, Moll Michael¹ PH/TA1
- Ravotti Federico¹ TS/LEA
- My colleagues at SC/RP

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References

- [1] E. Piesch, B. Burgkhardt and M. Vilgis, Photoluminescence dosimetry: progress and present state of the art, Radiation Protection Dosimetry, Vol. 33 No. ¼ pp. 215-226 (1990)

Readout of dosimeter

- Amount of radiacals can be detected with EPR
- Resonance condition
$$h\nu = g \mu B$$
- Relation between EPR signal and absorbed dose

- New dosimeters are under development
- These new dosimeters allow the use of the newer EPR machine
- Further investigation concerning the use of most recent EPR machines for the means of HLD are ongoing



CERF October

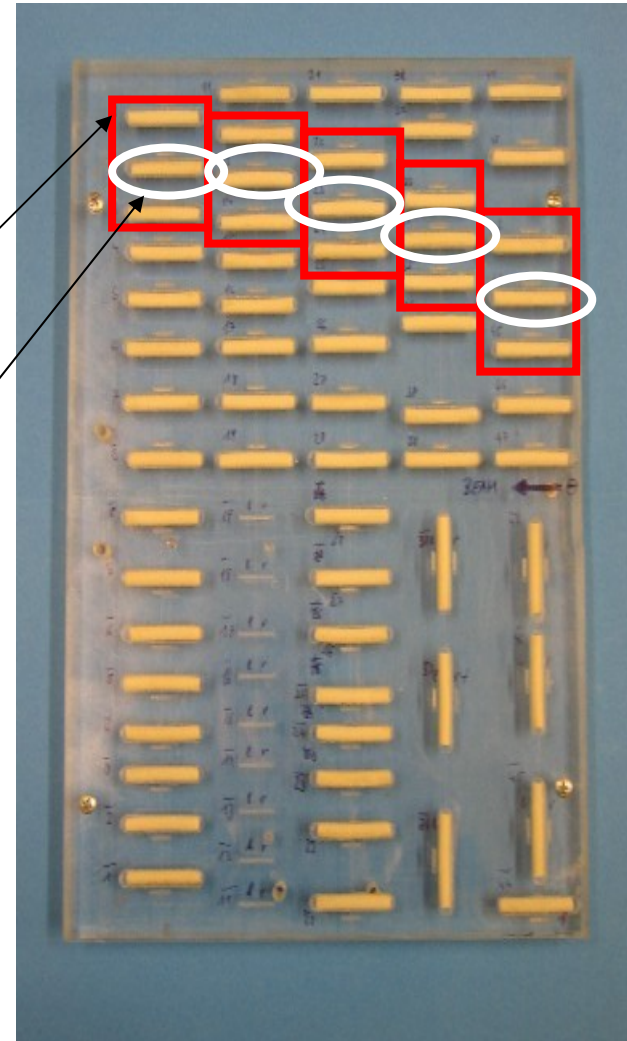
Motivation:

Comparison of the Results from August with:

Positions of the Dosimeter:

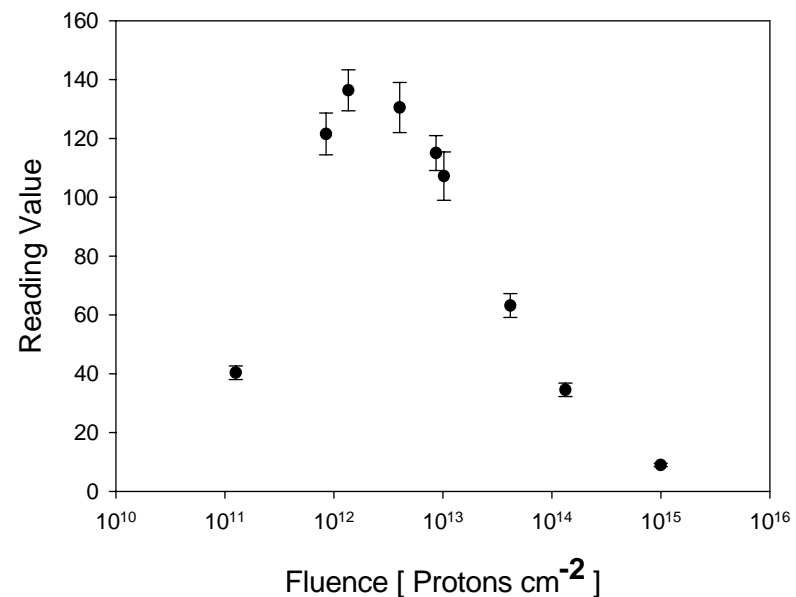
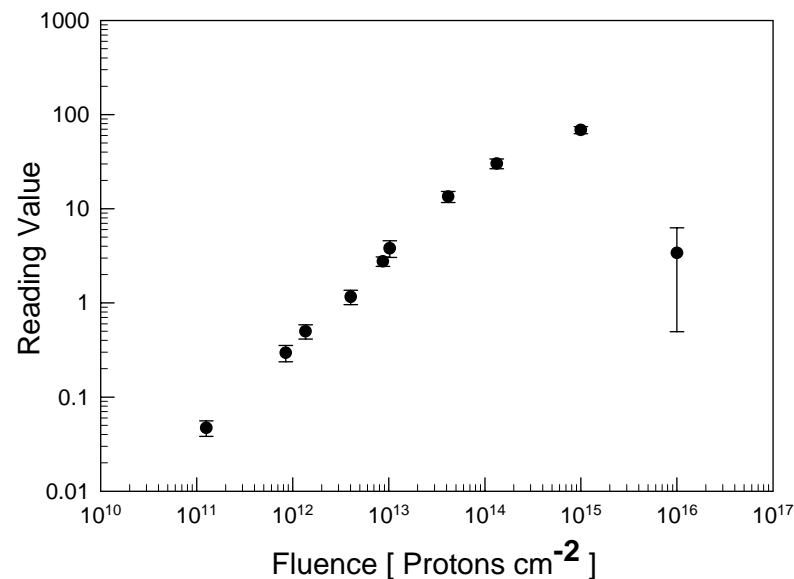
- TLD600/TLD700
- Mini Ionizationchamber
- RPL-Dosimeter

- Analysis is currently ongoing

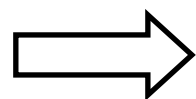


IRRAD1 proton calibration

- Irradiation facility IRRAD1 provides PS proton beam with a momentum of 24 GeV/c
- RPL and alanine dosimeters were exposed up to 10^{16} protons/cm²
- Measurement of Fluence → detector readout curve as a function of dose



Simulations: Fluence to dose in material conversion



Proton dose calibration curve

HLD systems used at CERN
Further development of the systems

SPS → LHC extraction tests (450 GeV/c Protons on beam dump)



- More than two hundred dosimeters (RPL and alanine) were installed on various positions on the dump (TED).
- Analysis of the read out results is ongoing.
- Preliminary simulations were performed.
- Accurate simulations will be performed in order to evaluate the various field components at the given detector positions.
- Measurements will be compared with simulations in order to improve the knowledge of the detector response in mixed fields

