Dose rate measurements of charged and neutral particles in the stratosphere

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- The Balloon flight
- The Phoswich Detector
- Preliminary Results: Phoswich Detector
- Future Work and Summary





Stratospheric Balloon Flight

- **Rome/Italy** 0.09.2010 08.09. **15th WRMISS**
- Balloon flight near Stillwater/ Oklahoma: cutoff rigidity 4 GV
- Height ~ 30 km
- Duration ~ 2 hrs
- payload restricted to 3 kg total mass
- two instruments designed to measure dose rates
 - Dosimetry telescope based on silicon diodes to measure charged particles
 - Phoswich detector based on two different scintillators to measure neutrons and γ-rays



C A UThe Instrumental Setup for the
Balloon Flight

1eap



Dimensions:

on top : 125 mm x 155 mm at the bottom: 160 mm x 180 mm total height : 230 mm total weight : ~ 2 kg without insulation





The Scintillation Detector



Phoswich Detector: Sensor Head



- **Rome/Italy** 10.09. 2010 15th WRMISS 08.09.
- two dissimilar scintillators are optically coupled to one photomultiplier (PMT)
- inner plastic scintillator BC412 and anti-coincidence made of CsI(Na) read out by PMT







The Scintillators



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• <u>BC-412</u>

- based on polyvinyltoluene, density: $1.032 \text{ g/cm}^3 \rightarrow \text{tissue equivalent}$
- decay time 2.4 ns
- wavelength of max. emission: 434 nm
- <u>Csl(Na)</u>
 - high density (4.51 g/cm³) and high atomic number \rightarrow high cross section for γ rays
 - decay time 630 ns
 - Wavelength of max. emission: 420 nm



C A U Electronics for the Phoswich Detector





- fast preamplifier, a fast ADC and an FPGA
- the signal goes differentially to the ADC
- the signals are further processed in the FPGA: two linear combinations are multiplied with the samples of the measured pulse
- data are stored on a SD card



Preliminary results

Measurements at the PTB: Calibration with Neutrons





- Red: 14.8 MeV primary neutron energy
- Green: 8 MeV primary neutron energy

U

C

CAU **Pulses from both Scintillators**





Rome/Italy 15th WRMISS 08.09. – 10.09. 2010













Convolved Pulses







Neutrons 14.8 MeV:mixed pulse





C A U <u>14.8 MeV neutrons and Bi207</u> gammas













Cut for neutrons









8 MeV Neutrons





Red: mixed signal, Blue: gamma events, Green: neutron events – 8 MeV neutrons at 284 mV



14.8 MeV Neutrons







Red: mixed signal Blue: gamma events Green: neutron signal ₁₉ – 14.8 MeV neutrons at 585 mV



Quenching in Plastic Scintillators





Future Work



- Improvement of the pulse shape analysis: use different linear combinations for the convolution to achieve the best separation for neutrons and gammas
 - First atmospheric measurements:
 - Measurement onboard an airplane: middle of September
 - Balloon flight in Oklahoma: Beginning of November



Summary

Silicon detector:

 has been built, tested and calibrated at HIMAC/NIRS with different heavy ions → works well



- Phoswich detector:
 - has been built and tested
 - calibration results show that by pulse shape analysis a cut can be found that distinguishes between gammas and neutrons





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