

Diamond hodoscope for hadron therapy

Michal Pomorski, Benoit Caylar, Philippe Bergonzo

Introduction-GamHadron

Experimental

Detector, Electronics and DAQ

Collection

Timing

Detectio

High Rate

Summary

Diamond hodoscope for hadron therapy

Michal Pomorski, Benoit Caylar, Philippe Bergonzo

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1st ADAMAS workshop, December 16-18th 2012, Darmstadt, Germany

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GamHadron Partners

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Charge Collectio Spectra

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Summary

GamHadron - Compton Camera for in vivo real time dose imaging in hadron therapy

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Outline

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- Charge Collection Spectra
- Timing
- Detection Efficiency
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3 Summary



$\mathsf{Prompt}\ \gamma$

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Prompt γ imaging: principle and feasibility studies



All content here Denis Dauvergne, IPN Lyon



GamHadron

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Electronics at DAQ Charge Collection Spectra Timing Detection Efficiency

High Rate Hit Map

Summary

A Beam-triggered Compton



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- Initial design study: 3 interaction-system
- Hodoscope: x,y,T
- Reconstruction = line-cone intersection

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GamHadron Hodoscope

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Efficiency High Rate Hit Map

Summary

Requirements for GamHadron Hodoscope:

- \blacksquare area 10 x 10 mm²
- position resolution <1 mm
- time resolution < 1 ns
- rate capability > 1 GHz/total area
- radiation hard

two candidates: scintilating fibers and diamond hodoscope

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Diamond Detector

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Summary

 3×3 cm² pcCVD diamond forseen for the test crushed just three days before beamtime.....





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Final configuration:

1x1 cm 2 EG pcCVD diamond (500 μm thick), Al 1.8 mm 4(X)x4(Y) strips with 100 μm pitch

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Electronics and DAQ

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Laboratory testing with 5.48 MeV α source

Electronics (8x Cividec voltage amplifiers) and DAQ (2 x LeCroy 2GHz DSO)

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Beamtime Configuration

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IPN Orsay tandem accelerator ALTO, 25 MeV p, 3.75MeV deposited in 500 μ m diamond



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Charge Collection Spectra

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Detector, Electronics ar DAQ

Charge Collection Spectra

Detection Efficiency High Rate Hit Map

Summary

Integral of current pulses for X1, X2, X3 strips from X plane, plastic trigger, HV = 700 V



SAC

Cea

Time Measurements

 $\label{eq:lambda} \begin{array}{l} \Delta t \mbox{ pcCVD diamond hodoscope (@700V) vs. plastic} \\ \mbox{and pcCVD hodoscope (@150V) vs. 3DDD (@150V)} \end{array}$



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About 100 random single-shots with aquistion time of 1 ms trigger event = plastic and diamond X(i) coincidence





An example of single-shot

hit efficiency (inter-strip events corrected)

100% detection efficiency vs. plastic

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High Rate

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stable, no cross-talk

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Hit Map

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Detector, Electronics : DAQ Charge Collection Spectra Timing Detection Efficiency High Rate Hit Map

Summany

no hit map at current stage..... we lost synchronization between files on two scopes need to analize about 30 Gb data but:

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- all chanels active
- no evidence of cross-talk
- inter-strips events observed
- double hit at high rate(?)



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 $1 \times 1 \text{ cm}^2 \text{ pcCVD}$ diamond double sided strip detector tested in 25 MeV proton beam. All requirements (apart of size....) of GamHadron hodoscope fulfiled:

- position resolution strip size limited (more precise for inter-strip events)
- time resolution $\sigma = 308$ ps (vs. plastic (plastic limited)) and $\sigma = 101$ ps (vs. 3DDD (low E field))
- \blacksquare rate capability (drift velocity limited) 0.1 GHz per strip for 500 $\mu \rm m$ thick
- stable operation, no evidence of cross-talk
- radiation hard (?)

Now need: 10 \times 10 cm^2 diamond (mosaic), multichannel integrated electronics ...

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