SC-diamond for ToF measurement with relativistic particles: First beam test with ²⁷Al ions @ 2 AGeV or The new start detector for FoPi experiment



workshop @ GSI, Darmstadt, 30.08. - 1.09. 2005.

NoRHDia

FoPi @ GSI

- 4π-detector for charged particles
 - large acceptance
 - good particle identification
 - high count rate
- SIS synchrotron beam energy ranges from 0.1 to 2 AGeV depending on the beam particles
- projectile/target heavy ions – Ca, Ni, Zr/Ru, Au...
- intermediate energy phenomena – flow, particle production (especially kaons), clusterization



START detector (present): scintillator readout via two PMs



- in-beam START detector: (scintillator foil 50÷300 μm)
- good resolution for heavy ions: $\frac{1}{2}(T_1 + T_R) \sim 45.50 \text{ ps}$
- STOP: ~ 1000 scintillators (~ 120÷350 ps)
- rate: < 10⁶ Hz
- expected for *p*-beam S297 (Fall 2005.): 10⁸/spill
- also for RPC: additional 2500 channels (~ 80 ps)

Experiment in Nov. 2004.: test of the polycrystalline diamonds







- test-beam ¹⁸⁴Ta @ 1050 AGeV
- two different types of diamond detectors tested:
 a: 10x10 mm², 600 µm
 b: "HADES"-type 8-fold strip detector 25x15 mm², 200 µm
 Diamond detectors by E. Berdermann

RPC FEE (1st generation)



- high gain amplifier (~200)
 for ToF: intrinsic time resolution (jitter < 5 ps)
 high counting rate
 - modification required

FoPi DAQ

TDC LRS 2228 A

50 ps/chan

QDC LRS 2249 A

R&D by M. Ciobanu



D2: 94% H: 70% (for all strips), 55% (single strip)

Analysis by A. Zhilin

Test of diamond detectors with ²⁷Al beam @ 1.9 AGeV

- standard START setup with 300 µm scintillator
- average rate during experiment 0.7 MHz
- diamond-detectors:
- polycrystalline-CVD diamond 10x10 mm², 500 μm, d = 8 mm
- single-crystal diamond 4.3x4.3 mm², 300 μm, d = 3 mm
- supplied signals high enough to be used with RPC FEE-card



Results for PC diamond detector



Results for SC diamond detector



- obtained efficiency (relative to each other): D1: 92% D2: 91%
- only time cuts were used
- energy response is better then for PC-CVD, but signal still small
- no walk-correction
- stability issue
- intrinsic TDC resolution
- additional analysis necessary

Summary: diamond as ToF start detector

- good time resolution possible
- PC diamond for heavy-ion detection (min Z ???)
- SC for MIPs, light ions
- for proton-beam experiment we need SC diamond
- detailed study of time resolution/rate/efficiency with a dedicated electronics setup
- single-crystal diamond size ???
- maximum active area d = 4 mm
- FEE development
- modification of present RPC FEE design
- next generation charge-sensitive amplifier
- FoPi:

what we can have for Oct. 2005. proton-run?