DIAMOND SENSORS:
ACTIVITIES @ DESY Zeuthen

Wolfgang Lange

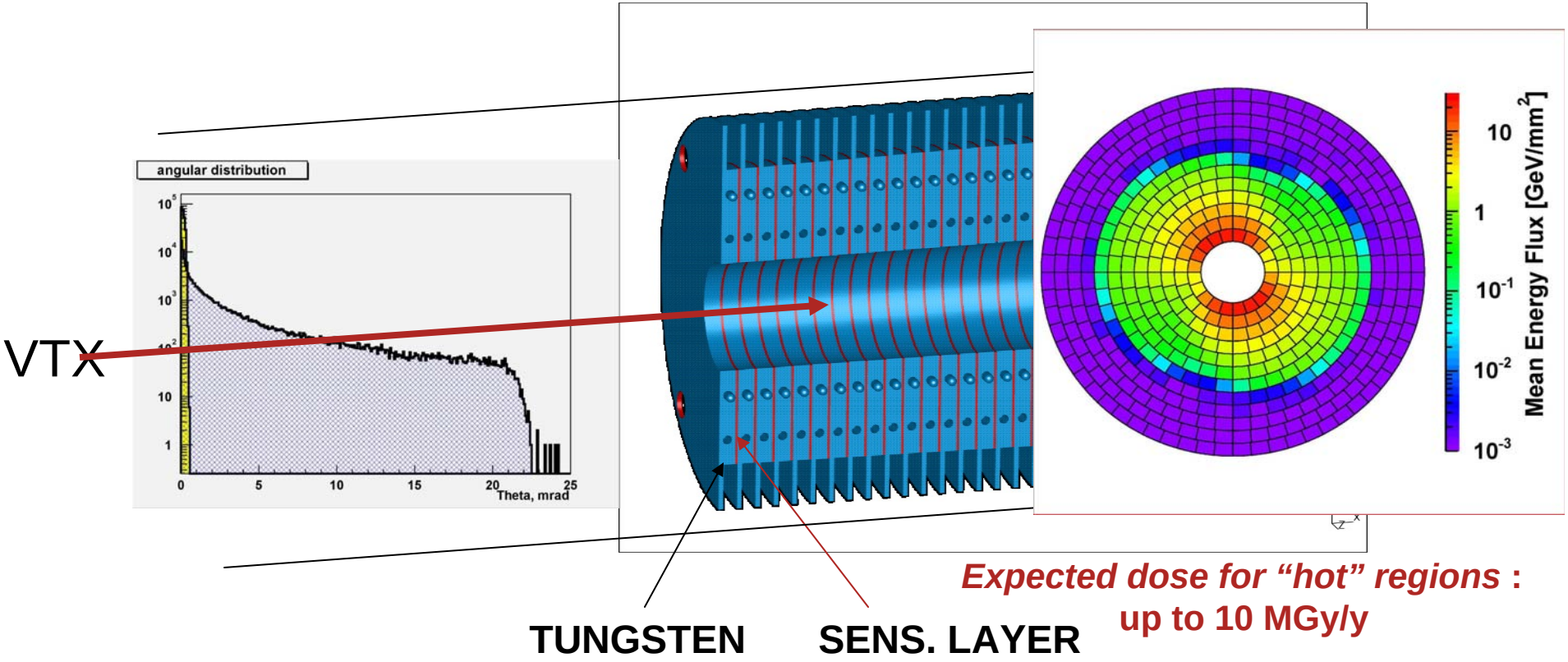
QuickTime™ and a
Graphics decompressor
are needed to see this picture.

OUTLINE OF THIS TALK

1. Motivation - People
2. First Sensors
3. Measurements
    1. Static
    2. Particle Detection (Source)
    3. Particle Detection (Testbeam)
    4. Additional Analysis
4. Results
5. Outlook

MOTIVATION - CALORIMETRY

- Calorimetry in an environment with high radiation doses (TESLA beam cal: Si-W or Diamond-W)

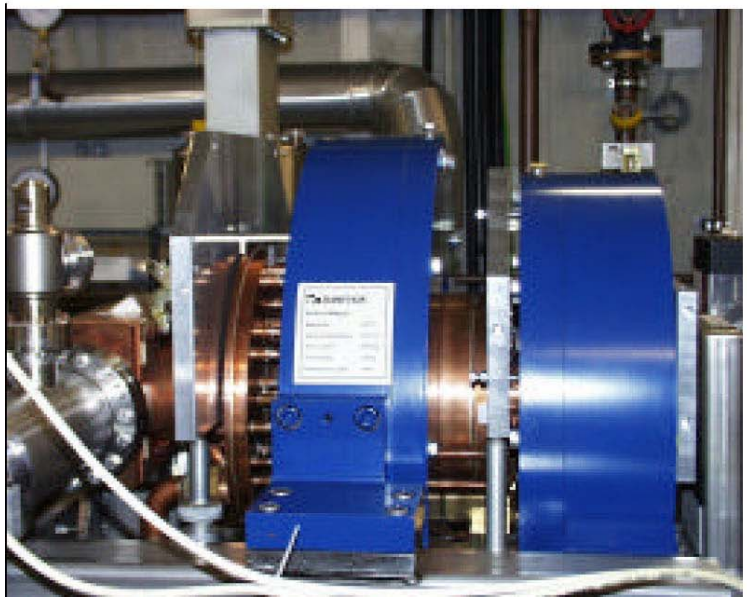


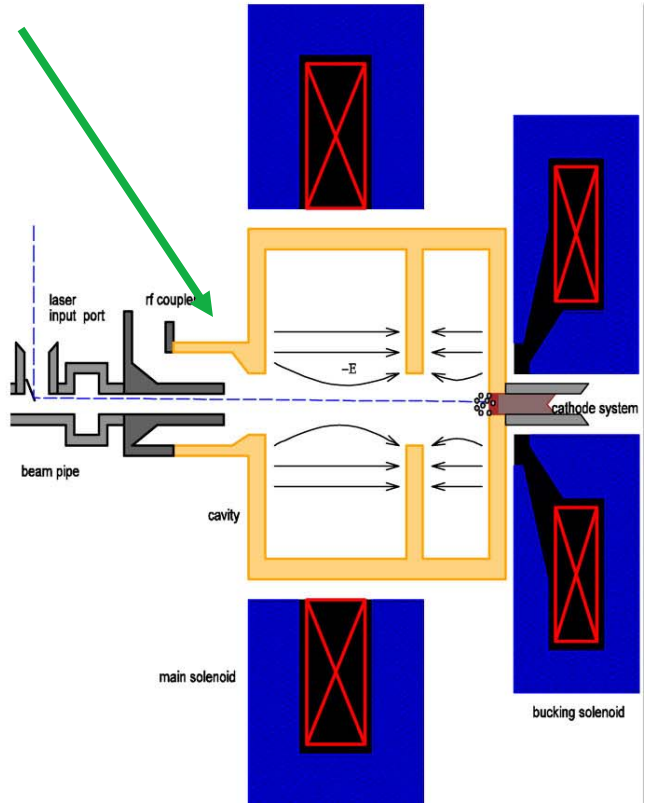
Expected dose for "hot" regions :
up to 10 MGy/y

MOTIVATION - BEAM DIAGNOSTICS

- Beam diagnostics in an environment with high radiation doses (accelerator - electron source, dark currents in cavities etc.)

Measurement of dark current





PEOPLE

- Currently 2 physicists (part of their time)

  1 PhD student (2 soon?)

  1 Postdoc (applications now checked)
- Support from ‘applying’ groups like Photoinjector…
- -> Small group, few people:

  search for potential collaborators under the headline:

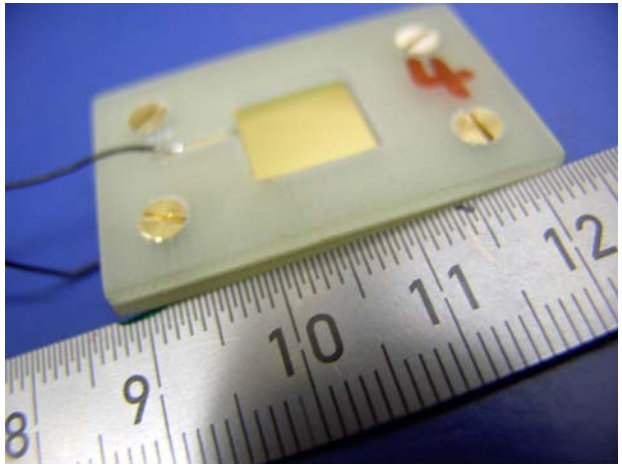
  Who does apply or produce diamonds?
  - DESY HH, GSI Darmstadt, IAP Freiburg
  - GPI Moscow, JINR Dubna
  - CERN / existing collaborations?
  - Diamond material from E6
- Decision: LEARNING BY DOIING…

FIRST SENSORS

Prototyping of sensors from different manufacturers: IAP, GPI, E6

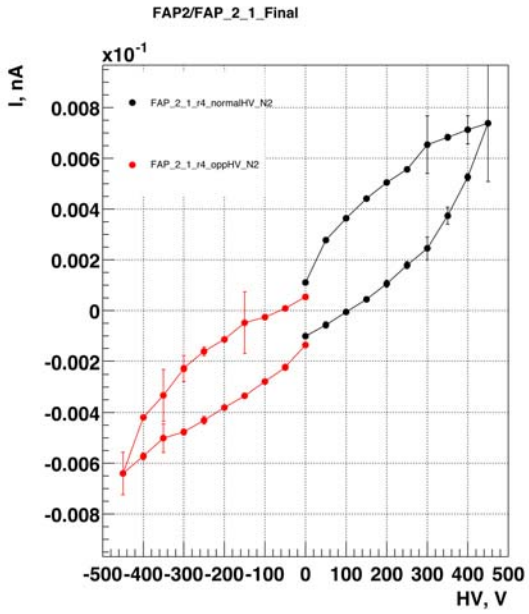
- IAP: polycrystalline CVD samples with different finishing and treatment
- GPI: different CVD polycrystalline samples
- E6: 2 CVD samples bought

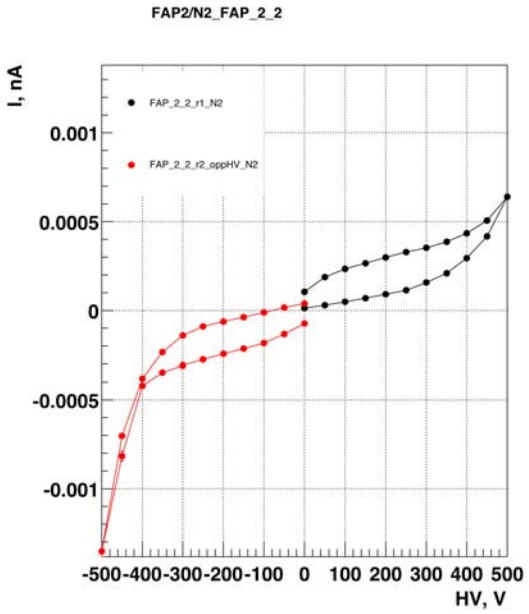
--> **INVESTIGATION OF PROPERTIES**

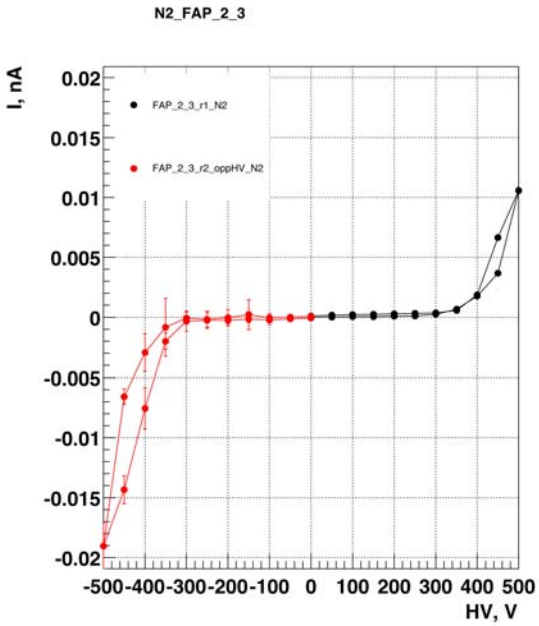


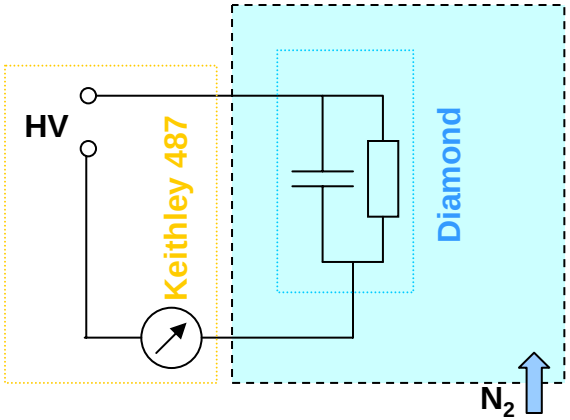
Sensors: up to 1cm², ≤ 500µm thick
Frames: take care of leakage currents

STATIC MEASUREMENTS



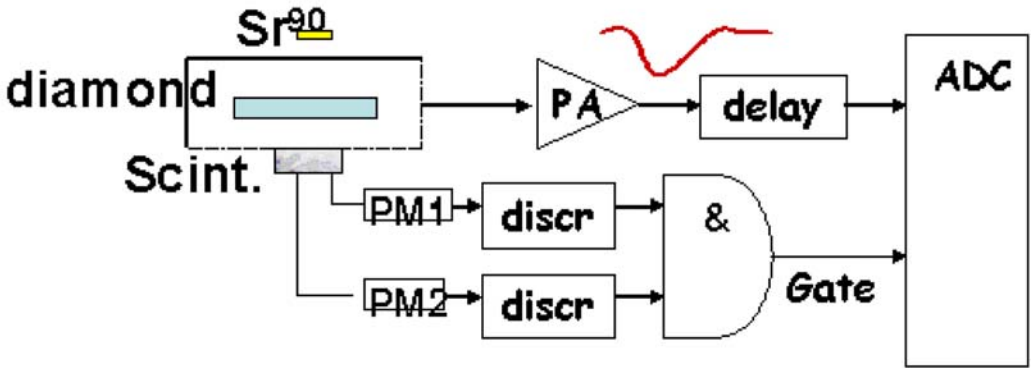




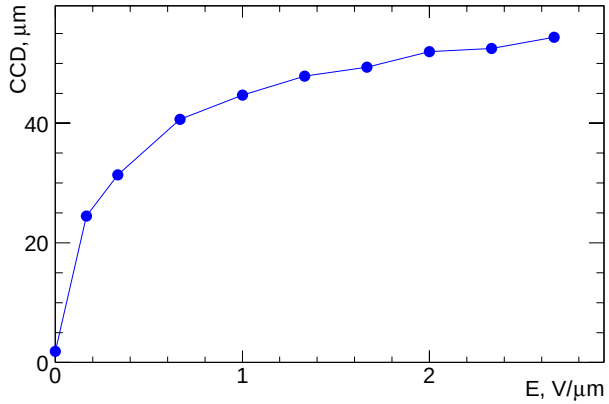


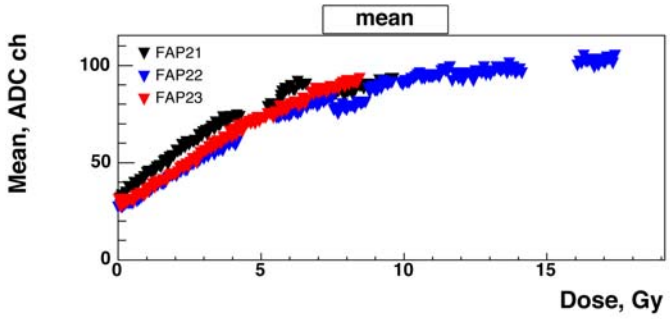
- Three different ‘behaviors’ observed:
  - symmetric I/V
  - asymmetric I/V
  - asymmetric I/V with ‘break through’
- Hysteresis effects for all sensors seen

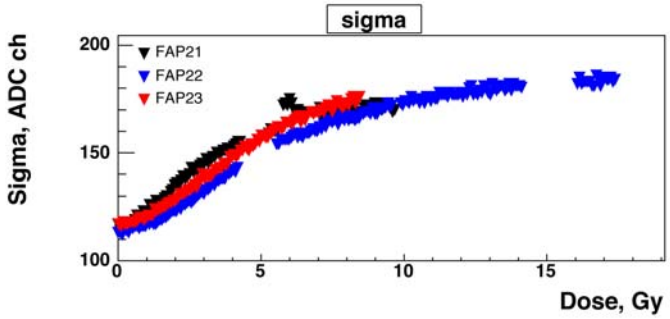
ELECTRONS FROM A ß SOURCE

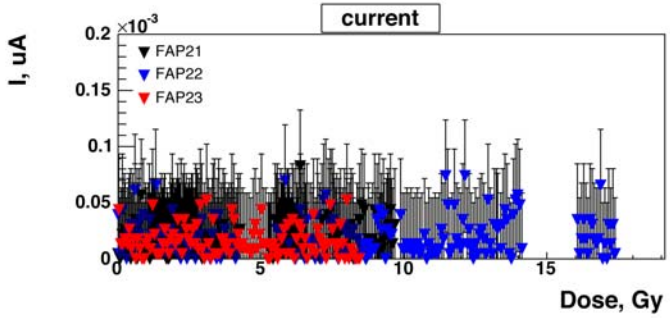


FAP33 - positive HV







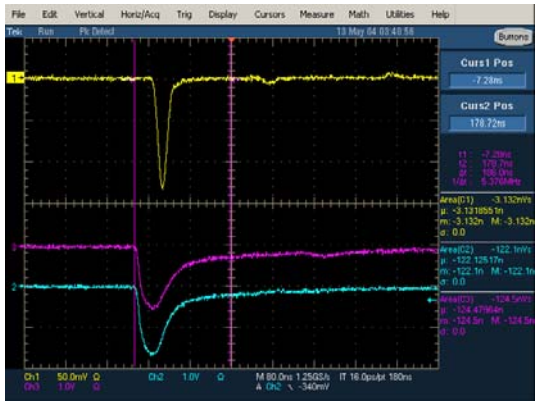


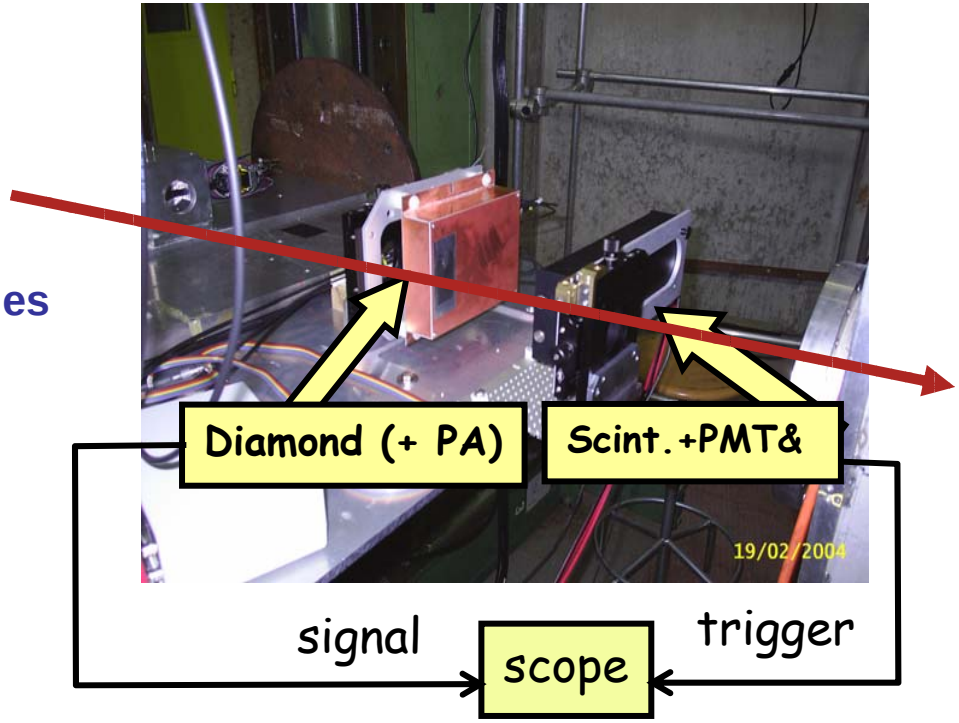
MEASUREMENTS IN TESTBEAM (1)

- Hadronic beam, 3 & 5 GeV
- 2 ‘extraction’ modes:

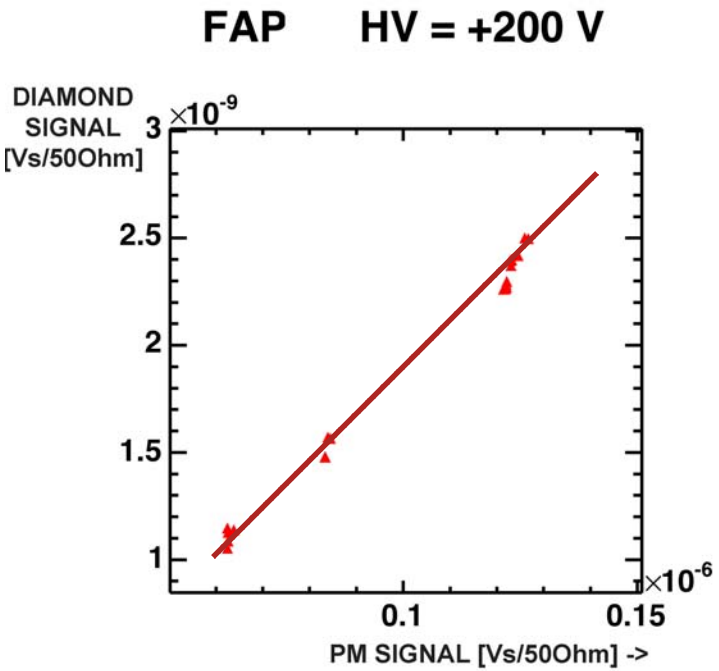
~ 1 s slow extraction ~10^5 - 10^6 continously

~ 10ns fast extraction ~10^5 - 10^7 particles



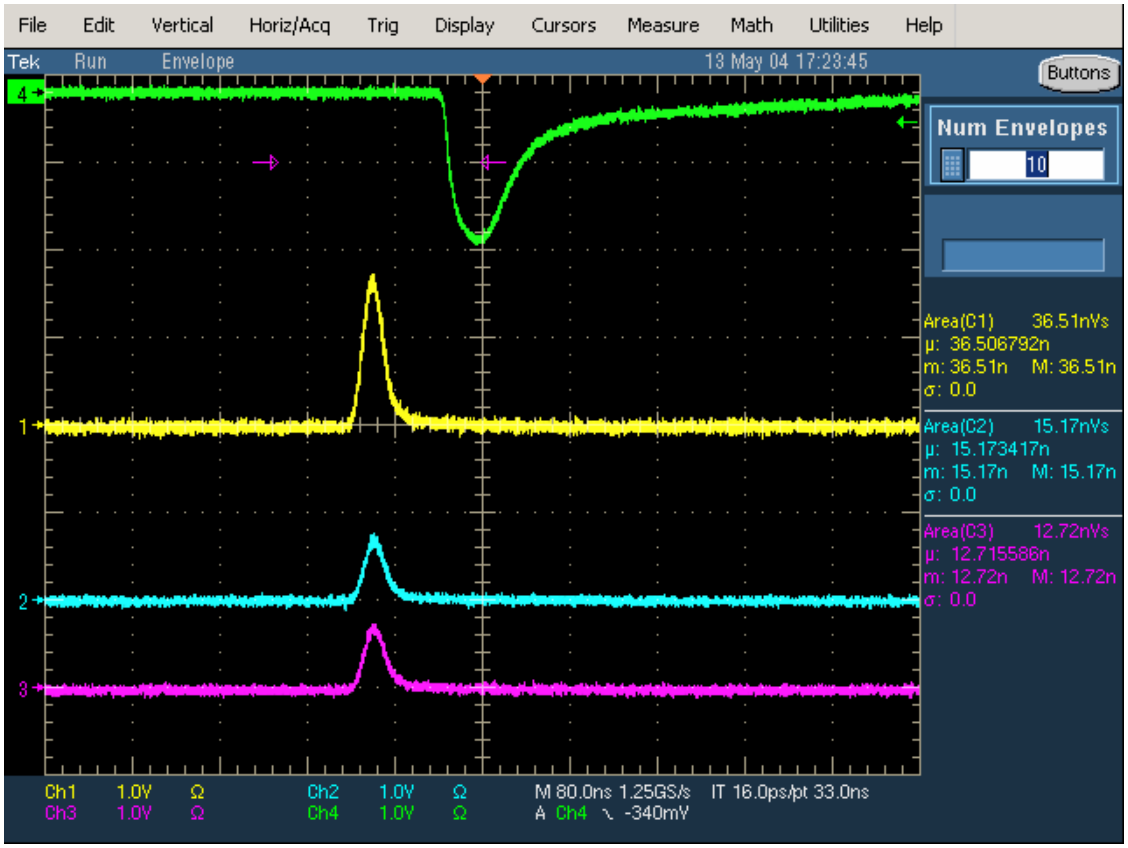


MEASUREMENTS IN TESTBEAM (2)



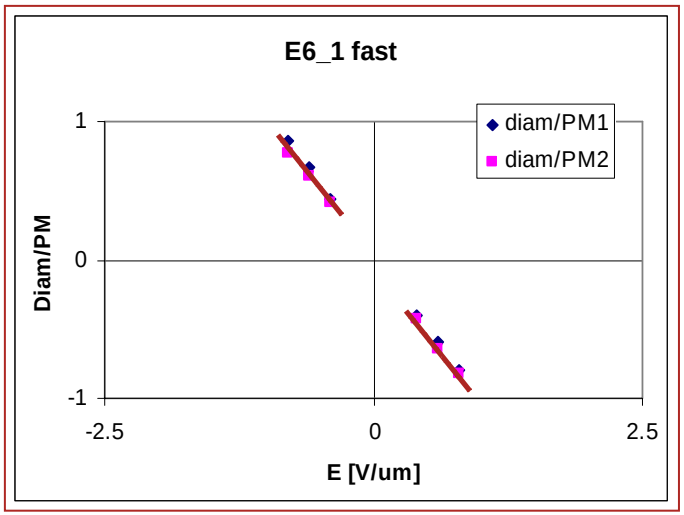
MEASUREMENTS IN TESTBEAM (3)

Sensor (1 cm^2) with structure: 4 (2*2) pads, 5 GeV/c (CERN PS T7)



2 pads parallel (yellow)
2 individual (blue and magenta)

Scintillator for calibration (green)



ADDITIONAL ANALYSIS

We are currently investigating different analysis methods to find out correlations between their results and observed ‘detector’ properties of the diamonds:

- Raman spectroscopy to identify different carbon modifications (graphite or diamond) and of other elements (N_2) contained
- Infrared spectroscopy
- -> collaboration with Fraunhofer (FAP Freiburg) and local universities

RESULTS

- diamonds from different manufacturers investigated
- different charge collection efficiencies observed:
  GAP < FAP < E6 (CCDs of xxxµ*m* < yyyµ*m* < zzzµ*m*)
- linearity from 1 MIP to about 10^5 particles within 10 ns
  (~ 200 pC signal charge)
- samples irradiated with up to 20 Gy
- E6 diamonds perform best - others could also be used
- diamonds with a removed substrate side show a more
  stable and predictable behaviour
- structured sensors seem to perform as expected
  (only capacitive effects)
- treatment of sensors (irradiation: pumping, heat etc.)
  needs more understanding and experience (‘black art’)
- for fast and large signals current readout to be investigated

OUTLOOK

- continued measurements with high ionization (> 10^5 particles)
- investigation of pumping (irradiation) and thermal treatment
- larger sensors
- investigation of different readout methods (charge, current)
- improve analysis to control properties of CVD diamonds
- applications in beam monitoring etc.

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