# DIAMOND SENSORS:
## ACTIVITIES @ DESY Zeuthen

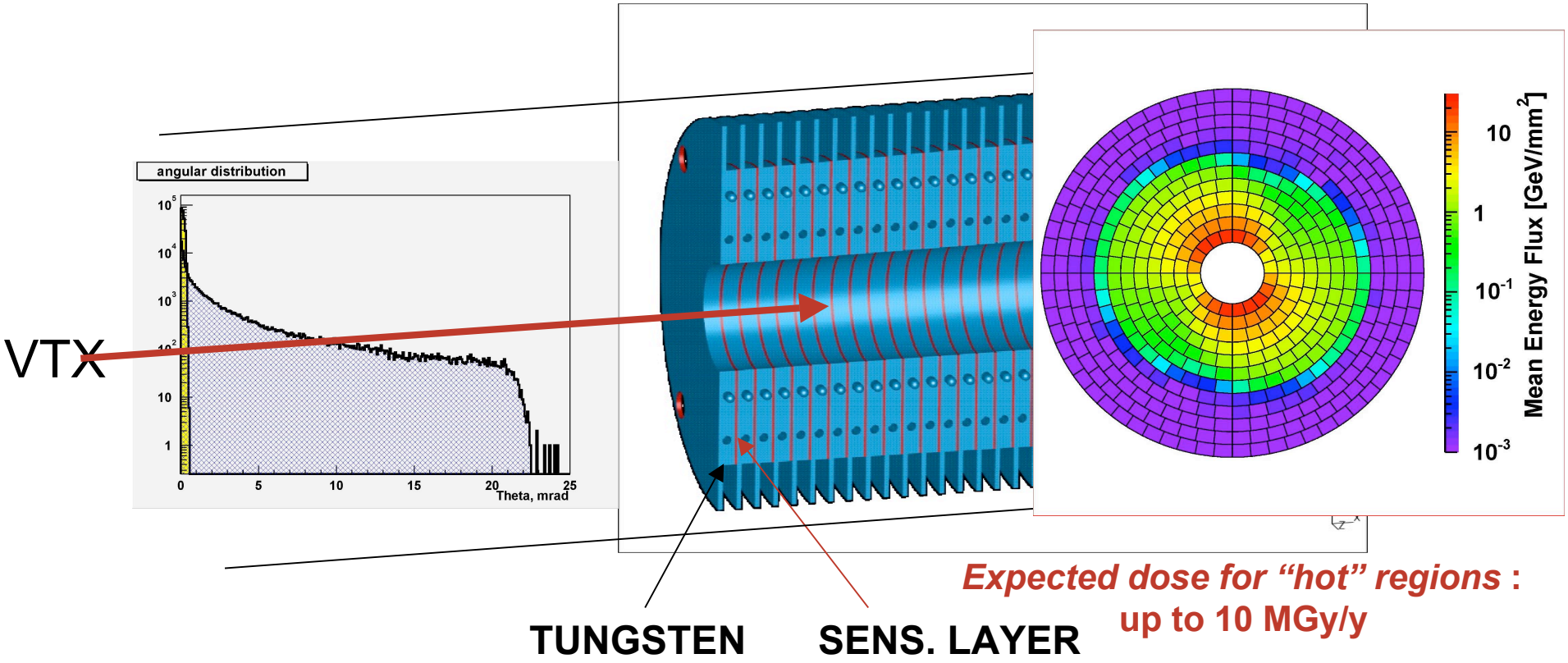
Wolfgang Lange

# 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

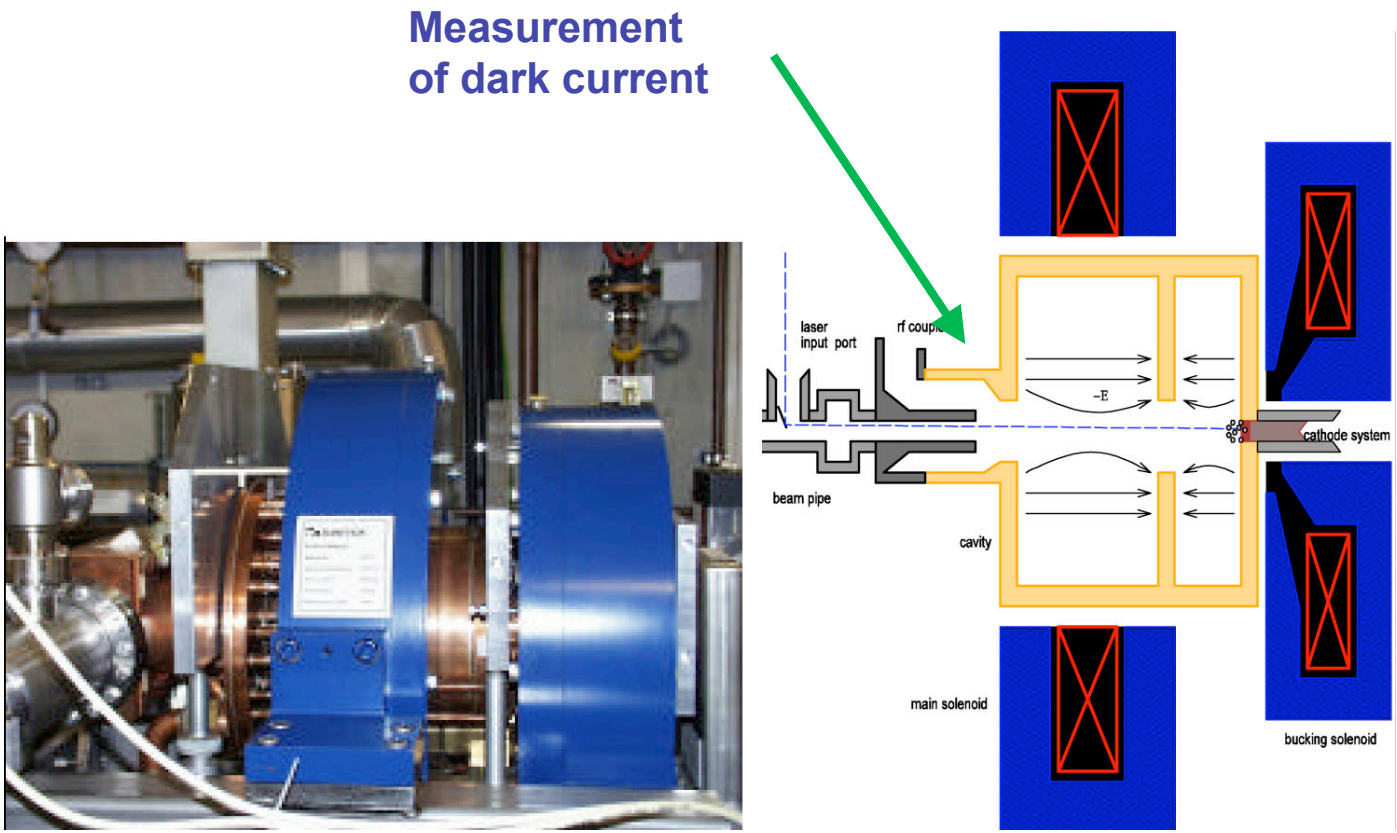
# MOTIVATION - CALORIMETRY

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



# MOTIVATION - BEAM DIAGNOSTICS

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



# 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:

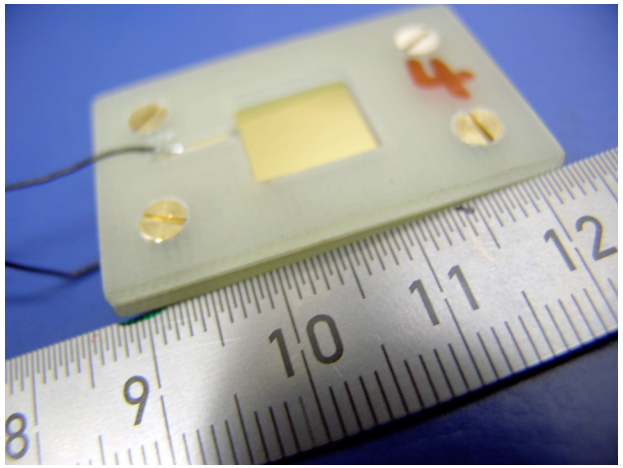
  *Who does apply or produce diamonds?*
  - DESY HH, GSI Darmstadt, IAP Freiburg
  - GPI Moscow, JINR Dubna
  - CERN / existing collaborations?
  - Diamond material from E6
- Decision: LEARNING BY DOIING…

# FIRST SENSORS

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

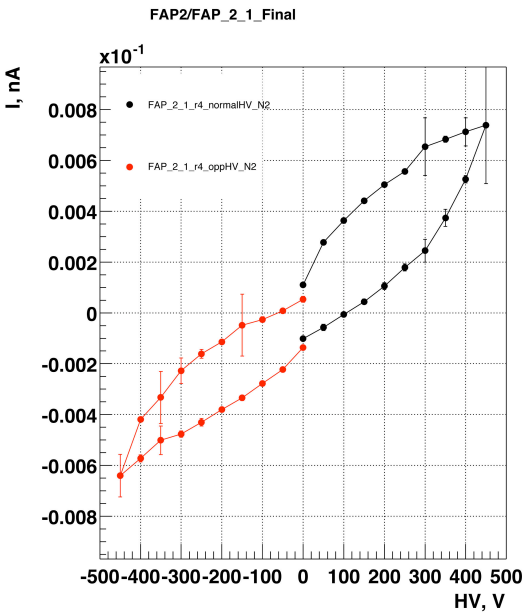
- IAP: polycrystalline CVD samples with different finishing and treatment
- GPI: different CVD polycrystalline samples
- E6: 2 CVD samples bought

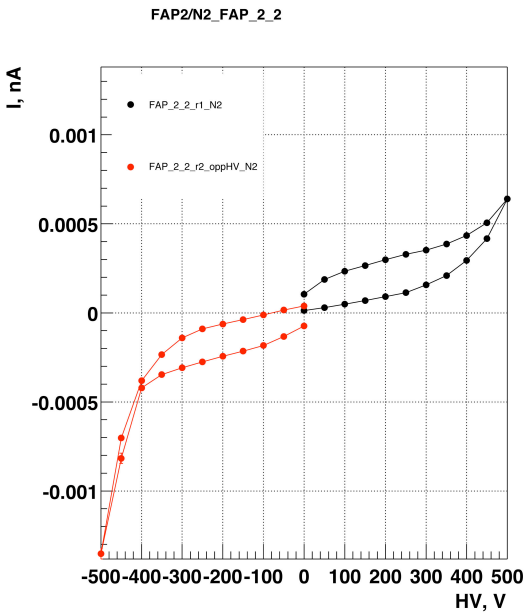
**--> INVESTIGATION OF PROPERTIES**

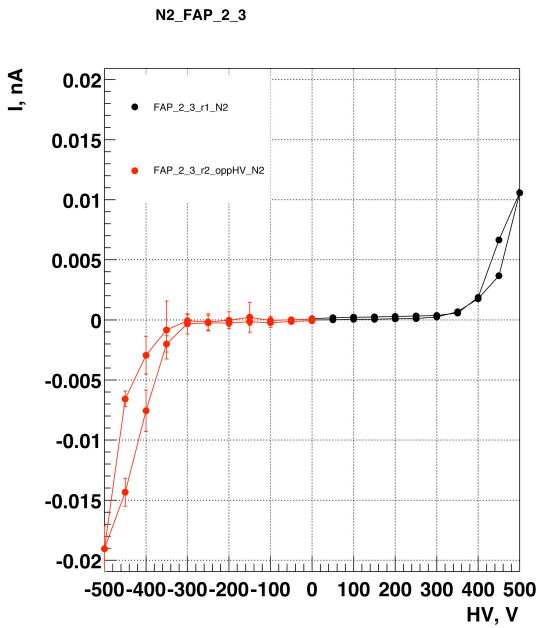


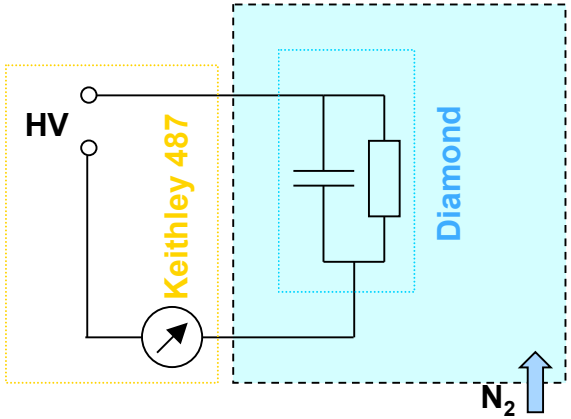

Sensors: up to 1cm², ≤ 500$\mu$m thick
Frames: take care of leakage currents

# STATIC MEASUREMENTS



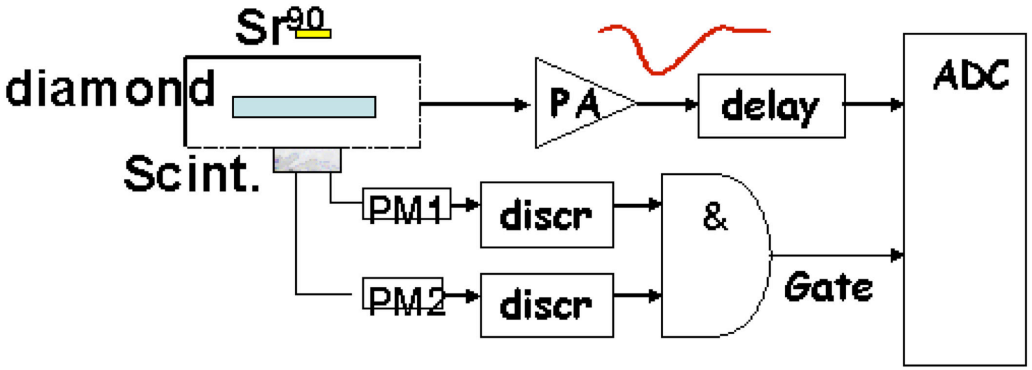



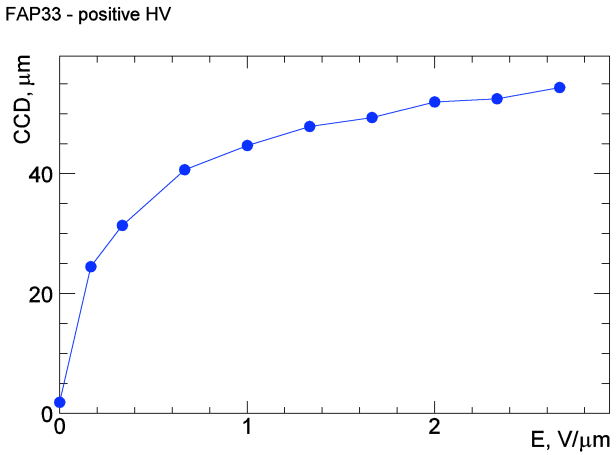



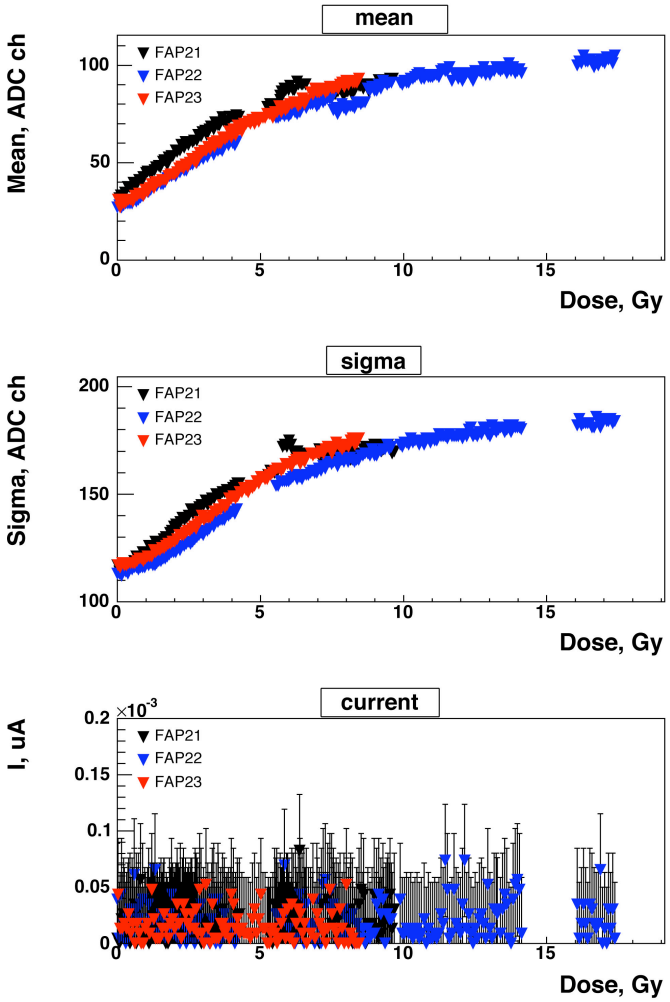




- Three different 'behaviors' observed:
  - symmetric I/V
  - asymmetric I/V
  - asymmetric I/V with 'break through'
- Hysteresis effects for all sensors seen

# ELECTRONS FROM A ß SOURCE



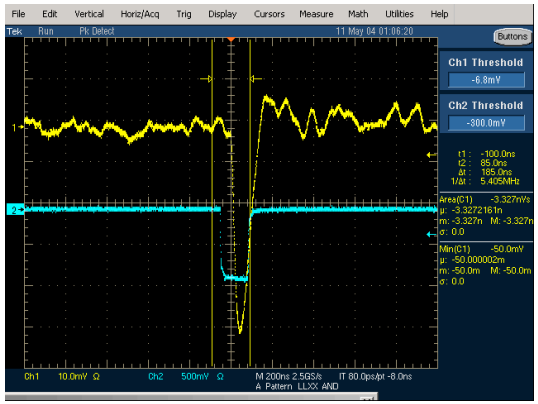



# MEASUREMENTS IN TESTBEAM (1)

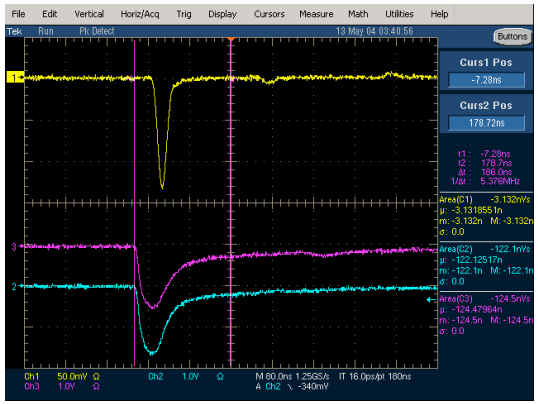
- Hadronic beam, 3 & 5 GeV
- 2 ‘extraction’ modes:

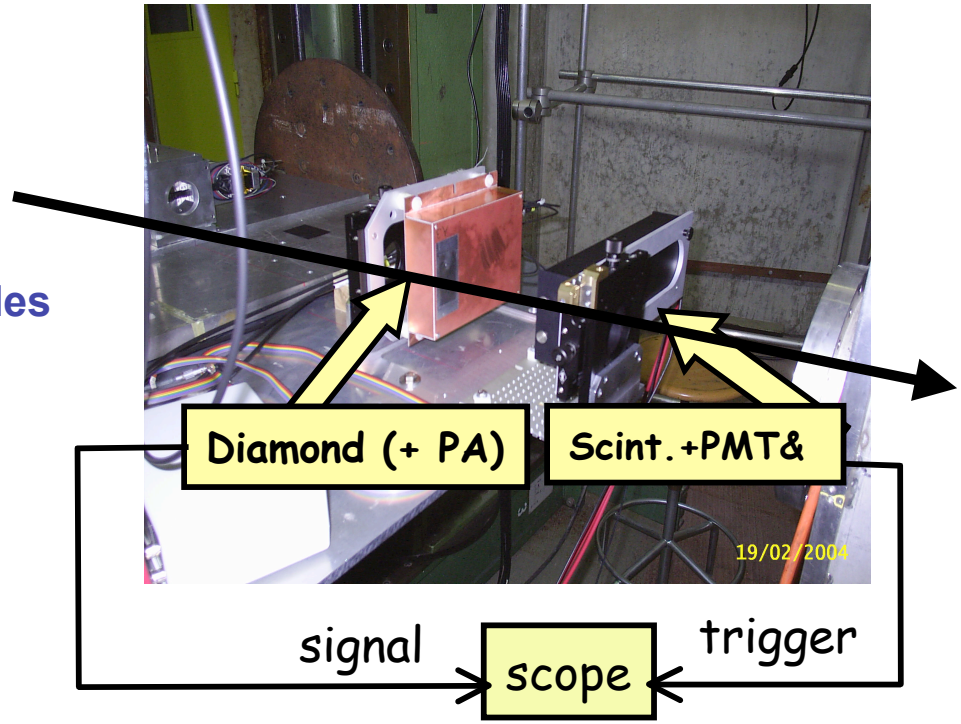
**~ 1 s slow extraction ~$10^5$ - $10^6$ continously**



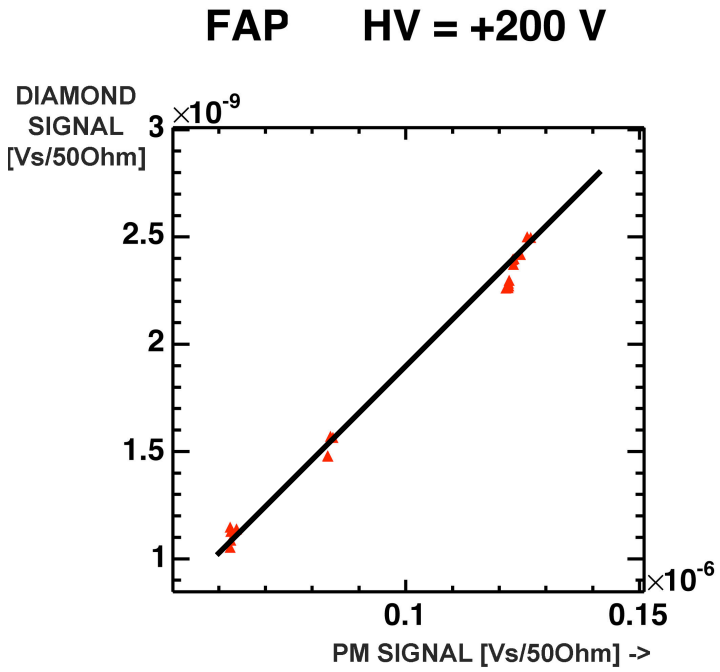


**~ 10ns fast extraction ~$10^5$ - $10^7$ particles**



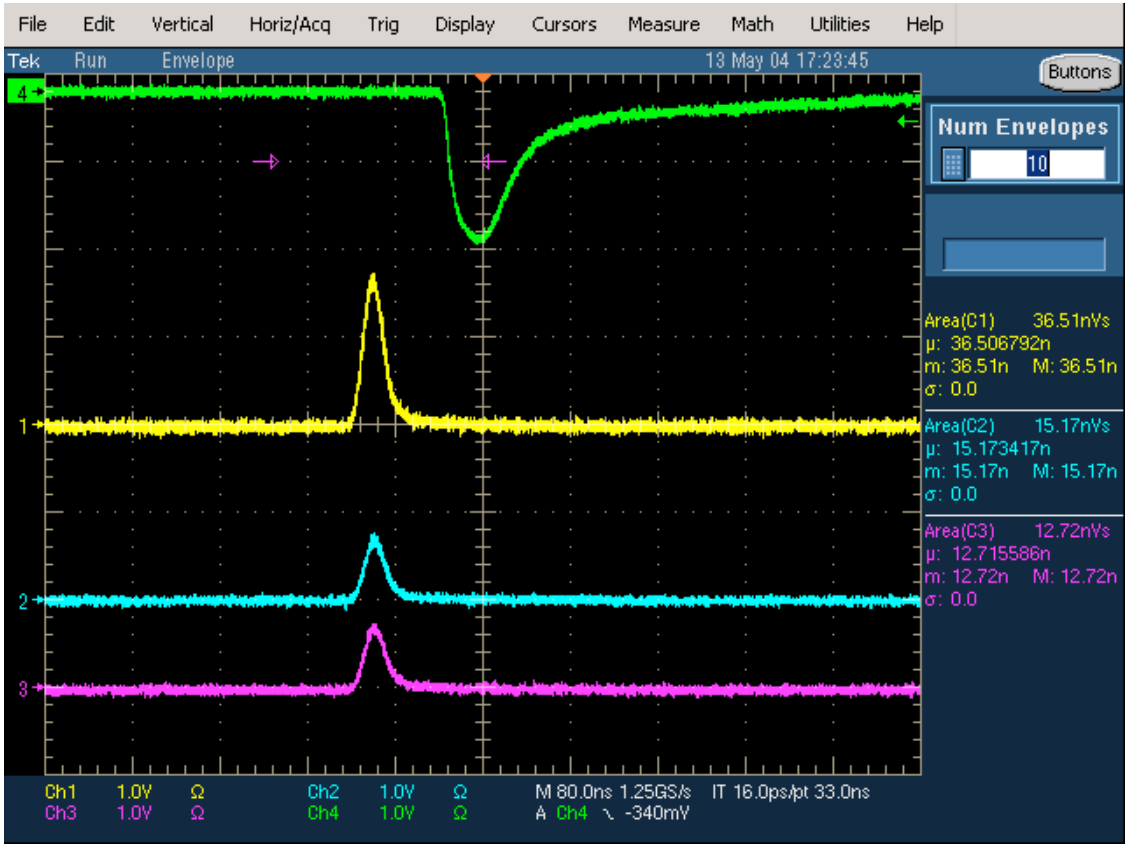



# MEASUREMENTS IN TESTBEAM (2)



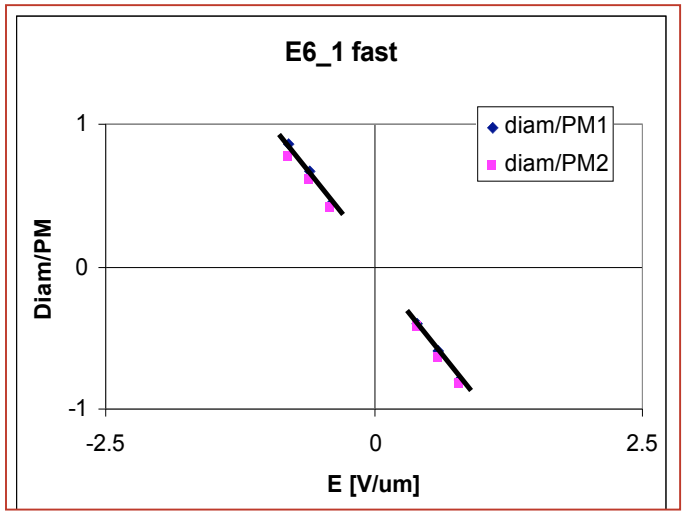
# MEASUREMENTS IN TESTBEAM (3)

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 xxx$\mu m$ < yyy$\mu m$ < zzz$\mu m$)
- 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.