Diamond Sensors for Beam Monitoring

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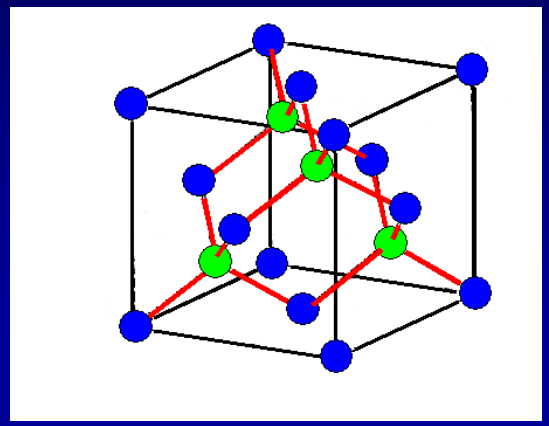
Diamond is an extraordinary material

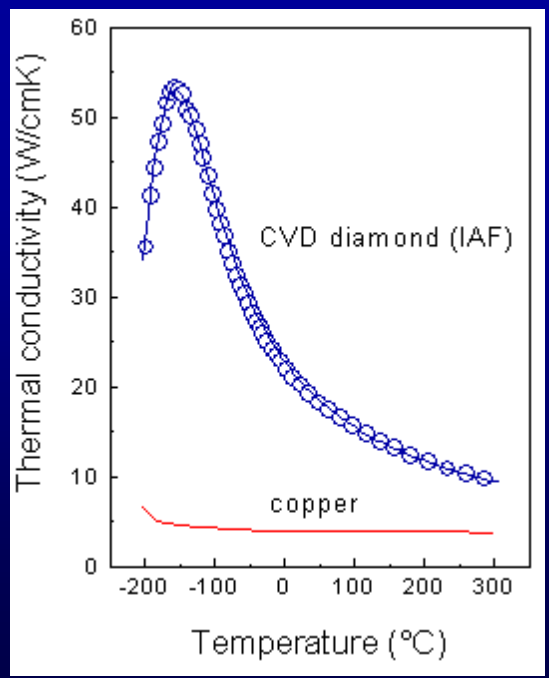
Highest atomic number density (1.77 x10^{23})

Extremely hard (10,000 kg/mm^2)

Thermal conductivity (20.0 W/cmK)

Radiation Hard !



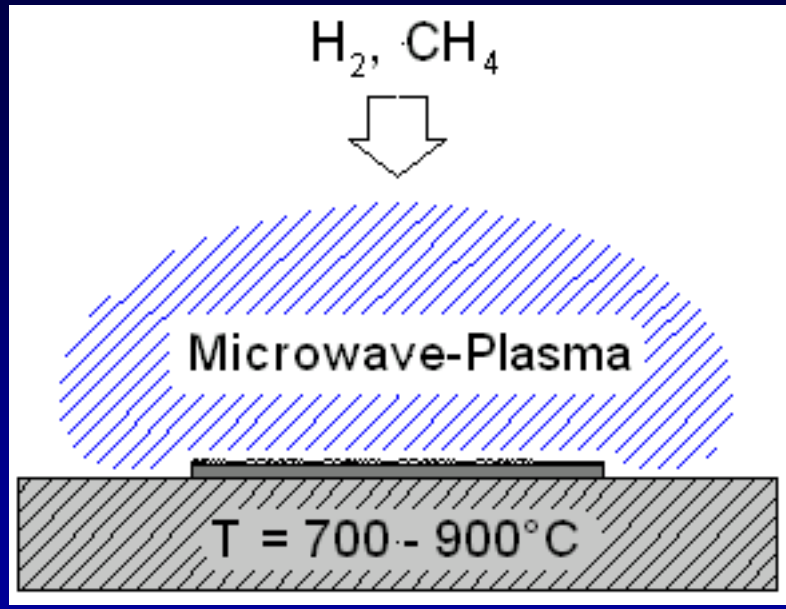


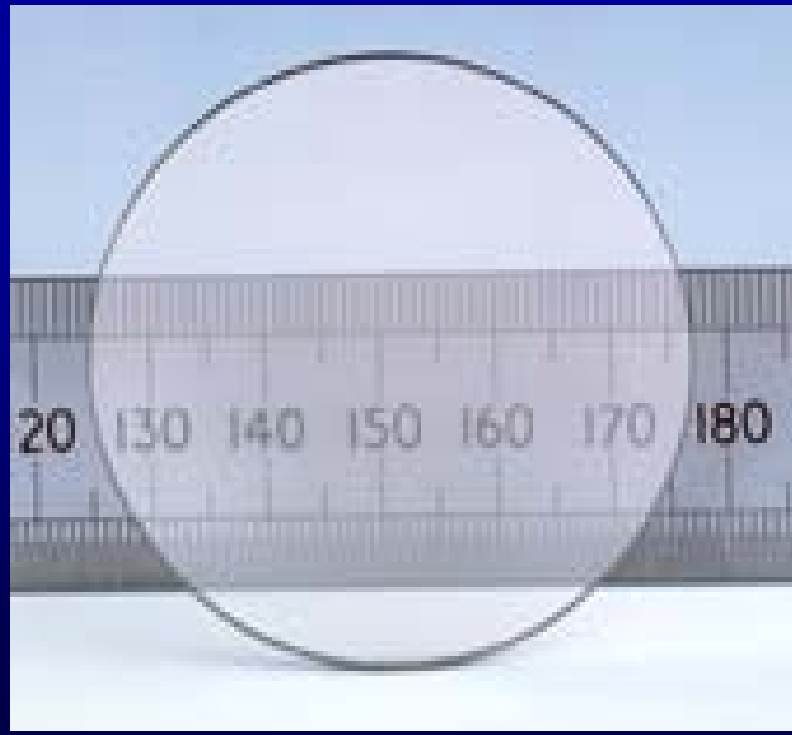
CVD Diamonds

Large areas (15 mm diameter)

Thickness up to mm

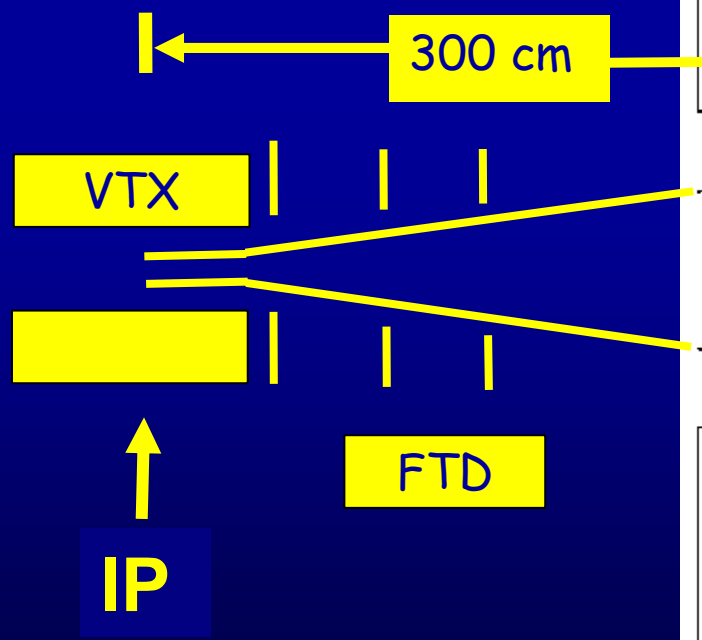
Crystallite structure

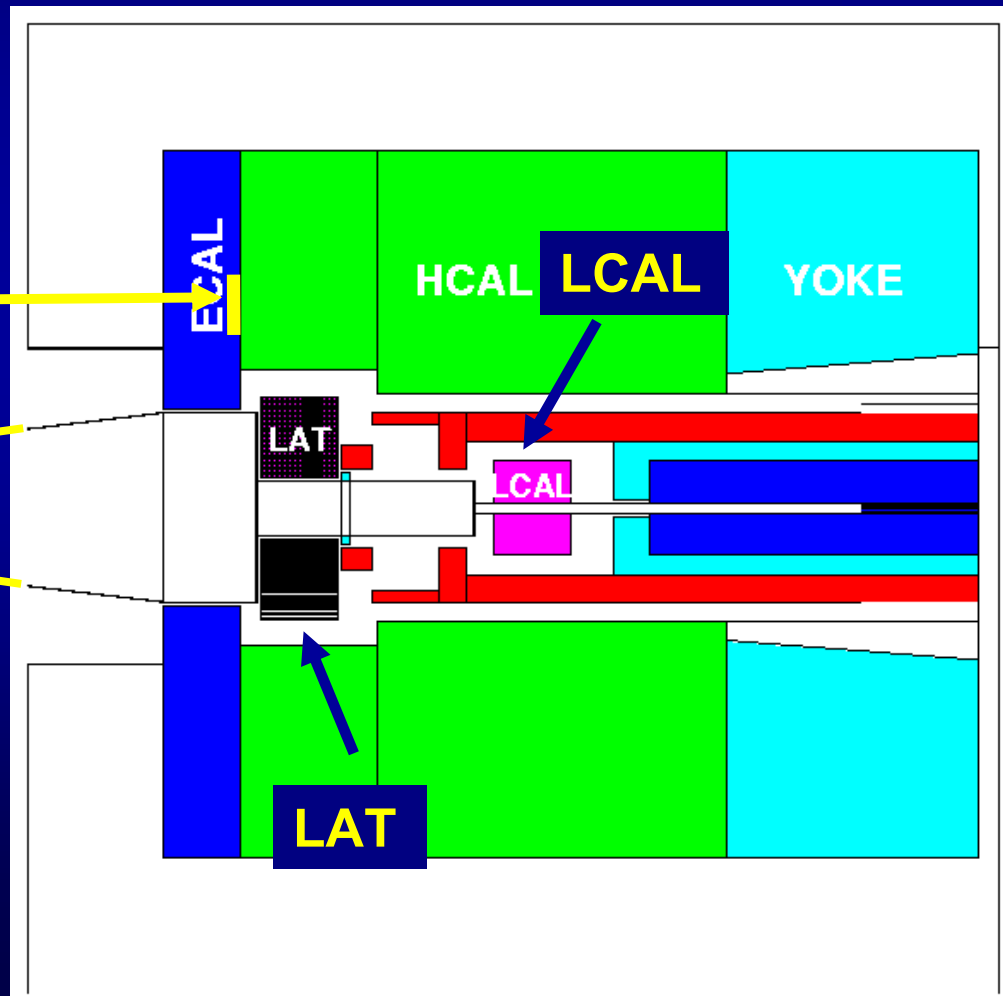




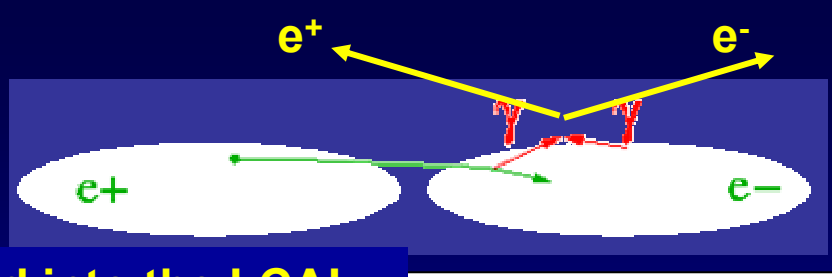
Very Forward Detectors of a LC detector

- Measurement of the Luminosity (LAT)
- Fast Beam Diagnostics (LCAL)
- Detection of Electrons and Photons at very low angle
- Shielding of the inner Detector





•Fast Beam Diagnostics

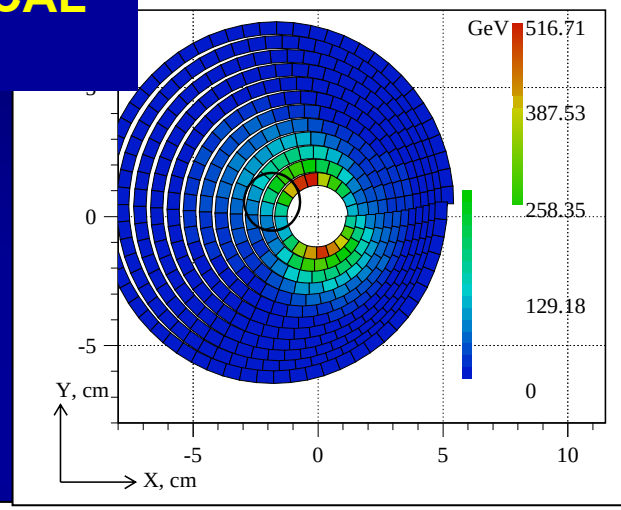


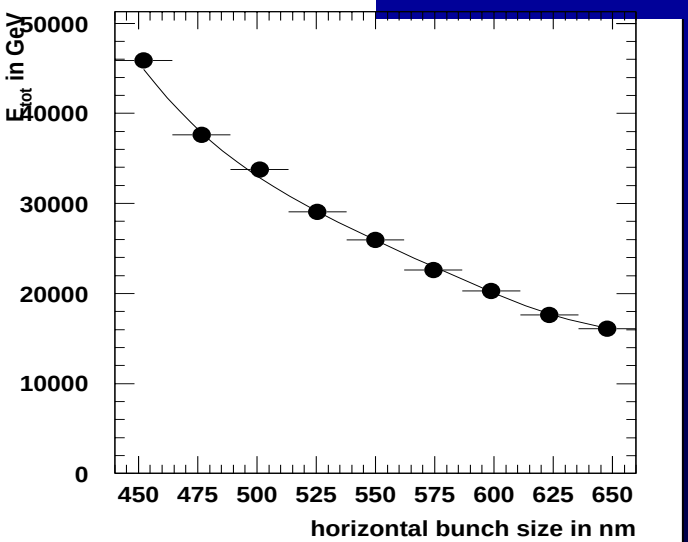
- e^+e^- pairs from beamstrahlung are deflected into the LCAL
- 15000 e^+e^- per BX ⟶ 10 – 20 TeV
- 10 MGy per year ⟶ Rad. hard sensors

•Technologies: Diamond-W Sandwich

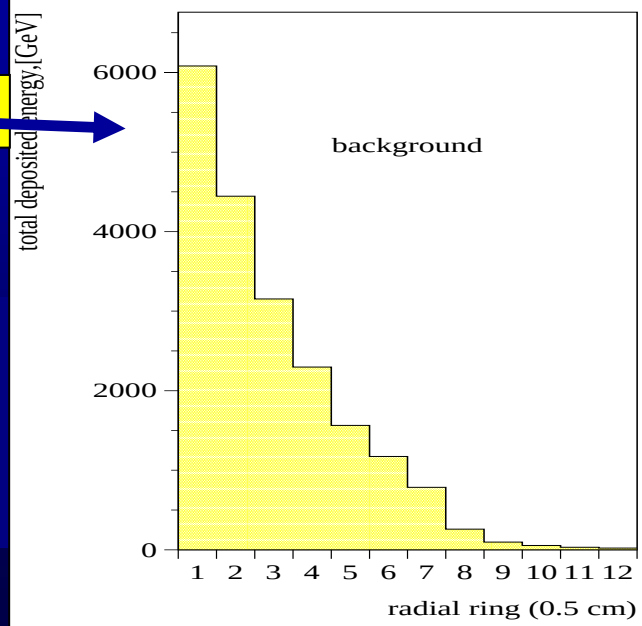
Scintillator crystals

Gas ionisation chamber





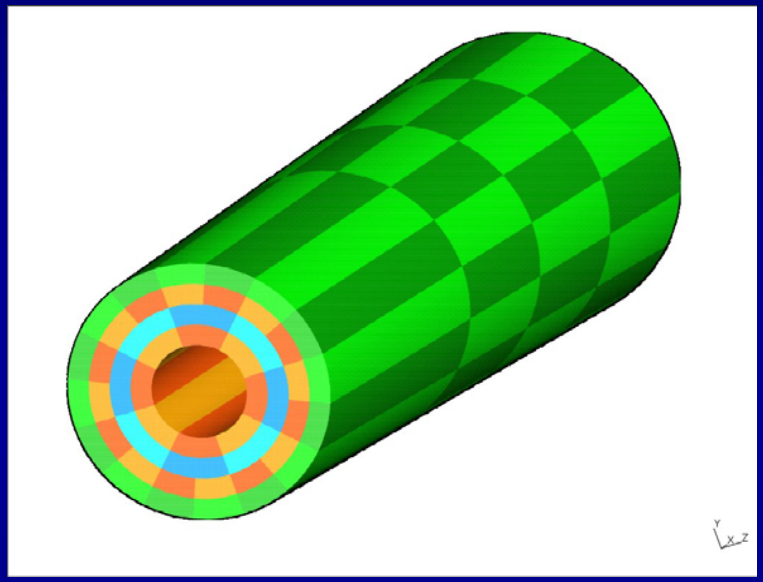
GeV

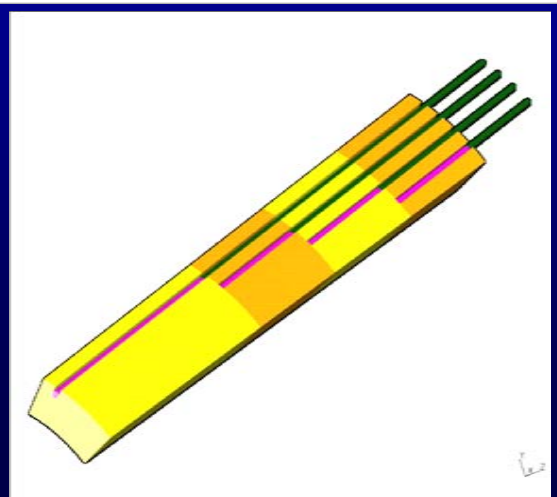


Deposited energy over R and ϕ contains information about beam parameters

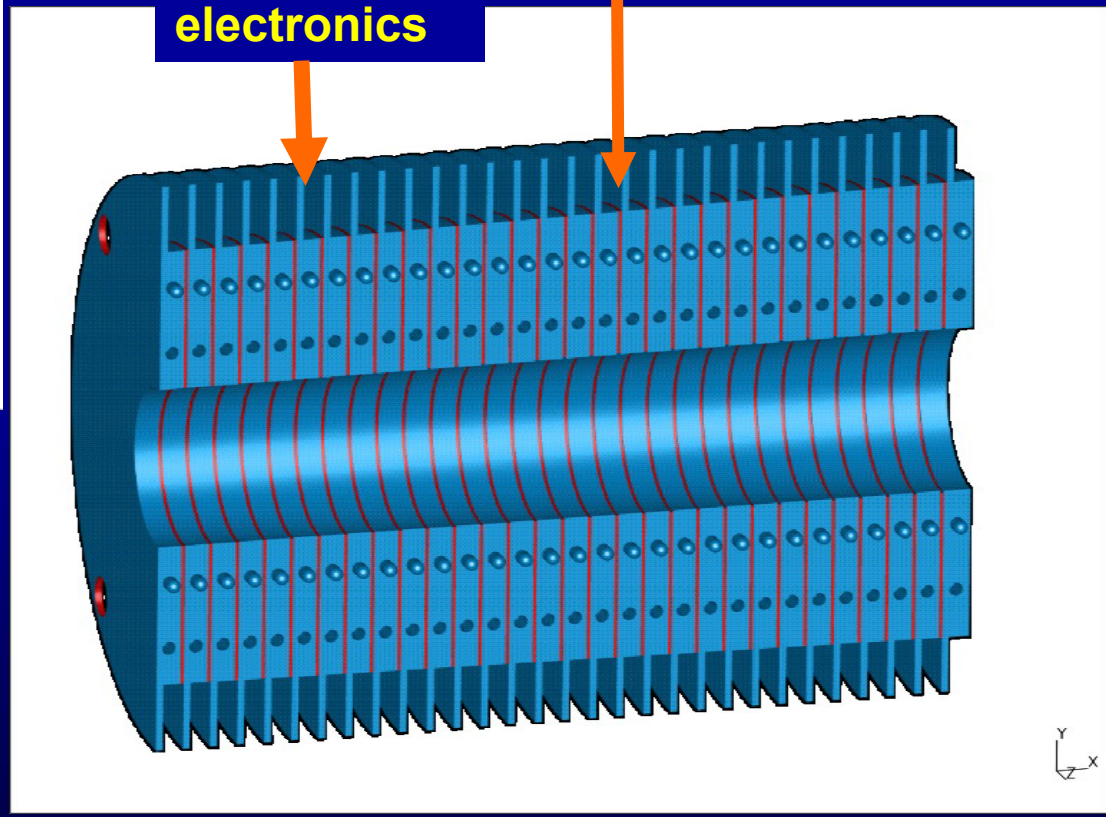
Schematic views

Heavy crystals

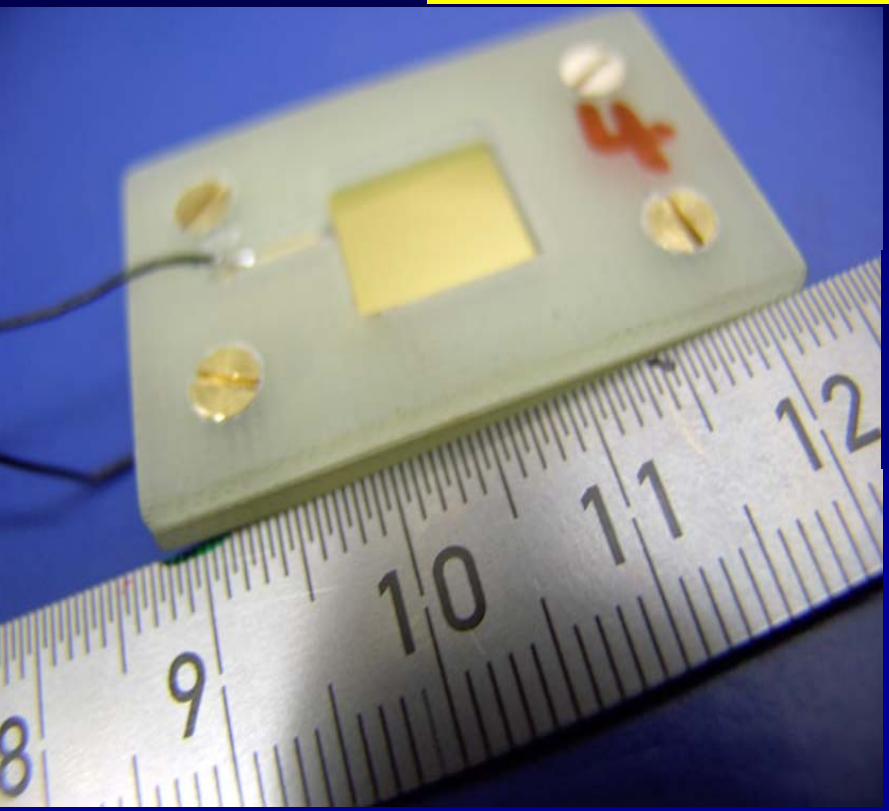




W-Diamond sandwich



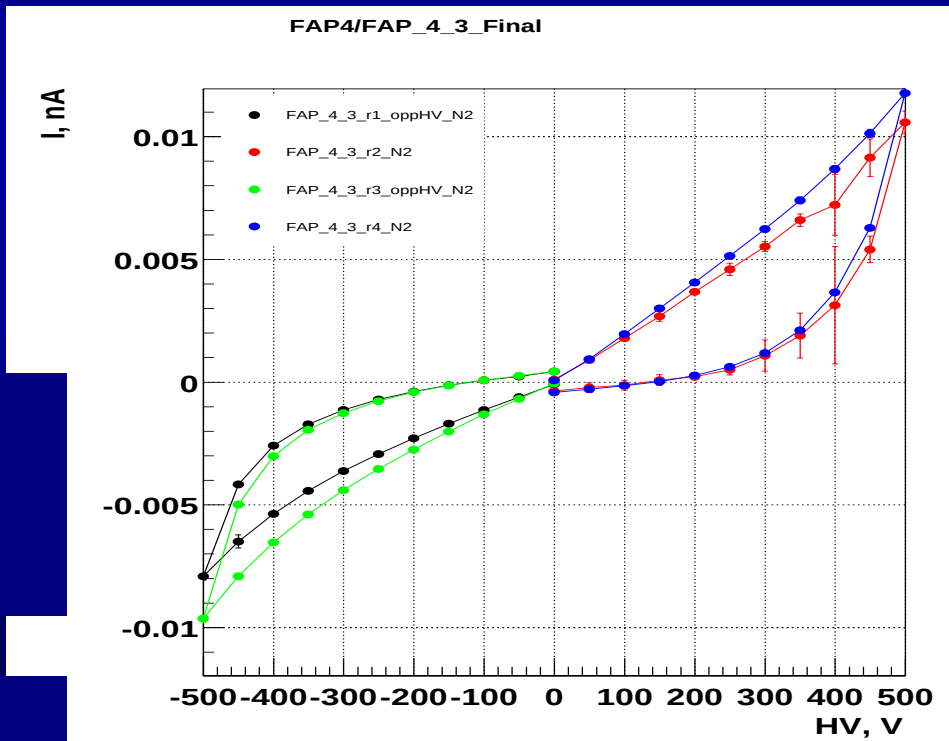
Sensor prototyping, Diamonds



CVD Diamonds produced by Fraunhofer Institut (IAF) Freiburg

Current (I) dependence on the voltage (V)

Ohmic behavior for 'ramping up/down', hysteresis



Different surface treatments :

- #1 – substrate side polished; 300 µm
- #2 – substrate side grinded & polished; 200 µm
- #3 – growth side polished; 300 µm
- #4 – both sides polished; 300 µm

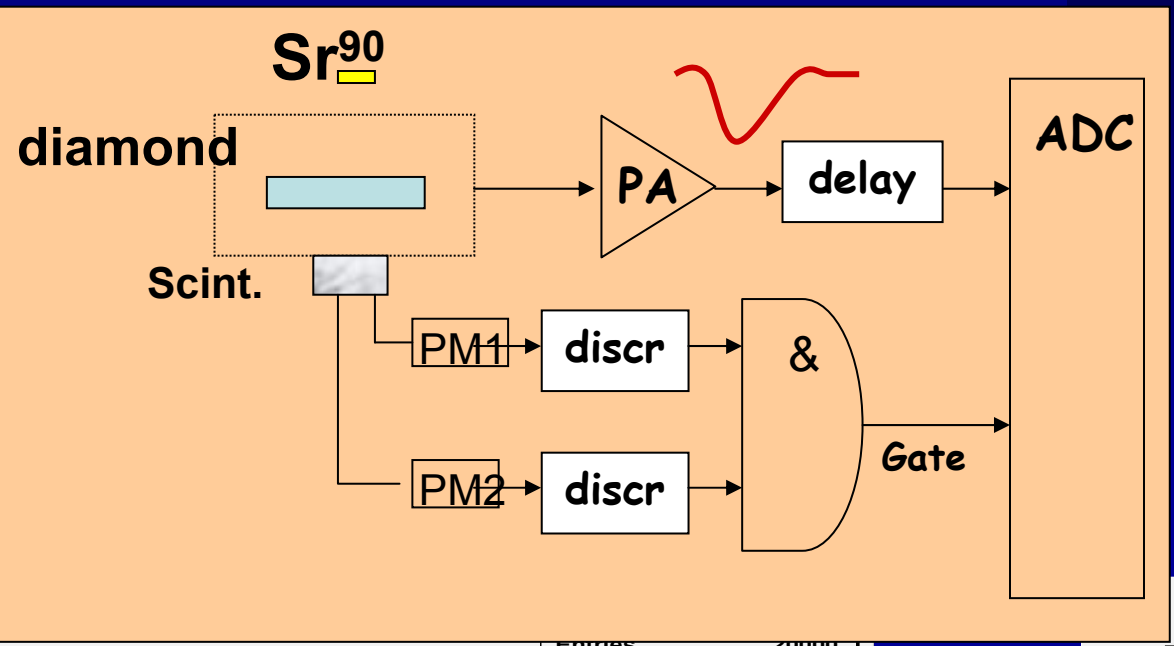
Diamond Size: 12x12 mm ^{2}

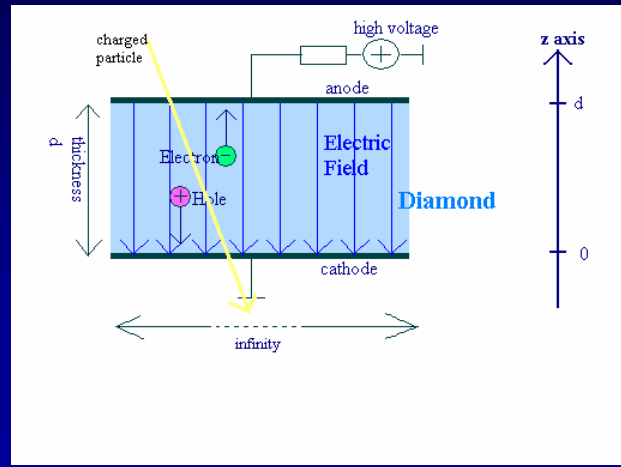
Metallisation: 10 nm Ti + 400nm Au

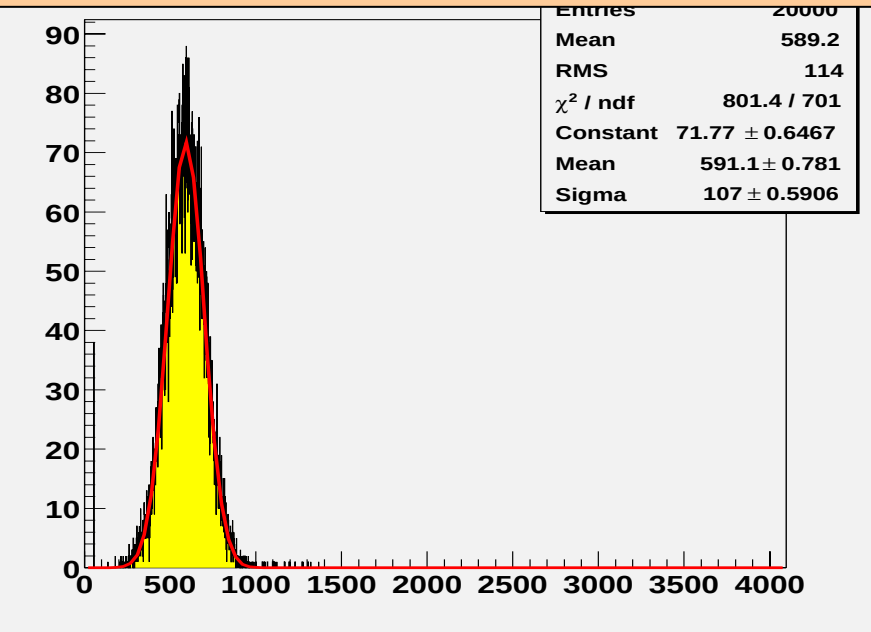
Charge collection distance measurements

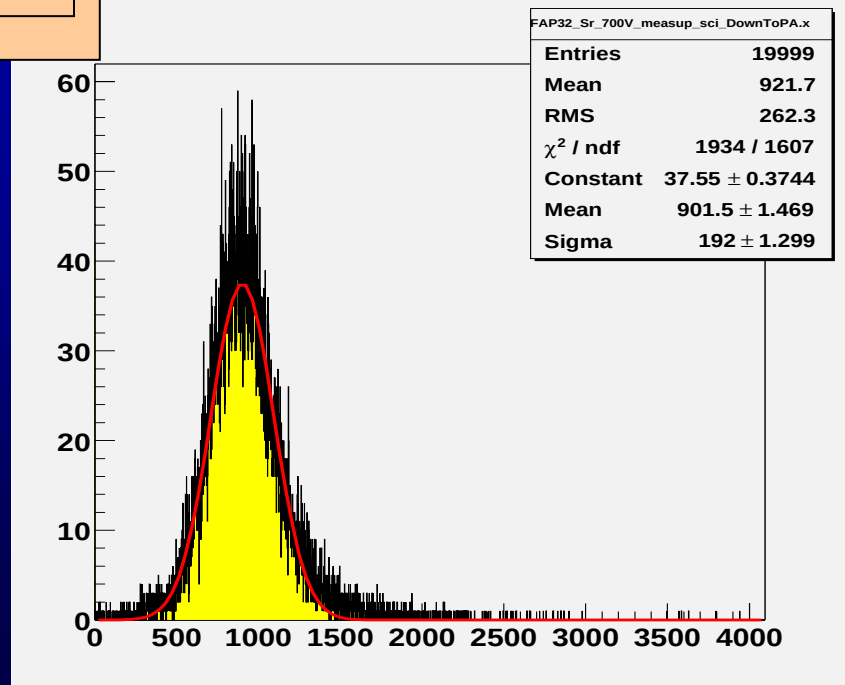
Using electrons from a Sr^{90} source (mips)

$Q_{meas.} = Q_{created} \times ccd / L$



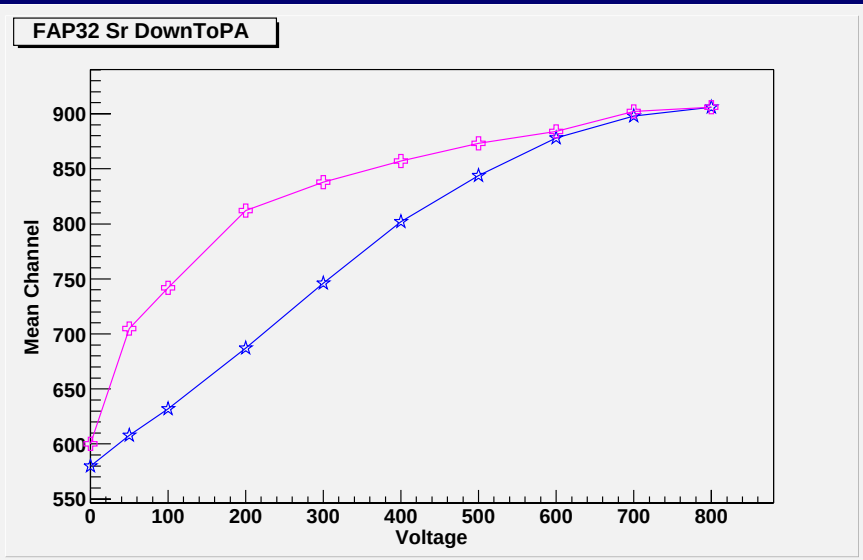


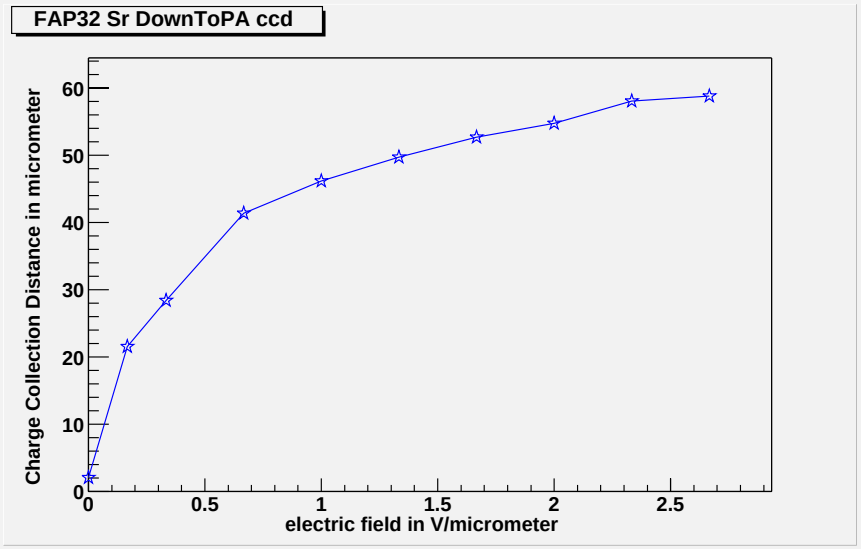




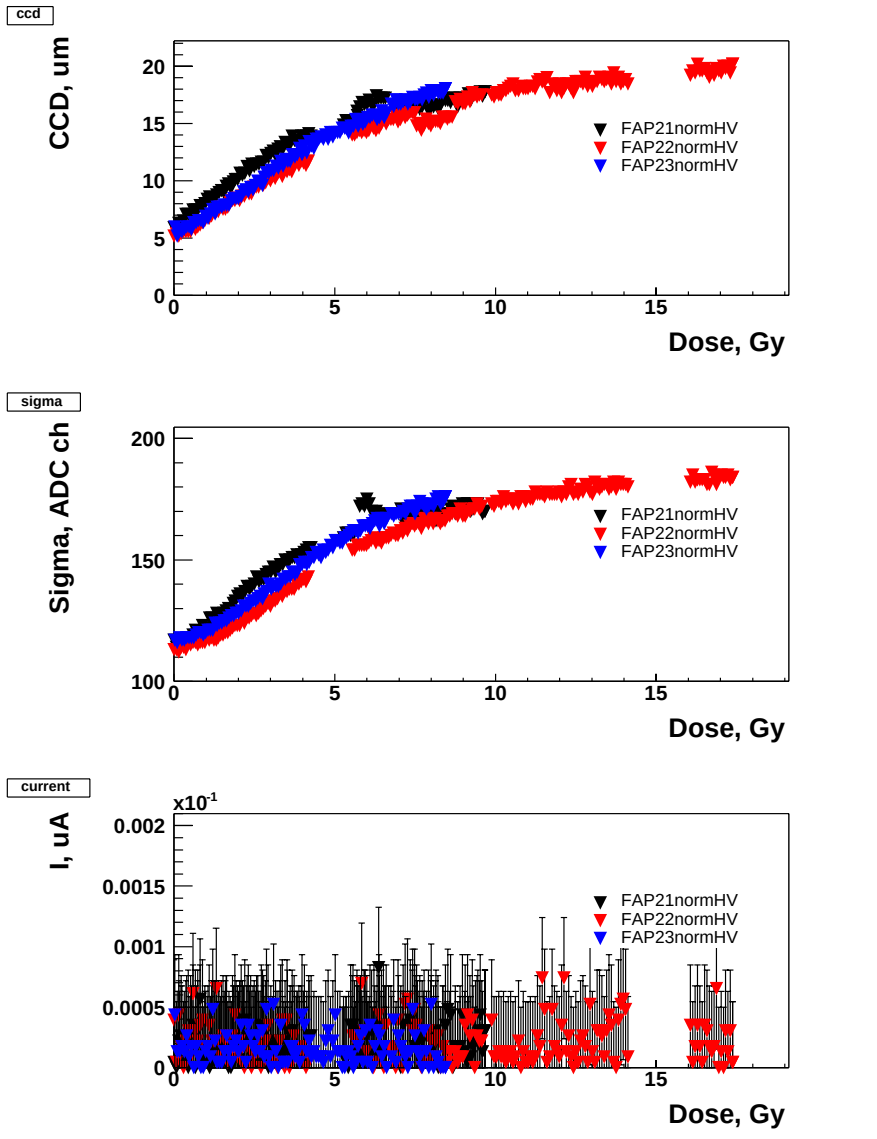
Charge collection distance measurements

Charge collection distance is saturated at 60 μm (@ 300V)

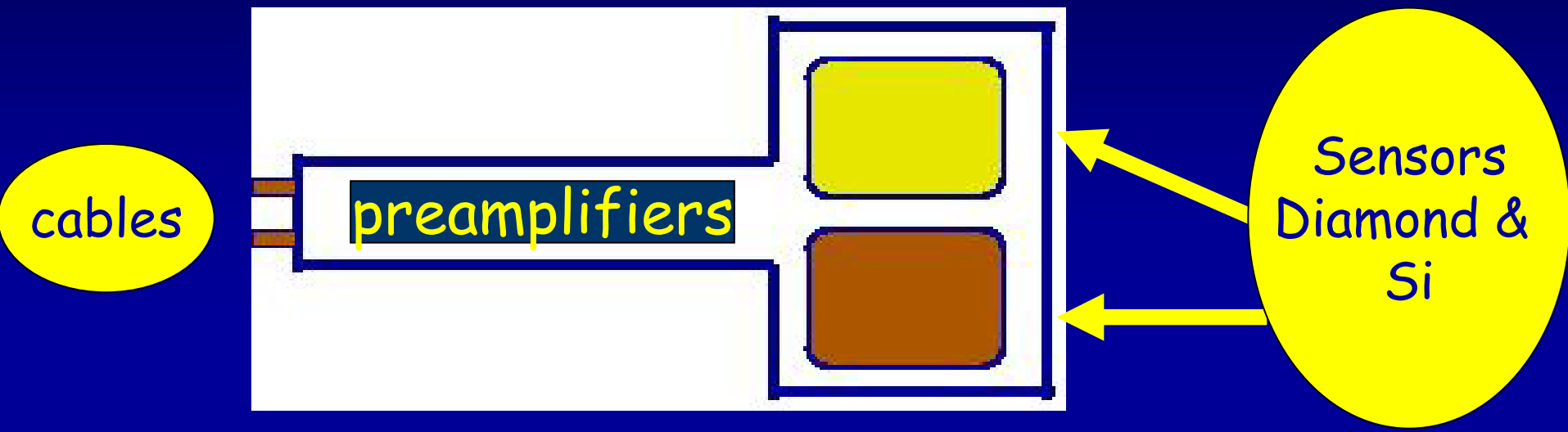




Charge collection distance as function of the radiation dose



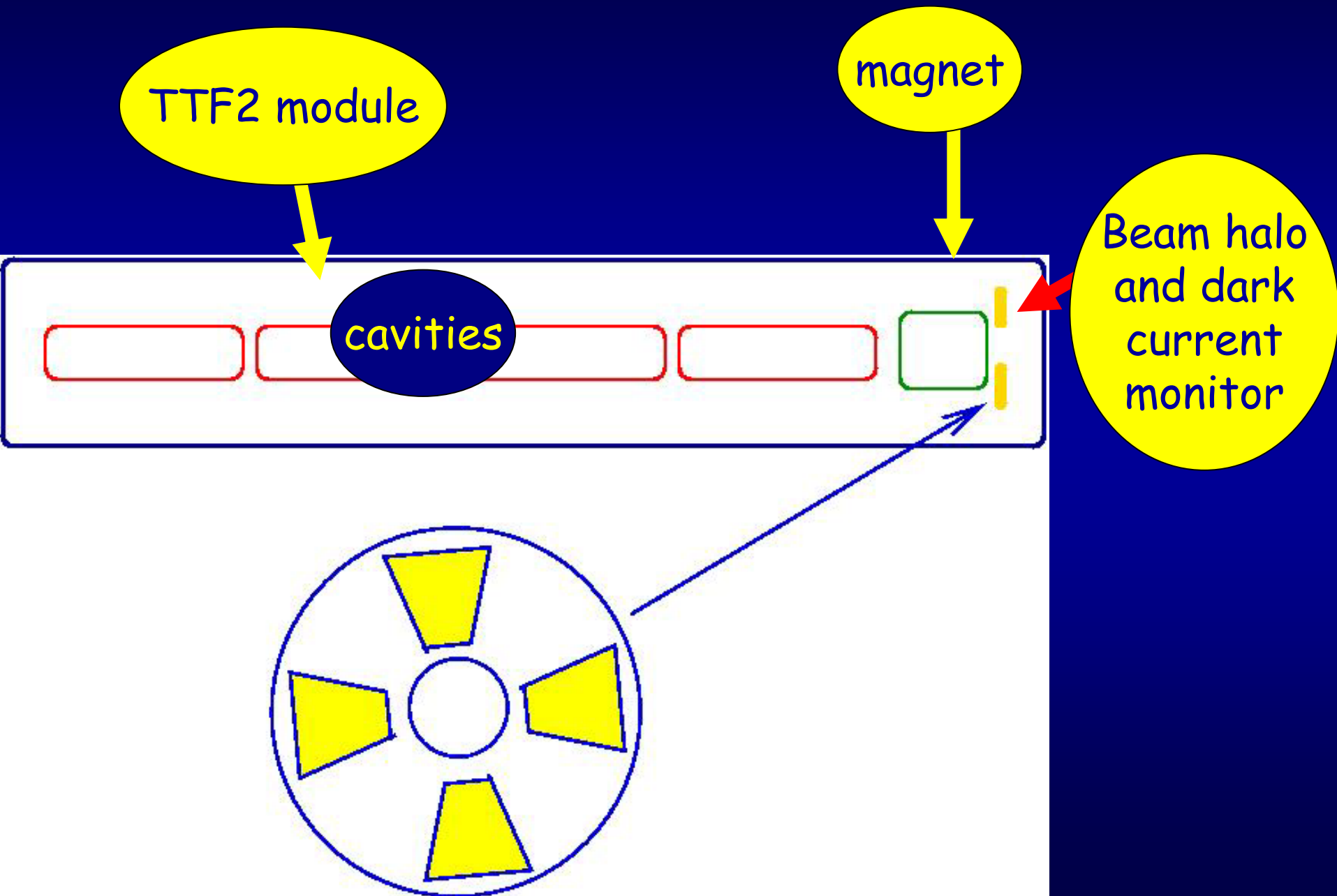
Tests of a sensor head at PITZ (or HERA)



Test of the readout, stability near a cavity

If first step successful- longterm measurements at HERA

Prospects for TTF2



Summary

Diamond sensors are an interesting new field

They are an option for the very forward calorimeters of a LC Detector

We made the first steps to understand these sensors

Their application for beam monitoring seems very promising

A good opportunity to exploit "Synergy"

(Similar projects at KEK, SLAC and LHC)