# Diamond Sensors for Beam Monitoring

Wolfgang Lohmann, DESY

(W. Lange, D. Noelle, K. Wittenburg)

TESLA Meeting,
Zeuthen Jan. 22

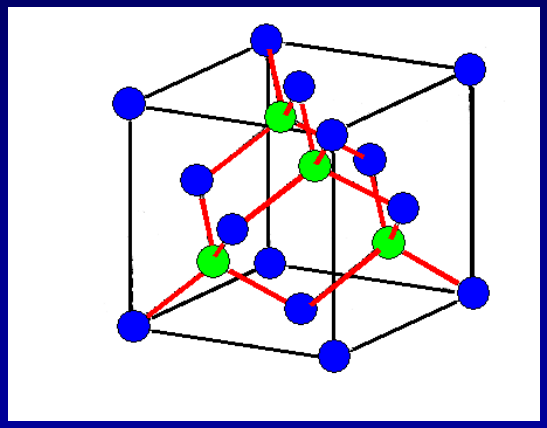
# Diamond is an extraordinary material

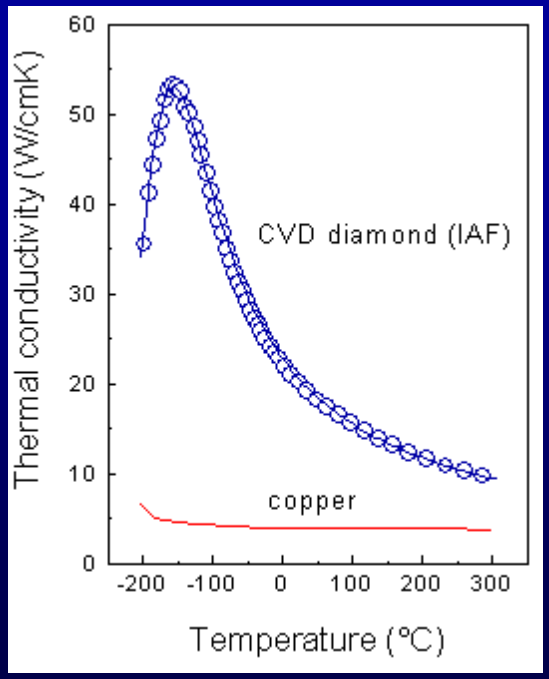
**Highest atomic number density (1.77 x$10^{23}$)**

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

**Thermal conductivity (20.0 W/cmK )**

**Radiation Hard !**



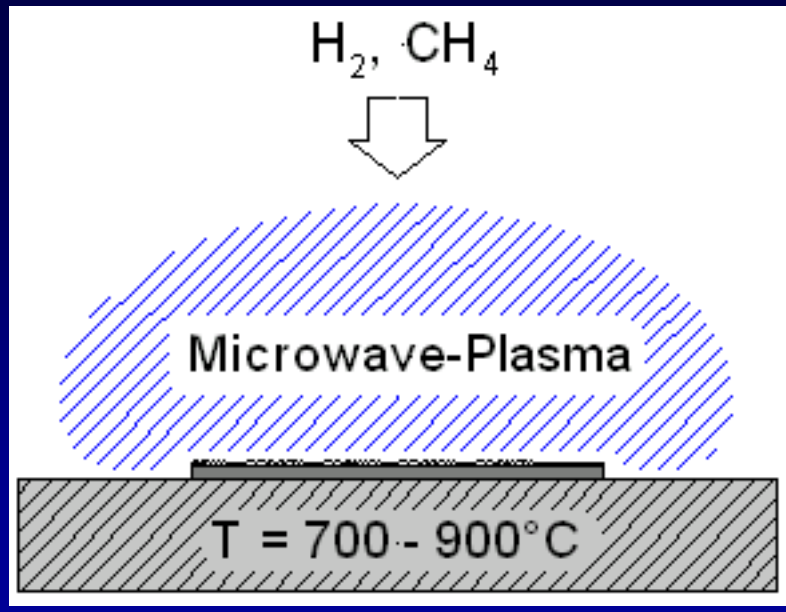


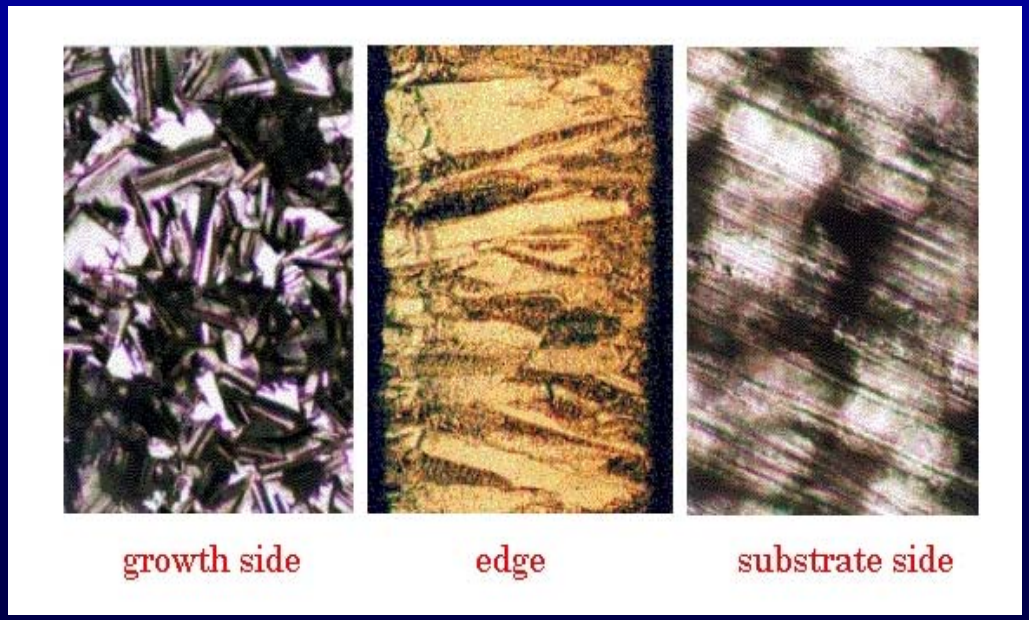
# CVD Diamonds

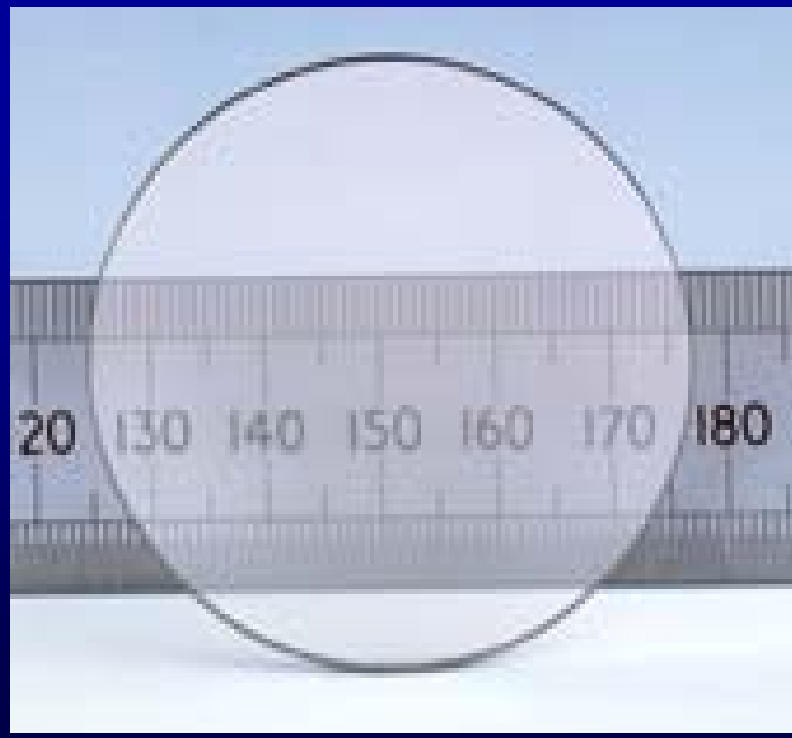
**Large areas ( 15 mm diameter)**

**Thickness up to mm**

**Crystallite structure**

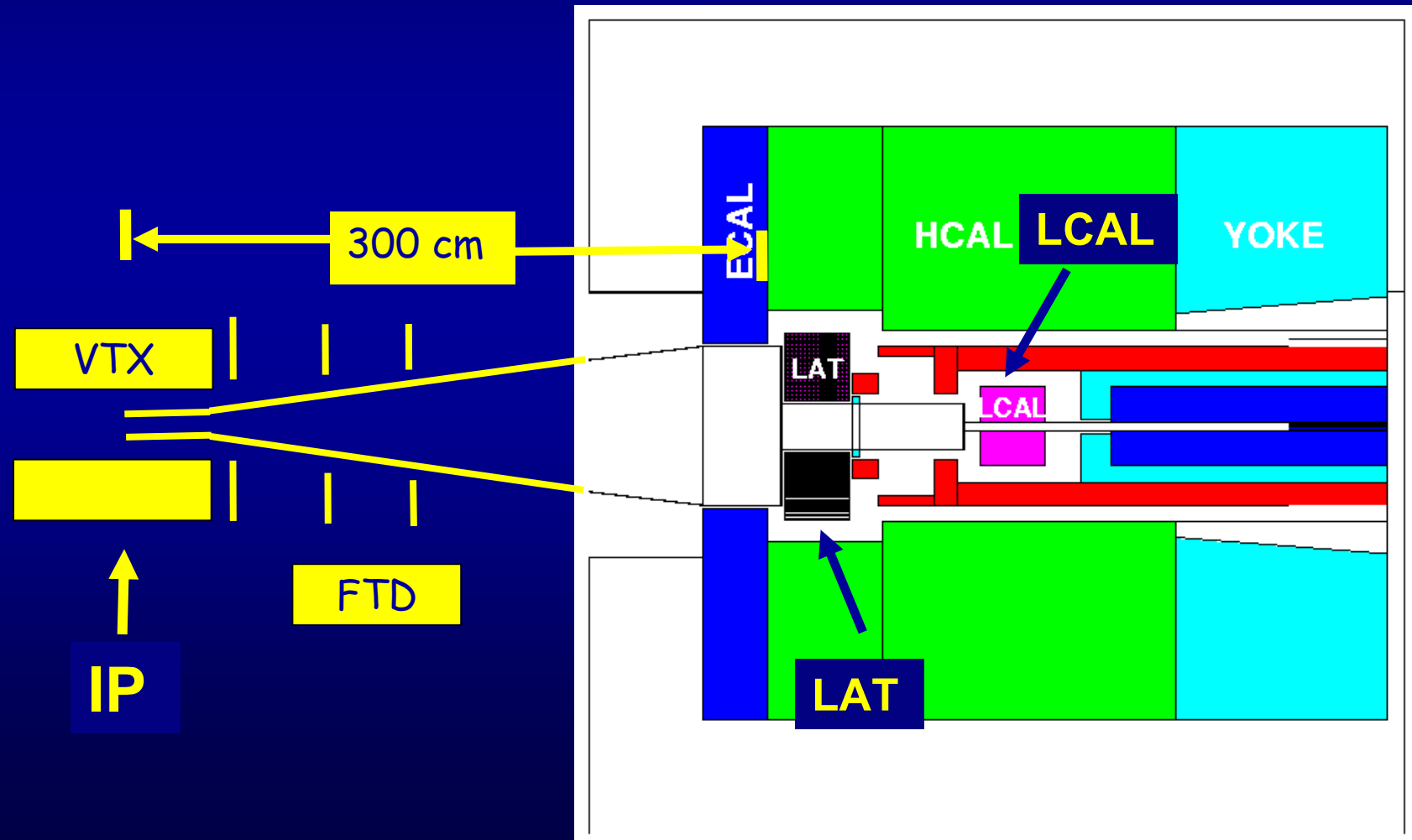


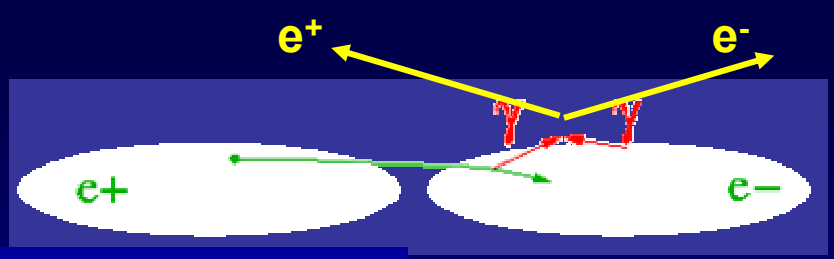



# Very Forward Detectors of a LC detector

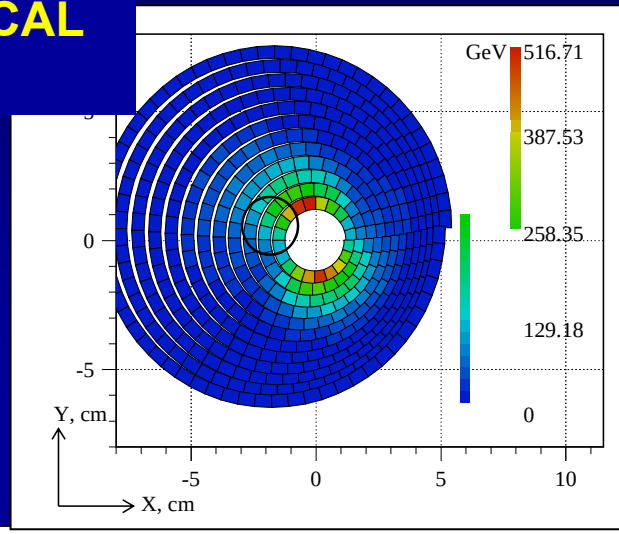
- Measurement of the Luminosity (LAT)
- Fast Beam Diagnostics (LCAL)
- Detection of Electrons and Photons at very low angle
- Shielding of the inner Detector

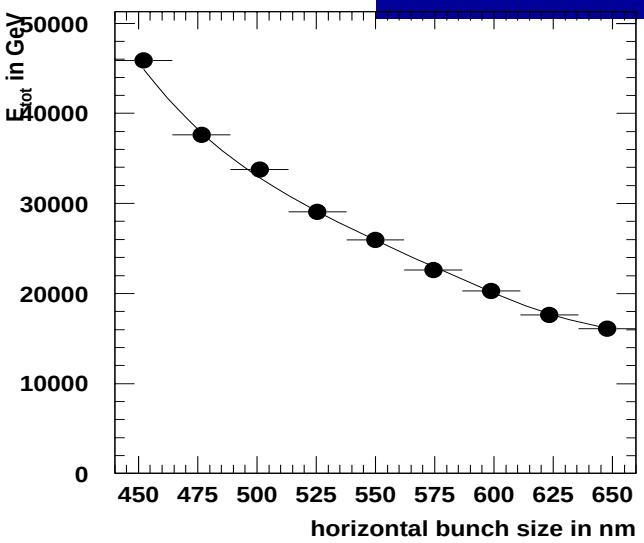


# •Fast Beam Diagnostics

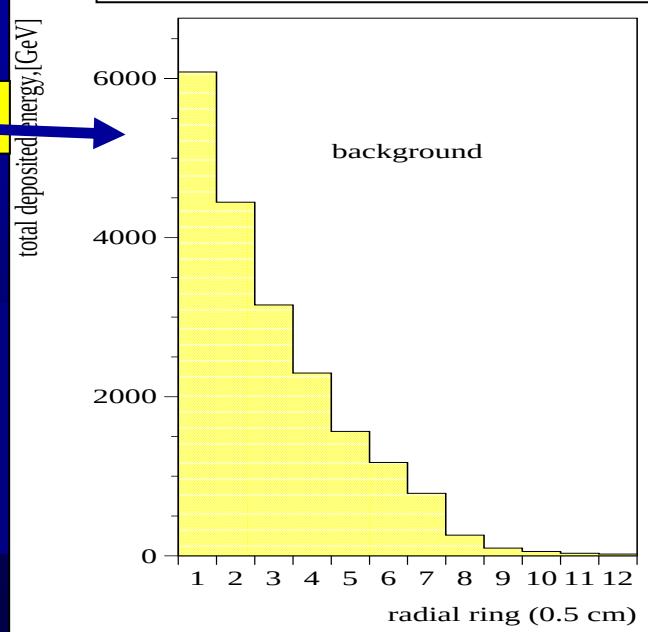



- $e^+e^-$ pairs from beamstrahlung are deflected into the LCAL
- 15000 $e^+e^-$ per BX ⟶ 10 – 20 TeV
- 10 MGy per year ⟶ Rad. hard sensors
- Technologies: Diamond-W Sandwich
  Scintillator crystals
  Gas ionisation chamber



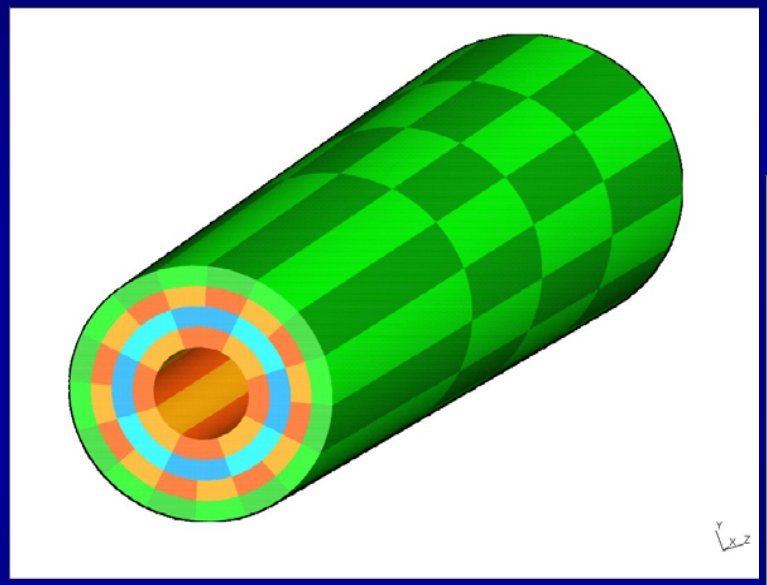

GeV

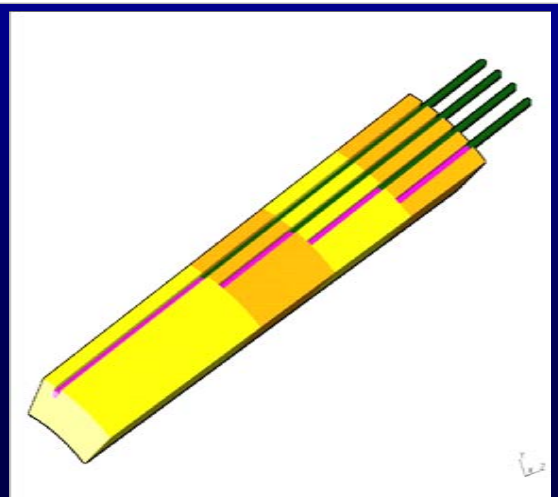



Deposited energy over R and $\phi$ contains information about beam parameters

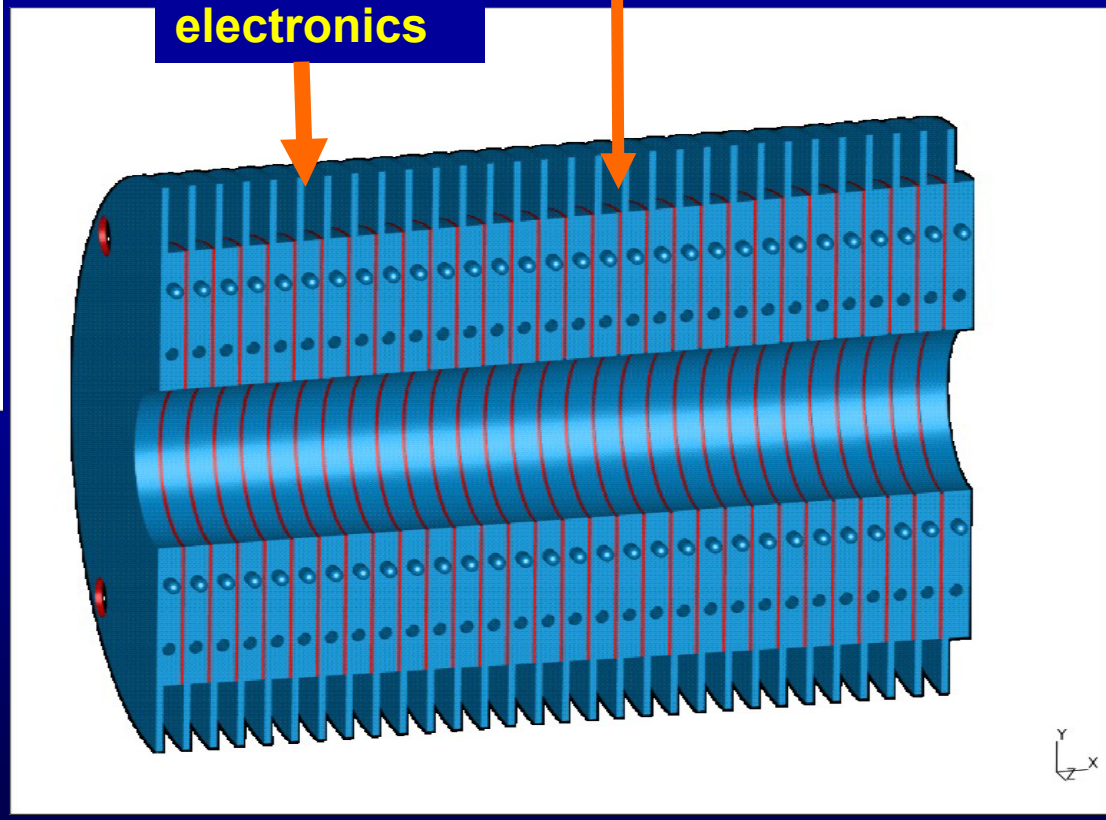
# Schematic views

## Heavy crystals

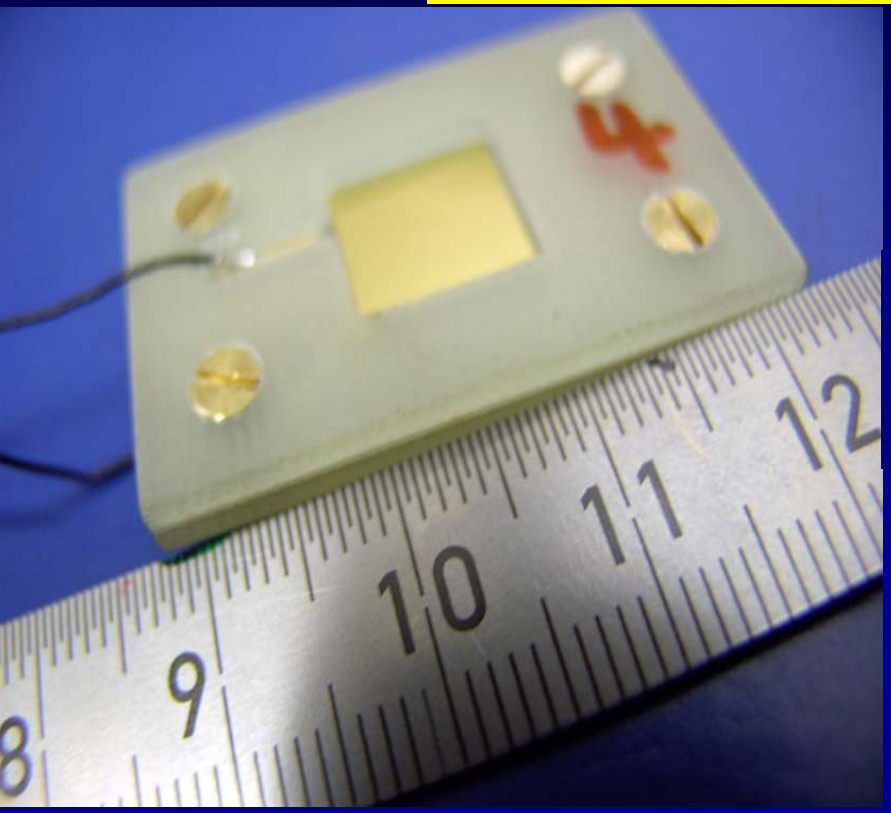




## W-Diamond sandwich



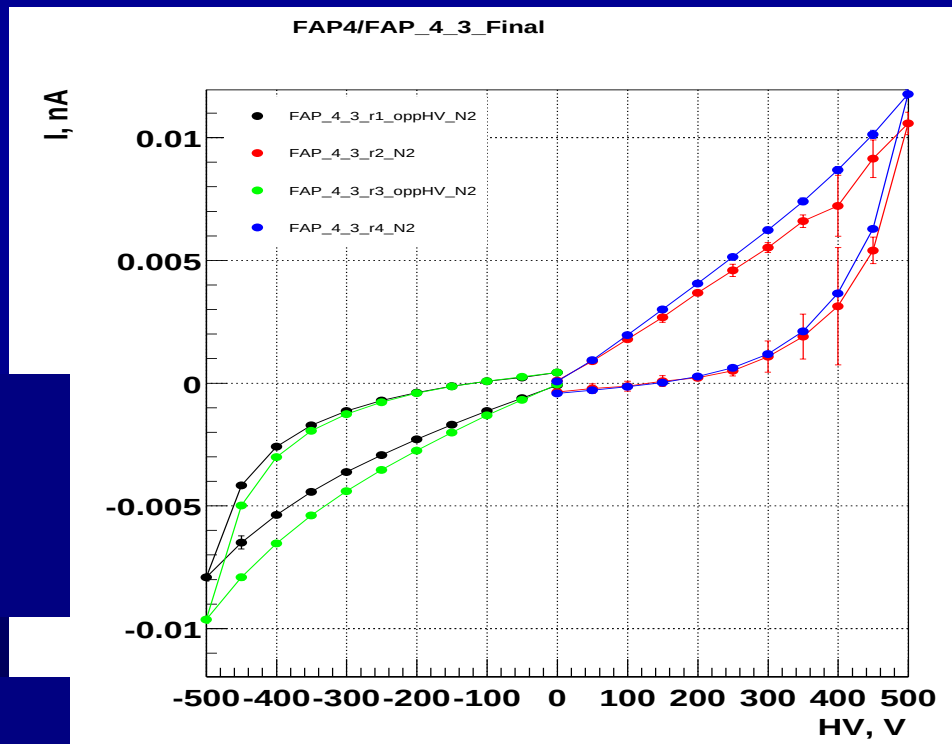
# Sensor prototyping, Diamonds



**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**

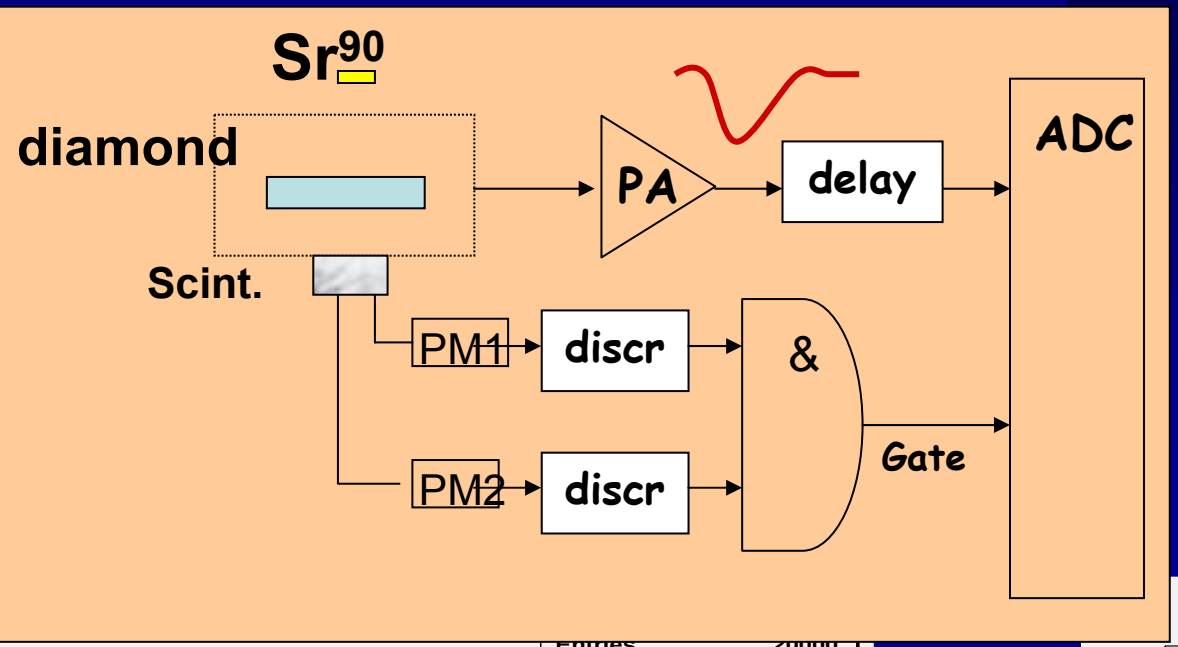
**Diamond Size: 12x12 mm $^2$**

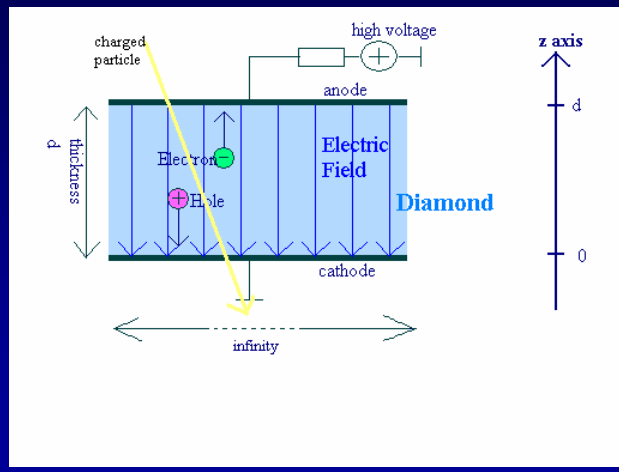
**Metallisation: 10 nm Ti + 400nm Au**

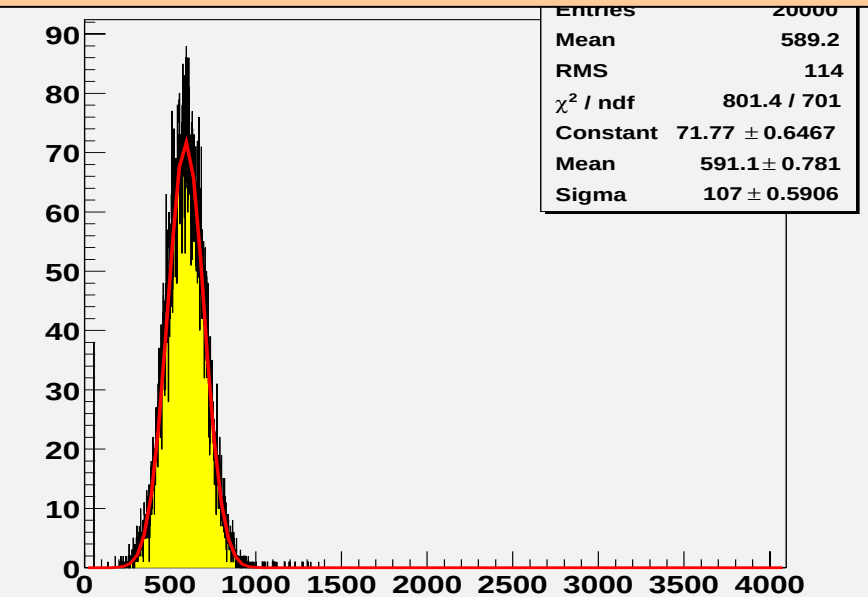
# Charge collection distance measurements

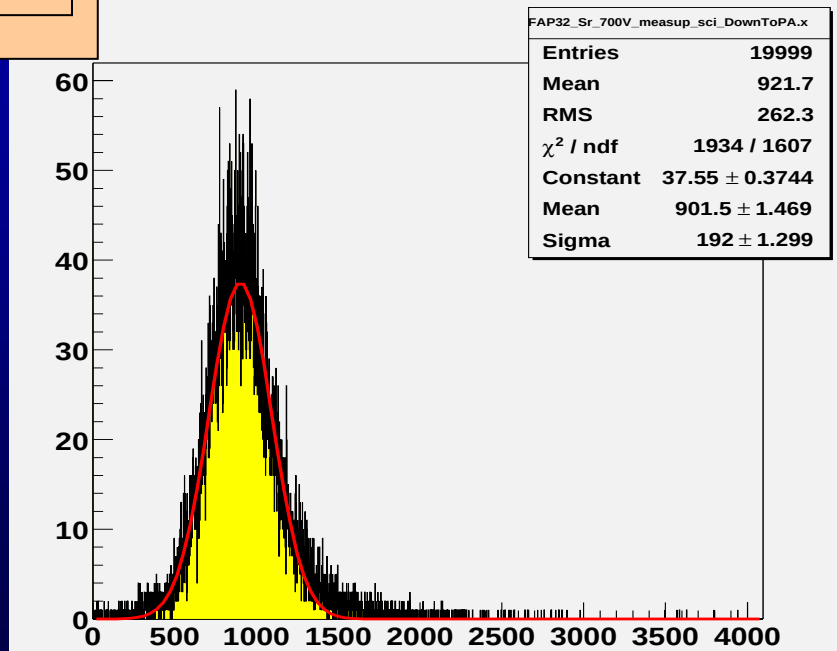
## Using electrons from a $Sr^{90}$ source (mips)

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



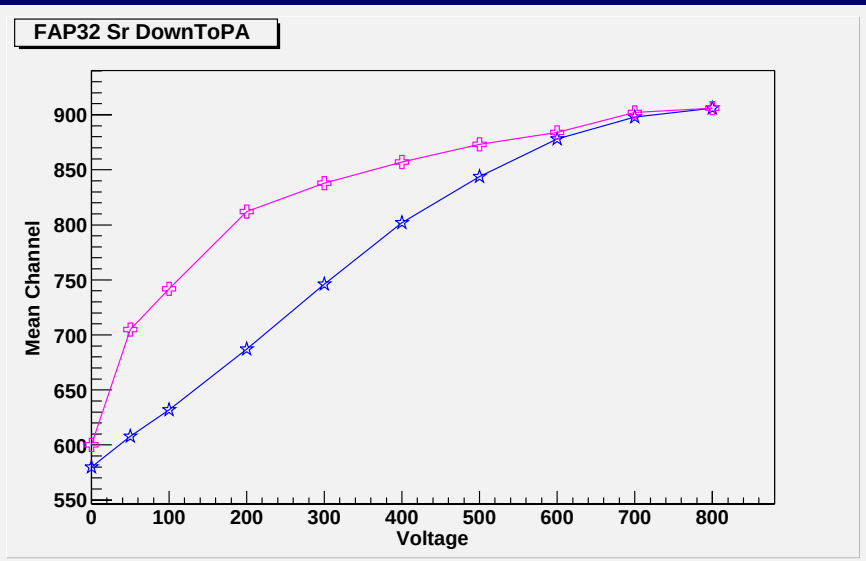



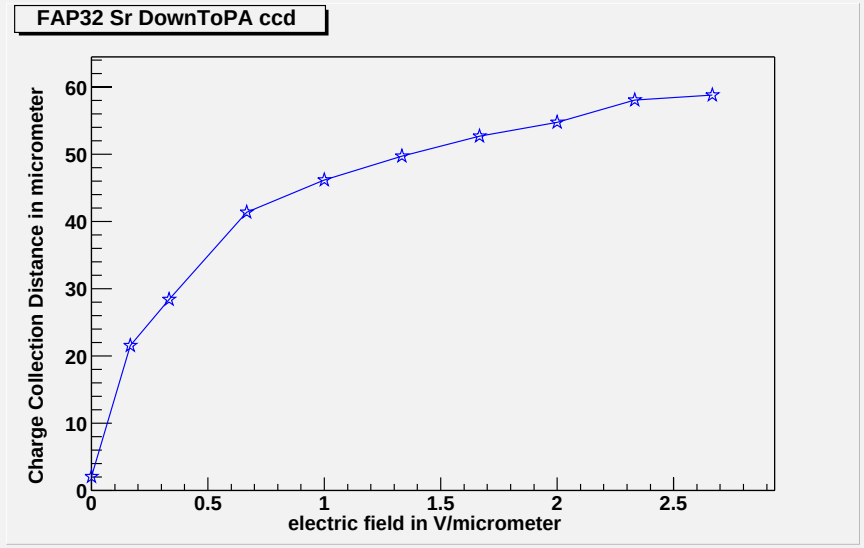



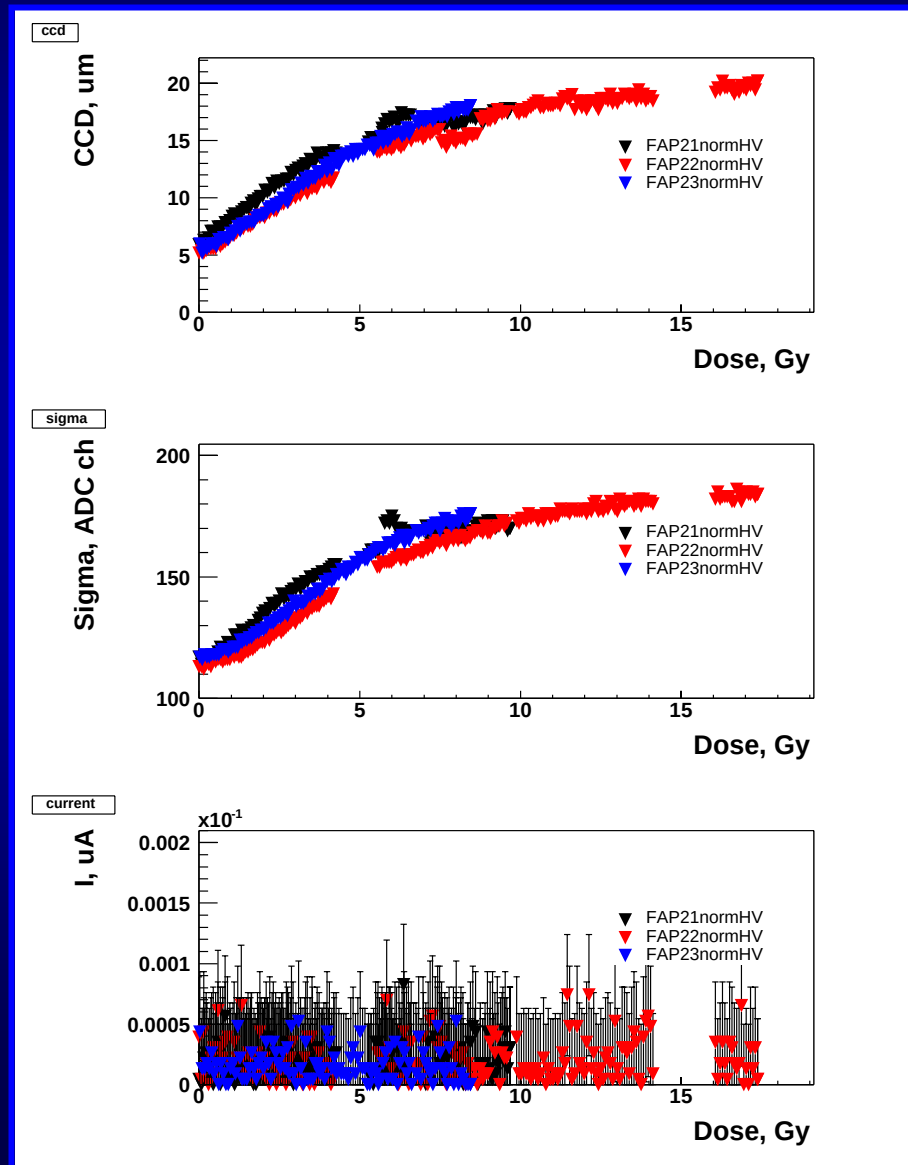
# Charge collection distance measurements

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

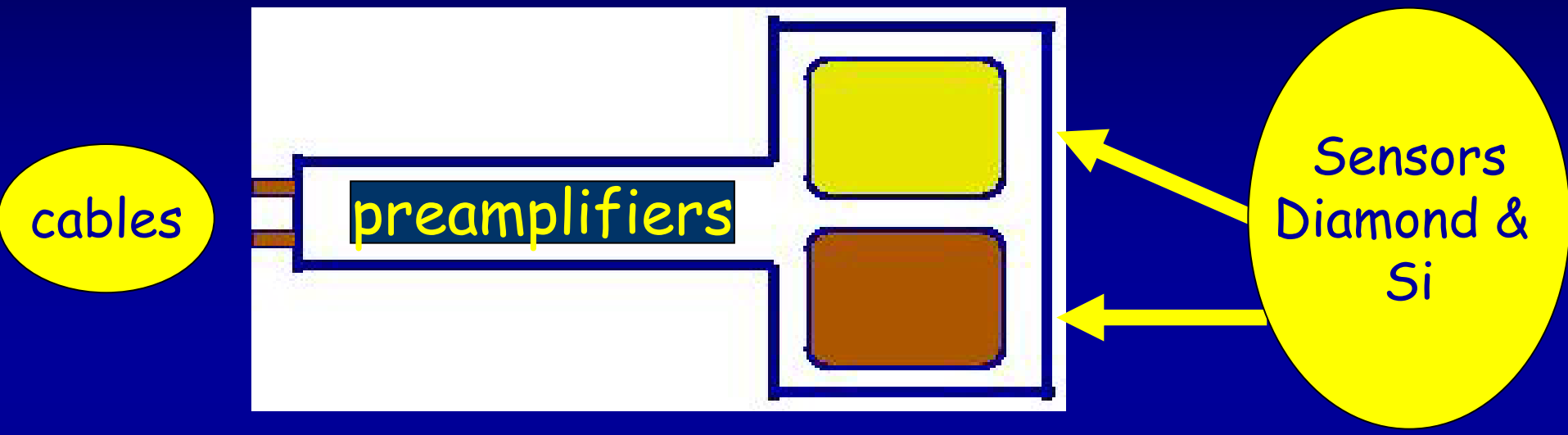



**Charge collection distance as function of the radiation dose**



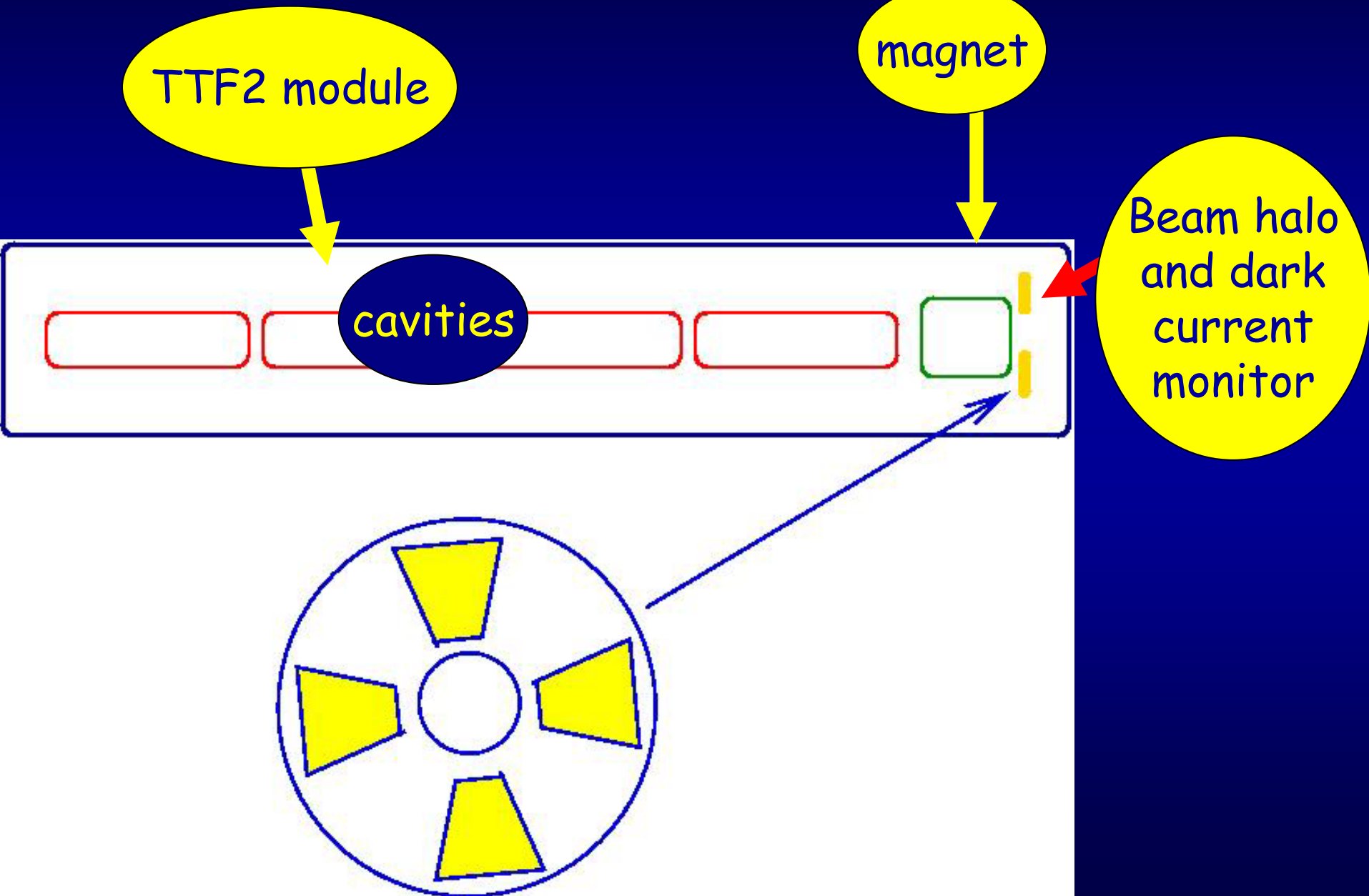
# Tests of a sensor head at PITZ (or HERA)




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)