

Diamond Detectors

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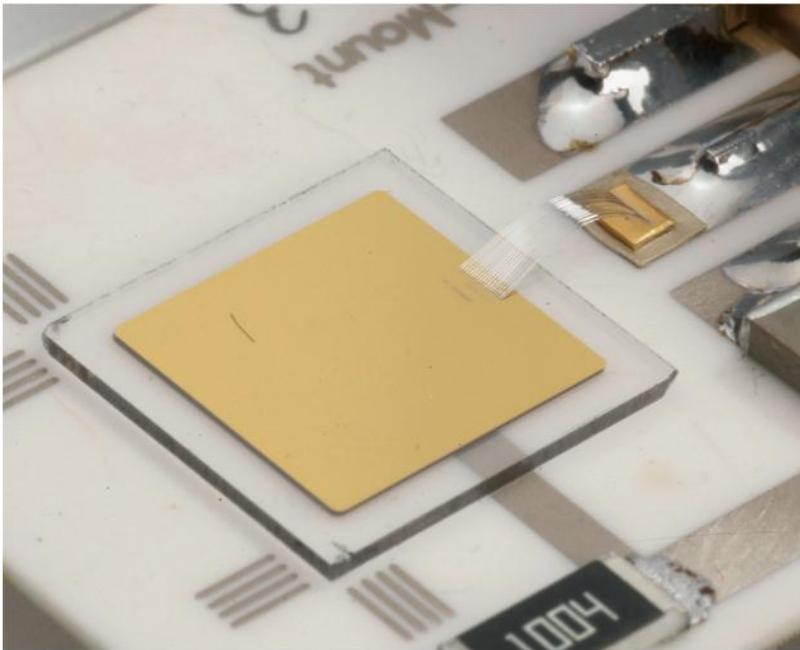
Outline

- Why Diamond Detectors
- Technical information about Diamond Detectors
- Measurement results
- Diamond as cryogenic Beam Loss Monitor?
- Conclusions

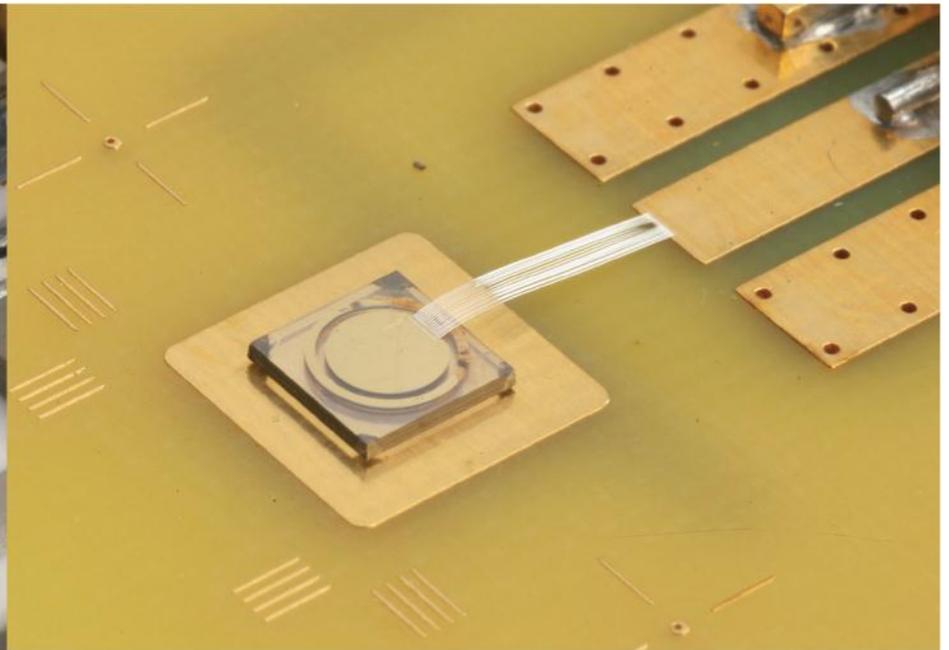
Why Diamond Detectors

- Measurement of fast beam losses
 - ns response time
 - Bunch by bunch structure
- Radiation tolerant detector type
 - Low maintenance
 - Constant operating conditions
- Small dimensions
 - Easier positioning in areas with space limitation
- Well known response signal
 - Detector tested under many conditions for verification of the performance
 - High dynamic range ~ 8 order of magnitude
 - Linear response to particle flux

Diamond Detector Types



pCVD



sCVD

pCVD = polycrystalline Chemical Vapor Deposition ($10 \times 10 \text{ mm}^2 \times 0.5 \text{ mm}$)

sCVD = single-crystal Chemical Vapor Deposition ($5 \times 5 \text{ mm}^2 \times 0.5 \text{ mm}$)

BLMD (type Cividec)



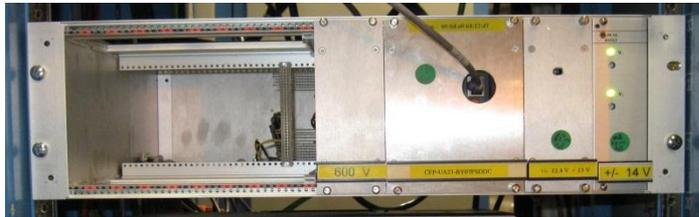
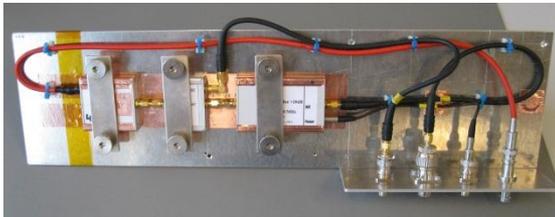
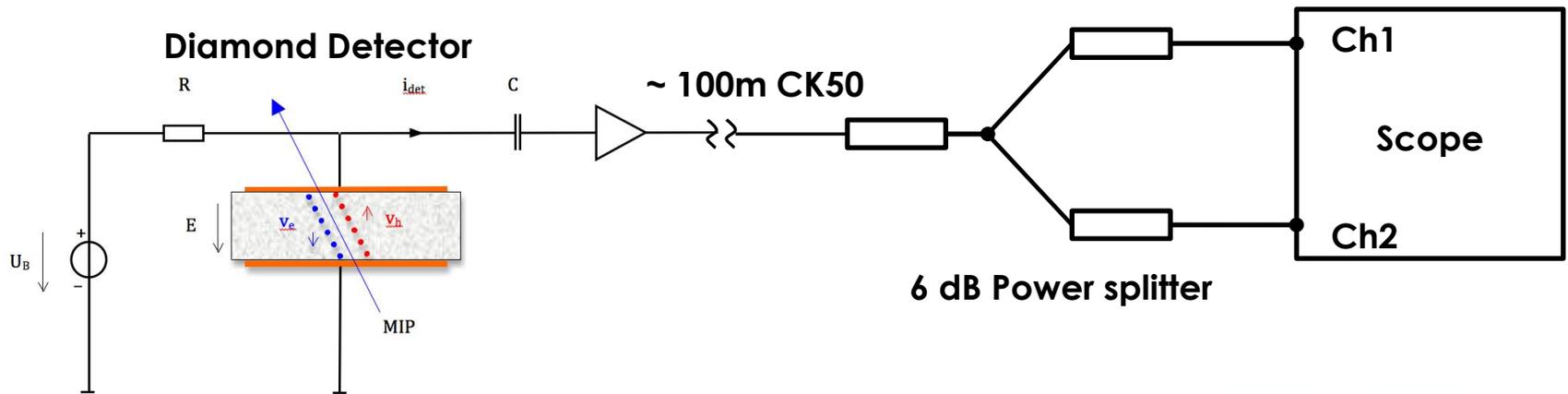
Detector

AC/DC Splitter

2 GHz Amplifier

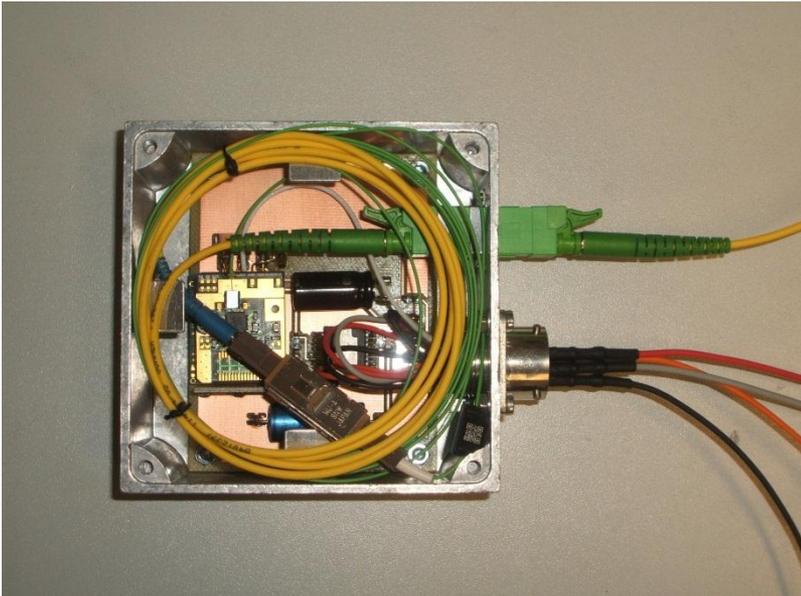
- pCVD detector: with high voltage and signal connection
- AC-DC-Splitter: to separate AC signal current from DC leakage current
- 2 GHz / 20 dB Broadband Amplifier (various amplifier available)
- Internal HF copper housing and aluminum housing for mechanical protection

Principle of Cividec detector



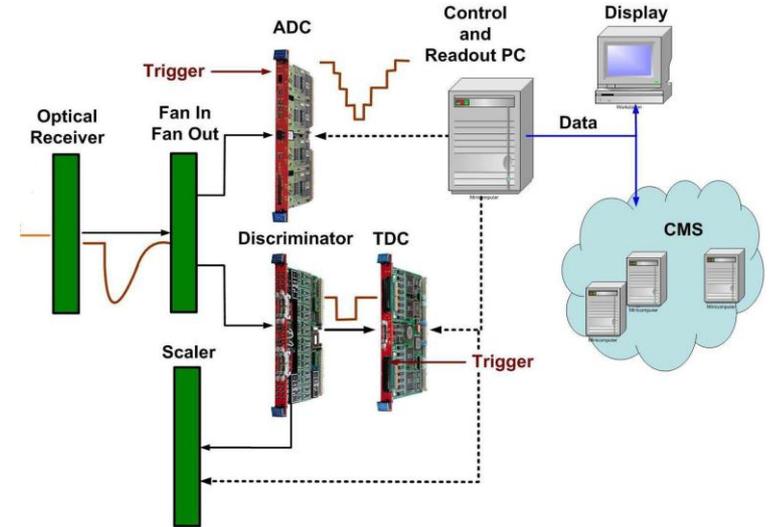
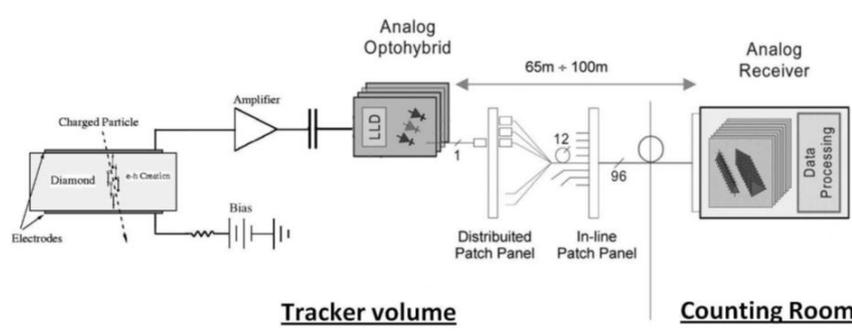
- Detector, splitter and amplifier on support plate
- High and low voltage supply
 - Controlled via ET-7026 Ethernet Controller
- 1 GHz Scope from LeCroy
 - Readout via FESA Application from S.B. Pedersen

BLMD (BCM1F CMS / DESY Zeuten)



- sCVD detector: mounted on the analogue optical link
- analogue optical link mounted on support PCB including radiation tolerant voltage regulator and test pulse generator
- Housing with Burndy-8 (for high and low voltage supply)
- E-2000 connector for optical signal

Principle of BCM1F



Detector description

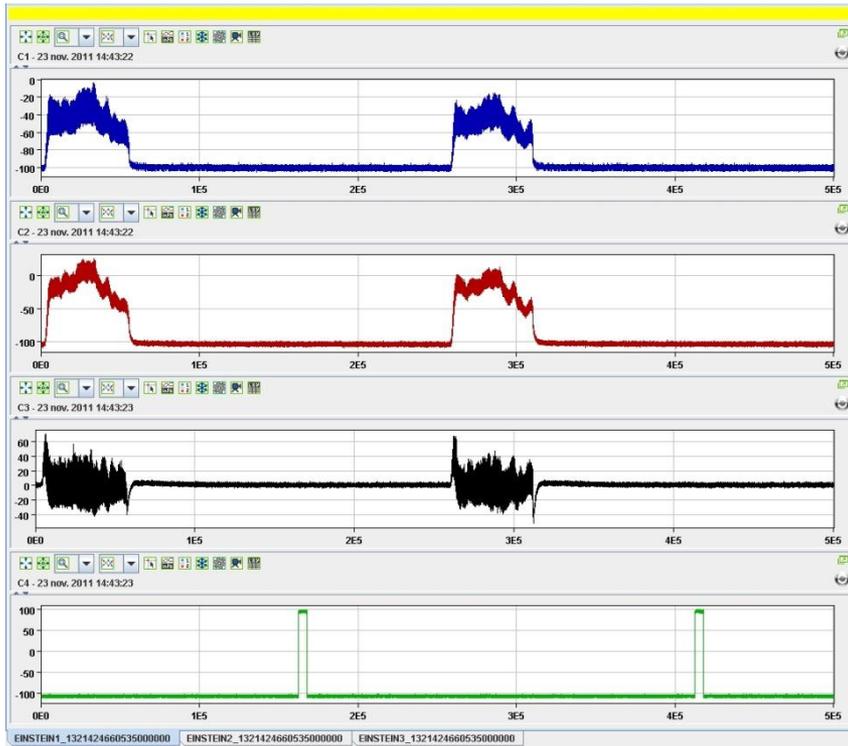
- sCVD detector with a bias voltage 125 V
- Fast amplifier (rad tolerant)
- Analogue optical link LLD from the MIC
- Optical single mode fiber of around 2km

Analogue Receiver (865-RA-04)

- Optical receiver from CMS
- ADC CEAN V1721
- LTD CEAN V814
- TDC CEAN V767
- Bridge CEAN V2718
- BOBR for timing signals
- PC for data treatment

Measurement results Cividec

Measurement from CNGS Detector (16/11/2011 -- 7.24AM)

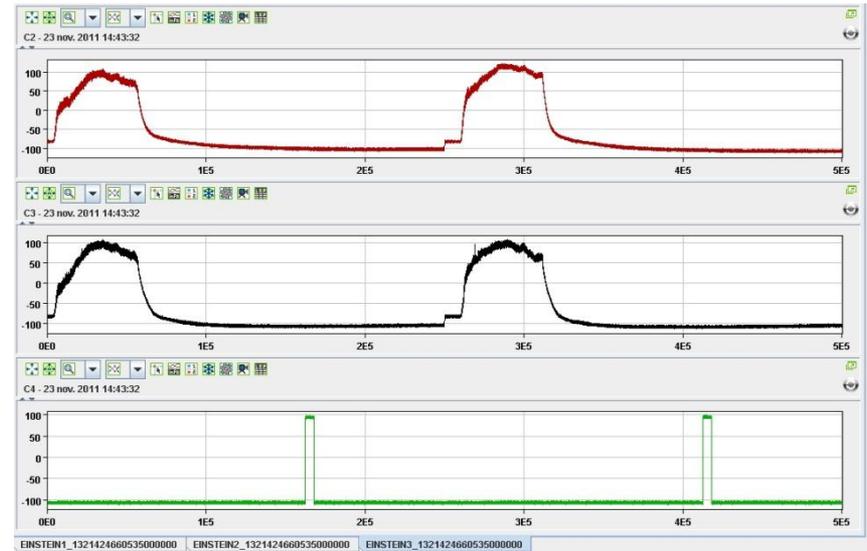


Detector 1 (pit 1) without amplifier

Detector 2 (pit 1) without amplifier

Detector 3 (pit 2) with 20dB AC amplifier

Extraction trigger



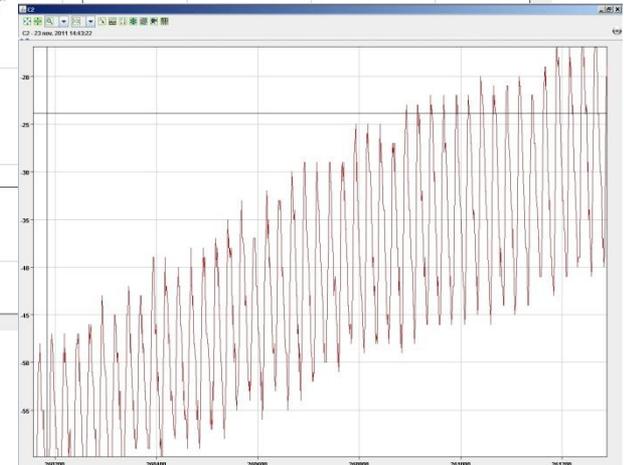
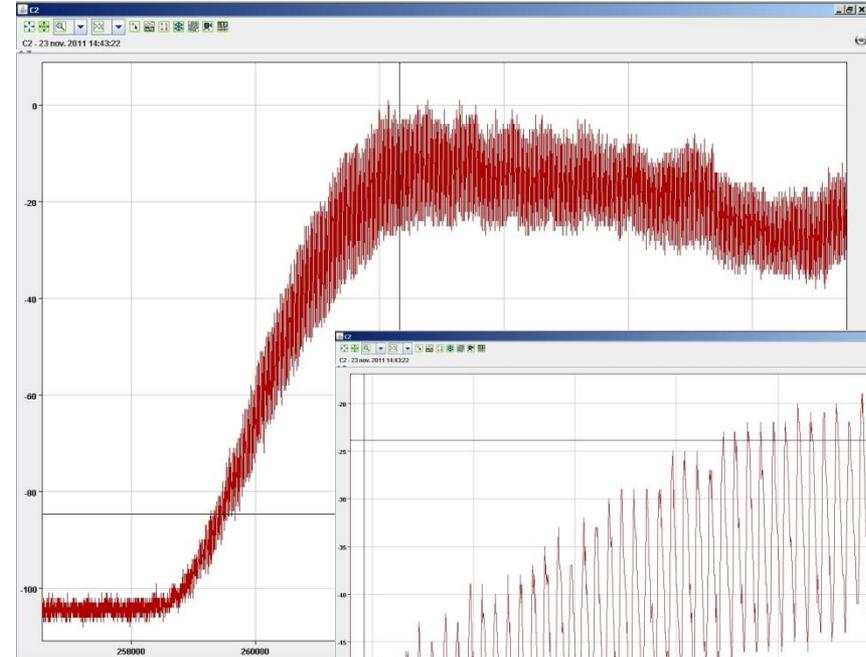
Detector 4 (pit 1) with 40dB AC amplifier

Detector 5 (pit 2) with 40dB AC amplifier

Extraction trigger

Measurement results Cividec

Measurement from CNGS Detector (16/11/2011 -- 7.24AM)



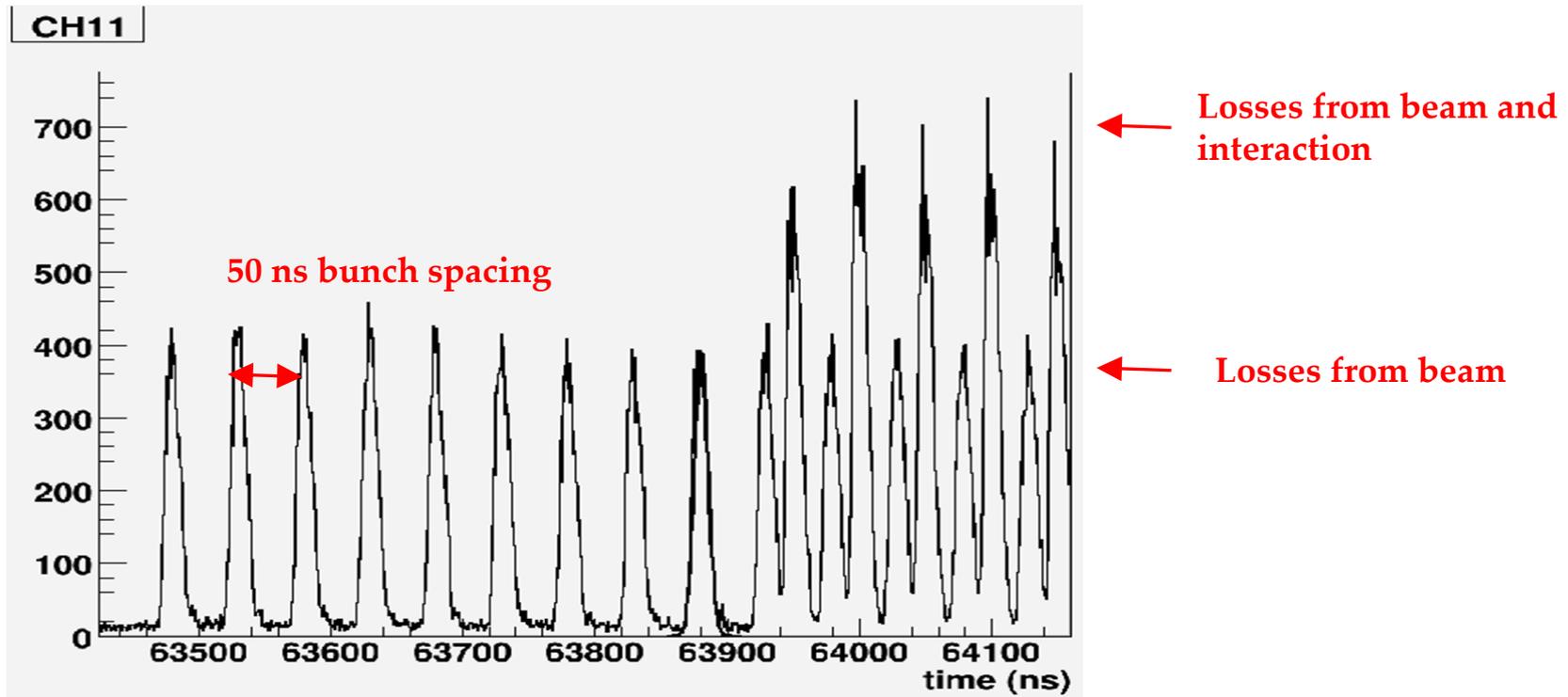
Pic 1. Detector 2 (pit 1) without amplifier (complete extraction)

Pic 2. Detector 2 (pit 1) without amplifier (zoom of rising edge)

Pic 3. Detector 2 (pit 1) without amplifier (zoom 5ns structure visible)

Measurement results BCM1F

Arrival Time Histogram from Losses downstream at Collimator in Point 8



CryoBLM Project

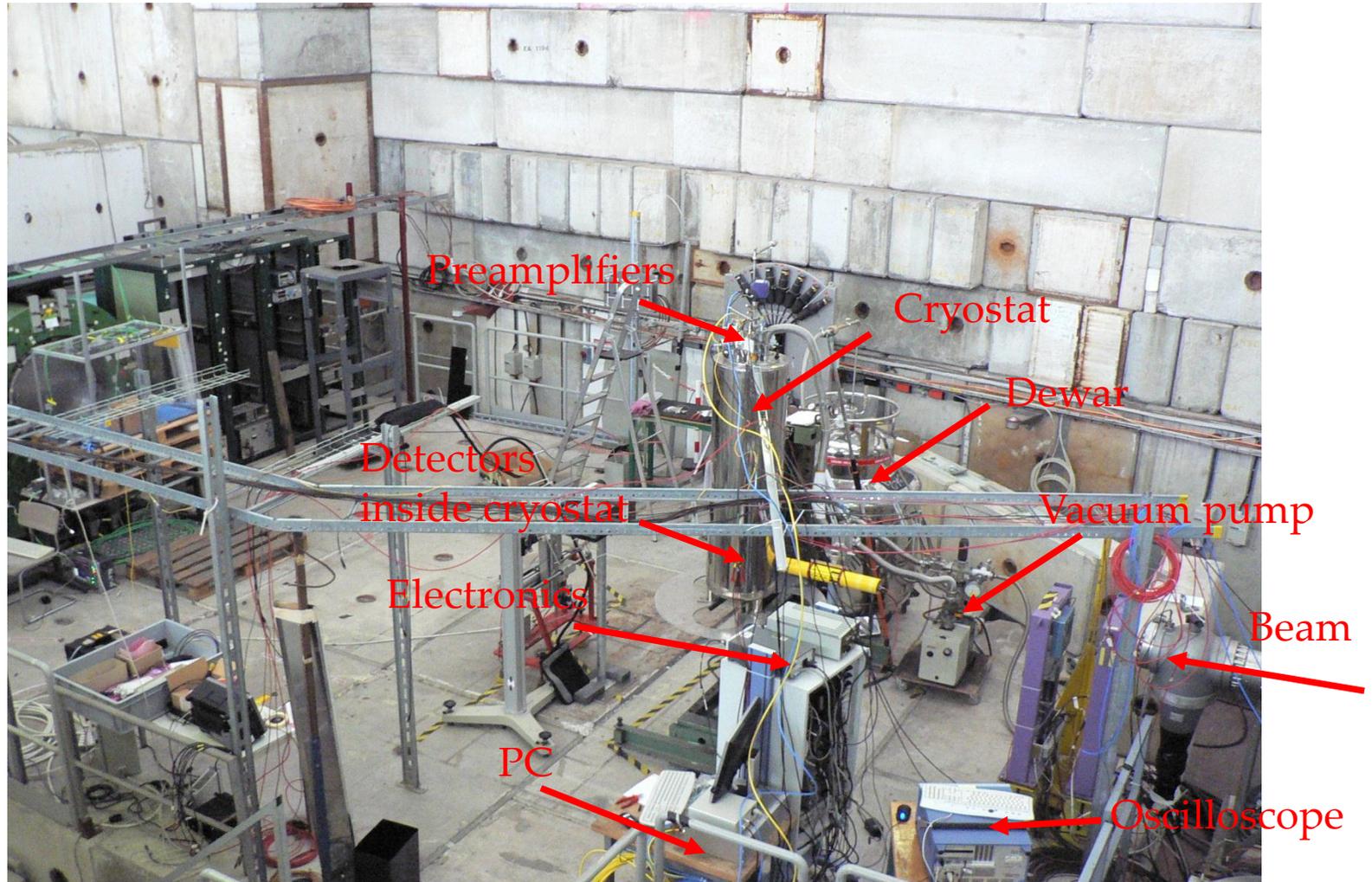
- At IR: ability to measure energy deposition in coil limited because of debris from collisions
- **Problem:** signal from debris with similar height as simulated beam losses in steady state case
- **Solution:** placing detectors closer to losses (inside cold mass of the magnet, 1.9 K)
- Further possible amelioration: injection area, behind collimators

- Detectors under test: **Diamond**, Silicon and liquid helium chamber

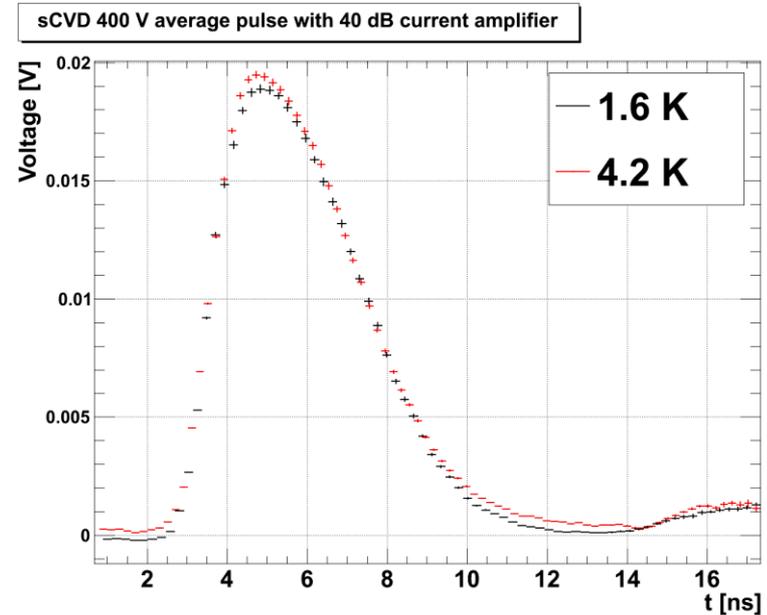
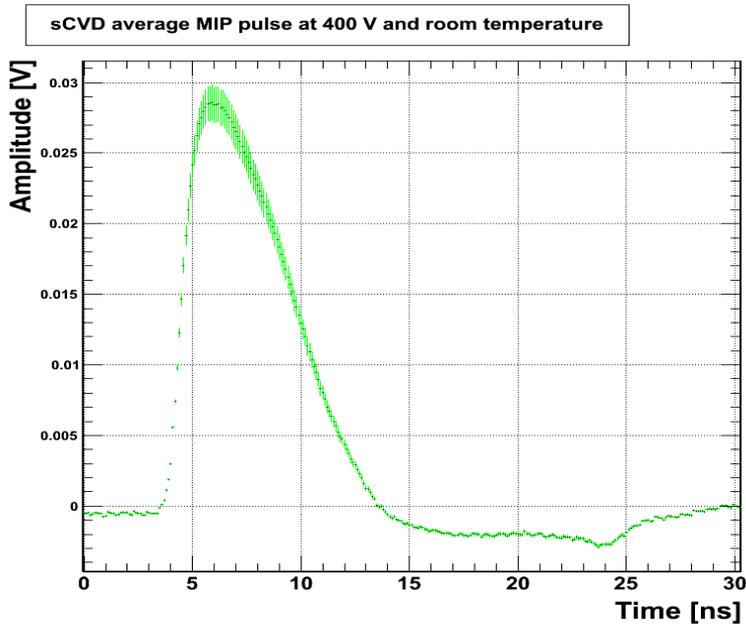
Question:

Does diamond work at 1.9 K for particle detection?

Beam test area with cryogenics

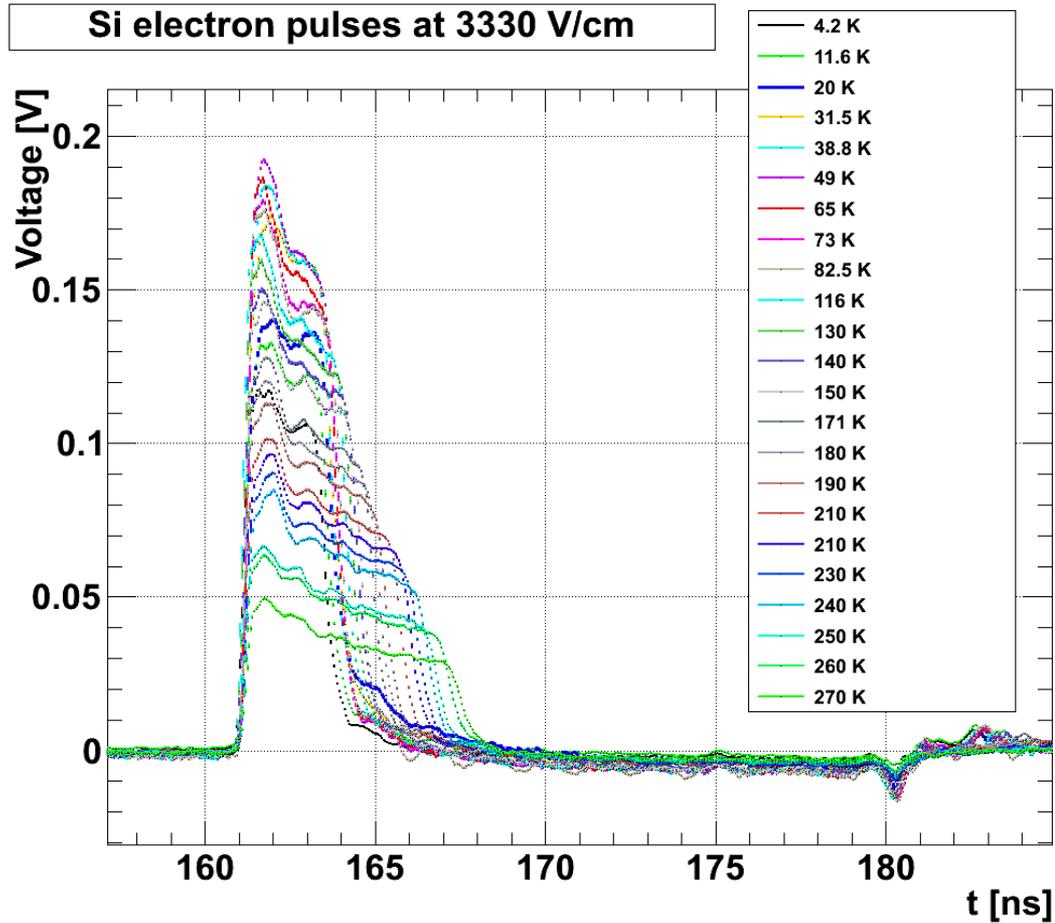


Single Particle pulse

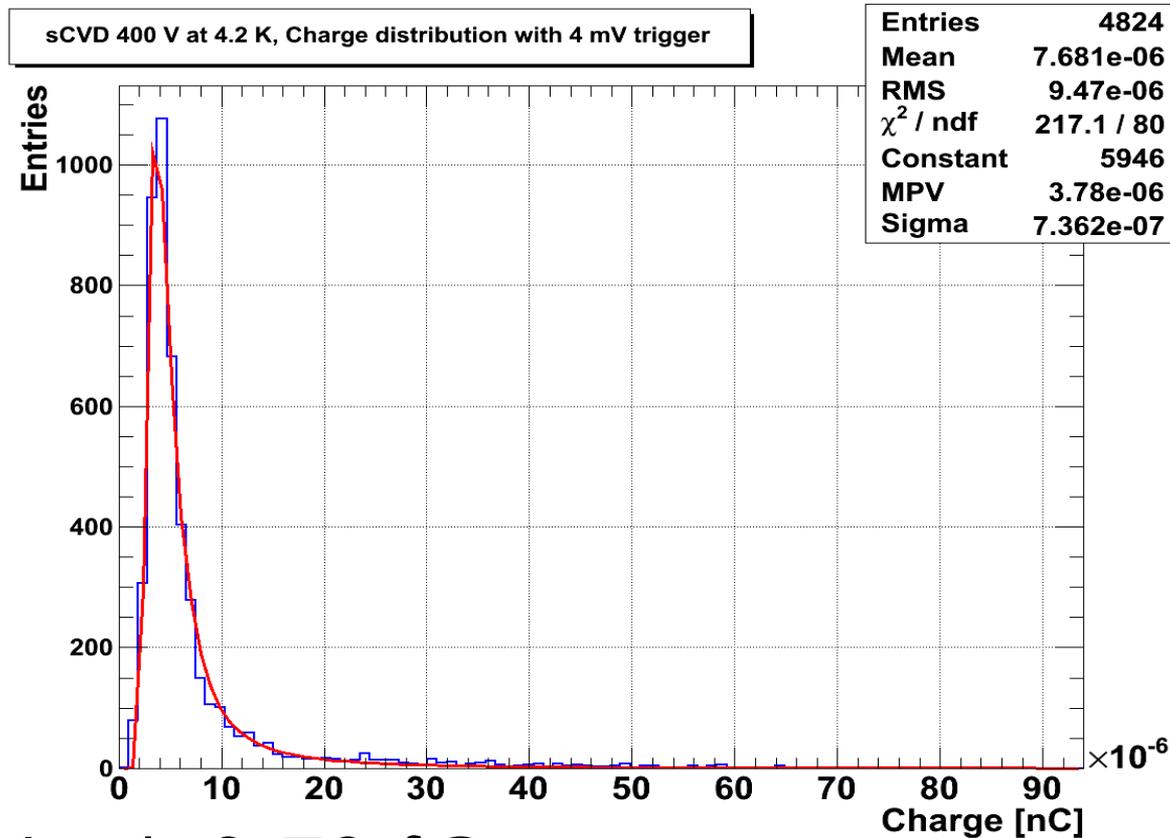


Detection of minimum ionising particles possible with diamond at liquid helium temperatures

Pulse variation with temperature

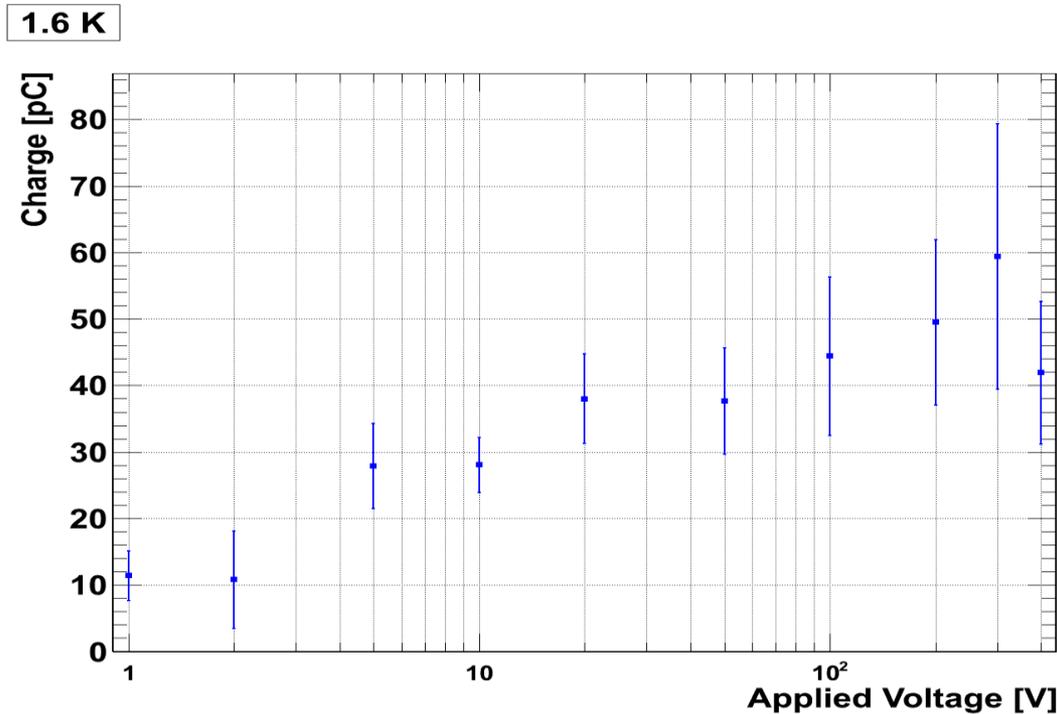


Collected charge per particle



Estimated: 3.79 fC

Collected charge per spill



Measurements in DC mode, as needed for final application

Conclusion

- Diamond proves good properties for BLM application
- Diamond usable for particle detection at liquid helium temperatures
- Open questions:
 - Radiation hardness of material at 1.9 K (tests planned for 2012)
 - Polarisation at low temperatures might be issue for final application

Acknowledgments

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