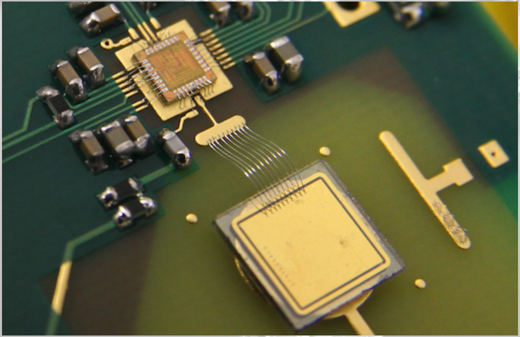
ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

IPA



Pad Analysis of CVD Diamond Detectors

ETH Pixel/Diamond Meeting

Michael Reichmann

9th December 2018

Table of Contents

1. Introduction
2. Test Site
3. Setup
4. Conclusion

Section 1

Introduction

Introduction

- diamond used as beam condition monitors at LHC
- diamond as future material for tracking detectors in high radiation areas

Introduction

- diamond used as beam condition monitors at LHC
- diamond as future material for tracking detectors in high radiation areas

Properties

- radiation tolerant
- isolating material
- high charge carrier mobility

Introduction

- diamond used as beam condition monitors at LHC
- diamond as future material for tracking detectors in high radiation areas

Properties

- radiation tolerant
- isolating material
- high charge carrier mobility

PhD Topics

- Pad Detectors
- Pixel Detectors
- 3D Pixel Detectors
- High Resolution Studies

Introduction

- diamond used as beam condition monitors at LHC
- diamond as future material for tracking detectors in high radiation areas

Properties

- radiation tolerant
- isolating material
- high charge carrier mobility

PhD Topics

- **Pad Detectors** → investigate behaviour at different particle rates
- Pixel Detectors
- 3D Pixel Detectors
- High Resolution Studies

Measurements

- several beam test starting from May 2015

Name	Nick	Type	Irradiation [n/cm^2]
S129	S129	scCVD	0
II6-78$^{*\diamond}$	poly A	pCVD	0
II6-79$^{\diamond+}$	poly B	pCVD	0
II6-81$^{\diamond}$	poly D	pCVD	$1 \cdot 10^{14}$
II6-94	94	pCVD	0
II6-95	95	pCVD	$5 \cdot 10^{14}$
II6-97	97	pCVD	$0 \sim 3.5 \cdot 10^{15}$
II6-B2	B2	pCVD	$0 \sim 8 \cdot 10^{15}$

Table: Measured diamonds.

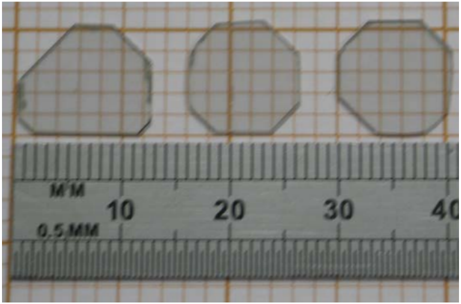
* only measured in May 2015 (bad timing)

$^{\diamond}$ processed by II6 with surface issues

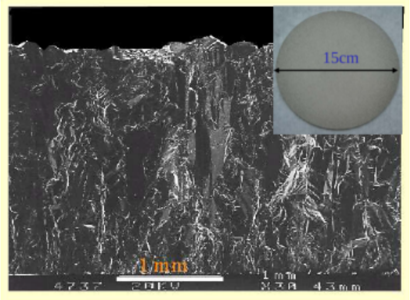
$^{+}$ reprocessed at OSU

Diamond Types

- diamonds artificially grown with chemical vapour deposition (CVD)
- investigation of two different diamond types:



(a) single-crystalline CVD



(b) poly-crystalline CVD (courtesy of E6)

- only small sizes ($\sim$0.25 cm^2)
- large wafers ($5 \sim 6'' \varnothing$)
- pCVD signals smaller than scCVD (1:2) in planar configuration

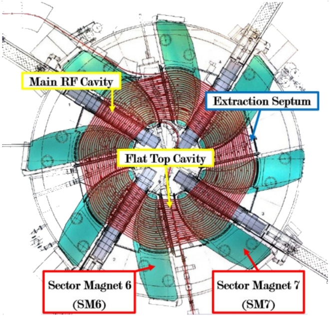
Section 2

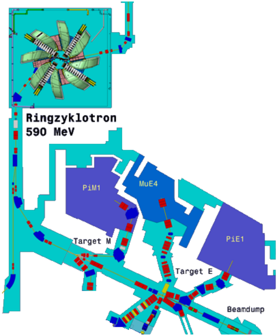
Test Site

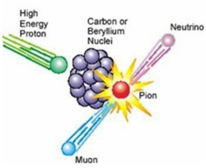

SCHWEISSWERK BÜLACH AG

Test Site

- High Intensity Proton Accelerator (HIPA) at PSI (Cyclotron) $\rightarrow$ beam line PiM1
- clean positive pion beam ($\sim$98 % π^+) with momentum of 260 MeV/c
  - ¾ smaller signals than at CERN! (120 GeV/c)
- **tunable particle fluxes from $\mathcal{O}\left(1\,\mathrm{kHz/cm^2}\right)$ to $\mathcal{O}\left(10\,\mathrm{MHz/cm^2}\right)$**
- **significant multiple scattering $\rightarrow$ worsens resolution**







Section 3

Setup

Setup

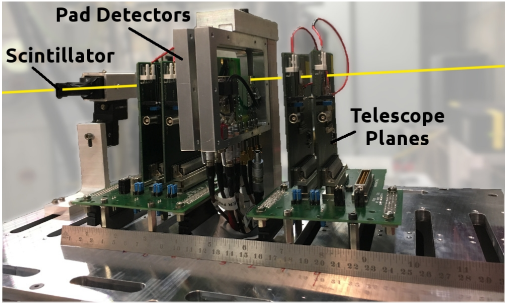
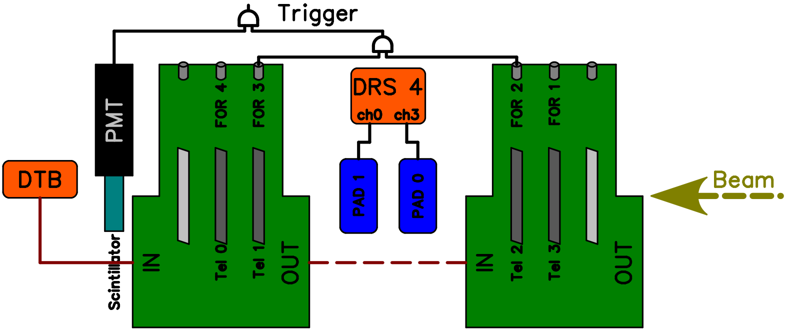


Figure: Modular Beam Telescope

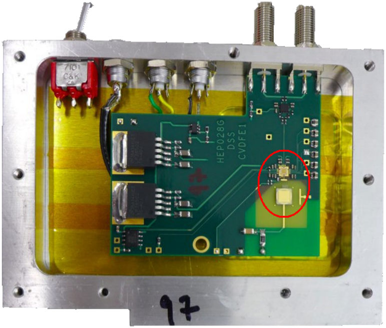
- 4 tracking planes $\rightarrow$ trigger (fast-OR) with adjustable effective area
- diamond pad detectors in between tracking planes
- low time precision of fast-OR trigger
- fast scintillator for precise trigger timing $\rightarrow \mathcal{O}\,(1\,\mathrm{ns})$

Schematic Setup

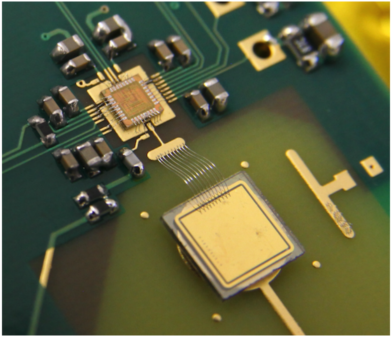


- PSI DRS4 Evaluation Board as digitiser for the pad waveforms
- Digital Test Board (DTB) and pXar software for the telescope readout
- global trigger: using coincidence of FOR 2 and FOR 3 + scintillator signal

Pad Detectors



(a) Detector Box



(b) Pad Detector with Amplifier

- building the detector: cleaning, photo-lithography and Cr-Au metallisation
- gluing to PCBs in custom built amplifier boxes
- connecting to low gain, fast amplifier with $\mathcal{O}\,(5\,\text{ns})$ rise time

Section 4

Conclusion

Conclusion

- empty
- moreempty
- moremoreempty


Del Fin