

## RESEARCH PLAN

for the Dissertation of Michael Reichmann  
born on 15<sup>th</sup> December 1988

submitted in May 2018

# *High Rate and High Resolution Studies of planar and 3D Poly-Crystalline Diamond Detectors*

## The Collaboration

This dissertation is done within the CERN's RD42 Collaboration which investigates diamond as a future material for high energy particle detectors. Aiming to build a fully functional tracking detector that can be operated in the extremely high radiation environment of the LHC's (and the HL-LHC's) innermost layers close to its beam pipe the RD42 Collaboration is involved in every process leading to that purpose.

Starting from the close relation and constant exchange with the manufactures of artificial diamonds which grow diamonds using a Chemical Vapour Deposition (CVD) process the collaboration is investigating the bulk and surface properties of this interesting material and develops own procedures on preparing the diamonds for different detectors designs which are namely are pad, pixel and 3D detectors. These prototypes are then qualified using various different testing methods including long time current and irradiation studies as well as the investigation of their signal behaviour depending on incident particle flux and high resolution studies of the detector structure.

The collaboration has already shown that diamonds are radiation tolerant up to a fluence of  $1 \times 10^{16}$  hadrons/cm<sup>2</sup> and can operate for several years in the environment of the HL-LHC and that they do not show evidence of any damage due to electrons and photons up to 100 Mrad.

## Research Topics

Within the RD42 Collaboration Mr. Reichmann is investigating the behaviour the signal response of planar and 3D poly-crystalline CVD (pCVD) diamond detectors in pad or pixel geometries depending on incident particle flux and characterising their internal structure with a high resolution beam telescope. The rate tests are solely performed at Paul Scherrer Institut (PSI) using the beam line piM1 with a positive 260 MeV/c pion beam and tunable particle fluxes from 1 kHz/cm<sup>2</sup> up to 10 MHz/cm<sup>2</sup> whereas the high resolution test are performed at CERN using the SPS beam H6 with pions or protons up to momenta of 200 GeV/c.

### Rate Beam Tests:

Mr. Reichmann is in charge of organising and conducting the RD42 high rate beam tests at PSI as well as assisting other members of the collaboration performing experiments at this facility. This includes maintaining and operating the ETH beam telescope and the overall set-up at PSI, supervising the data-taking and running and improving the data acquisition (DAQ) framework EUDAQ.

### Pad Detectors:

As a proof of principle that pCVD diamond material is suited as particle detectors at high particle rates, the most simple detector geometry - pad detectors - are investigated. The investigated detectors are built at Ohio State University (OSU) by cleaning diamonds from the company II-IV and metallising them with a thin Cr-Au layer on both sides. They will then be measured at PSI at various fixed rates recording their signals as digital waveforms which are then to be analysed to get conclusions about their behaviour at

different rates.

### **Pixel Detectors:**

Since the current technology at the innermost tracking layers of the LHC is based on planer pixel detectors it also very important that Mr. Reichmann will investigate pCVD diamond sensors read out with state of the art pixel detectors which digitise the signals already on chip using an analogue to digital converter (ADC).

### **3D Detectors:**

3D detectors are a very promising detector concept. Within RD42 these detectors are built in collaboration with the Universities of Manchester, Oxford and Ohio utilising a femtosecond laser. Mr. Reichmann will test the general working principal as well as the rate behaviour of these detectors both pad-like and pixel geometry.

### **High Resolution Beam Tests:**

As the name already suggests pCVD material is not uniform and therefore Mr. Reichmann shall also upgrade the current ETH telescope in order to measure the various detector geometries and designs with high resolution and resolve their inner structure.

## **Time Frame**

empty

## **Results & Progress**

empty

## **Teaching**

25 % of Mr. Reichmann's working time is designated to the function as teaching assistant at ETH Zürich.

## Research Plan

### Doctoral thesis:

Investigation of the Rate Dependence of pCVD Diamond Pad, Pixel and 3D-Pixel Detectors

Doctoral thesis title (provisional)

02/12/2016

Beginning date of doctoral thesis

### Doctoral student:

12-946-414

Student number

Michael Reichmann

Name

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E-mail

Institution (if external doctoral thesis)

Date, signature

### Supervisor:

Prof. Dr. R. S. Wallny

Name, title

Date, signature

### Co-examiner (if already known):

Name, title

Affiliation

E-mail

**Please hand in this form together with the research plan and the form "Approval of the research plan" to the Doctoral Administration Office of D-PHYS**

Studierenden-Nummer  
*student number*      12   -   946   -   414

Name  
*family name*      Reichmann

Vorname  
*first name*      Michael

Departement  
*department*      D - PHYS

**Der Forschungsplan wurde eingesehen und angenommen durch:**  
***The research plan has been seen and approved by:***

Prof. Dr. R. S. Wallny

Name Dissertationsleiter/in  
*Name of supervisor*

Datum  
*Date*

Unterschrift  
*Signature*

Name Bevollmächtigter Doktoratsausschuss  
*Name of representative of doctoral board*

Datum  
*Date*

Unterschrift  
*Signature*

**Für Kandidaten mit weiteren Zulassungsbedingungen:**

Die Zulassungsbedingungen müssen **vor** Genehmigung des Forschungsplans erfüllt sein!

***For candidates who have to fulfil further conditions of admission:***

***These conditions must be fulfilled before the research plan can be approved!***

**Frist für Einreichung des Forschungsplans**

Frühestens nach erfüllen und offiziell verfügbarem Bestehen der Zusatzbedingungen, spätestens ein Jahr nach der Einschreibung

**Vorgehen zur Genehmigung des Forschungsplans**

Lassen Sie dieses Formular und den Forschungsplan von Ihrer Leiterin / Ihrem Leiter unterzeichnen und senden Sie danach beides an das zuständige **Studiensekretariat**. Dieses kümmert sich um die Unterschrift des Bevollmächtigten des Doktoratsausschusses und schickt das Formular anschliessend an die Doktoratsadministration.

**Deadline for submission of the research plan**

Only after having passed and received official notification of having successfully fulfilled the further conditions of admission, one year after registration at the latest.

**Procedure for approval of your research plan**

Please ask your supervisor to sign this form and your research plan and send both to the **Study Administration Office of your department**. They will take care of having it signed by the representative of the doctoral board and will forward it to the Doctoral Administration Office afterwards.