

# Lithuanian Consortium for Particle Physics

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# Lithuanian Consortium for Particle Physics (LCPP)



- Recognizing need for wider inclusion of scientists and better coordination of CERN-related activities, three universities - **VU, KTU, LSMU** – established **Lithuanian Consortium of Particle Physics** in 2022.
- In 2024, **Lithuanian Energy Institute** joins the LCPP
- Currently, LCPP includes **11 scientific groups** with more that **40 researches**
- Openness for all scientists working with CERN is among the key principles of LCPP
- **New scientific group for LHCb** data analysis is to be established in LCPP

# Organization of LCPP



## International Advisory Board

Chair – Christoph Schäfer  
5 members



## LCPP Council

Chair - Gintautas Tamulaitis  
13 members



## Research groups



- Center for Nuclear and Particle Physics (Center has its own IAB)
- 7 other Research groups



1 Research group each

## LCPP executive body

**Executive director**

Ramūnas Aleksiejūnas

**Managers**

Mažena Mackoit-Sinkevičienė  
Jolanta Juodvalkienė  
Tatjana Zaiceva

**Coordinators of particular activities:**

- **CMS** Andrius Juodagalvis
- **Outreach** Greta Tamulionienė
- **Schools** Aušra Kynienė
- **Students** Brigita Abakevičienė
- **Business** Saulė Mačiukaitė Žvinienė

# Goals of the Consortium

- to unify Lithuanian scientists working in CERN-related topics and areas
- to facilitate knowledge spillover to Lithuanian businesses
- to facilitate the interest of children and teachers in CERN activities
- to ensure an adequate access to scientific infrastructure for Lithuanian scientists
- to represent Particle Physics Community in national and international organizations, on all levels
- to manage the financing dedicated for CERN activities in Lithuania



# International Advisory Board

- Dr. Christoph Schäfer (Chair)
- Prof. Tadeusz Lesiak
- Dr. Susanne Kuehn,
- Dr. Maxim Titov
- Prof. Marco Gersabeck



*„Our goal is to check all boxes for the full membership of Lithuania in CERN till the end of next evaluation period “*

- C. Schäfer





# Research groups

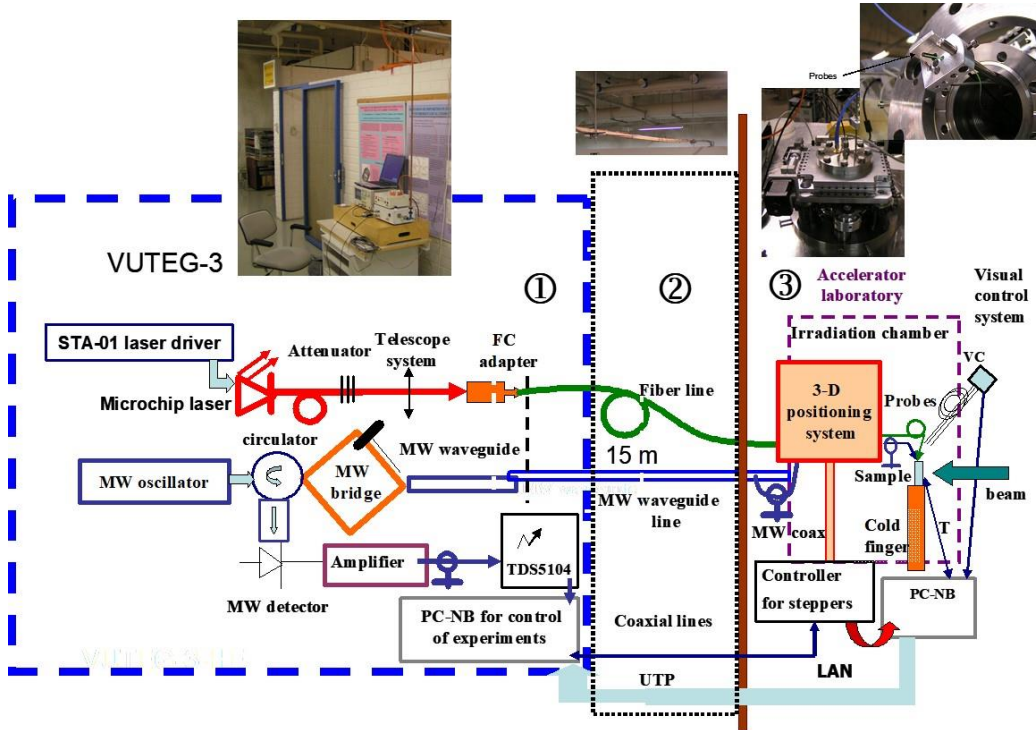
# Research groups of LCPP

- Nuclear and Particle Physics Center (A. Rinkevičius);
- High Energy Proton Collision Analysis (A. Juodagalvis);
- Particle Physics Theory (D. Jurčiukonis);
- Detector Construction and Monitoring (V. Rapševičius);
- Scintillation Detectors (G. Tamulaitis);
- Radiation Tolerance of Semiconductor Detectors (T. Čeponis);
- Pixel Sensor Characterization (V. Rumbauskas)
- Ferrite Materials for Accelerators (V. Kalendra)
- Radiobiology (E. Juozaitytė)
- RG of Institute of Materials Science at KTU (S. Tamulevičius)
- Neutron Dynamics Research (G. Stankūnas)

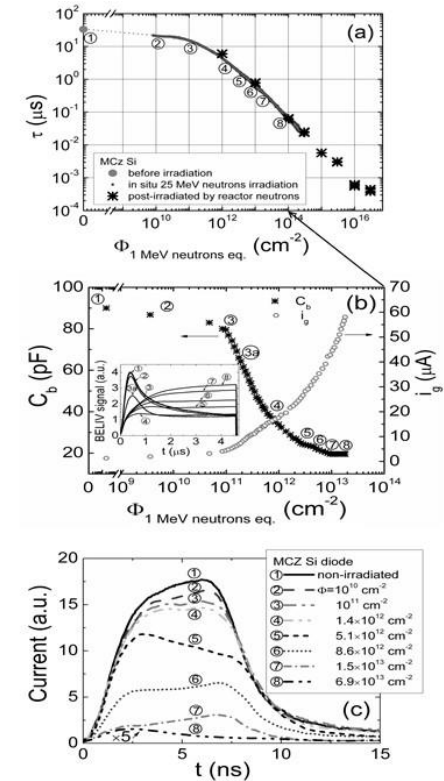
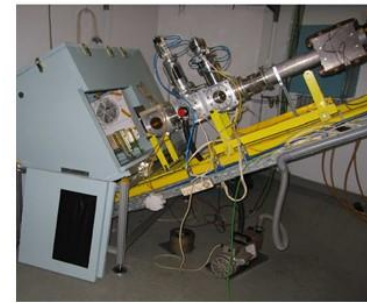
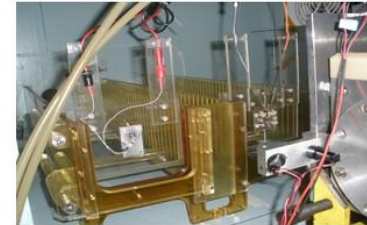
# CERN RD50 related activities: evolution

In situ control of the radiation defects introduced by 8 MeV protons at **Helsinki University** accelerator laboratory.

In situ variations of carrier recombination (a- MW-PC), of barrier capacitance (b-BELIV) and of detector response (c-TCT/ICDC) during irradiation by spallator neutrons, installed at **Louvain-la-Neuve Cyclotron laboratory**.



Correlated evolution of the MW-PC, BELIV and ICDC characteristics during spallator neutrons irradiation: transients registered every 10 ms, irradiation - bunches of 4 ns duration.





# CERN RD50 related activities: evolution

Patented method and equipment for the measurements of high cumulative doses collected under ionizing irradiations by gamma rays, leptons and hadrons.



**URKUNDE      CERTIFICATE      CERTIFICAT**

**Europläisches Patent**  
Es wird hiermit bescheinigt, dass für die in der Patentschrift beschriebene Erfindung ein europäisches Patent für die in der Patentschrift bezeichneten Vertragsstaaten erteilt worden ist.

**European patent**  
It is hereby certified that a European patent has been granted in respect of the invention described in the patent specification for the Contracting States designated in the specification.

**Brevet européen**  
Il est certifié qu'un brevet européen a été délivré pour l'invention décrite dans le fascicule de brevet, pour les États contractants désignés dans le fascicule de brevet.

European Patent No. 3594723

Patent holder: Vilnius University, Vilnius, Lithuania

EU patent: E. Gaubas, T. Čeponis, et al, „DOUBLE RESPONSE IONIZING RADIATION DETECTOR AND MEASURING METHOD USING THE SAME“- App No.: 18213254.8, Patent No.: 3594723.

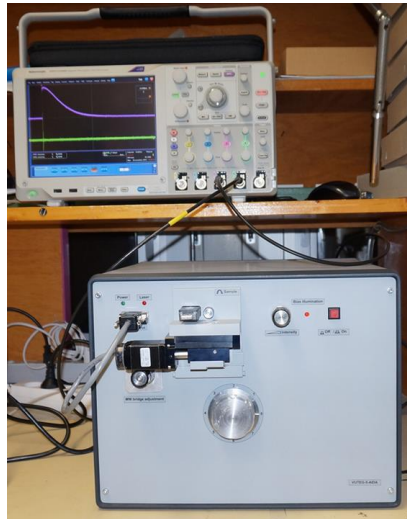
Instrument and technology for dosimetry and fluxmetry of high energy electromagnetic and particle radiations.

Particle identification, fluxmetry and dosimetry instrument „VUTEG-7“ (front view)

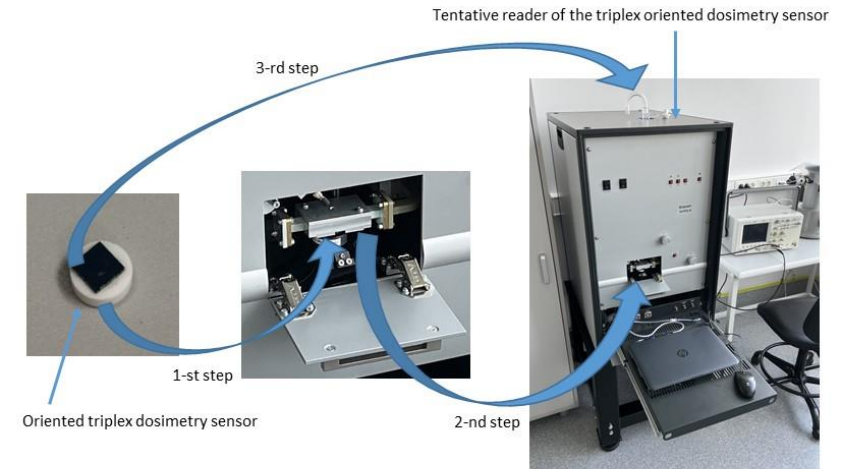


HYBRID MULTI-LAYER SENSOR AND METHOD FOR LARGE FLUENCE DOSIMETRY AND FLUXIMETRY, Authors: Eugenijus Gaubas, Tomas Čeponis, Laimonas Deveikis, Jevgenij Pavlov, Vytautas Rumbauskas. Application No. 21 165 145.0, submission date: 2021 03 26.

Dosimeter VUTEG-5-AIDA has been **installed at CERN in 2012** for the RD50 program and other CERN research. The dosimeter VUTEG-5-AIDA is devoted for dosimetric control of hot irradiation zones of large areas.



The prototype system for the control of radiation doses in a wide range. This prototype system allows measuring low and very high fluences and to identify the spectrum of high energy radiations.

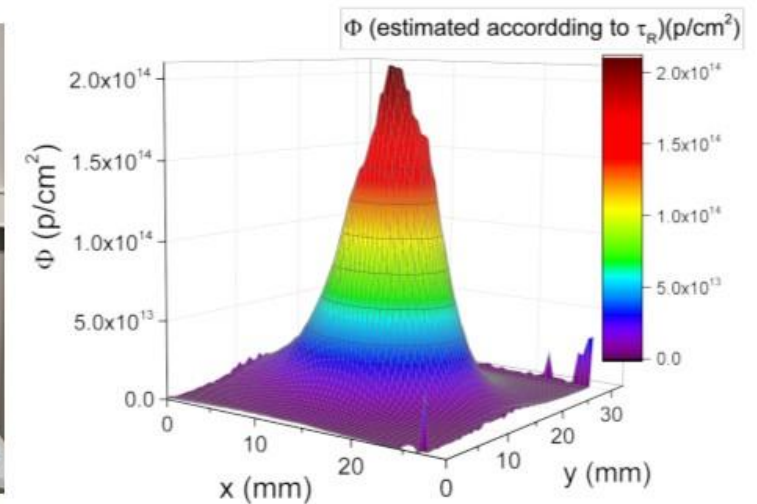
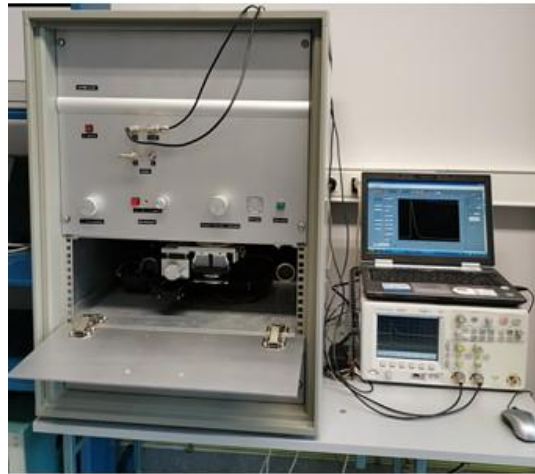


The oriented sensor is in succession set in PL as well as MW-PC opening and into the EPR insert of the tentative reader

E. Gaubas, T. Čeponis, L. Deveikis, J. Pavlov, V. Rumbauskas, Oriented triplex sensor and method of identification of the radiation source location and its dosimetry, EU patent application No. EP22171639.2, submission date: 2022 05 04.

# CERN RD50 related activities: Technology and instruments for particle beam profiling

The particle beam profiling techniques based on dosimetry of the hadron irradiated Si and GaN sensors have been developed. The fluence distribution profiles for high energy penetrative particles are recorded by carrier lifetime measurements within Si wafer. For beams of rather low energy particles, sensors with thin active layers are preferable. Then, the scintillation techniques are eligible to have recordable responses from thin sensor layers.



Recorded profile of 26 GeV/c proton beam.

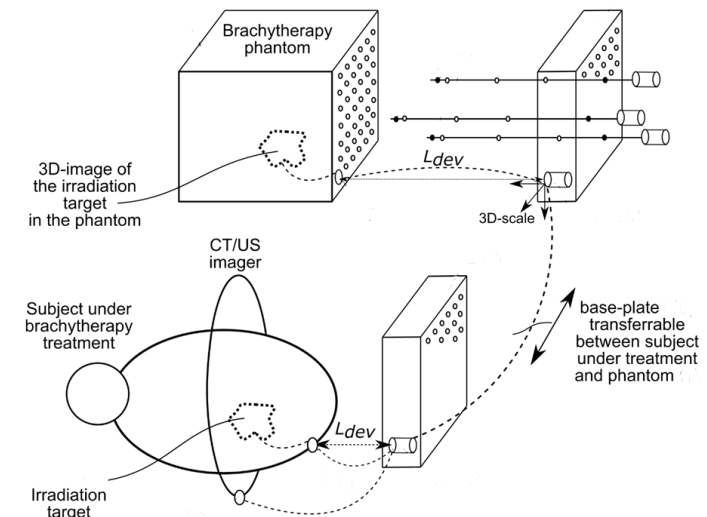
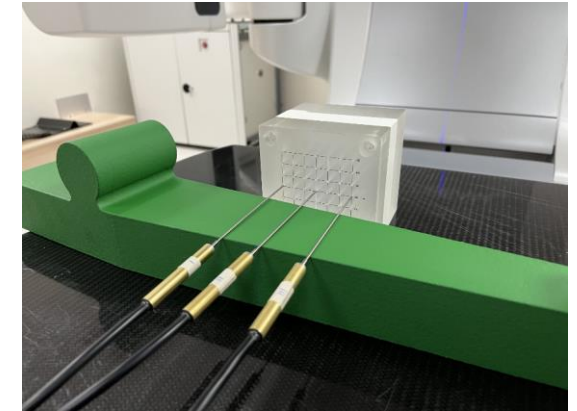
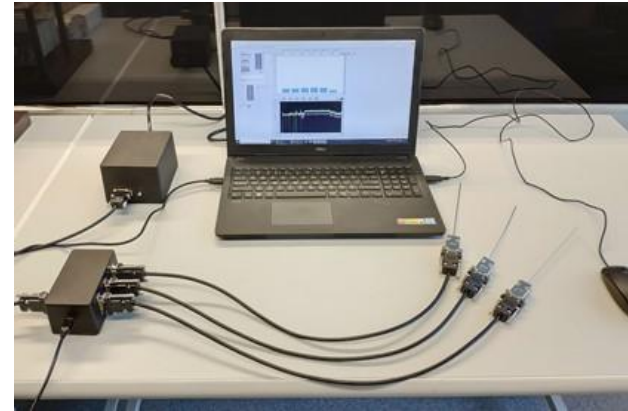
- L. Deveikis, J.V. Vaitkus, T. Čeponis, M. Gaspariūnas, V. Kovalevskij, V. Rumbauskas, E. Gaubas, *Profiling of proton beams by fluence scanners*, Lith. J. Phys. **61** (2021) 75–83.
- T. Ceponis, L. Deveikis, E. Gaubas V. Rumbauskas, M. Moll, Particle beam profilers based on fluence dependent variations of carrier lifetime and scintillation intensity in Si and GaN materials, Presentation at RD50 workshop, CERN 2022-06.

# Radiation dose monitoring in medical applications

Development of technology and instrumentation for time-resolved positioning of radiation emitters and for dosimetry during the brachytherapy planning and a subsequent in vivo brachytherapy treatment stages, where the method and apparatus are based on triangulation of needle-type probes fixed within time-space resolved coordinates.

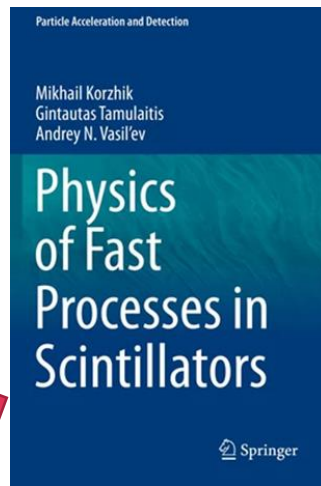
The technology and instrumentation have been approved at The National Cancer Institute.

The first in vivo measurement of radiation dose during brachytherapy therapeutic procedure has been performed in October 2022.

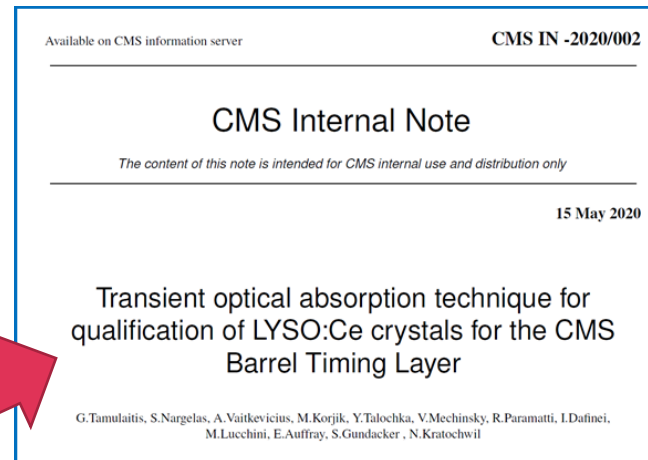


# Development of scintillators for fast radiation detectors: evolution of the field

31 research papers  
+



Two Lithuanian Science Awards on semiconductor spectroscopy as a background



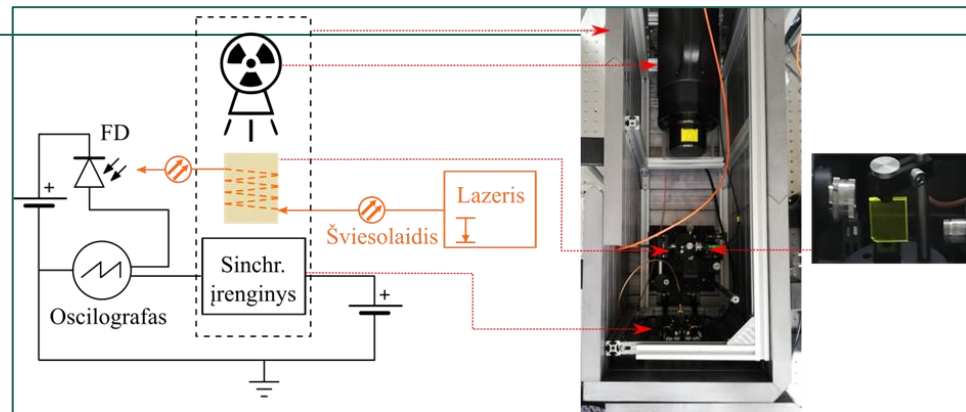
Testbench for routine testing of scintillators for the coming update of CMS experiment



165 000 such crystals will be installed in the Barrel Timing Layer of CMS

# Development of scintillators for fast radiation detectors: national projects

The European Regional Development Fund project under grant agreement with the Research Council of Lithuania (project No. 01.2.2-LMT-L-718-01-0041) *Neutron flux detection system with optical readout*, 2018-2022, total budget 529 447 Eur.



The European Social Fund under grant agreement with the Research Council of Lithuania (project No. 09.3.3-LMT-K-712-01-0013) *Fast scintillators for radiation detectors (FARAD)*, 2018-2022, total budget 591 144 Eur.

13 peer-reviewed papers published, mostly in Q1 and Q2 journals (10 such papers planned)

# Physics of Subatomic Particles at CERN CMS experiment: Participation in the CMS experiment



1. Analysis of the proton-proton collision data recorded with the CMS detector is focused on precision studies of the Drell-Yan process

Group uses data-driven methods to estimate the number of the background process events in data recorded in 2016-2018

Collaboration with Université Libre de Bruxelles University, University of Nebraska in Lincoln, University of Montenegro, and Yonsei University

Work towards differential cross section measurement is on-going, planning results in 2023

2. Calibration of the pixel silicon sensor for the CMS Tracker Phase II upgrade

Work supervised by S. Mersi (CERN)

Software development and remote testing on actual sensor (RD53B)

Hands-on work during 1 month visit in August

3. 30 remote CMS DAQ shifts to control data-taking with the detector

4. Participation in CERN LHC Electroweak Work group (EW WG) activities

Impact of uncertainty correlations on the estimated data-theory (dis)agreement

# Physics of Subatomic Particles at CERN CMS experiment: Phenomenological studies



Group theorists study several models beyond the standard model trying to address:

## 1. Neutrino flavor oscillations

➤ Study of Grimus-Neufeld model (this is the standard model extended by one extra Higgs doublet, and one heavy Majorana neutrino) lead to general questions about the accepted theory-experiment matching (renormalization) procedures

## 2. Lepton flavor violating reactions

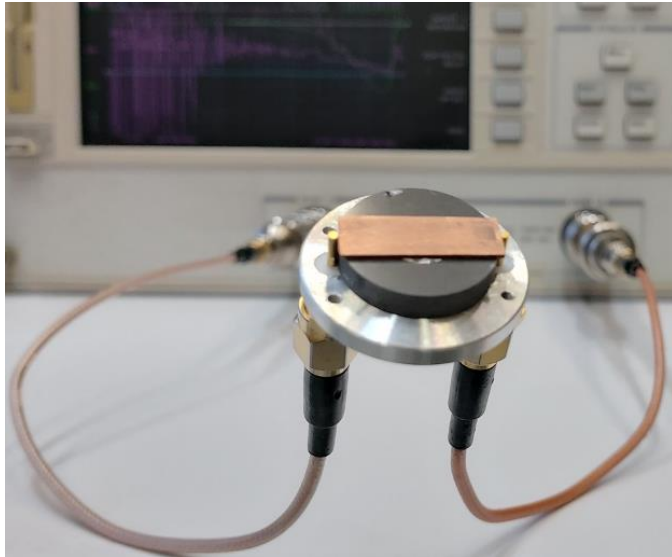
- Within the Grimus-Neufeld model
- A 2HDM model with soft breaking terms

## 3. Description of the stable dark matter

➤ Symmetry groups which could be used to describe the dark matter particles

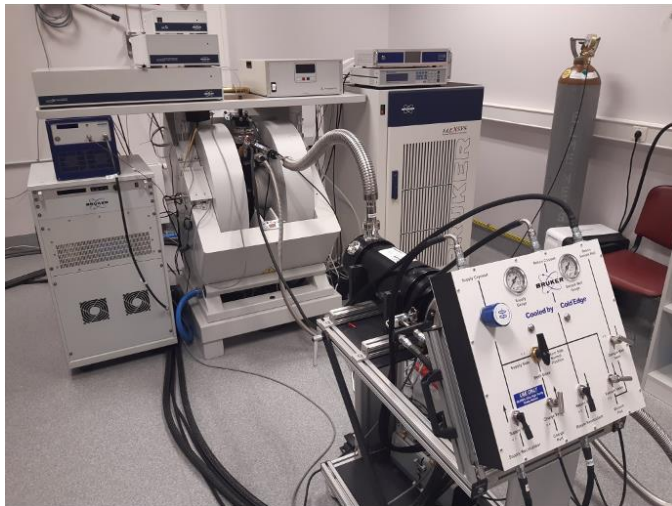
Collaboration with Lisbon CFTP, Dresden TU, Warsaw NCBJ, CERN TH

# Investigation of ferrite materials



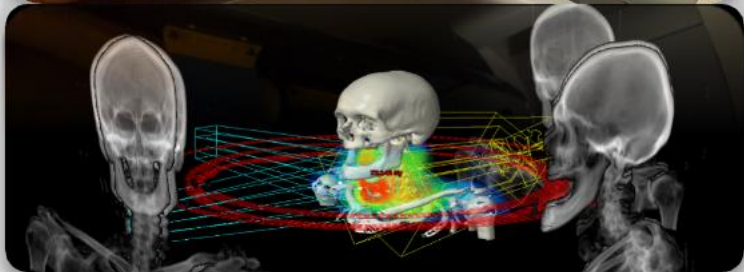
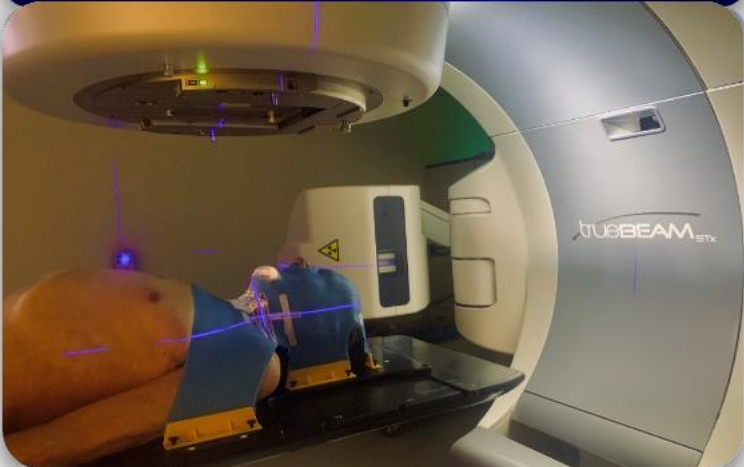
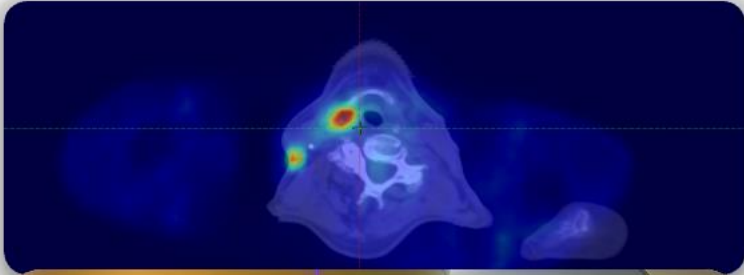
The aim of the research is to find out which ferrite materials are promising for CERN's particle beam introduction and extraction devices from the CERN accelerator rings.

Currently investigated ferrite materials will be used in the **high-speed ferrite tuner**, in one of the upgraded facilities at the proton synchrotron, which is one of the most important components in the CERN accelerator complex. This device **will operate at a high frequency of about 80 MHz**, which places special demands on the parameters of the ferrites used in it.





# LSMU-CERN: research areas in radiotherapy and radiobiology



- **Prognostic and predictive molecular markers of solid tumors;**
- **Molecular mechanisms of sensitivity and resistance to radiotherapy in breast cancer or other cell lines;**
- Radiotherapy optimisation using  $^{18}\text{F}$ -FDG-PET/CT images;
- Association between common genetic variations with individual patient variability in normal tissue late radiation toxicities;
- Linac-based fractionated stereotactic radiotherapy vs. intensity modulated radiotherapy;
- New brachytherapy techniques.

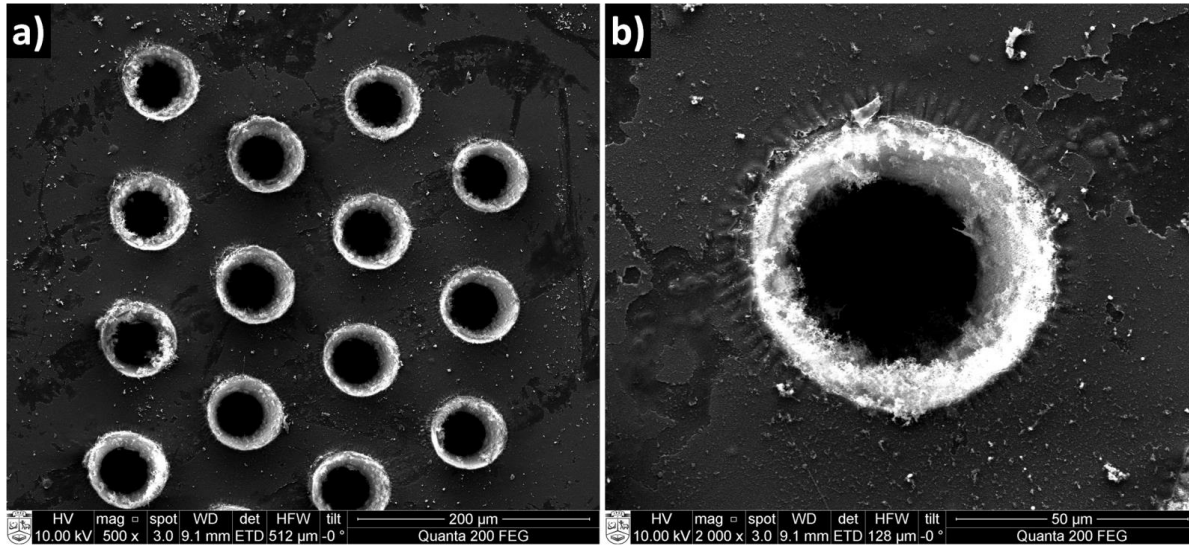
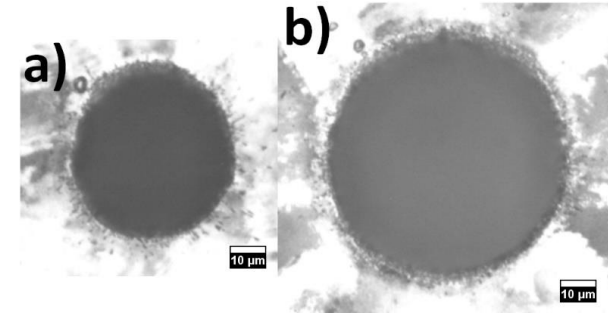
# Materials and technologies for the high-gain Fast Timing MPGD detector (FTM) (2021 – 2022)

The project aim to improve the technology used in the production of a new type of Micro Pattern Gaseous Detectors (MPGD).

KAPTON average hole diameters:

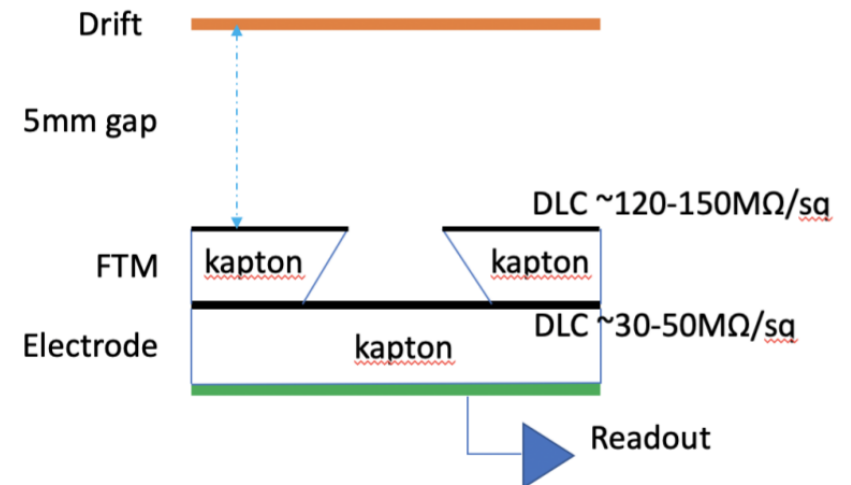
50  $\mu\text{m}$

70  $\mu\text{m}$



SEM images of holes formed in **KAPTON** coated with **DLC**:  
(a) small fraction of hole array formed by removing DLC prior to drilling,  
(b) a single hole from the array, showing DLC crumpling.

Schematic overview of a single layer of the FTM prototype



Ch. Roskas, P. Verwilligen et al. Proceedings of Science, EPS-HEP2019 (2020) 158. DOI: [10.22323/1.364.0158](https://doi.org/10.22323/1.364.0158)

# Nuclear and Particle Physics Center plus Hacker space





# **Outreach activities**



## Students and Academia

- Organization of Masterclasses
- Organization and opportunity search for student internship and programs at CERN
- Creation of Master level programme dedicated for HEP, together with Latvia and Estonia
- Organization of dedicated lectures, conferences, summer schools, etc.
- Inviting students to scientific groups working on CERN-related topics

# TEILCHEN- PHYSIK

UNTERRICHTSMATERIAL AB KLASSE 10

Erstellt in Kooperation mit der Joachim Herz Stiftung

BAND 1

**LADUNGEN,  
WECHSEL-  
WIRKUNGEN  
UND TEILCHEN**



NETZWERK  
TEILCHENWELT



## Teachers and children

- Creation of educational material and hands-on equipment for education of teachers and school children
- Organizing visits to CERN for teachers and (maybe) children
- Involvement in renewing of school programmes, expanding the HEP-related topics
- Supporting non-official Physics school “Photon”
- Visits and dedicated lectures in schools



**Thank you!**