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EURIZON: WP5 Second Reporting Period and Current Status

February 10, 2023

EURIZON Annual Meeting

Andre Sailer (CERN)

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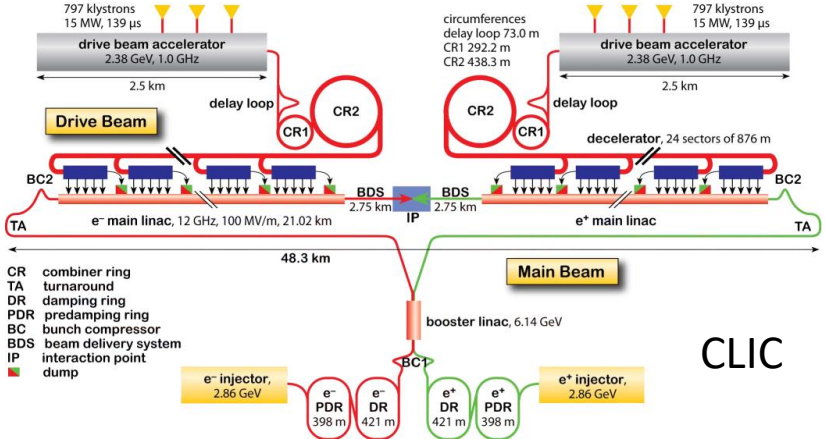
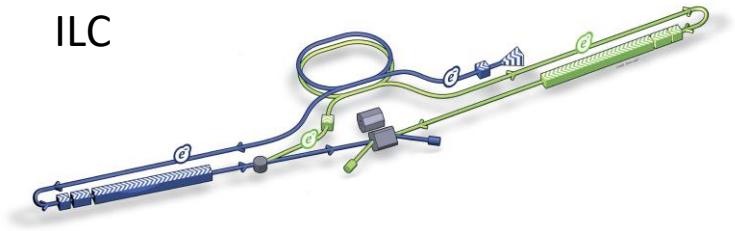
Different Lepton Collider Proposals

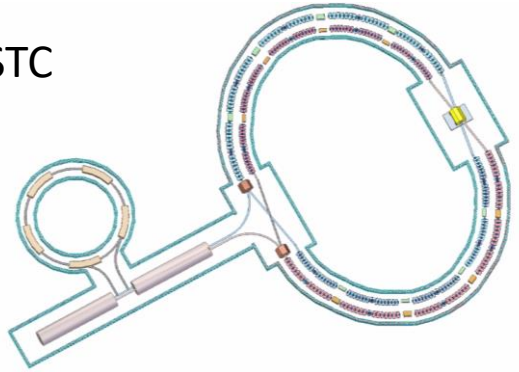


CLIC

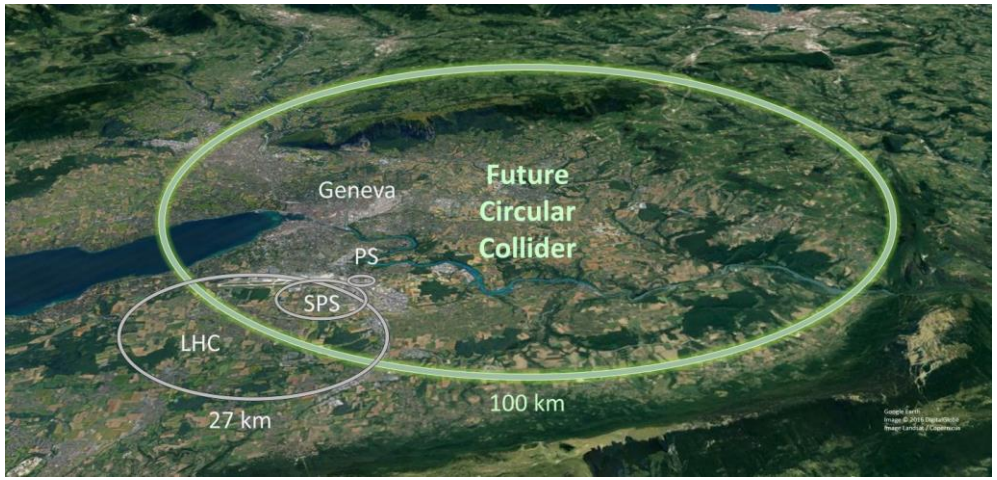
ILC



STC



https://cicpi.ustc.edu.cn/indico/contributionDisplay.py?contribId=22&confId=2760



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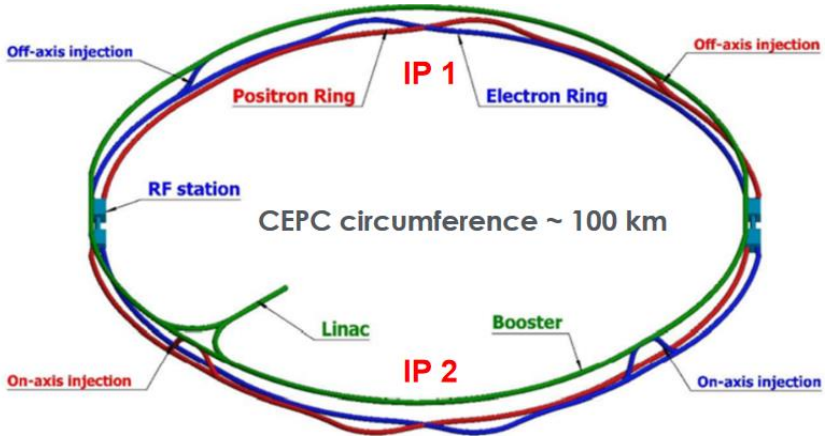

https://indico.ihep.ac.cn/event/17020/contributions/117889/

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Task 5.1: SCT Internationalization

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SCT Internationalization/Outreach

- November 18, 2021: SCT Partnership kick-off meeting
- SCT website launched
- Presentations at international workshops
- Joint Charm Tau workshop

The founding partners

We haven't tried to collect as much partners as possible. Only groups already involved in the project

1. The JLU group (2021-09-21)
   - **Prof. Michael Düren**
   - Prof. Joybrato Mukherjee (JLU President)
2. The NSTU group (2021-09-24)
   - **Dr. Alexander Barnyakov**
   - Prof. Anatoly Bataev (NSTU Rector)
3. The NSU group (2021-10-11)
   - **Prof. Alex Bondar**
   - Prof. Mikhail Fedoruk (NSU Rector)
4. The BINP group (2021-10-13)
   - **Dr. Ivan Logashenko**
   - Dr. Pavel Logachev (BINP Director)
5. The LPI group (2021-10-14)
   - **Dr. Pavel Pakhlov**
   - Dr. Nikolay Kolachevsky (LPI Director)
6. The SINP group (2021-10-29)
   - **Prof. Eduard Boos (SINP Director)**
7. The HSE group (2021-11-15)
   - **Prof. Tagir Aushev**
   - **Dr. Andrey Ustyuzhanin**
   - Dr. Nikita Anisimov (HSE Rector)
8. The JINR group (2021-11-17)
   - **Dr. Alexey Zhemchugov**
9. The BIRP VNIIEF group (2021-11-16)
   - **Dr. Nikolay Zavyalov (BIRP Director)**
10. The Cinvestav group (2021-11-12)
    - **Prof. Eduard De La Cruz Burelo**
    - Prof. Gabriel López Castro (Cinvestav Academic Vicepresident)

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Task 5.2: Accelerator Developments

Walid Kaabi (IJCLab)

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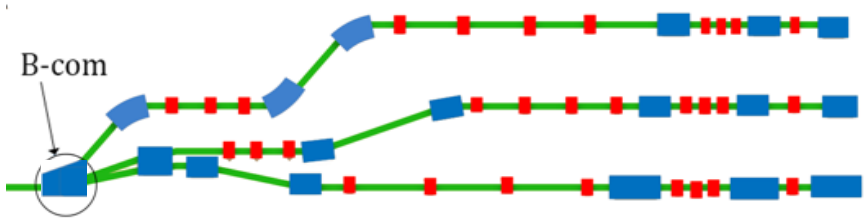
Plan of magnet activities

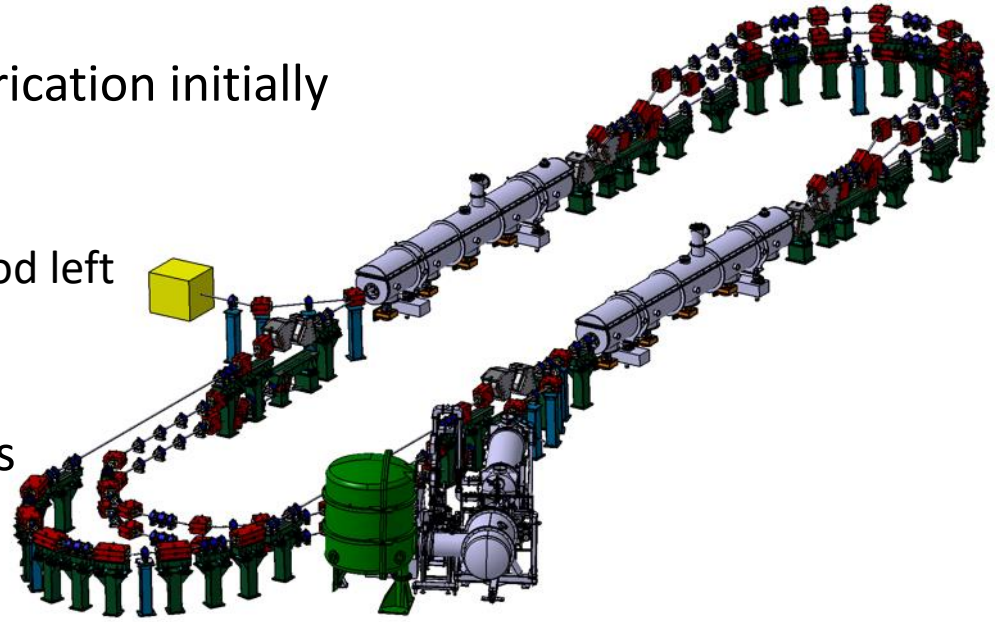


Prototype of B-COM magnet:

- Pursue the work toward B-COM magnet complete specification.
- Proceed to a thermal study and mechanical complete design
- Ordering a B-COM magnet prototype to be measured and qualified, **is still under discussion**.

Challenges:

- Prototype would now be made with an industrial partner (fabrication initially foreseen at BINP):
  - Risk of over-cost regarding the budget foreseen.
  - Long administrative process before purchase regarding the period left for the project (January 24).
- We are looking for a magnetic measurement bench to made measurements and characterize the prototype (measurements initially foreseen at BINP).



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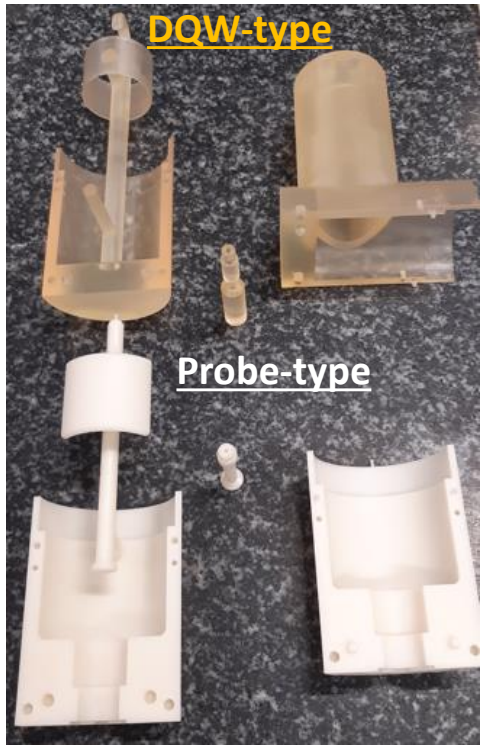
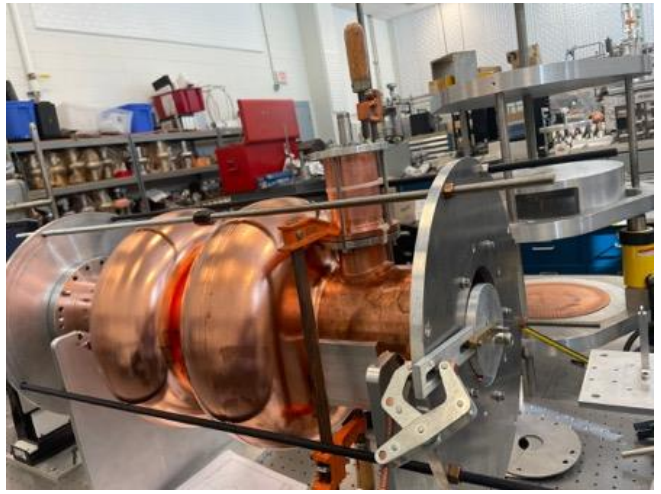
Plans on HOMs and cavity activities :

HOM couplers prototypes:

- 1 **hook HOM coupler** was 3D printed in polymer then Copper coated.
- Now installed on a 2-cell 801.58 MHz copper cavity to test HOM coupler performance





First Hook type polymer coupler 3D printed then copper coated, now installed in a double-cell Cu cavity for test

- Test will be performed also on **Probe-type** and **DQW-type coupler** currently under fabrication.
- A 5-Cell copper cavity will be fabricated soon @Jlab (same design as the 1st Nb 5-cell cavity fabricated in 2017) to allow end group design optimisation and to test several HOM couplers combinations to assess the best HOM damping scheme.
- Ultimately, we aim to fabricate **Nb HOM couplers with optimised design** and and install them on a new **Nb 5-cell PERLE cavity with optimised end groups**.

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5.2 Summary

- Design studies are progressing well, both for magnet and HOM technologies for Energy Recovery Linacs
- Magnet prototyping is under discussion due to new challenges related to cost and timeline (loss of the expertise and capacity of fabrication & test at BINP)
- HOM couplers prototyping will be made in the project timeline.
- Special request addressed to project coordinator: Use the money initially allocated to Post-doc hiring (104 k€) to prototypes funding. Need to know how to formalize it.

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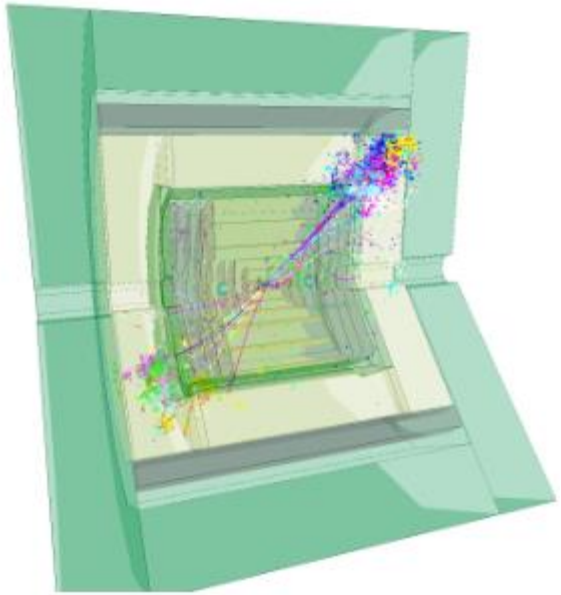
Task 5.3: Development of software for the design of an HEP detector

Andre Sailer (CERN)



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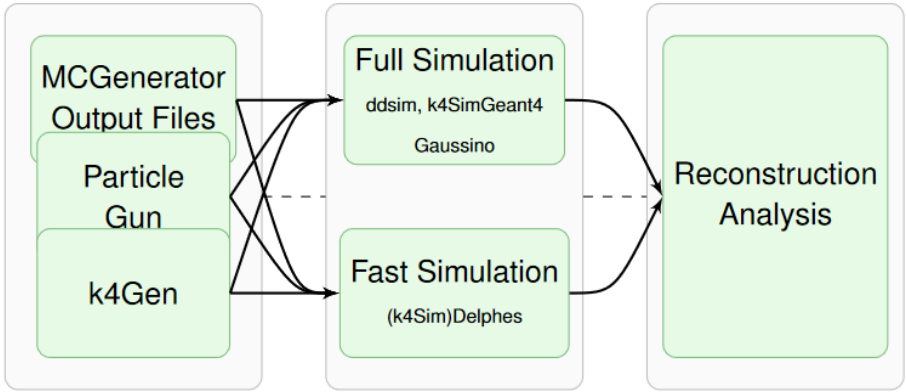
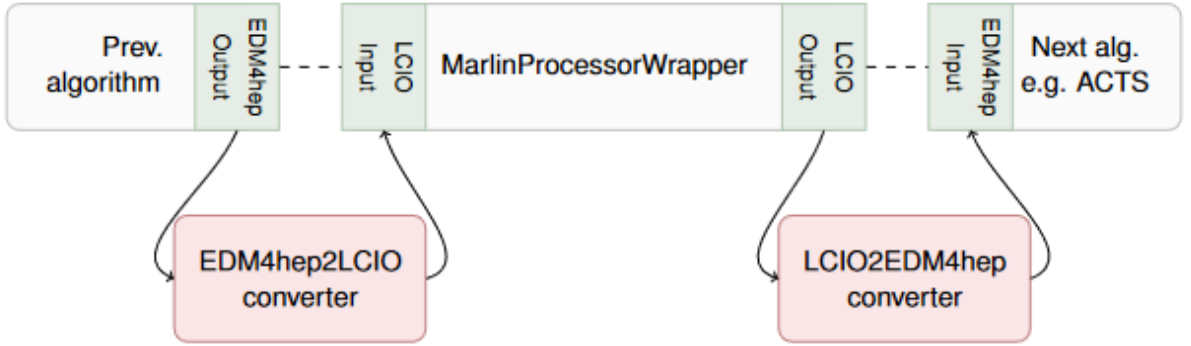
Software for Future Collider Studies (Key4hep)

- Fully integrated framework for event generation, simulation (fast/parameterized, full), reconstruction, analysis
  - "Turnkey Software Stack"
  - Endorsed by ECFA Higgs/Electroweak/Top Factories studies (ILC, CLIC, FCCee experiments)
- Integrating standard tools from HEP world
  - Gaudi, DD4hep, podio, Geant4, ROOT, spack
- Integration of existing tools (FCCSW, iLCSoft (→k4MarlinWrapper)





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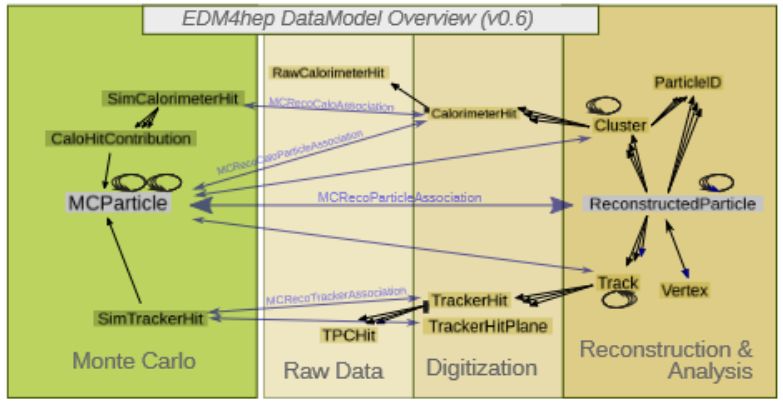
Software for Future Collider Studies

- Continued developments
  - Event Data Model evolution: e.g., necessary for drift chambers (cluster counting, cf. task 5.5)
  - Integration of new state-of-the art tools: e.g., ACTS for track reconstruction
  - Development of continuous validation system



- Technical Student started this month to work on Distributed Computing (DIRAC) with focus for FCCee large scale MC production

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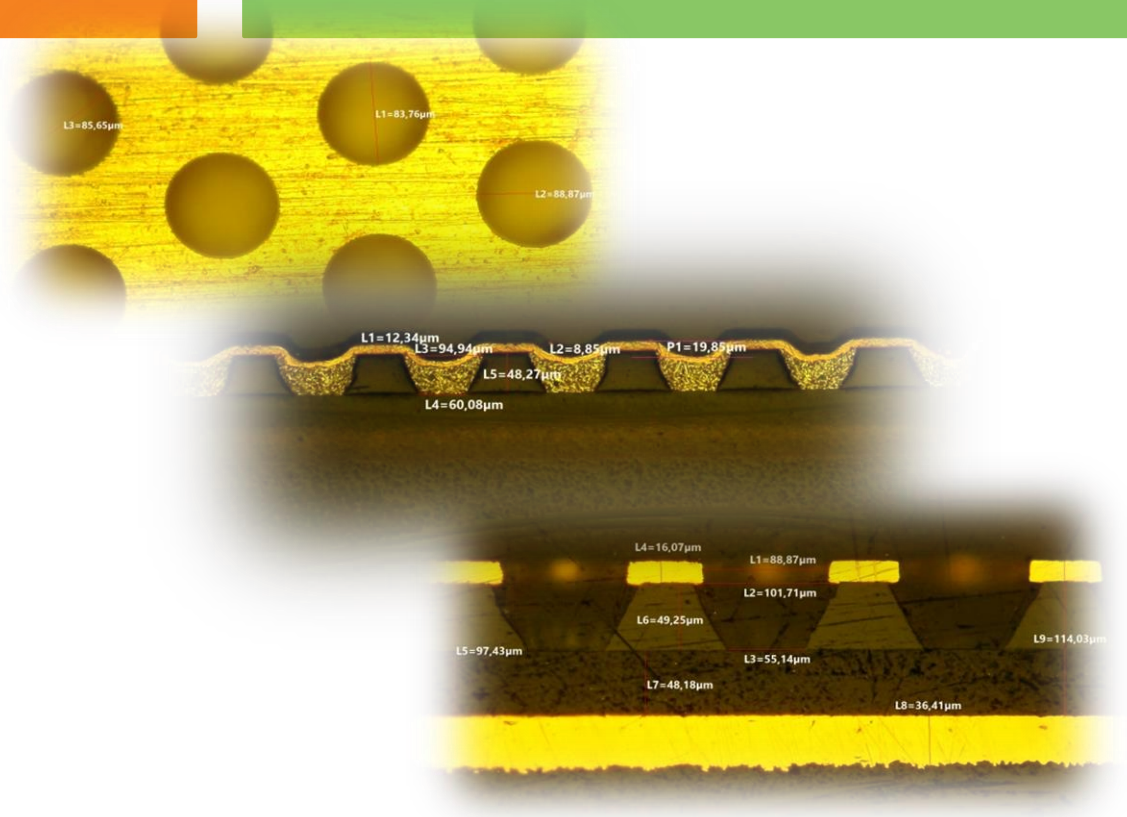
WP 5.4: Cylindrical RWELL as Inner tracker for SCTF



G. Bencivenni, E. de Lucia
on behalf of
LNF-INFN, Ferrara – INFN, Torino INFN

February 2023

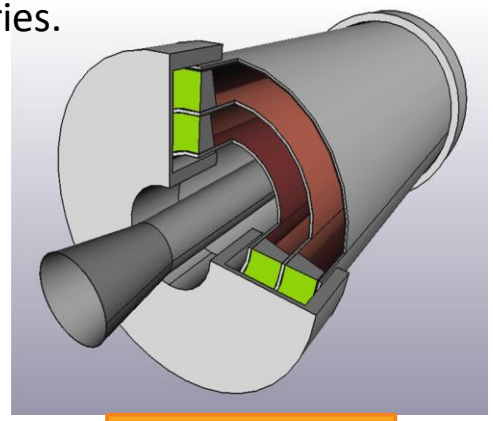
INFN
LNF - DDG

WP 5.4 Status Report – Detector construction

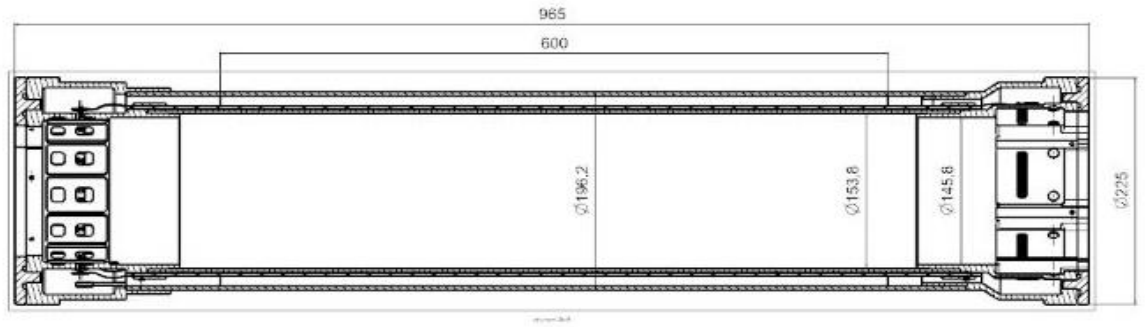
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072

Development of an **ultra-light modular cylindrical µ-RWELL (C_RWELL)** as **inner tracker** for Tau-Charm Factories.
The **B2B layout** (a double radial TPC – with a central cathode) is designed to have a **very low material budget** (**0.86÷0.96% X_0**) and **modular roof-tile shaped detector units, based on µ-RWELL technology.**
A single gap C-RWELL prototype is under construction as demonstrator.

B2B layout

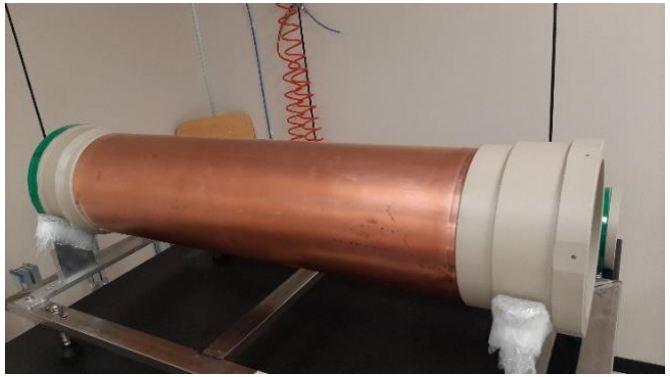


Final concept



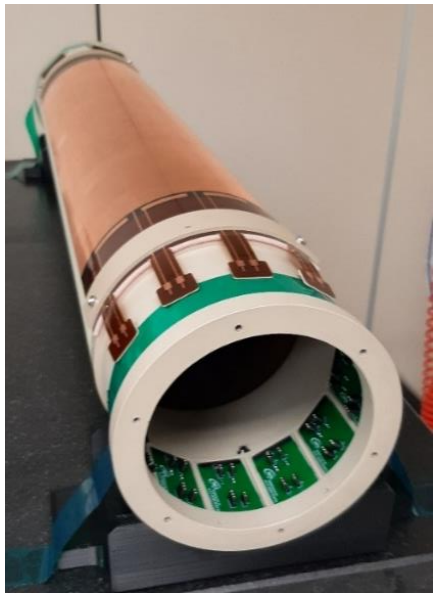
Prototype size

- anode diameter = 168.5 mm
- cathode diameter = 188.5 mm
- active length = 600 mm
- drift gap = 10 mm



Project Status

- Design completed
- Components manufacturing completed
- Detector assembly started
- Cosmic ray test



WP 5.4 Status Report – Simulation: Detector Response Parametrization

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The complete simulation of the C_RWELL includes also the response of the detector to the energy deposition, with the description of the formation of the electronic signal inside the detector

- Simulation software developed for BESIII triple-GEM detectors
  → Adapted to μ–RWELL detector (`Parsifal tool-kit`)

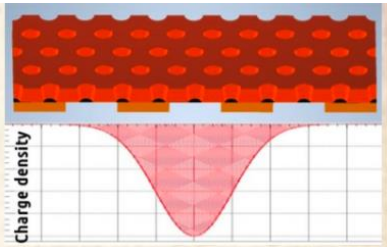
- Simulate resistive configuration

GEANT4	Poisson(primary) + secondary ionizations
IONIZATION	
DETECTOR GAIN	Polya distribution
ELECTRON DRIFT	Transverse / longitudinal diff
RESISTIVE	
INDUCTION	RAMO THEOREM
ELECTRONICS	APV25
RECONSTRUCTION	
ANALYSIS	

CHARGE DENSITY SPREAD ON THE RESISTIVE LAYER [6, 7]

$$\rho(x,y,t) = \frac{N q_e}{2\pi\,(2ht + w^2)} exp\left[-\left(x^2+y^2\right)/\left(2\left(2ht+w^2\right)\right)\right]$$

- N = number of electron in avalanche
- Q_e = electron charge
- h = 1/RC
- t = time
- w = width of the avalanche
- x, y = position coordinates



ADAPTATION TO ONE–DIMENSIONAL STRIP

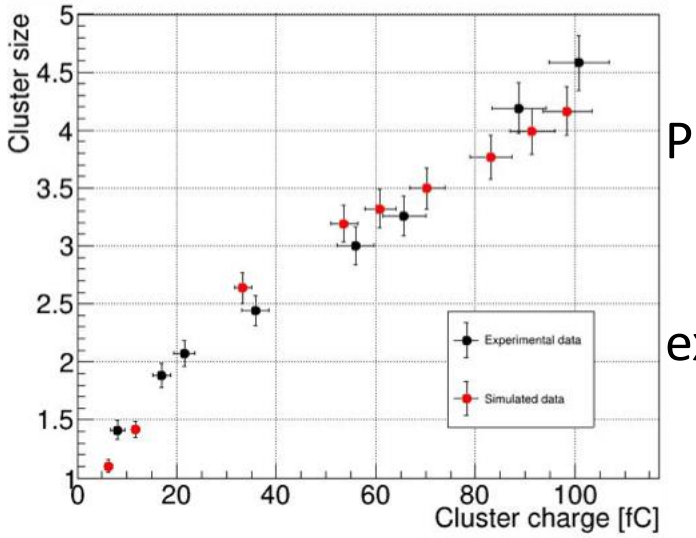
$$\rho(x,t) = \frac{q}{\sqrt{2\pi}\left[\sigma_0\left(1+\frac{t-t_0}{\tau}\right)\right]} exp\left[-\frac{(x-x_0)^2}{2\sigma_0^2\left(1+\frac{t-t_0}{\tau}\right)^2}\right]\Theta(t-t_0)$$

- q charge the avalanche
- x_0 electron starting position
- σ_0 width of the avalanche
- t_0 starting time of the track
- τ = RC

ELECTRONICS (APV – 25)

$$Q_{shaped}(t) = Q_{preamp}\left(\frac{t-t_0}{\tau}\right) \exp\left(-\frac{t-t_0}{\tau}\right)$$

- Q_{preamp} = integrated charge
- t_0 starting time of the track
- τ shaping time of the chip



Preliminary results from the comparison of simulation with experimental data show a good agreement

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Task 5.5 Status

F. Grancagnolo

for

INFN Bari and Lecce

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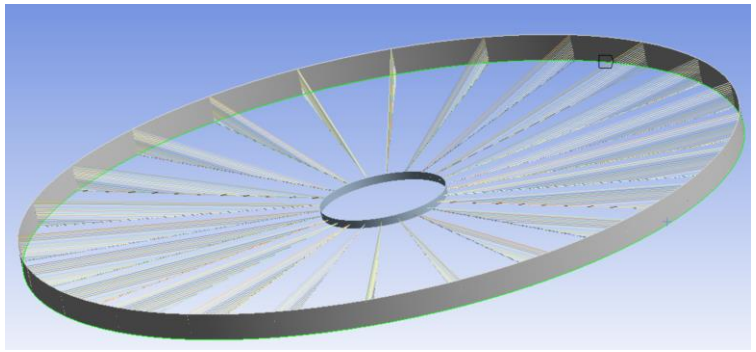
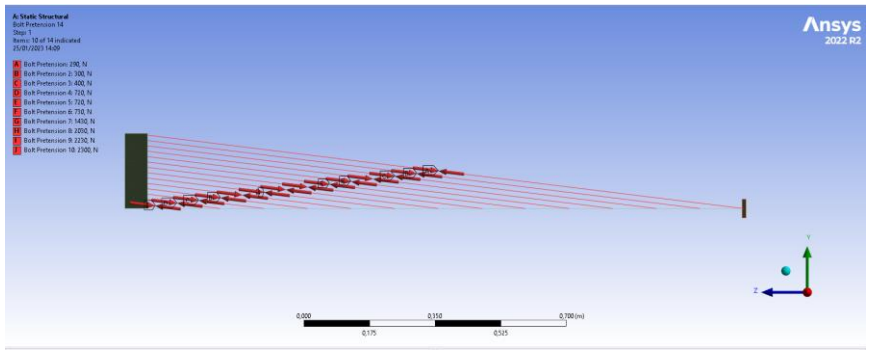
Subtask 5.5.1 - Mechanical design of the IDEA drift chamber

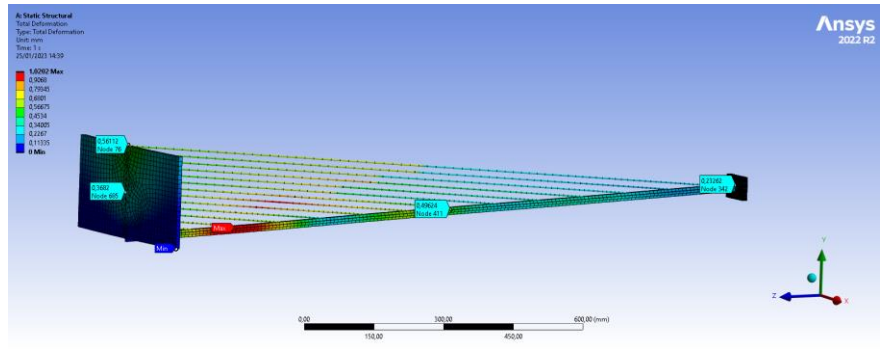
Boundary conditions of the end-plate model



Pre-stressing of stays to compensate DC wires tension



Stays and spoke deformation (to be fully optimized)



- Conceptual design of the IDEA drift chamber completed.
- Preliminary FEA with homogeneous materials in conclusive phases.
- Transition to composite materials undergoing.

- Goal is to complete the full design by fall 2023 and to start construction of a full-length, 1/12 wedge, prototype before the end of 2023.

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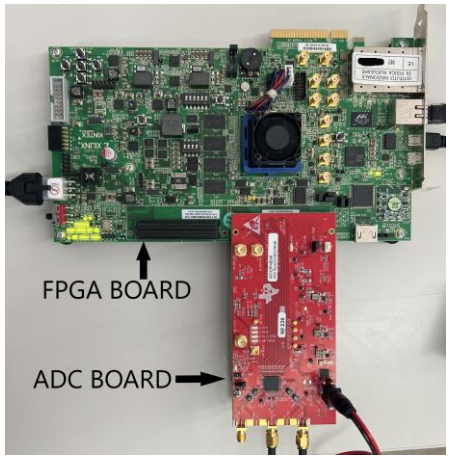
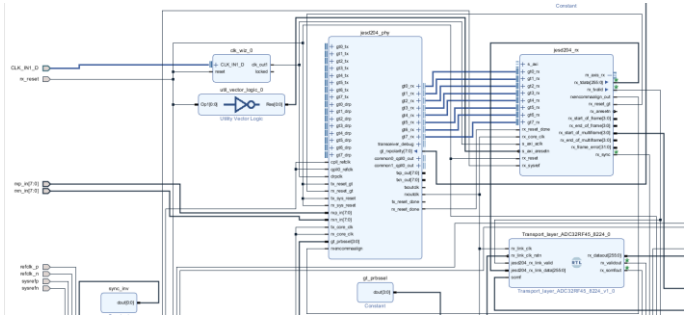
Subtask 5.5.2 - FPGA-based fast digitizer for the cluster counting regime

approach #1: KINTEX KCU105 + TEXAS ADC ADC32RF45



some synchronization issues yet to be solved

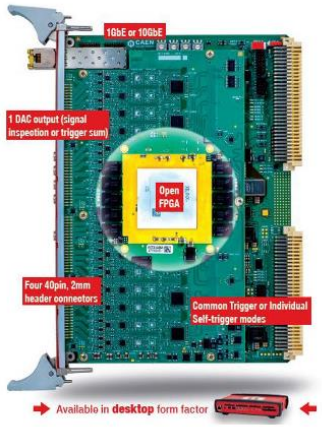


approach #2: CAEN VX2740 (VX2751, when available)

VX2740: the first of a kind

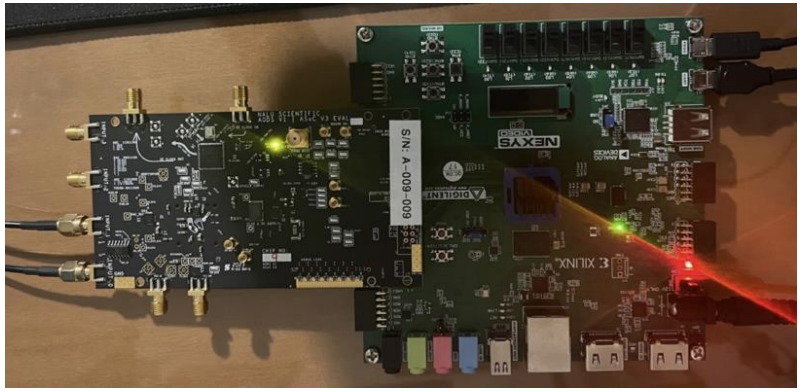
64 channel, 125 MS/s, 16 - bit waveform digitizer

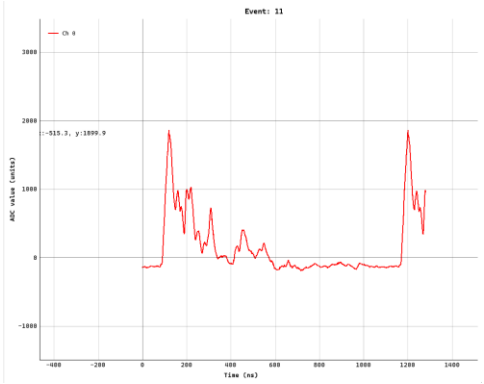
- High channel density spectroscopy
- Good fit for Neutrino and Dark Matter experiment
- **Open FPGA**: SCI-Compiler tool for beginners (**COMING SOON**) or advanced firmware template
- Four 40-pin, 2 mm header connectors with DIFF or SE inputs
- **1 GbE, 10 GbE, USB 3.0** and CONET 2.0 (optional) connectivity
- Common Trigger (waveforms) or Individual Self-trigger modes
- **DPP options**: PHA, QDC, PSD, CFD
- Advanced Waveform Readout modes: ZLE, DAW
- DT2740, 64 channels in Desktop form factor (**COMING SOON**)



just received the software license to program our cluster finding algorithms

approach #3: NALU Scientific ASoCv3





real signals read out with the AsoC chip, (used AWG with low performance: not all peaks detected)

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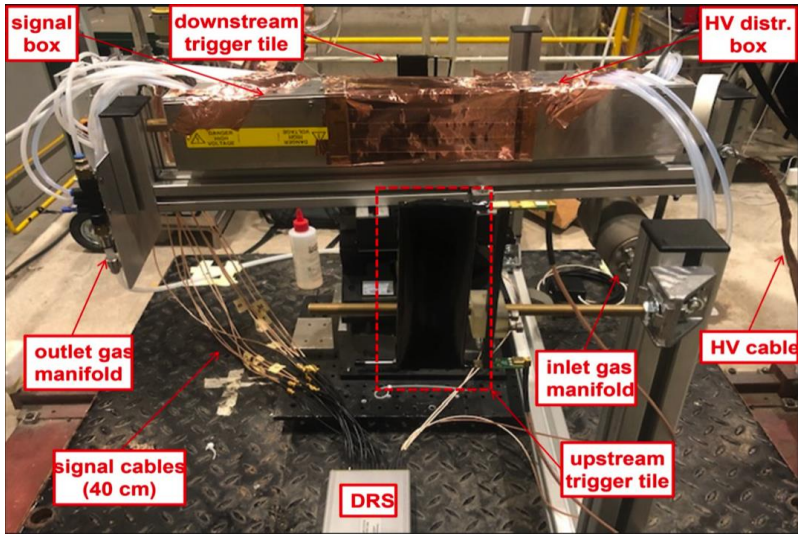
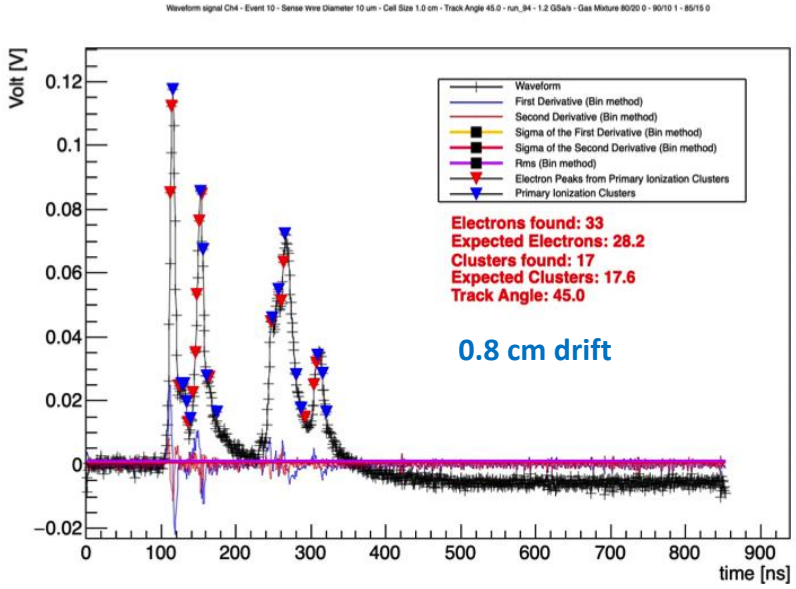
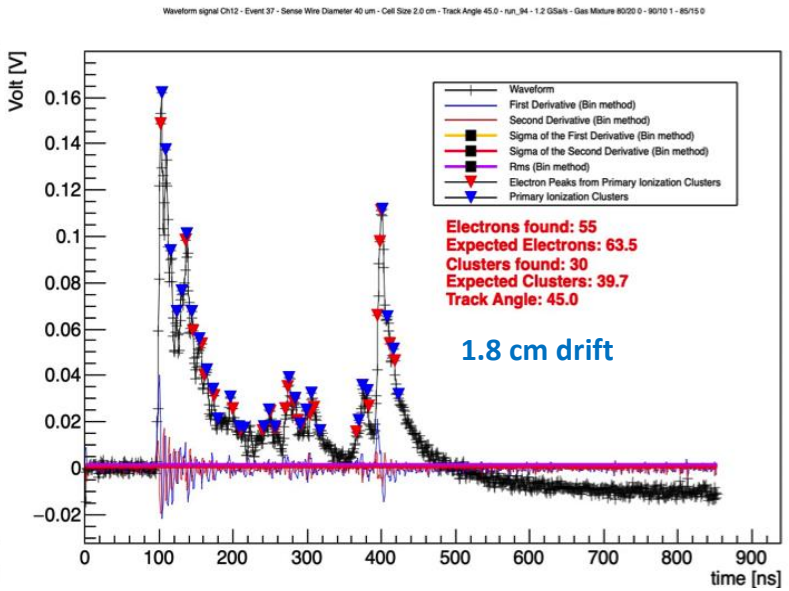
Subtask 5.5.3 - Analysis of beam tests data for cluster counting

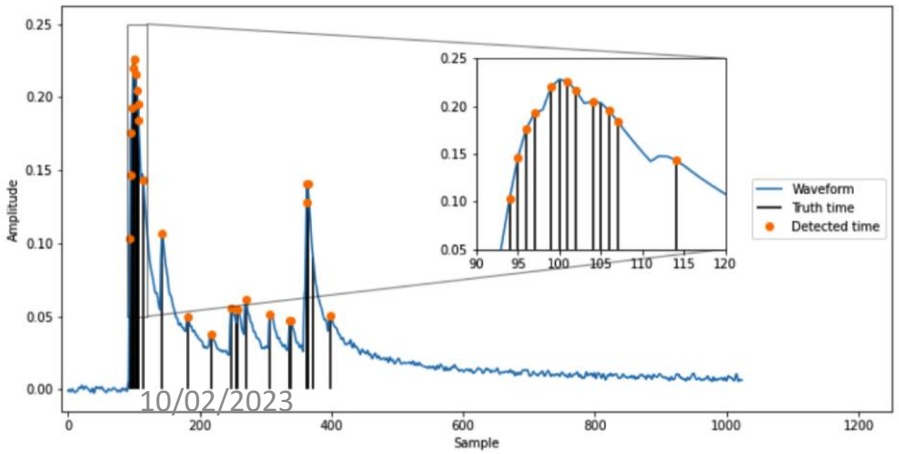
Beam test setup at CERN-H8



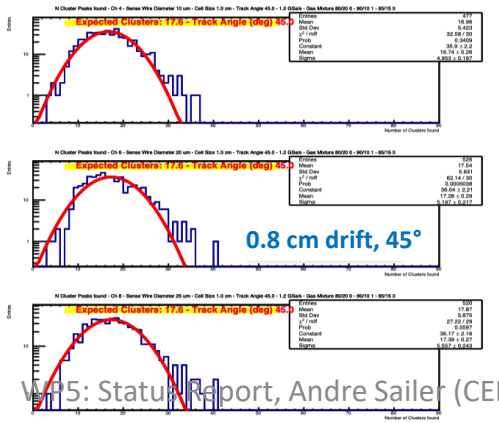


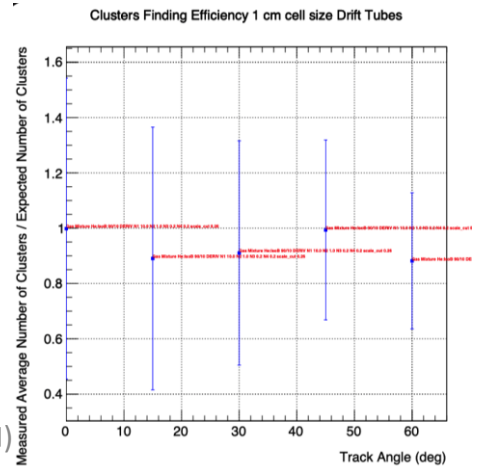


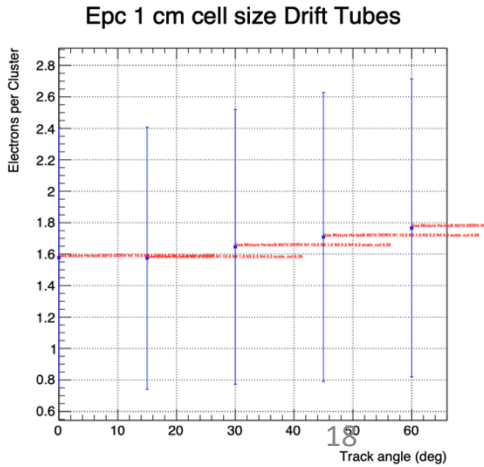
Neural Network



Poisson distributions!







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Task 5.6: PID

Michael Düren (JLU Giessen)

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- Task 5.6 (1.8.21-8.4.22):
  CREMLINplus: Development and design of a **Particle Identification system** for the SCT detector

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

FARICH prototyping

FDIRC prototyping

- Bi-weekly intense cooperation by video conferences
- Discussion and modification of PID detector design
- Common development of Monte Carlo Simulations

- Chinese-Russian-European Workshop on Super Charm Tau Experiments

- Memorandum of Partnership signed by JLU Sept. 2021 as first non-Russian institution; discontinued March 2022

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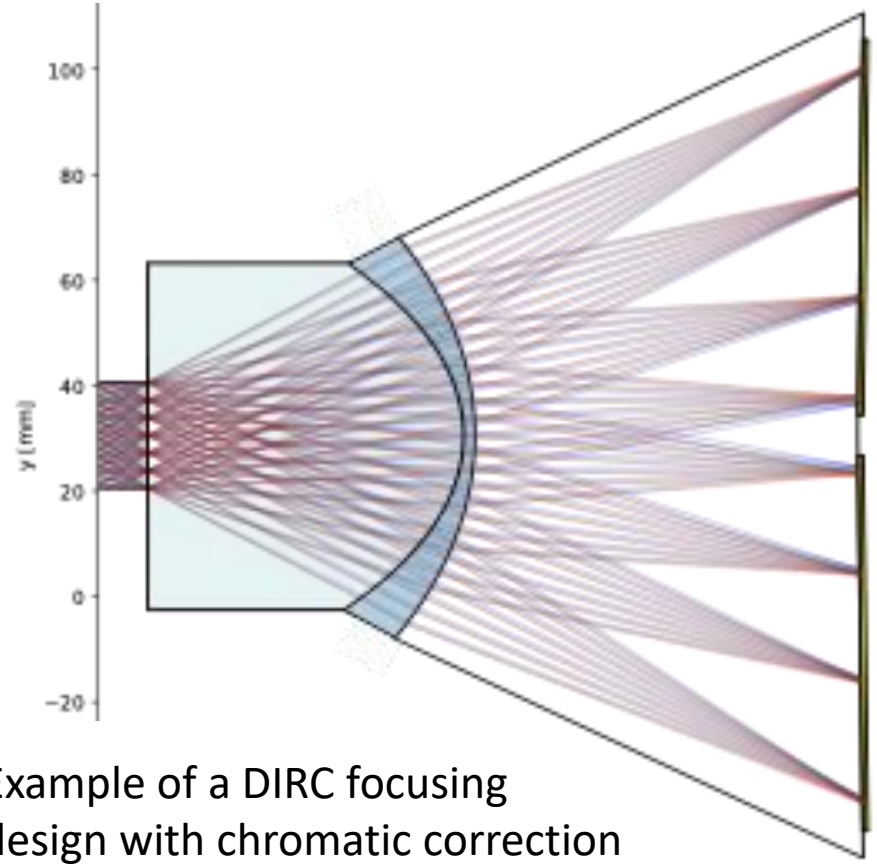
- Task 5.6 (9.4.22-31.1.23): EURIZON: Development and design of a **Particle Identification system** for a future flavour factory detector

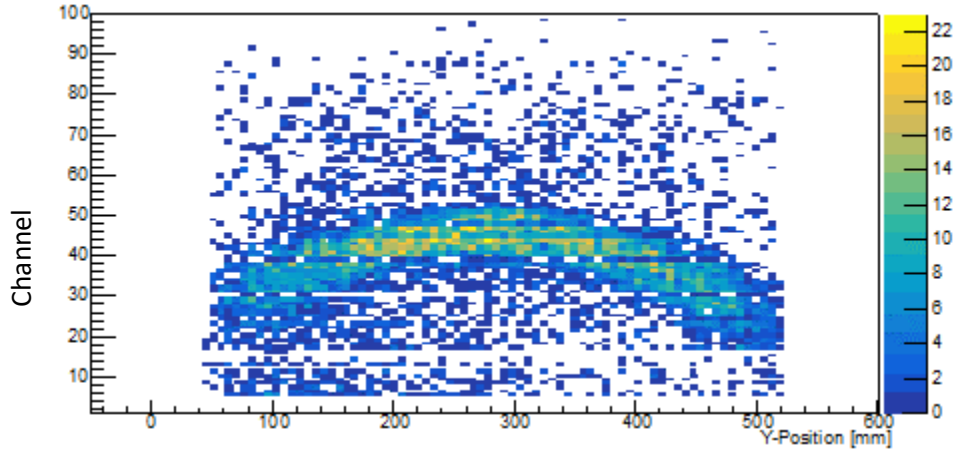
JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

FDIRC prototyping



Example of a DIRC focusing design with chromatic correction
(Thesis Sophie Kegel)

- Optimize FDIRC optics by using lenses instead of focusing mirrors and by including chromatic dispersion corrections
- Monte Carlo simulations of a Disc DIRC Cherenkov Detector with Dispersion Correction
- Study the use of SiPMs in single photon detection in RICH and DIRC detectors
- System tests of a prototype FDIRC in the Giessen Cosmics station using reconstructed muons



"Cherenkov-Smile" from Cosmic Muons in DIRC prototype
(Thesis Lisa Brück)

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Deliverables and Milestones

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Outstanding Milestones and Deliverables

Relative Number in WP	Number	Name	Lead Beneficiary	Type	Dissemination Level	Due Date (in months)
D5.5	D48	Report on development of collider technologies for lepton colliders	CNRS-IJCLab	R	PU	44
D5.6	D49	Final report on the software developments	CERN	R	PU	44
D5.7	D50	Final report on R&D work on (low mass, modular) inner tracker for a detector at future lepton colliders	INFN	R	PU	44
D5.8	D51	Final report on R&D work on central tracker for a detector at future lepton colliders	INFN	R	PU	44
D5.9	D52	Final report on R&D work on charged particle identification systems at future lepton colliders	JLU	R	PU	44

Number	Name	Lead Beneficiary	Due Date (in months)	Description
M28	Construction and test of the inner tracker based on C-RWELL prototype	INFN	40	Conference contribution
M29	Prototype of RF equipment for high power beam	CNRS-IJCLab	42	Conference contribution
M30	Construction and test of the drift chamber prototype	INFN	42	Conference contribution
M31	Prototype for PID system	JLU	42	Conference contribution

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Summary

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Summary

- More details in https://indico.desy.de/event/37137/sessions/14728/
- Despite difficulties progress has been made in all tasks
- Reaching Milestones and Deliverables should be possible, maybe with delay of few months (44→48?) to achieve more complete results

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Thank you for your attention!