MC studies and Physics Performance

A. Mastroserio, S. Fazio

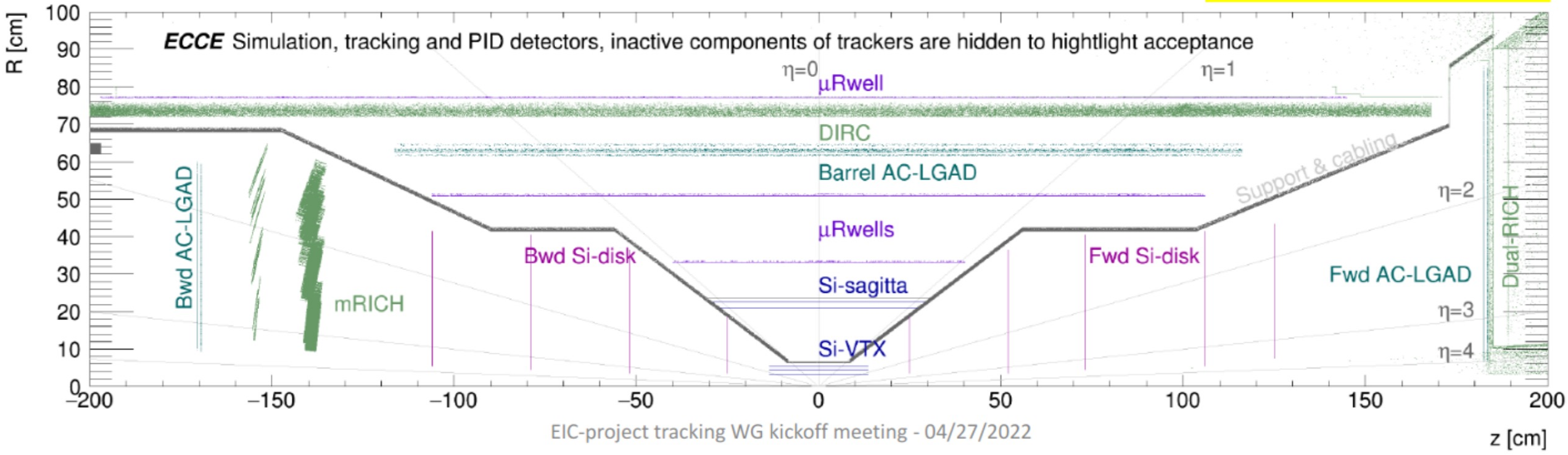
Montecarlo Simulations - Ongoing Activities

- Bi-weekly meetings on Monday mornings
- EIC_NET - Simulation activities:
  - Tracking perfomance studies
  - dRICH
  - Physics simulations
- Our community (ex ATHENA) gained experience with fun4all and DD4hep, now waiting for further indications on how to proceed

- EIC SWG : Dicussions ongoing to define a common strategy /tools for a common software
  - Discussion decision schedule
  - End of June : Geometry, Data Format, Reconstruction framework, container
    - EIC Detector 1 – Software Decision (Geometry)
  - End of July : Calibration, Data preservation

Geometry : ECCE geometry

MC studies for Detector-1 start from the ECCE geometry



Tracking Performance studies

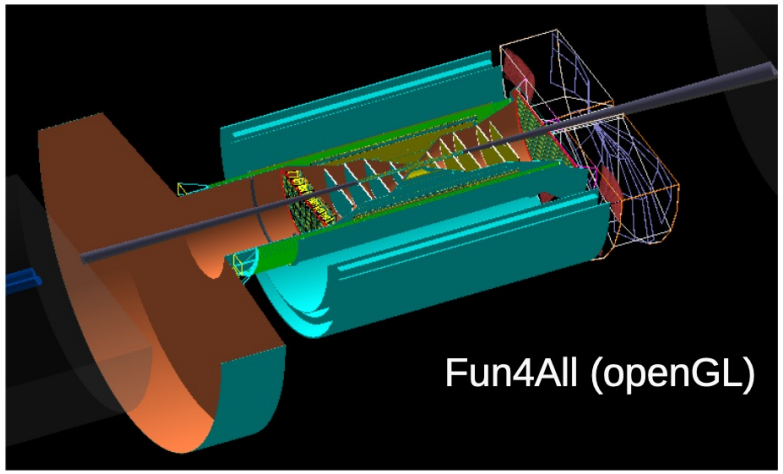
- Studies on Detector-1 geometry
  - Vertex detector performance optimization
  - Fast Simulation tools
    - Validation
    - Detector geometry modification (e.g.: inner barrel radii)

Shyam Kumar

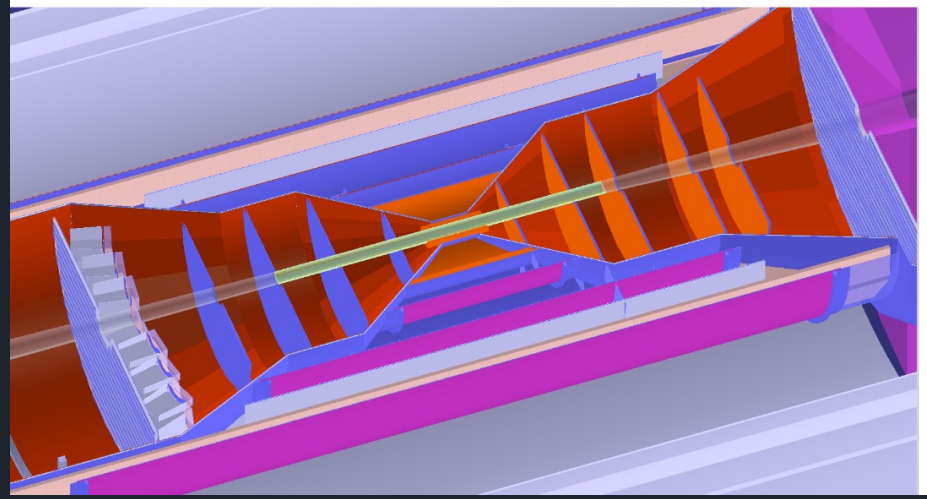
- Performances compared with the Physics Working Group (PWG) requirement

Ecce Geometry

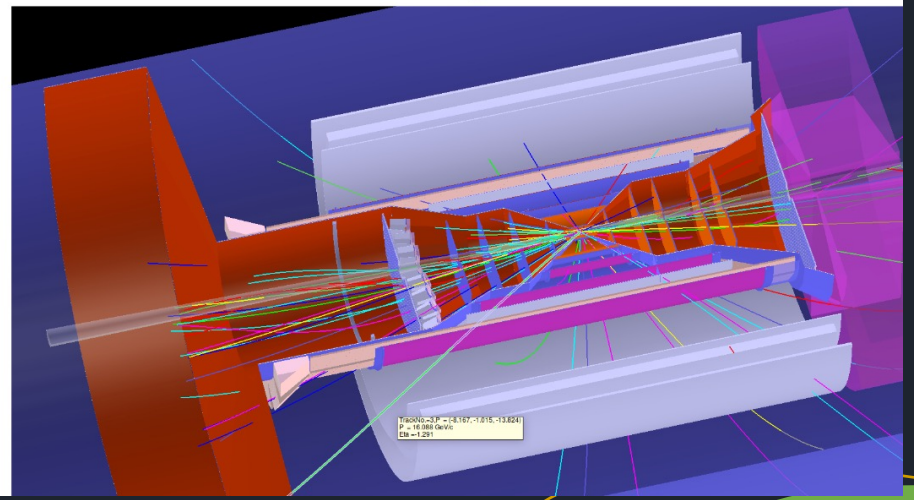
Geometry used for the simulation in Fun4All



EveManager



EveManager with tracks



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Fast Simulation tool

Barrel layers detector

Internal parameters tuned to the ECCE vertex detectors and B field

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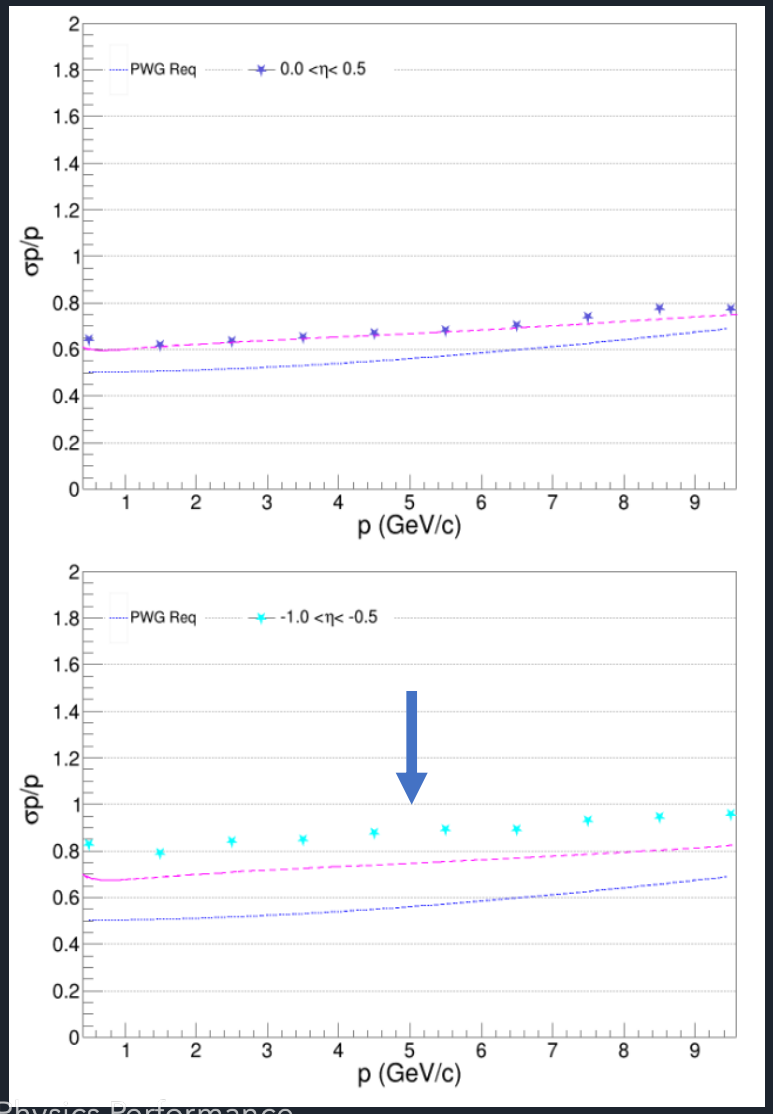
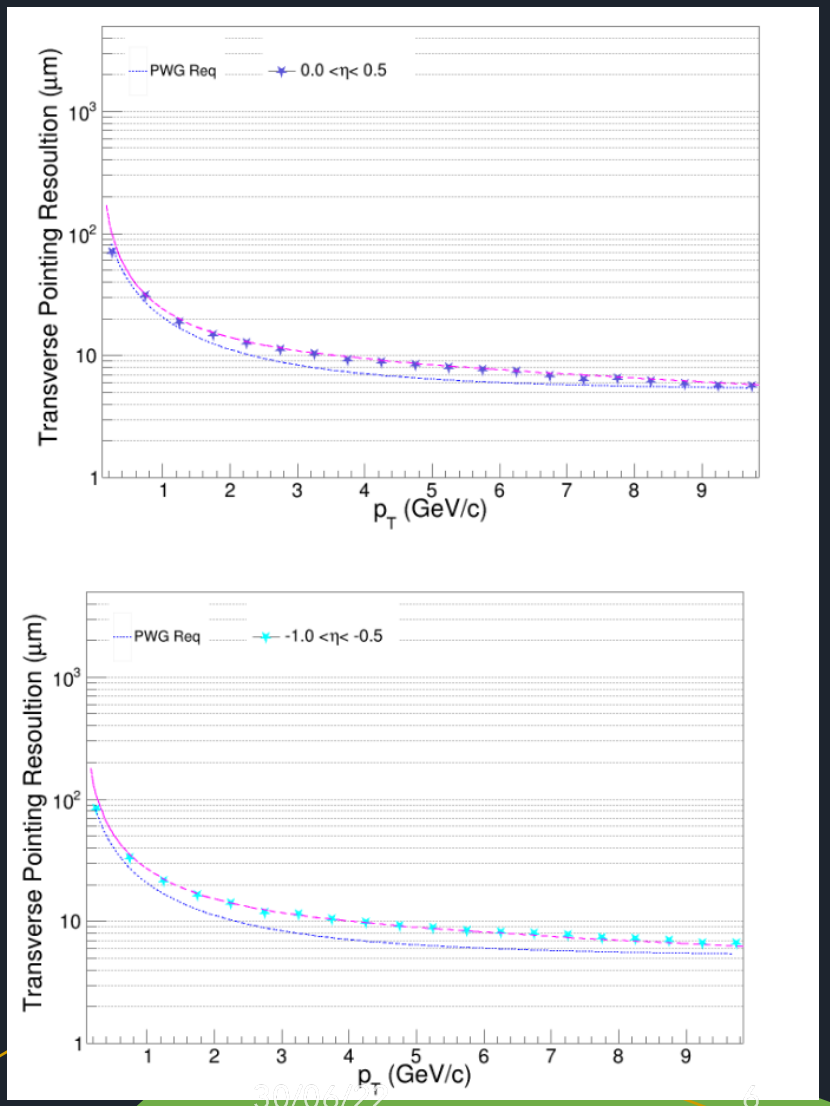
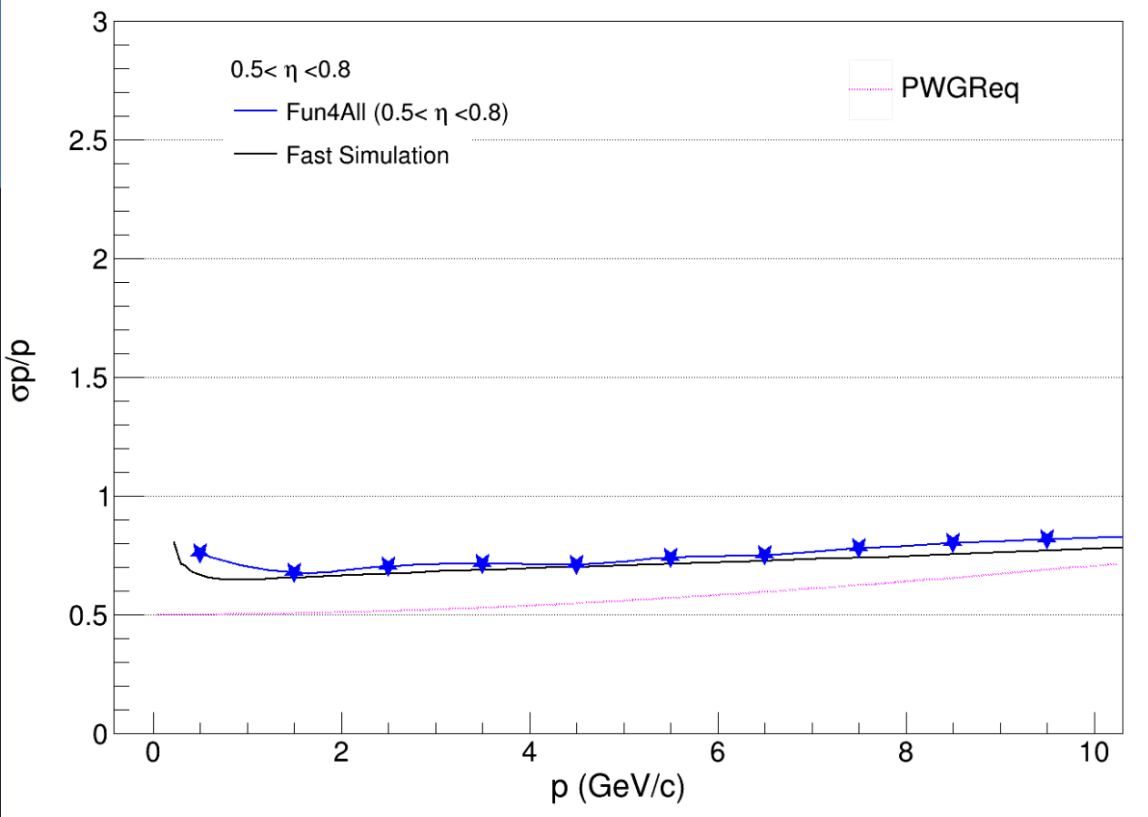
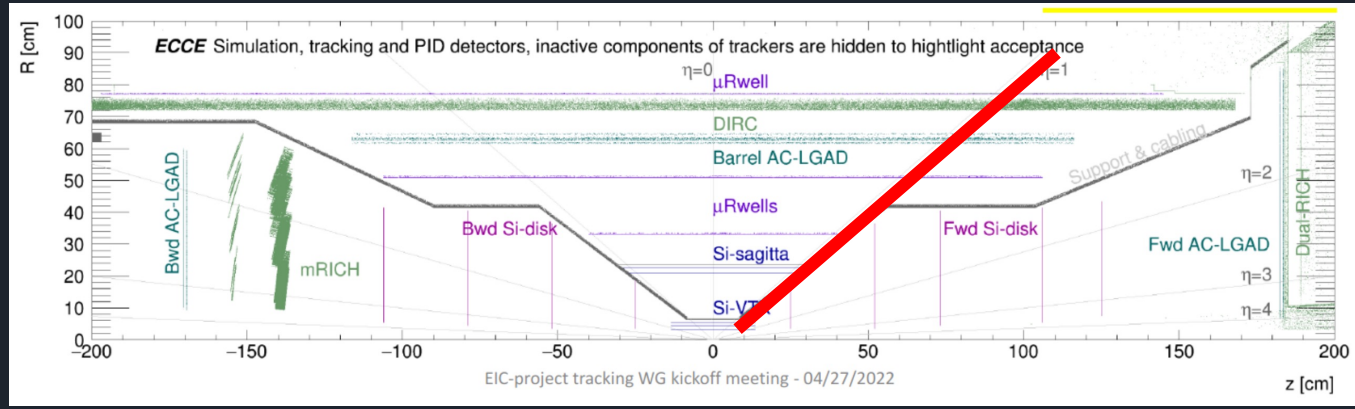




Fast Simulation Tool





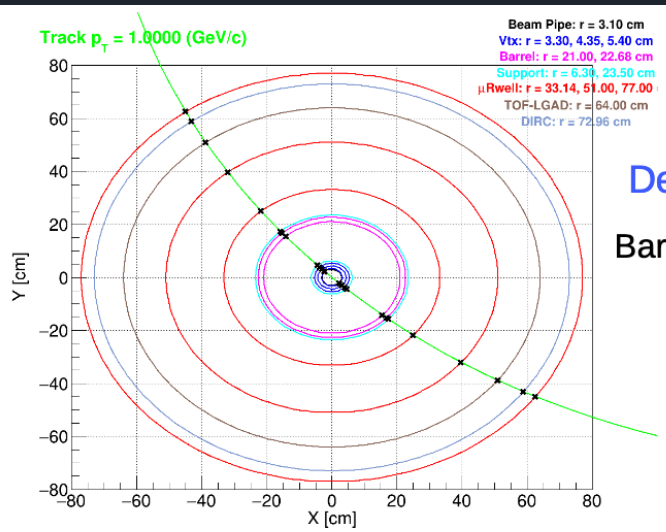
FS tool well under control

Fast Simulation tool : optimization studies

Shyam Kumar

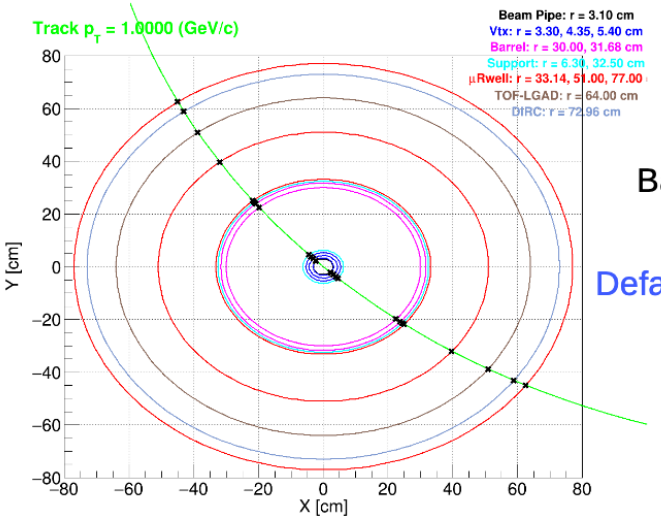
Several results on
- moving internal layers
- changing their material budget
- Changing detector resolution

-> Shyam' s talk at the tracking working group meeting on next week



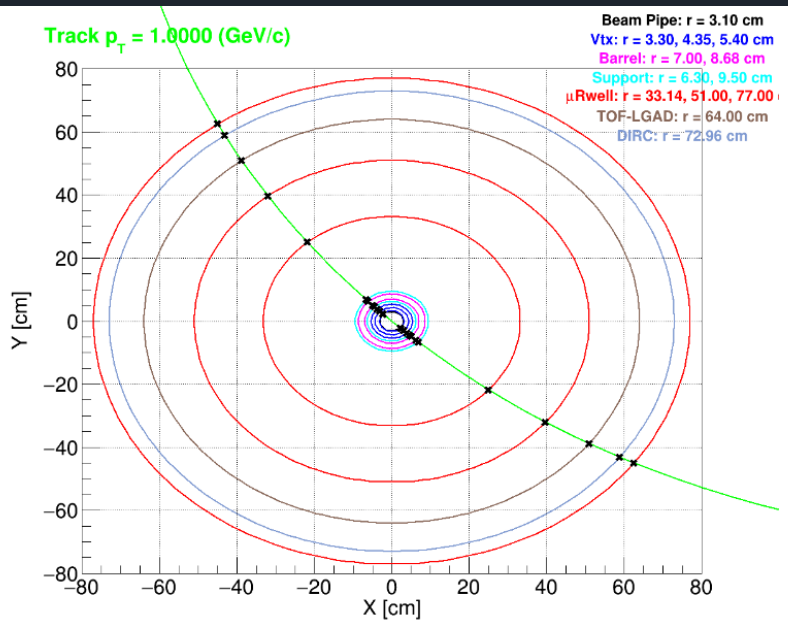
Default

$Barr_1$-Vtx_3 =15.6 cm



$Barr_1$-Vtx_3 =24.6 cm

Default+Sagitta Shift 9.0cm



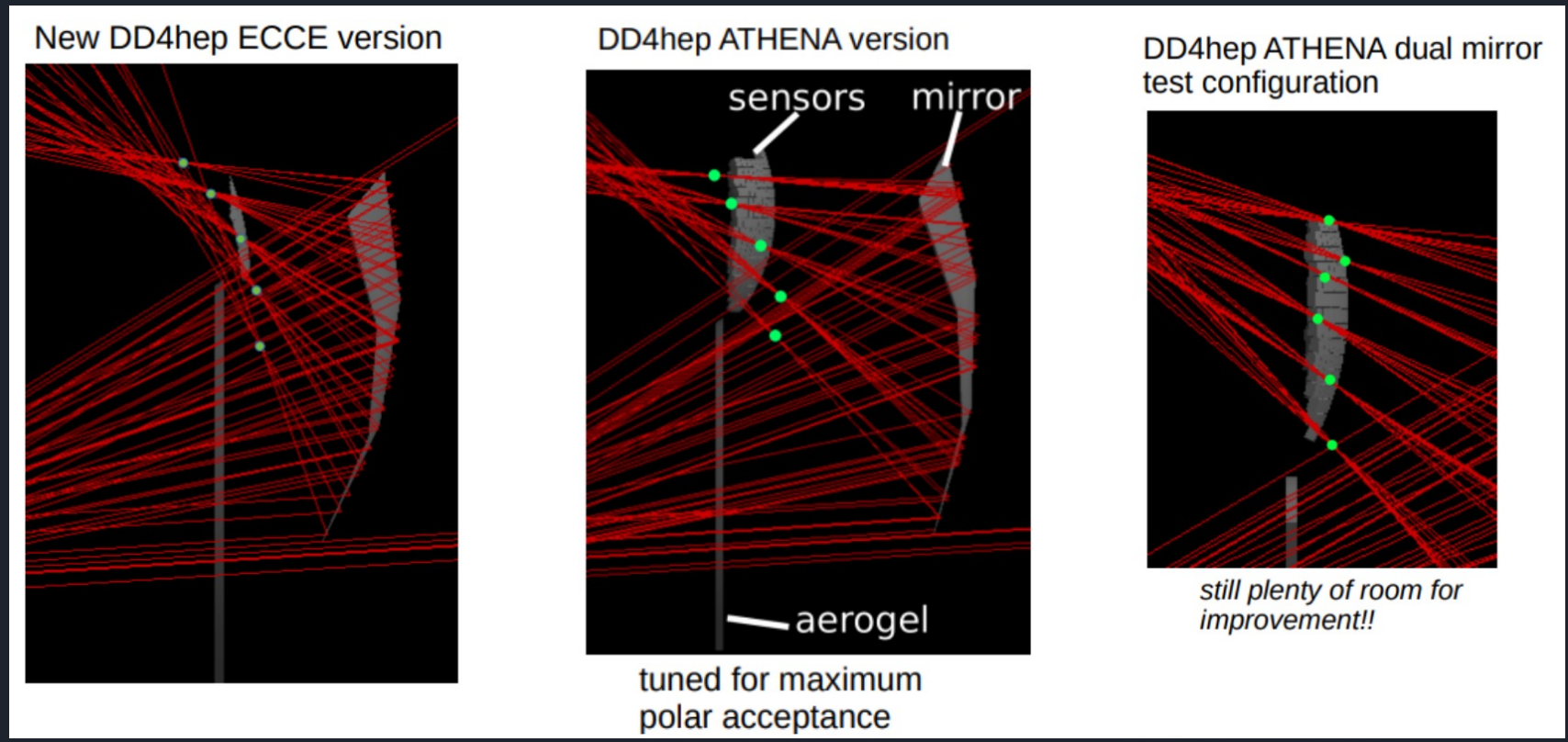
Default+Sagitta Shift -14.0cm

MM_1-$Barr_2$ = 24.46 cm

Material budget of sagitta layers = 0.55 % and also VTX_Support = 0.1 %

dRICH simulations

- Work ongoing on pattern recognition
- Inverse Ray Tracing approach
- Code developed within dd4hep framework
- Issues occurred during this transition period on the general software development
  - Work ongoing to adapt the algorithm to the new data model



Chandradoy Chatterjee

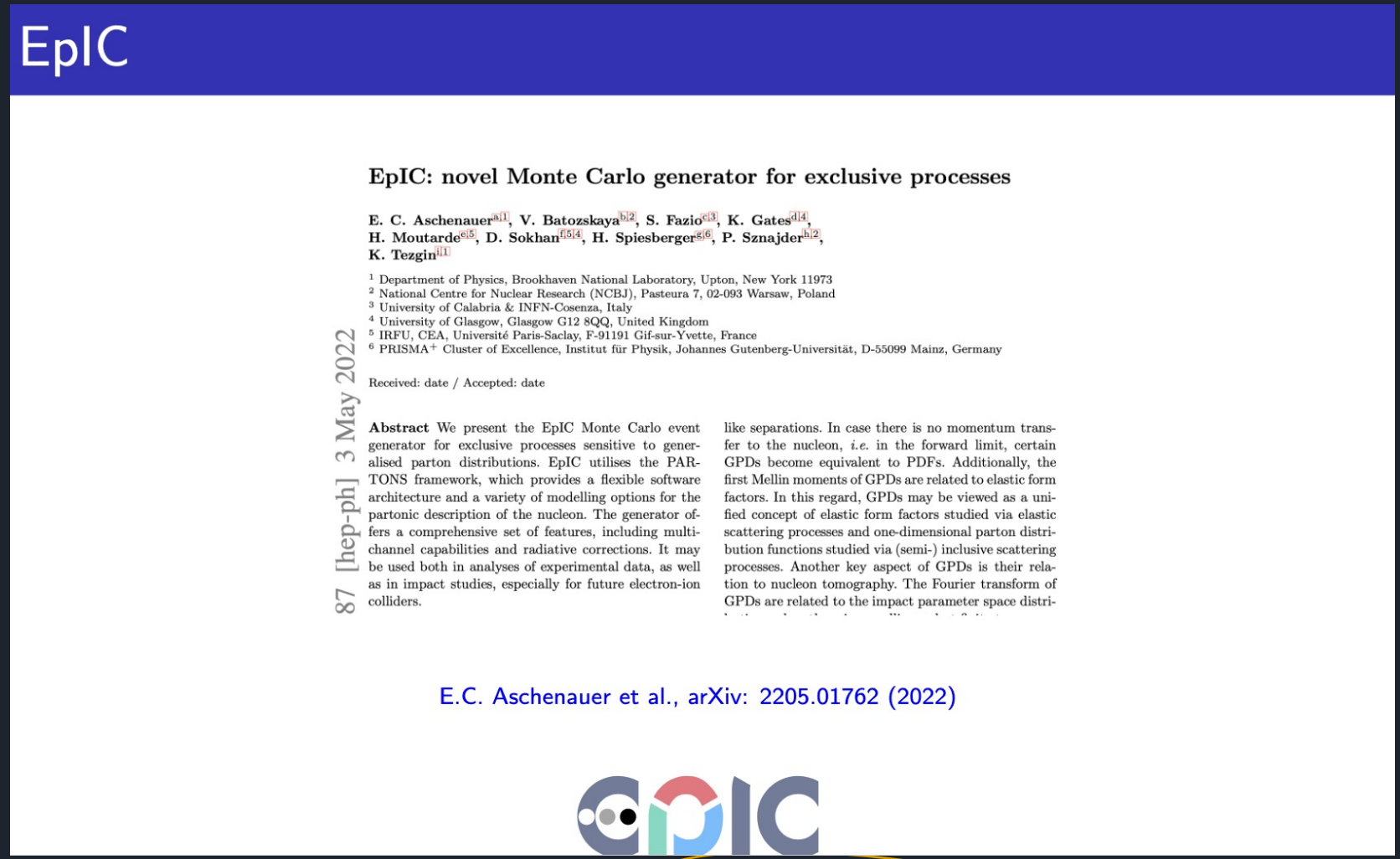
See Chandra's talk

Physics Simulations *(→ pubblication)*

- Salvatore one of the authors of the EpIC Monte Carlo event generator for exclusive processes sensitive to generalised parton distributions
  - https://inspirehep.net/literature/2077191

Slides from Kemal Tezghin

EpIC



EpIC: novel Monte Carlo generator for exclusive processes

E. C. Aschenauer[a,1], V. Batozskaya[b,2], S. Fazio[c,3], K. Gates[d,4], H. Moutarde[e,5], D. Sokhan[f,5,4], H. Spiesberger[g,6], P. Sznajder[h,2], K. Tezgin[i,1]

[1] Department of Physics, Brookhaven National Laboratory, Upton, New York 11973
[2] National Centre for Nuclear Research (NCBJ), Pasteura 7, 02-093 Warsaw, Poland
[3] University of Calabria & INFN-Cosenza, Italy
[4] University of Glasgow, Glasgow G12 8QQ, United Kingdom
[5] IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France
[6] PRISMA$^+$ Cluster of Excellence, Institut für Physik, Johannes Gutenberg-Universität, D-55099 Mainz, Germany

Received: date / Accepted: date

Abstract We present the EpIC Monte Carlo event generator for exclusive processes sensitive to generalised parton distributions. EpIC utilises the PARTONS framework, which provides a flexible software architecture and a variety of modelling options for the partonic description of the nucleon. The generator offers a comprehensive set of features, including multi-channel capabilities and radiative corrections. It may be used both in analyses of experimental data, as well as in impact studies, especially for future electron-ion colliders.

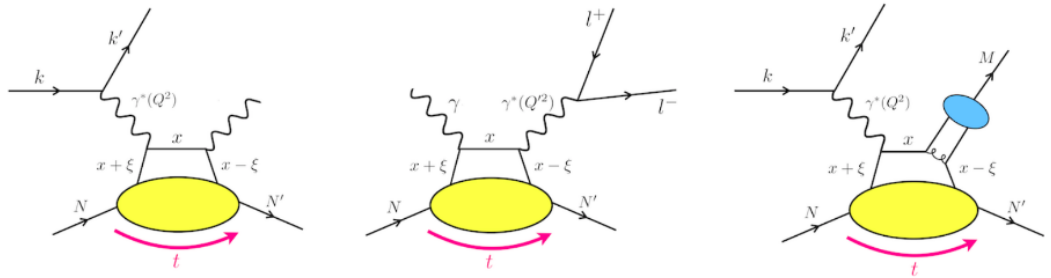
like separations. In case there is no momentum transfer to the nucleon, *i.e.* in the forward limit, certain GPDs become equivalent to PDFs. Additionally, the first Mellin moments of GPDs are related to elastic form factors. In this regard, GPDs may be viewed as a unified concept of elastic form factors studied via elastic scattering processes and one-dimensional parton distribution functions studied via (semi-) inclusive scattering processes. Another key aspect of GPDs is their relation to nucleon tomography. The Fourier transform of GPDs are related to the impact parameter space distri-

E.C. Aschenauer et al., arXiv: 2205.01762 (2022)

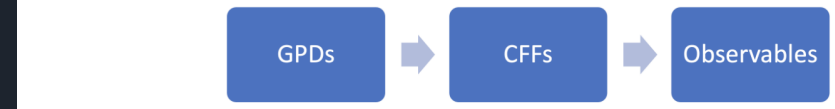
Physics Simulations

EpIC

- EpIC: an event generator for exclusive reactions
- EpIC uses the PARTONS framework: takes advantage of
  - multiple GPD models that already exist
  - flexibility for adding new models
- Multiple channels: DVCS, TCS, DVMP (pseudoscalar mesons)



- Written in C++
- XML interface for automated tasks
- Open-source



- Input file: model, model parameters, number of events, kinematic limits, beam and target type, beam helicity, target polarization, beam and target energy, mFOAM parameters
- Output file: 4-vectors of all particles

Flexible Architecture that utilises a modular programming paradigm

Open Tasks : tracking & PID simulations

- Tracking & Vertexing:
  - Check the tracking performances (σ_p/p and pointing resolution, η dependance) in several scenarios:
    - Fast simulation in more than one detector configurations
    - Full simulation in the simulated detector geometry(ies)
  - Check the same performances with two (or more) B fields
  - Check the reconstruction performance of particles as physics benchmarks (e.g.: D0)
    - Both local and MC simulations (generator)
    - Same checks with different fields
  - Contact persons : D. Elia, A. Mastroserio

Slide from Riunione Nazionale EIC_NET 28/03/2022

- PID : dRICH, development of pattern recognition methods, studies in different configurations and B field
  - Contact person : C. Chatterjee

Open Tasks : Physics simulations

- DVCS: quantify the effect of the ECAL energy resolution on the reconstruction of kinematics using a full simulation of the detector and realistic PID.
- Exclusive Processes: investigate the possibility of mitigating the systematic effects due to radiative corrections by measuring initial state radiation photons at zero degree with the Lumi detector.
  - contact person: S. Fazio
- Diffractive PDFs: perform a first EIC impact study. CFNS-Stony Brook Workshop on PDFs at EIC (M. Ruspa organizer) https://indico.bnl.gov/event/14009/
  - contact person (M. Ruspa)
- HERA4EIC: several analyses at HERA can help tuning EIC Physics Studies and train a younger generation of researchers on data analysis of e+p collisions in collider mode.
  See also CNFS workshop at Stony Brook: https://indico.bnl.gov/event/9370/
  - contact persons: M. Ruspa, M. Capua, S. Fazio

Slide from Riunione Nazionale EIC_NET 28/03/2022

Summary

- Work ongoing despite the transition period of the official software framework on several items
- People interested are welcome to join our meeting EIC_NET: Simulation and physics performance meeting
  - https://agenda.infn.it/category/1559/
- Several topics from detector simulations to physics simulations are available for further studies

Electron Ion Collider School

EIC School proposal

School dedicated to Electron Ion Collider

[physics and detectors]

- Who : students both from master thesis / PhD (I year)
- When : 2023 April/May/summer, -> 3.5 days
- Where : Bertinoro/Maratea/Vieste/….
- What : lessons from theory, detectors, hands on sessions (MC simulations)

EIC School proposal

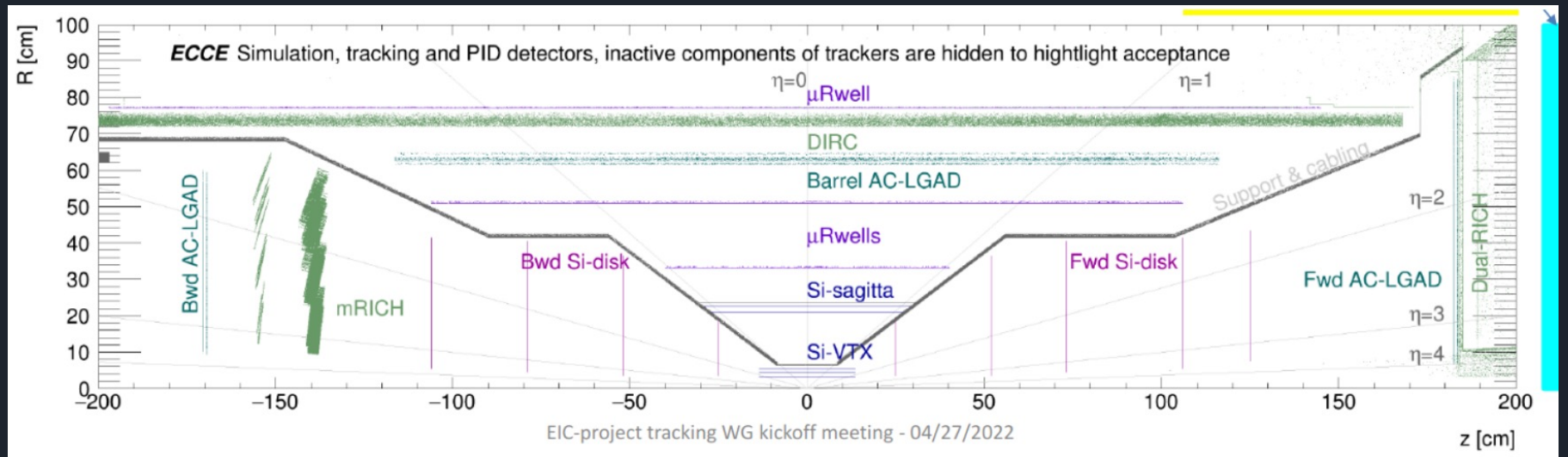
Preliminary ideas on lectures

- Deep Inelastic Scattering history (from SLAC-MIT to HERA)
- Detectors: detectors and technologie chosen for DIS measurements at HERA (ZEUS, H1, HERMES)
- Nucleon tomography: longitudinal structure function, TMD e GPD
- JLAB e COMPASS: overview of physics results
- Diffractive physics
- EIC Physics Program
  - Spin physics
  - Mass of the nucleon
  - Hadron spectroscopy
- ….

→*Availability of Abhay Deshpande*

Discussion

Tracker geometry details



Barrel Tracker

Name	Radius (cm)	X/X0	R-Phi resol (cm)	R-Z resol (cm)
BeamPipe	3.1	0.0022		
Vtx1	3.3	0.0005	10.0e-4/sqrt(12)	10.0e-4/sqrt(12)
Vtx2	4.35	0.0005	10.0e-4/sqrt(12)	10.0e-4/sqrt(12)
Vtx3	5.40	0.0005	10.0e-4/sqrt(12)	10.0e-4/sqrt(12)
VtxSupport	6.3	0.3/30		
Barr1	21.0	0.0005	10.0e-4/sqrt(12)	10.0e-4/sqrt(12)
Barr2	22.68	0.0005	10.0e-4/sqrt(12)	10.0e-4/sqrt(12)
BarrSupport	23.50	0.03/30		
MM1	33.14	0.0026	55.0e-4	55.0e-4
MM2	51.0	0.0026	55.0e-4	55.0e-4
ACLGAD	64.0	0.0558	30.0e-4	30.0e-4
DIRC	72.96	0.1274		
MM3	77.0	0.0026	55.0e-4	55.0e-4

Material budget for Vtx support should be similar to Barrel support