TDIS Run-Group Meeting

12 June, 2024

C12-15-005

The TDIS experiment was reapproved by PAC 51

Goal:

A direct measurement of the mesonic content of the nucleon and a unique extraction of the pion's F_2 structure functions, by scattering from a virtual pion target, accessed via spectator tagging.

Spokespersons: D. Dutta, N. Liyanage, C. Keppel, P. King, R, Montgomery, H. Nguyen, B. Wojtsekhowski

C1 conditionally approved with A- rating for 27 PAC days

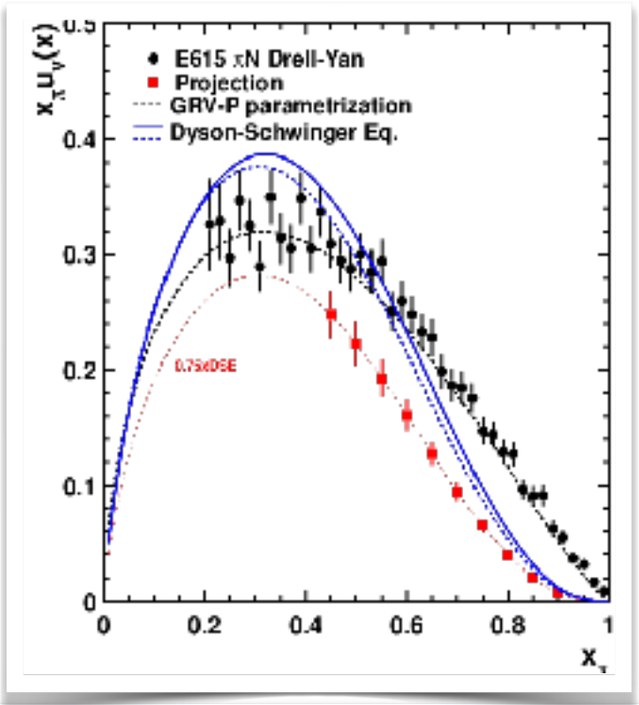
Motivations:

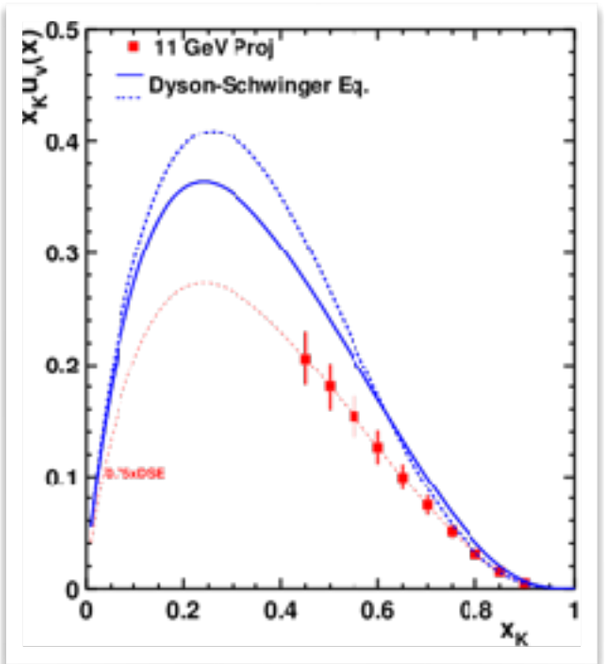
There is ample evidence that nucleons have pionic content in them, but no direct measurements.

Pions and kaons are the simplest bound states of QCD and its Nambu-Goldstone bosons- knowledge of meson structure is critical to a complete understanding of the emergence of hadron mass.
But, very little data due to the lack of "meson targets".

TDIS will use spectator tagging - a well established technique- to tag the "meson cloud" of the nucleon.

TDIS is a pioneering experiment but the proposed technique to extract meson structure function is an essential proof-of-principle for future experiments at the EIC & 22 GeV JLab.





Questions from the TDIS Technical Review

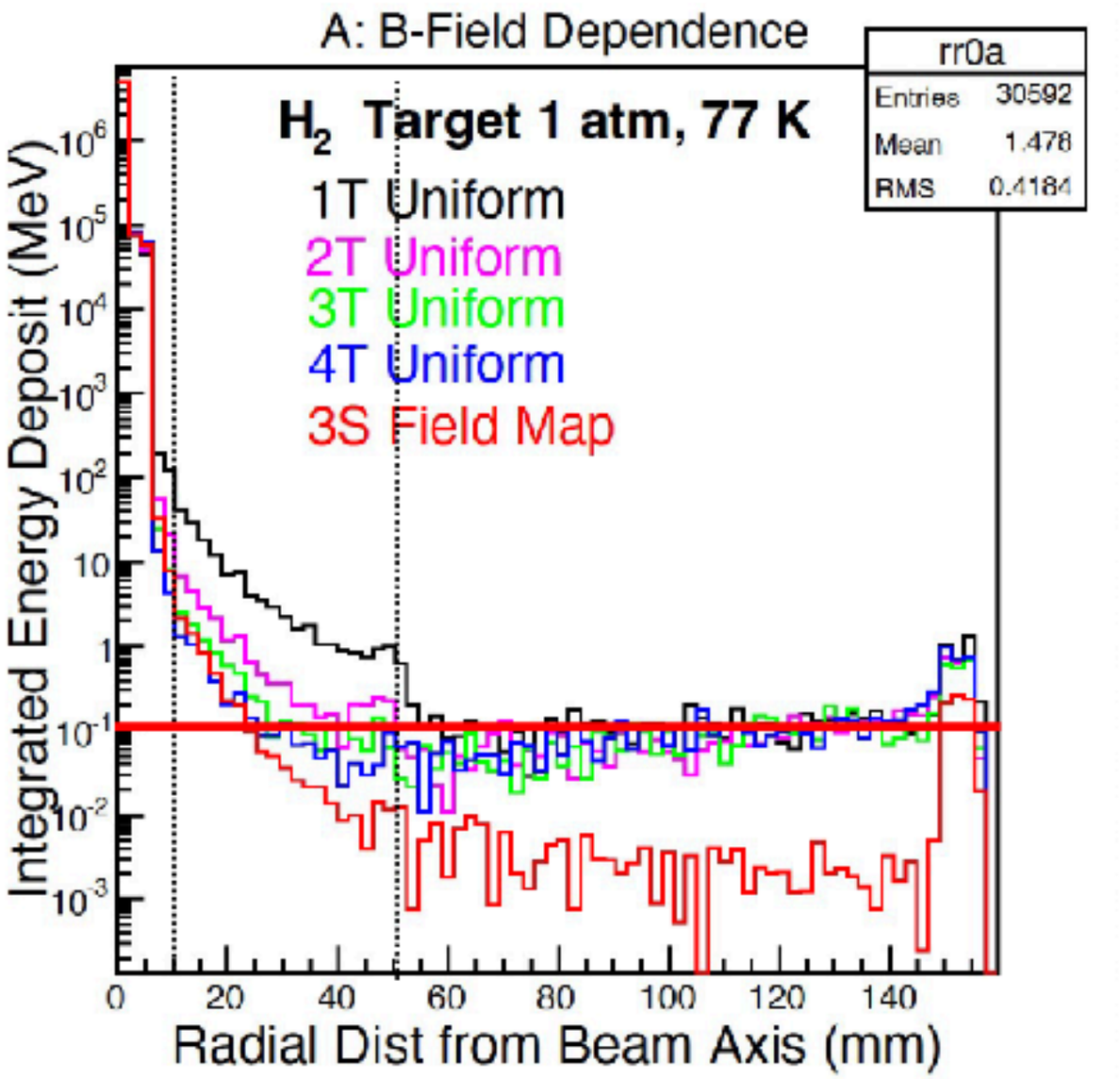
mTPC:
Is the structural design of the mTPC sound?
Is the inner tube strong enough to support the lateral loads of the individual cells keeping them aligned?
Is the diffusion of the Helium gas into the target cell understood and within the tolerances of the experiment?
What is the double peak timing resolution in a readout cell? How far do two pulses have to be apart to be detected as individual hits in the same pad?

Solenoid/SBS Magnet:
What is the interaction between the solenoid field and the SBS Dipole iron?
What are the forces between these magnets?
Are additional support structures required to mitigate the forces on the magnets?

Tracking:
How can tracks be identified and reconstructed given the expected high occupancy, in particular in the first few layers/rings of a single detector module?
What is the yield of “false”/”fake” tracks given the high hit multiplicity?
Can either algorithm be run from the outer ring in, reducing the effect of the inner ring occupancy?

Target:
It is strongly recommended that a JLAB Design Authority be assigned to this system.
What are the safety margins regarding target operation (pressures/temperatures)?
What safety mitigations are planned if the pressure margin requirements cannot be met?
What is the impact of the downstream flange material on the scattered electron trajectory?
What is the impact of beam-heating on the aluminum entrance and exit windows?
Is active cooling required?
What is the impact of the heat and radiation environment on the target flange seal o-rings? Are special/ dedicated materials needed?

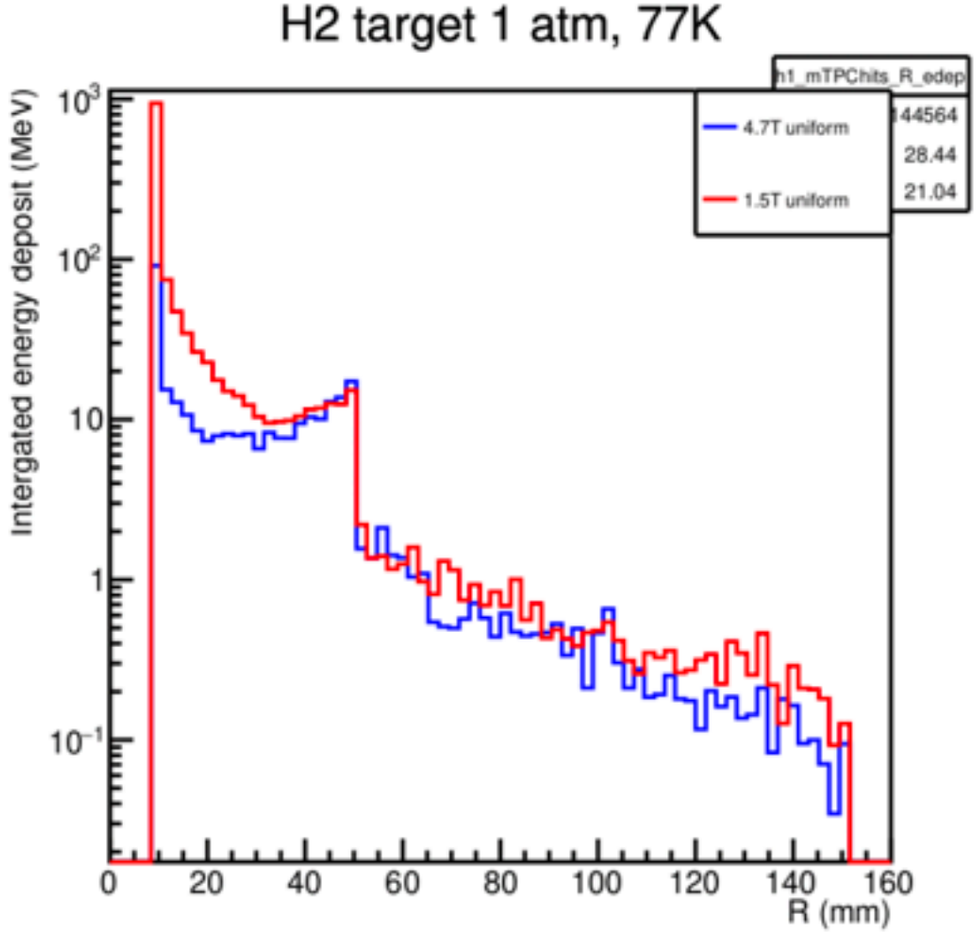
Do we need a 4T solenoid field?



0.15 atm 4He

d_{H2} = 0.084e-3*293./77. g/cm^3

8x10^8 electrons



0.15atm 4He, 77K

d_{H2} = 0.084e-3*293./77. g/cm^3

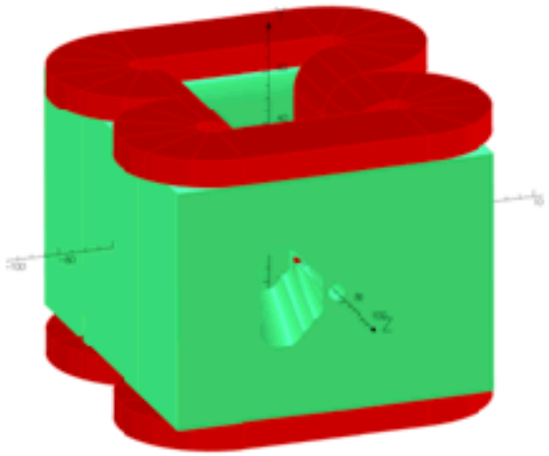
Normalized to 8x10^8 electrons

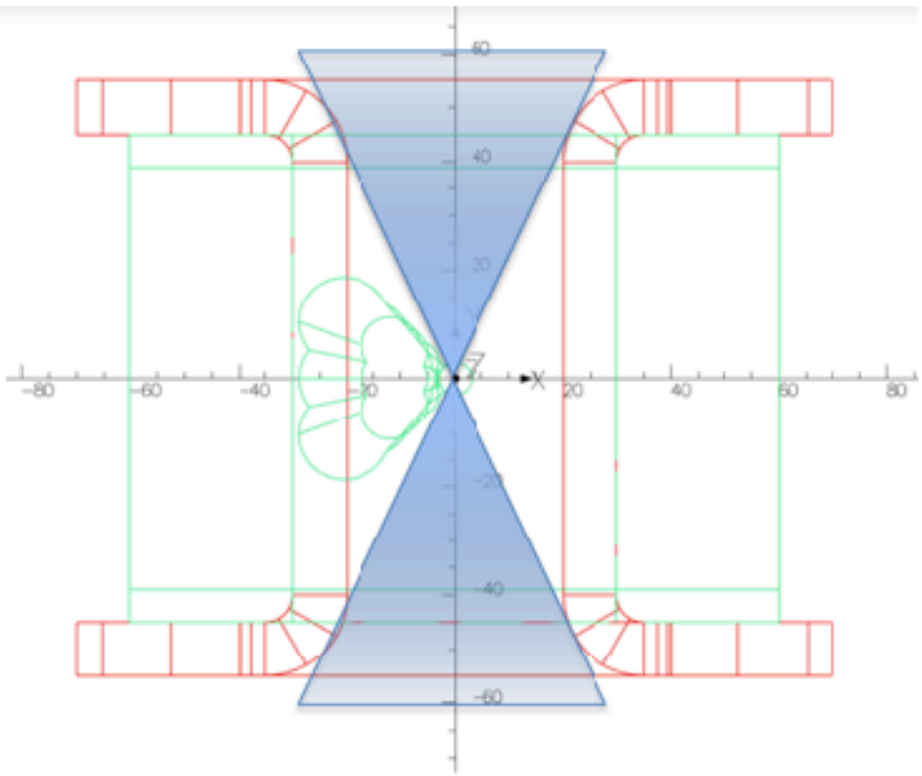
Electrons generated 35cm upstream of center of target

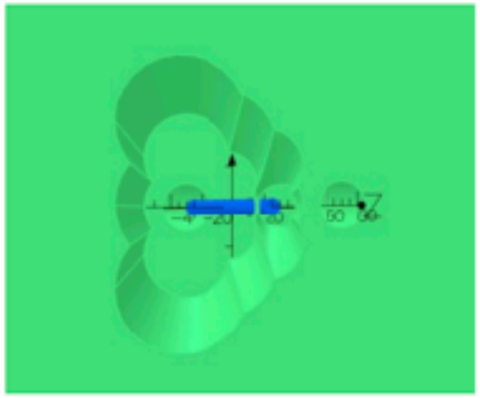
Eric Fuchey has confirmed the Moller background is independent of the field

Smaller fields will allow an open magnet design

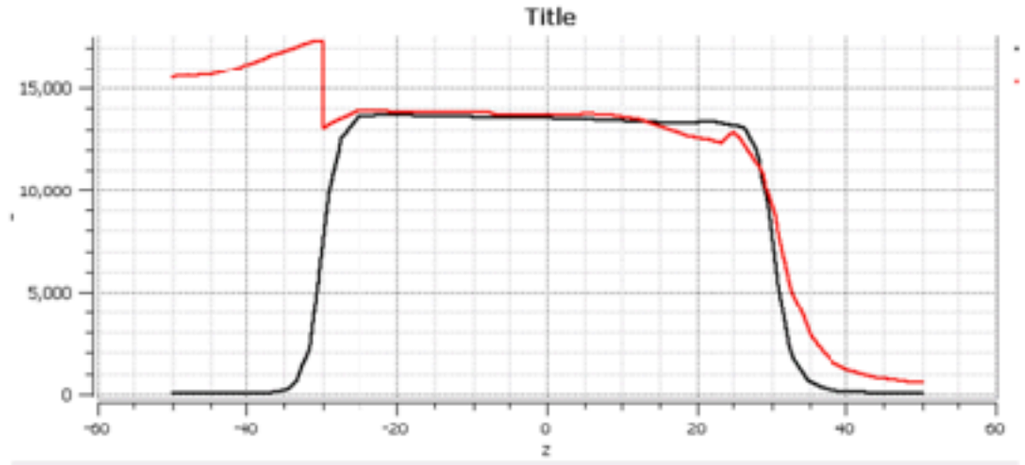
New magnet design by Bogdan





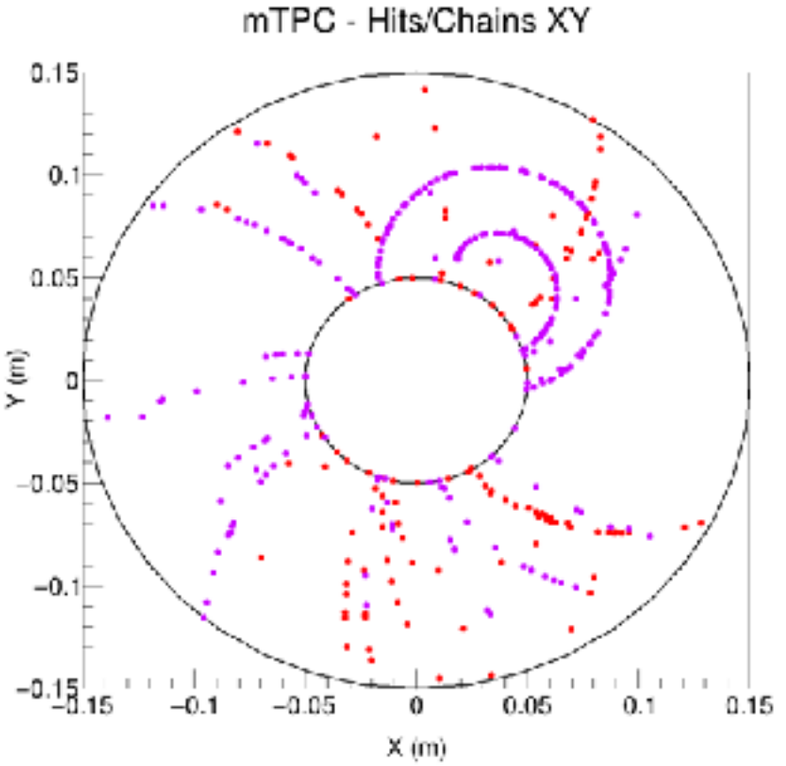


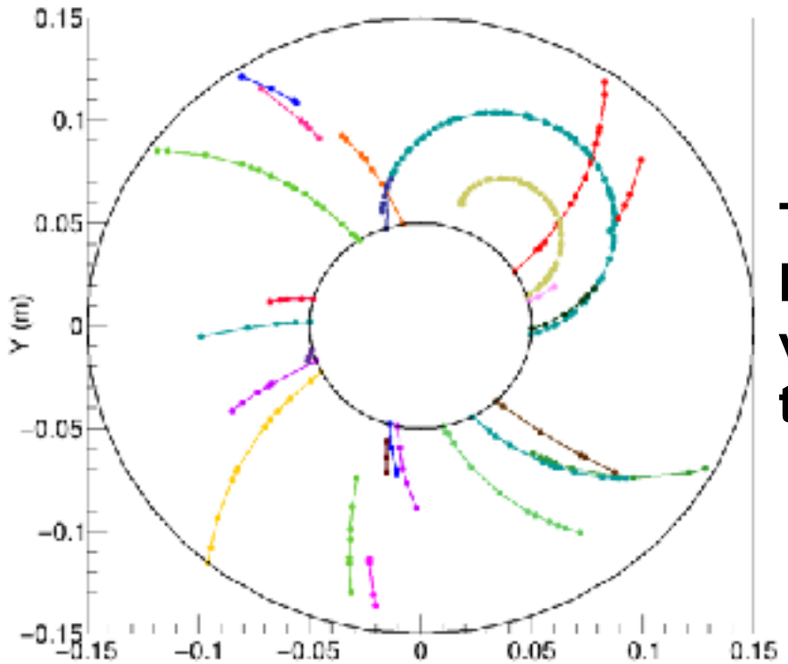
Opening to SBS at 12 deg.



The momentum resolution at 1.5T is still sufficient for TDIS requirements — Steve Wood's study

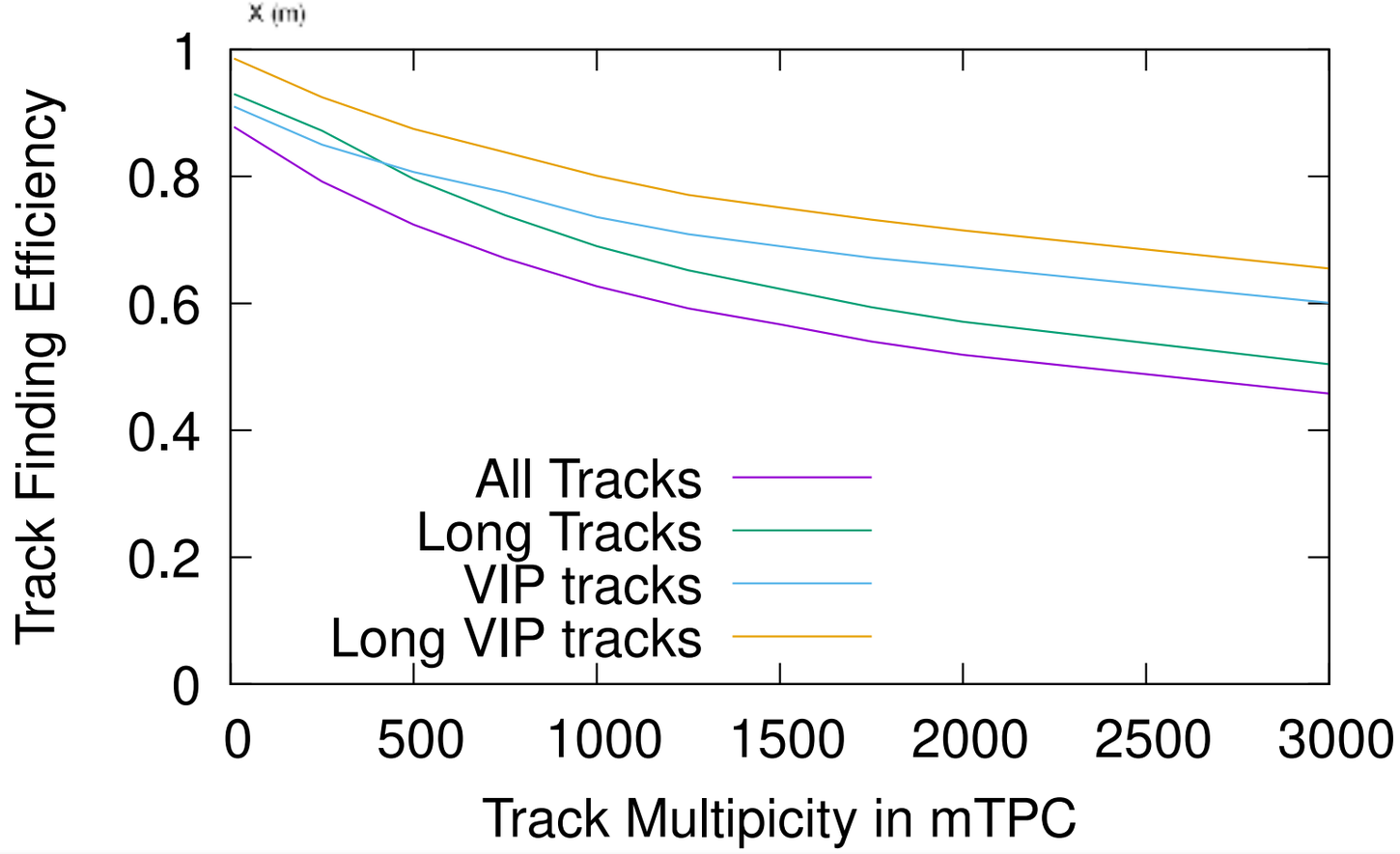
High rate and high occupancy tracking algorithms have been developed and are being optimized





Two tracking algorithms have been developed, a new hybrid version is being developed using the best features of each.

At multiplicity of 2000 tracks per event (i.e. rate of 1 GHz in the mTPC) shows an efficiency of 68% for clean tracks

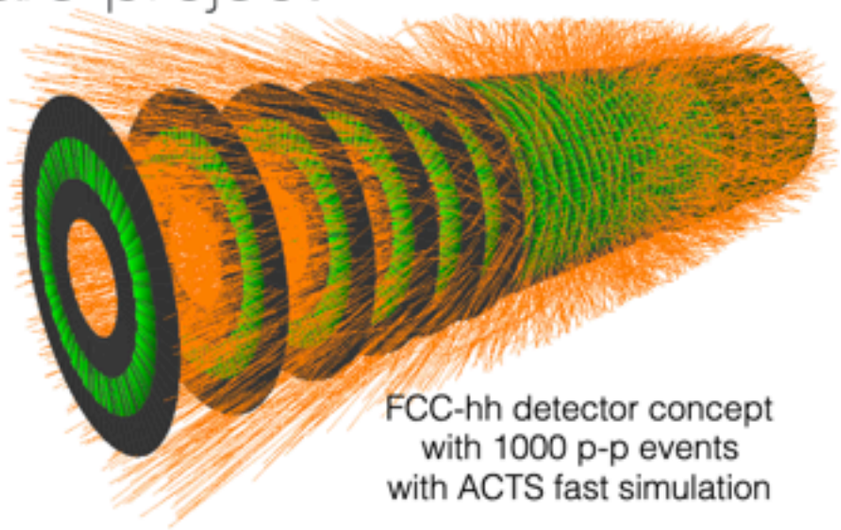


plots credit: C. Ayerbe Gayoso, S. Wood

Tracking remains the main challenge (several options under consideration)

ACTS A Common Tracking Software project

Project to preserve and enhance LHC track reconstruction software for future **detectors** and **computing infrastructure**



FCC-hh detector concept with 1000 p-p events with ACTS fast simulation

A flexible, **open source R&D testbed**:

- facilitate collaboration across experiments and external contributors, e.g. machine learning experts
- allow for novel algorithms and detector components (e.g. timing, track lets)

A **high-performant toolbox** for track reconstruction based on LHC experience

- modern code and software concepts to allow for concurrent computing
- support high luminosity and high precision tracking algorithms

Currently developers from ATLAS, LHCb, FCC-hh

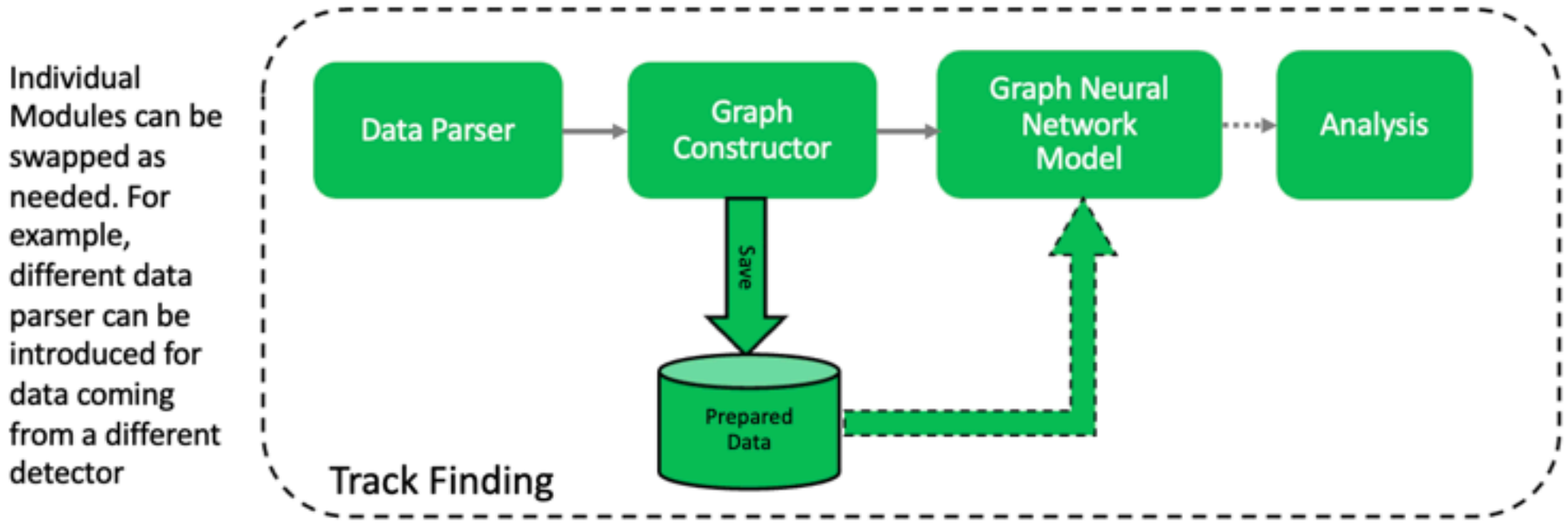
- supporting: FCC-hh, Tracking machine learning challenge

http://acts.web.cern.ch/ACTS/

Tracking remains the main challenge (several options under consideration)

A Composable Framework for Tracking

- Modular and Composable framework for track finding with GNN
- Maximum code re-use across different data sources



- The workflow is being tested at CLAS as well; simply replaced data parser and graph constructor
- The plan is to introduce track fitting using Recurrent Neural Networks in the above workflow

What should be our strategy going forward?

What should be our strategy going forward?

1. Focus on answering the bulk of the review committee's questions

a) Get basic device parameters from the square prototype and move forward with a cylindrical prototype.

b) Make progress with including the toy algorithm within an already developed framework such as ACTS + adopt ML/AI.

c) Seek design help on the target.

d) Incorporate new magnet design into technical review.

Aim for passing technical review at least 1 month before PAC deadline (i.e. April 2025).

What should be our strategy going forward?

2. Based on outcome of technical review go back to PAC 53

Pros:

a) Can incorporate all the new design optimizations that have been performed since the original proposal.

b) New higher impact physics motivation can be articulated (i.e. A grade possible).

c) Can ask for more beam time enabling at least a factor of 2-3 reduction in luminosity (makes tracking and all other subsystems less challenging).

d) If there are additional technical issue brought up by the technical review we can try to address them in the new PAC proposal

Cons:

a) The new PAC proposal will come with added risks

b) We will have to address the issue of SBS in Hall C