Report from MVTX Workfest at MIT

Ming Liu

Los Alamos

MVTX-HF Workfest @MIT 4/30-5/1

- Primary goals: discuss and refine a roadmap for MVTX realization
  - ~20 people attended, MVTX, INTT experts and sPHENIX management and project offices;
  - defined near term action items for MVTX/INTT integration in sPHENIX
  - A mini-sPHENIX integration review proposed, ~last week of June

- Monday April 30:

  a series of presentations & discussions of current considerations on budget & schedule and possible cost reduction measures, and MVTX+INTT integration
- Tuesday May 1:

  mostly follow up on day-1 discussions, near term R&D, MVTX + INTT

Workfest indico page: https://indico.bnl.gov/event/4380/

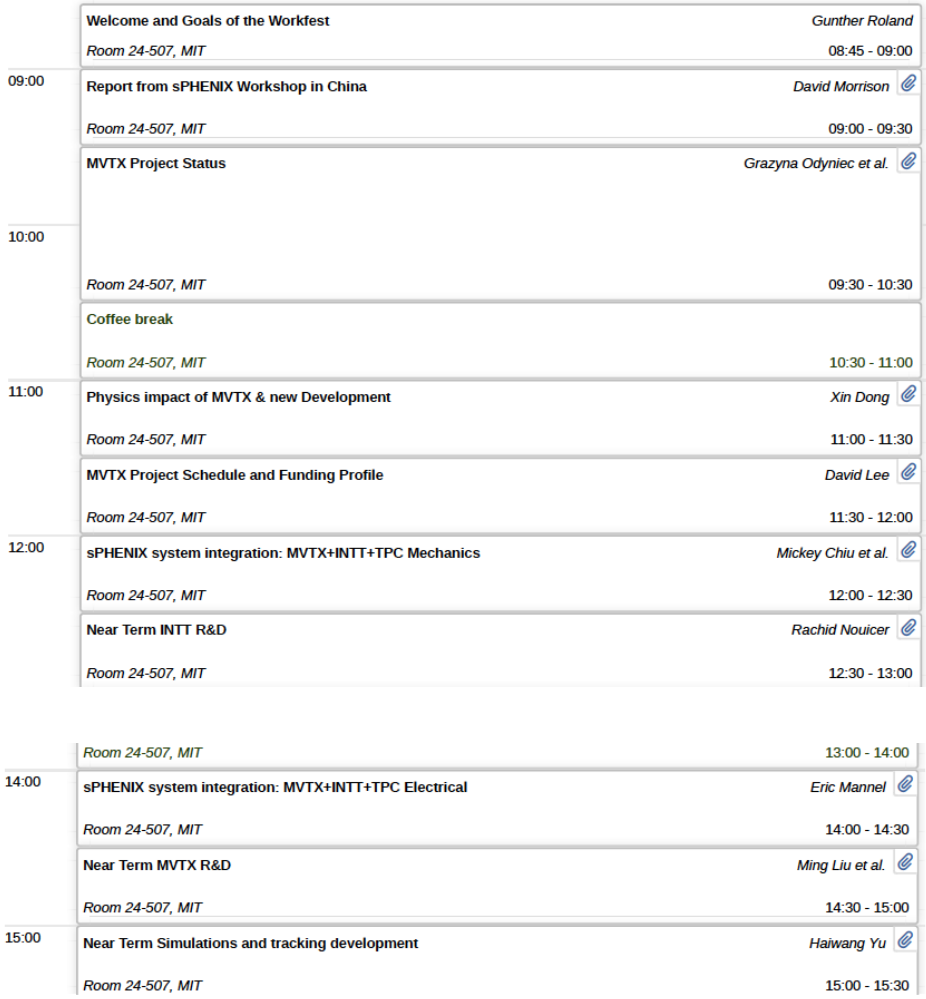
Topics discussed

News from sPHENIX workshop in China;
Involvement in MVTX project from Chinese Consortium;
1) stave production, test and simulations;
2) possible joint R&D and/or production of carbon structures

MVTX project status and plan:
- Working on early procurement of Readout Units and Staves from ALICE/CERN, EIC R&D proposal to DOE
- Highlight from Fermilab test beam
- MVTX integration in sPHENIX
- Project schedule and funding profile smoothing to fit projected sPHENIX cash flow
- Near term R&D for MVTX and INTT
- New development in physics and simulations

ALD asked to have a mini-review of sPHENIX tracking integration ASAP (MVTX+INTT+TPC + …)
- the week of June 25th or early July, TBD
- Carry out critical integration R&D MVTX, INTT..

A joint MVTX+INTT test beam at Fermilab, Jan-Feb 2019
- Full subsystem test
- INTT ~1.2m extension bus
- MVTX, full staves with possibly extended FPC



A Broad Physics Program

Xin & Jin

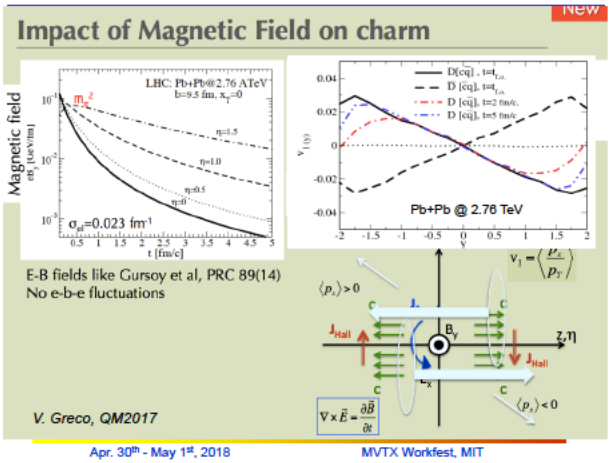
Total bottom cross section
- Upsilon suppression in heavy-ion collisions

Hadronization
- Charm baryon Λ_c production

Initial magnetic field
- Directed flow of D and Dbar mesons

Gluon distributions in nucleons/nuclei at EIC

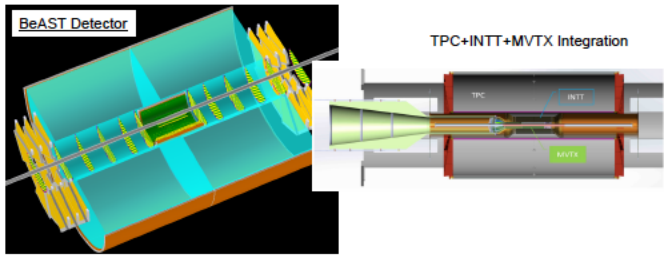
Charm Directed Flow – Direct Access to Initial B Field

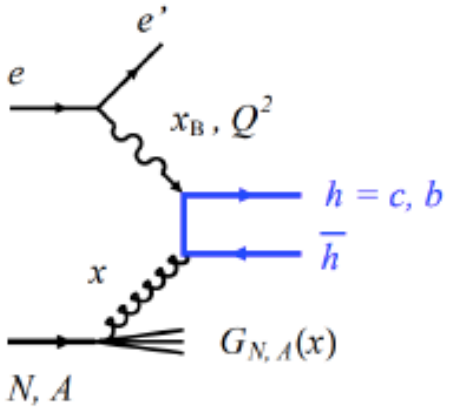


MVTX or MVTX+ for EIC ?

Kinematic coverage
Mechanical support/service
- integration effort with forward/backward tracking detectors

Radiation damage concern?
Readout speed / trigger (?)





Haiwang & Jin

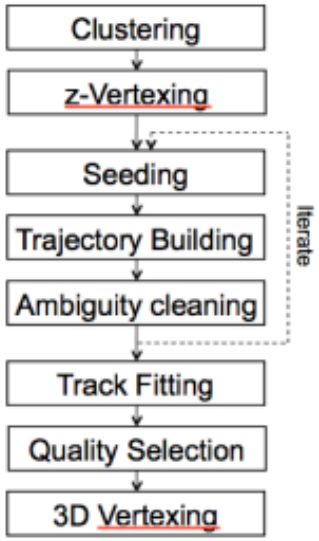
Simulations

sPHENIX tracking software

What we have:
- Laddered G4 models for MVTX and INTT
- Improved and improving clustering alg. for TPC, INTT and MVTX
- Kalman Filter track following pattern recognition
  - Configurable iterations
- GenFit based final track fitting
- RAVE based 3D multi-vertexing
- Track projection tools
- Fast tracking tools
- etc.

New update:
- TPC zig-zag readout simulation
- Optimization of seed fitting and iterative strategies for PatRec
- Standalone initial Z-vertexing module

Working on:
- Integrating the initial vertexing to the main track reco. chain
- Improving TPC clustering under high occupancy
- Code reorganization for long term development
- New PatRec alg.

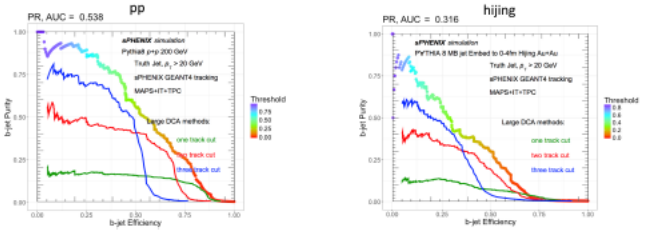


4/30/18 Haiwang for MVTX Workfest 2

More sophisticated algorithm?

More sophisticated algorithm
- Using all DCA information comprehensively
- Using more features to help
- Need to output one curve

First try with Random Forest
- https://www.stat.berkeley.edu/~breiman/RandomForests/cc_home.htm#overview
- At each split, 'mtry' features randomly chosen, use the one with best Gini gain



4/30/18 Haiwang for MVTX Workfest 13

As part of a EIC detector prototype

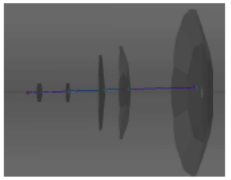
Vertexing info. used in fsPHENIX LOI last year:
- https://www.sphenix.bnl.gov/web/system/files/sPH-cQCD-2017-001_draft_2017_06_02.pdf

Available to simulate MVTX as part of a EIC detector
- G4 models of staves
- Fast tracking

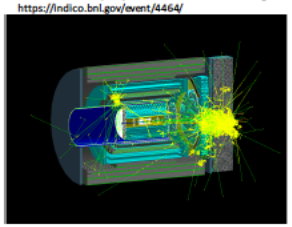
Missing:
- Material for (possibly redesigned) forward support structure
- Manpower in carrying out studies

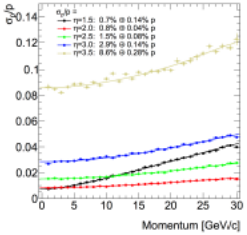
Suggestions welcomed

fsPHENIX



G4 event display - ePHENIX - J. Huang
https://indico.bnl.gov/event/4464/





4/30/18 Haiwang for MVTX Workfest 14

RU Production Plan

Plan-A

- To be part of ALICE ITS production
- Timeline:
  - Production starts ~May 2018, available by ~end of 2018, fully tested
- Need to make commitment “NOW”
  - BNL management actively working on funding RU through RHIC $

Plan-B

- Produce RU later, ~2019 as funding allows?
  - Procure GBT chips from CERN
  - Production & test in US, UT-Austin, LANL et al.
- Higher cost, 2x
- Higher technical and schedule risks

Stave Production Plan

Plan-A

- Produce staves following the completion of ALICE IB at CERN, using ALICE facility
- Timeline:
  - Starting as early as Aug/Sep 2018 +, last about 6 months for production and test
- All 84 staves produced and tested at CERN
- BNL management actively working with DOE to build staves at CERN

Plan –B

- Produce full staves at CCNU later as funding allows, ~2019?
- Earliest starting date - May 2019 + , ~12 months (could be shorter)
- Higher technical and schedule risks
- Impact on cost, TBD

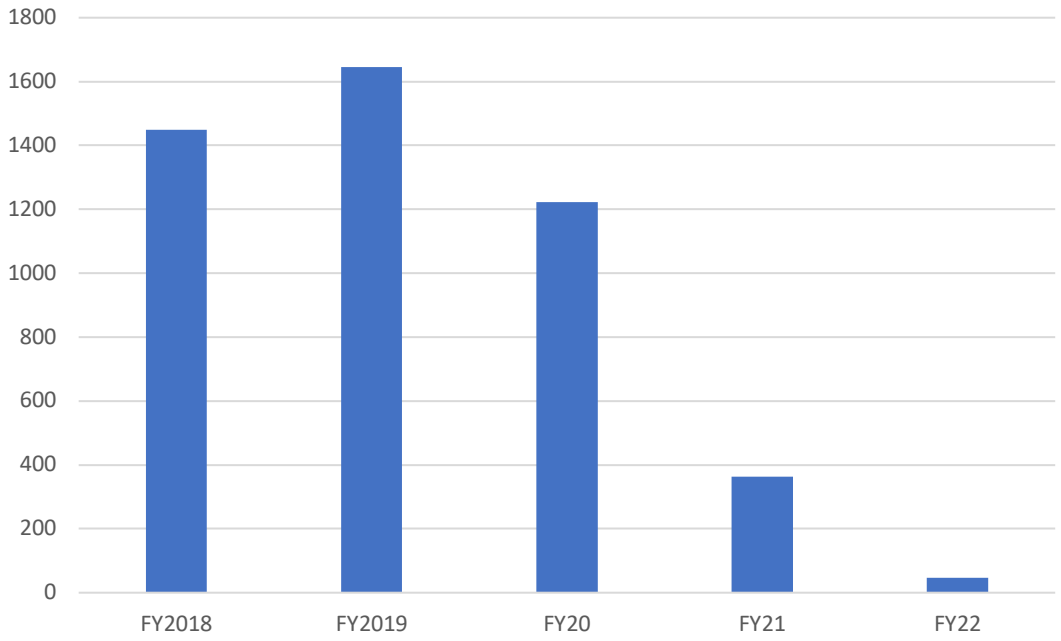
Carbon Structure Design and Fabrication

- Mechanical system design
  - MIT + LANL + LBNL + BNL
- Production
  - LBNL

- Alternative path for fabrication being explored
  - Europe (France & Italy, used for ITS Upgrade)
  - Asia (Korea, China)

Dave Lee

Current Profile (Cost): Funding Profile Smoothing, FY20-22



No Contingency and Passthru
Staves and RU in FY2018
Installation June 2022

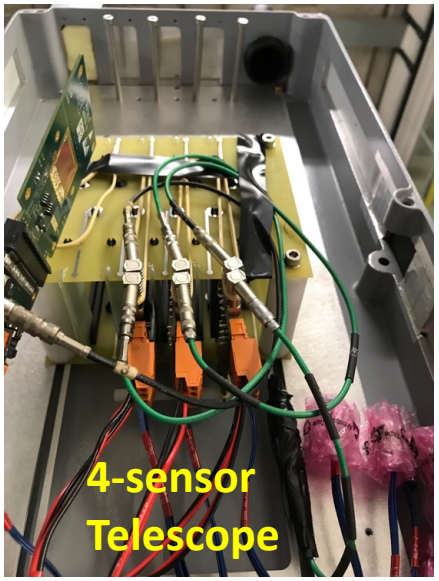
k$

FY2018	FY2019	FY20	FY21	FY22
1449	1645	1223	364	46

MVTX Test Beam at Fermilab 02/20-03/10, 2018

- Goals:
  - Test full readout chain
  - Evaluate ALPIDE sensor performance
- Experimental setup
  - A 4-sensor telescope
  - Full readout chain: MAPS+RU+FELIX+RCDAQ

120 GeV proton

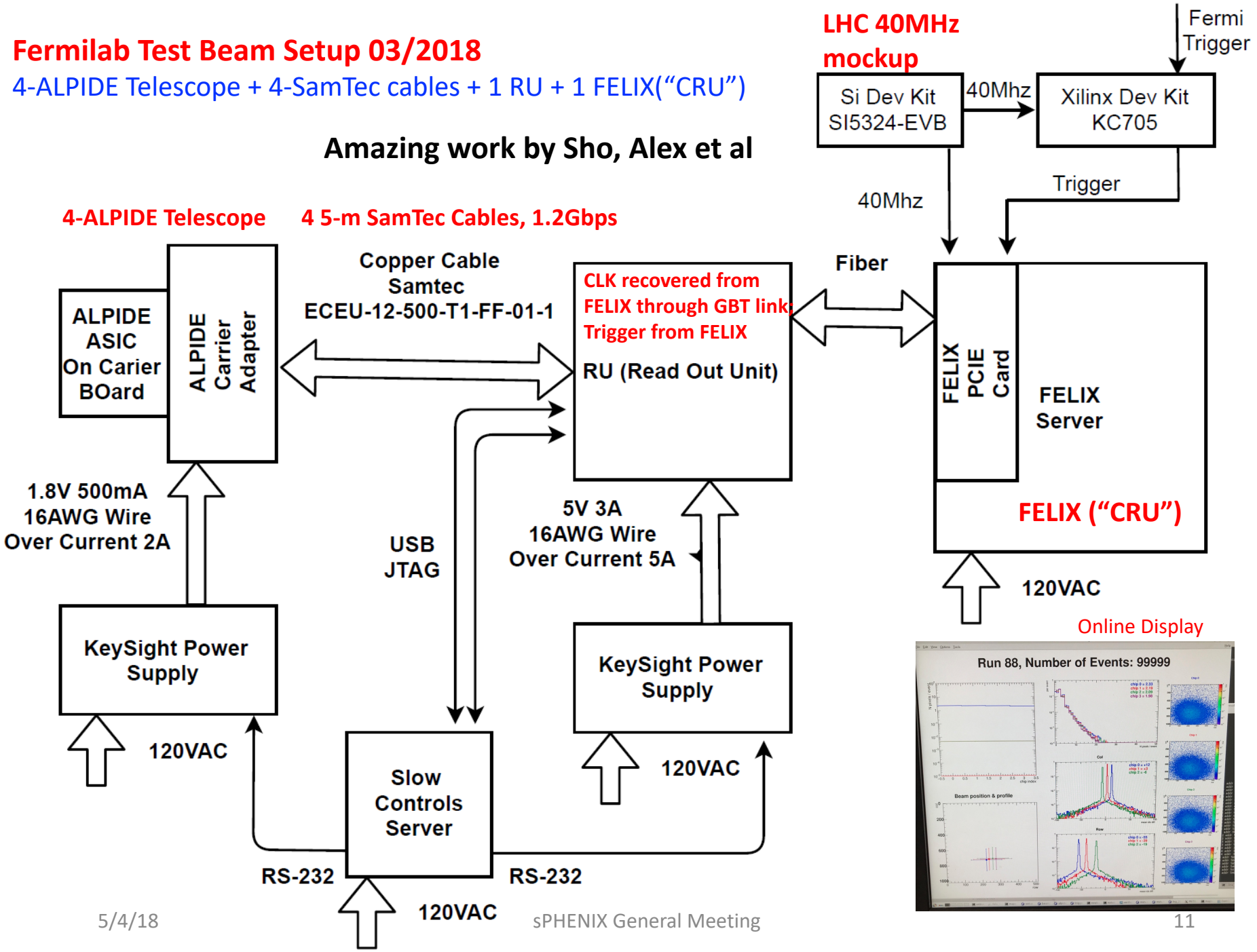


- Parasitic with INTT run
- Very productive & collaborative

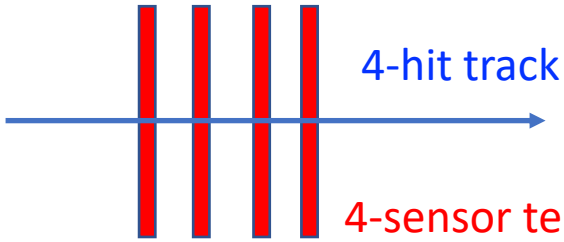
Fermilab Test Beam Setup 03/2018

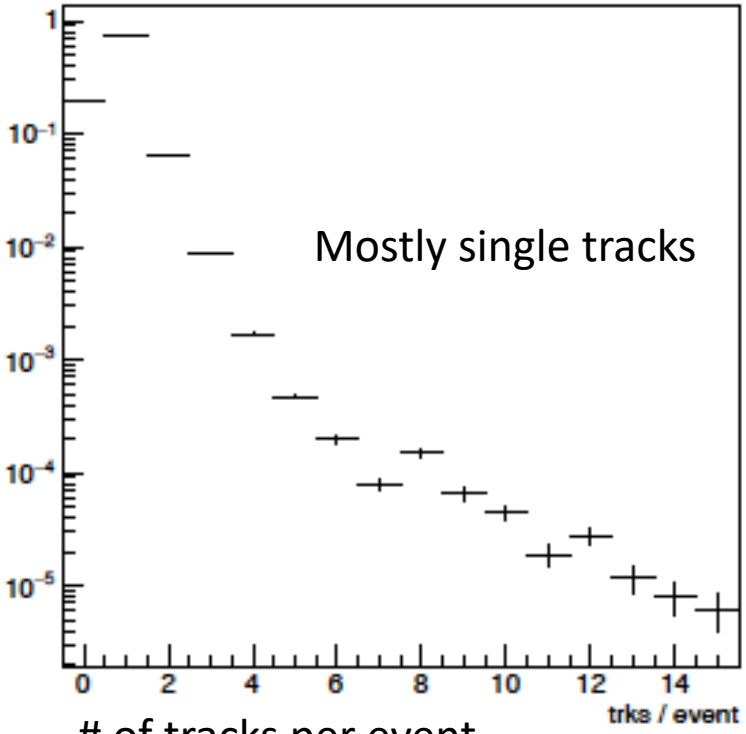
4-ALPIDE Telescope + 4-SamTec cables + 1 RU + 1 FELIX("CRU")

Amazing work by Sho, Alex et al

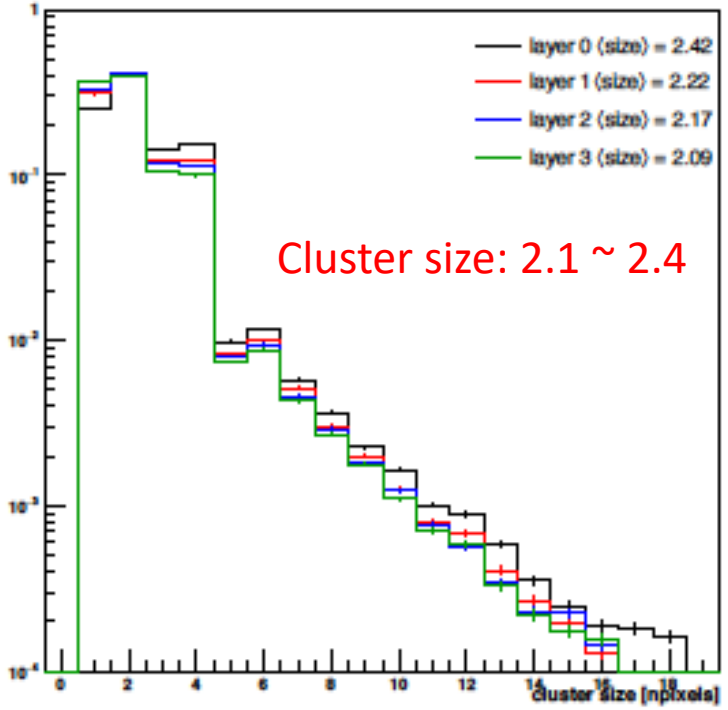


Fermilab Test Beam Results (I)





# of tracks per event

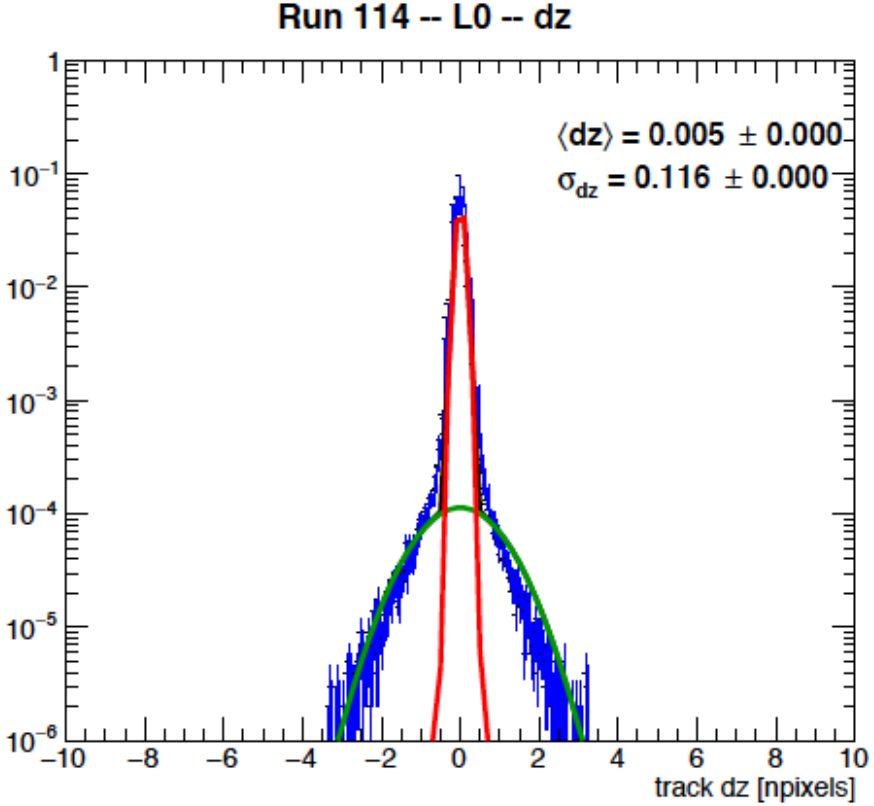


Cluster size

Beautiful analysis done by Sanghoon and Darren et al

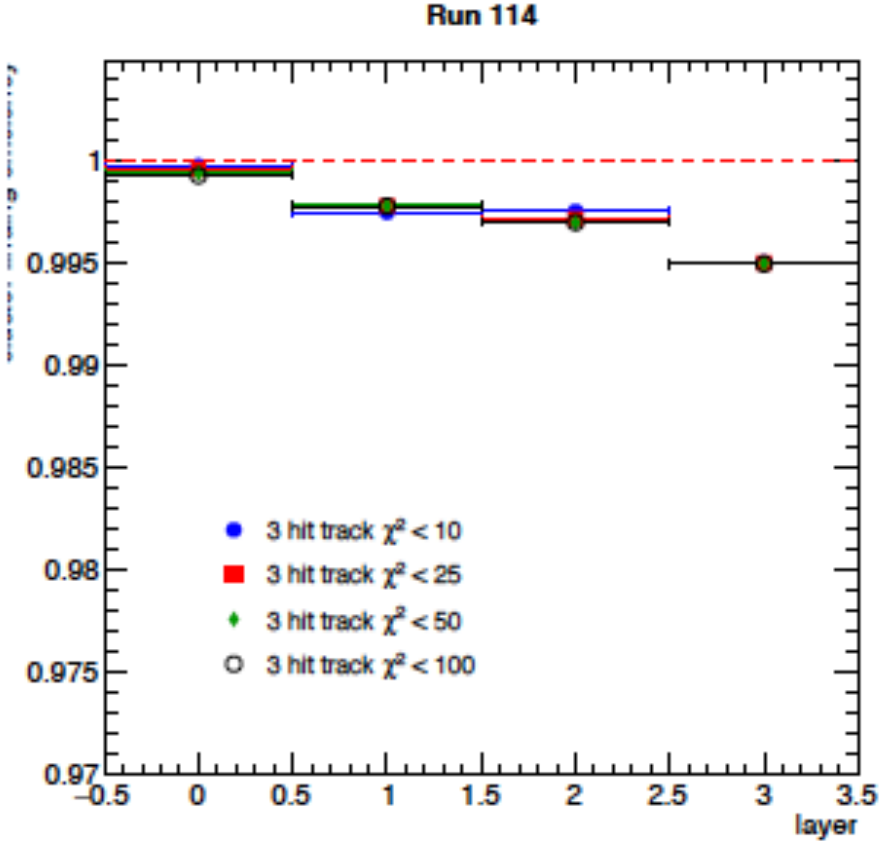
Fermilab Test Beam Results (II)

Hit Spatial Resolution: < 5 um



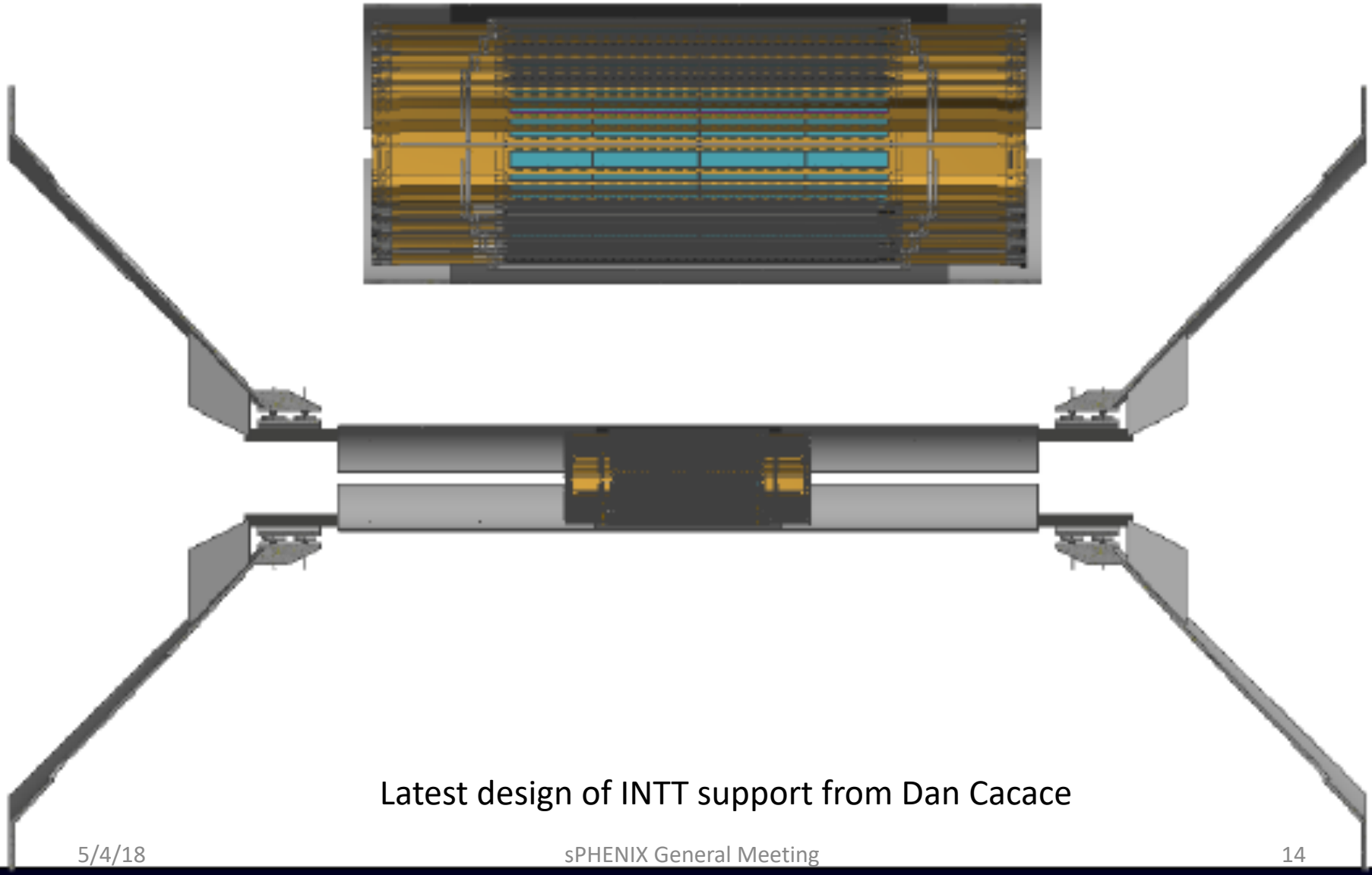
Pixel size (~28um)

Hit Efficiency > 99.5%



INTT Integration

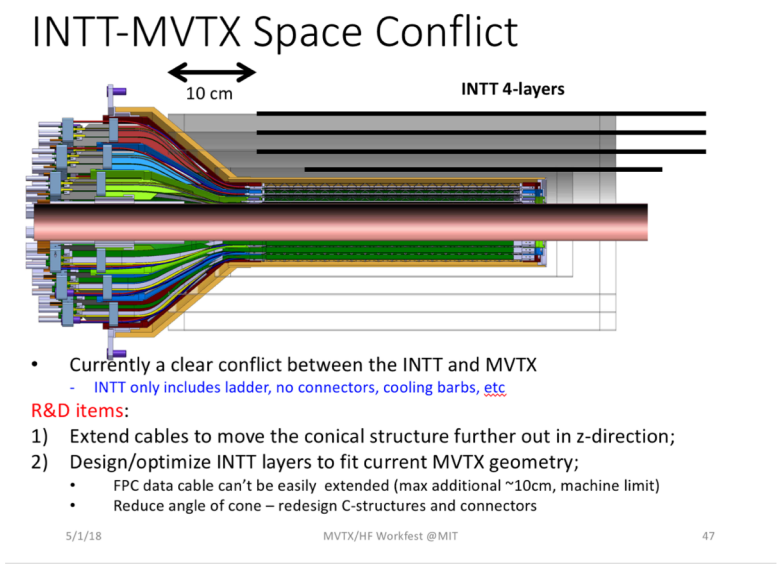
Rachid

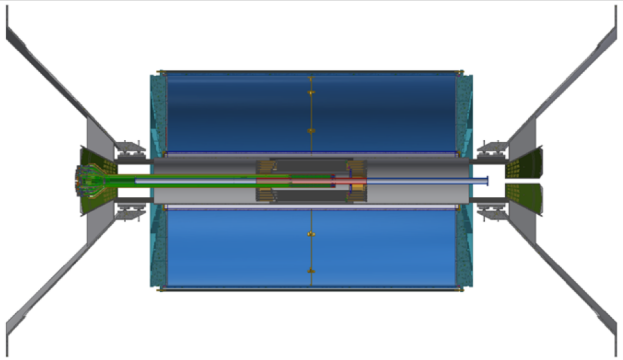


Latest design of INTT support from Dan Cacace

MVTX/INTT Integration Review: ~last week of June (TBD)

- w/ ~50cm FPC power extension
  - @LANL, voltage drop, noise pickup
  - MVTX conical structure modification, reduced radius
- w/ 10cm extension FPC – Plan A
  - INTT layout, "cables" and supporting structures
  - Final extension bus ~1.2m, INTT, summer 18
  - MVTX conical structure modification
  - 10cm HS signal simulation now ..
  - Early R&D possible? right now, ~Sept 2018 @CERN
  - Mechanical mockup: MVTX+INTT + .. , @BNL, LANL
- w/o FPC extension – Plan B
  - Revisit INTT layout, cables and supporting structures
  - Final 1.2m bus, summer 18
  - MVTX conical structure modification



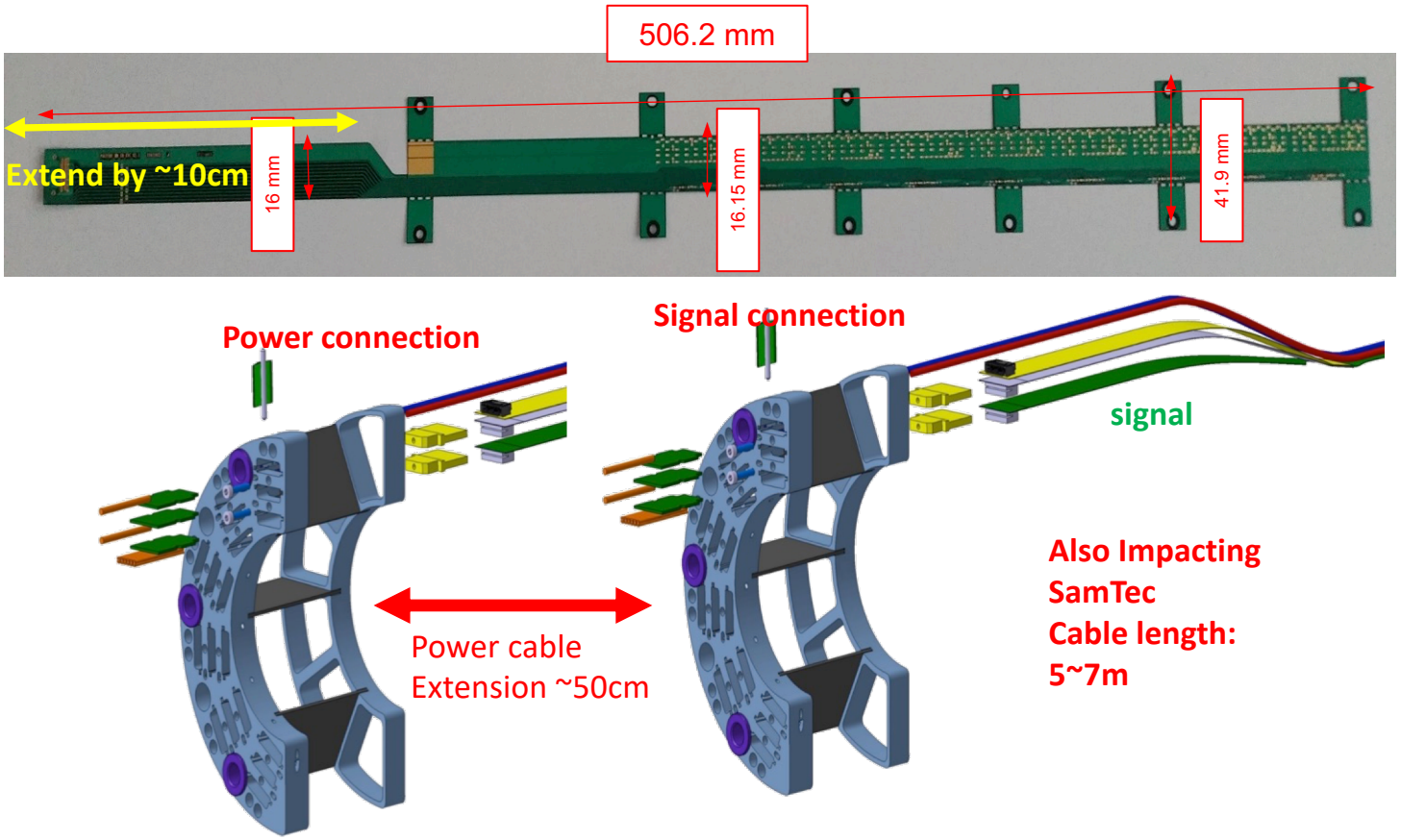


- INTT/MVTX simulations
  - New INTT postdoc, INTT optimization, including supporting str
- Resources
  - MIT engineers Jim/Jason ?
  - Walt, Dan, Mike L, Hubert, Chris …,
  - new $$ from non-MIE BNL project? New engineers? Under discussion

MVTX Flexible Printed Circuit (FPC)

Extend MVTX Service Cables?
Maximum +10cm for HS signal, TBD through R&D

Extend FPC/signal path by ~10cm



Work in Progress

Mickey, Dan, Walt, Rachid et al