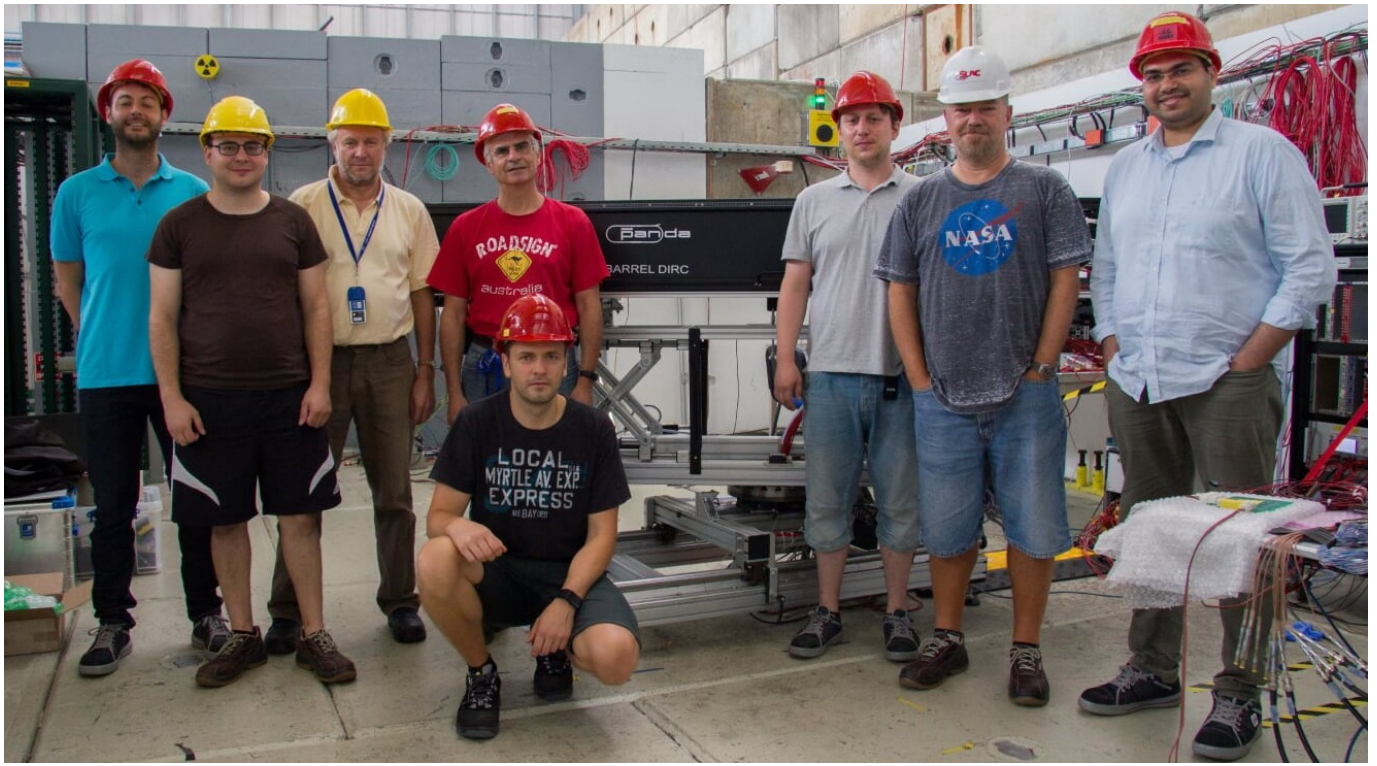
Status update of the Barrel DIRC Prototype Test @ CERN Aug 23 – Sep 13, 2017



GSI panda

THE CATHOLIC UNIVERSITY of AMERICA

JG|U JOHANNES GUTENBERG UNIVERSITÄT MAINZ

FAU FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

EIC PID Meeting
13.11.17

Roman Dzhygadlo, GSI DIRC Group
for the eRD14 collaboration

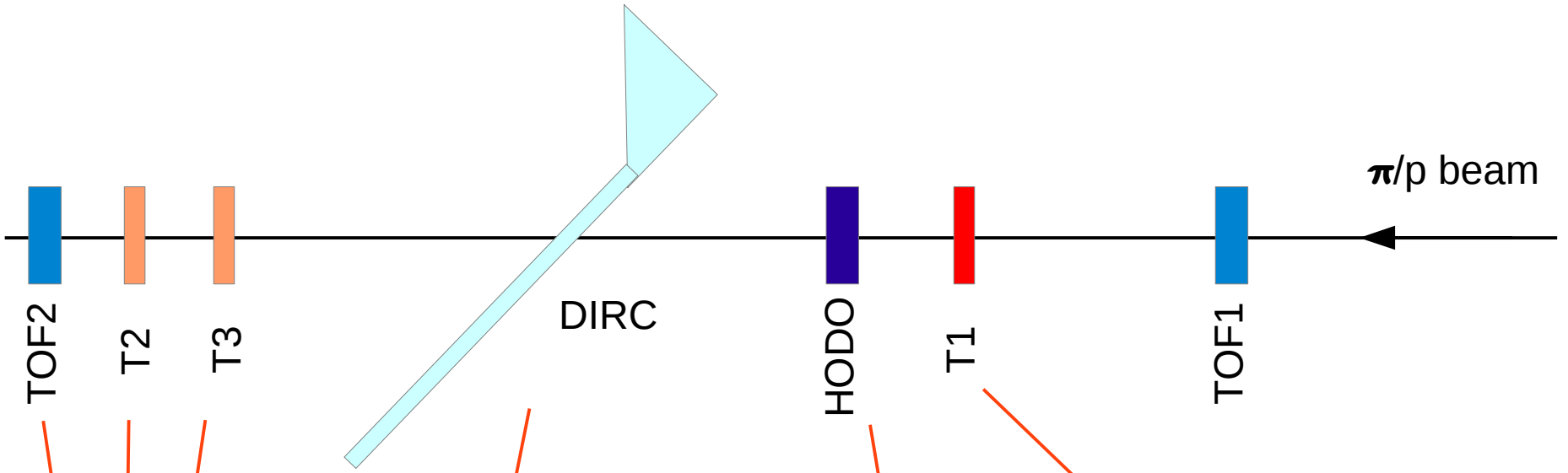
DIRC Prototype Test 2017

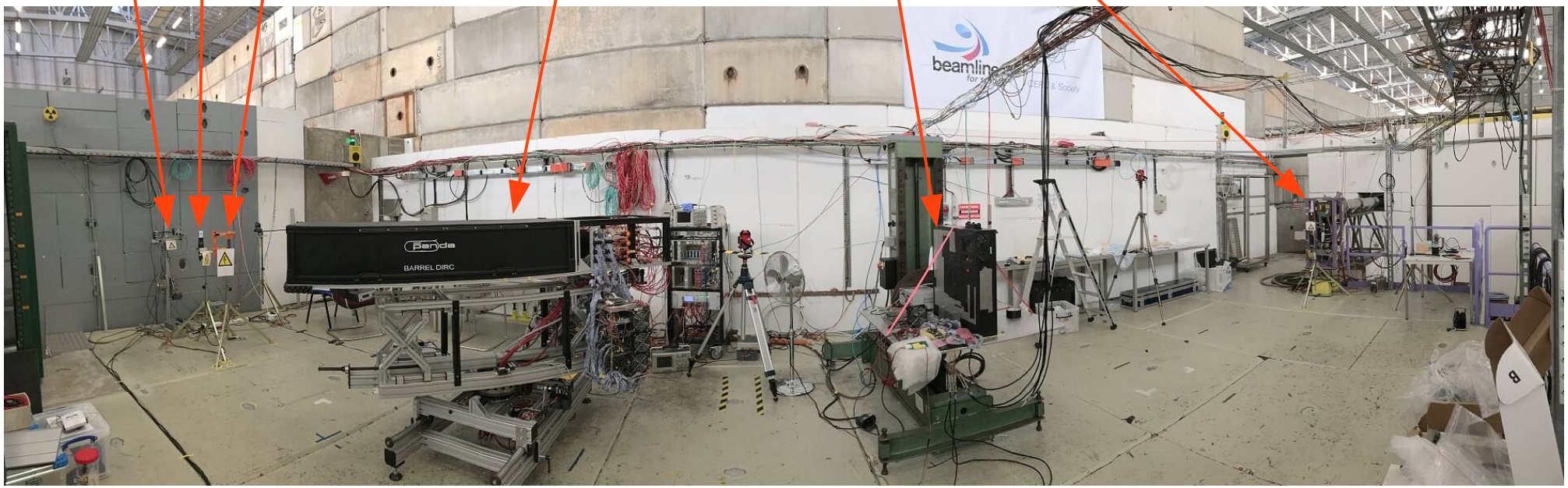
Goal:
- evaluate performance of advanced/near-final configuration of the PANDA Barrel DIRC
- test aspects of the EIC DIRC design

Highlights of the geometry:
- 33 degree prism as expansion volume => 12 MCP-PMTs (vs 9 last year)
- new readout modules
- new 3-layer cylindrical lens (eRD14 funding)
- narrow bar and plate as the radiators (plate for the EIC DIRC)
- updated mechanics to study impact of azimuthal angle on hit pattern, PID performance

- CERN PS/T9 area
- beam type: protons and pions
- beam momentum: 10, 9, 8, **7**, 6, 5, 4, 3, 2 GeV/c
- TOF PID
- different configurations of the DIRC prototype
- different DIRC prototype angles

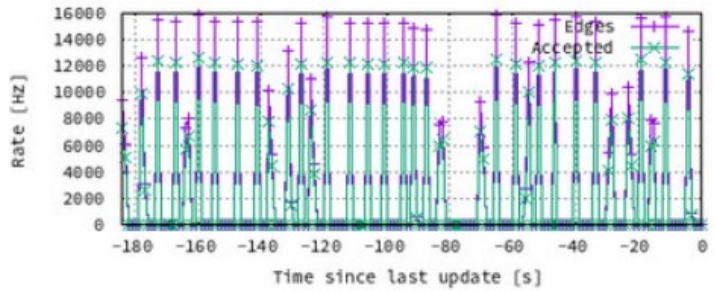
CERN 2017 Prototype Test



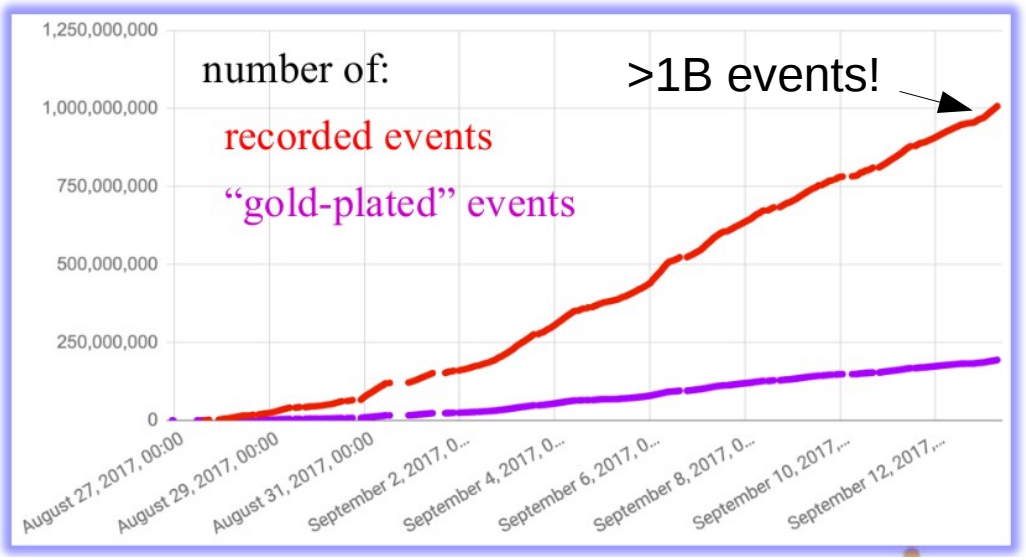


Data Set

Spill pattern of the beam, Sep 6, 6:15am



Sometimes 4-6 spills – that is a lot



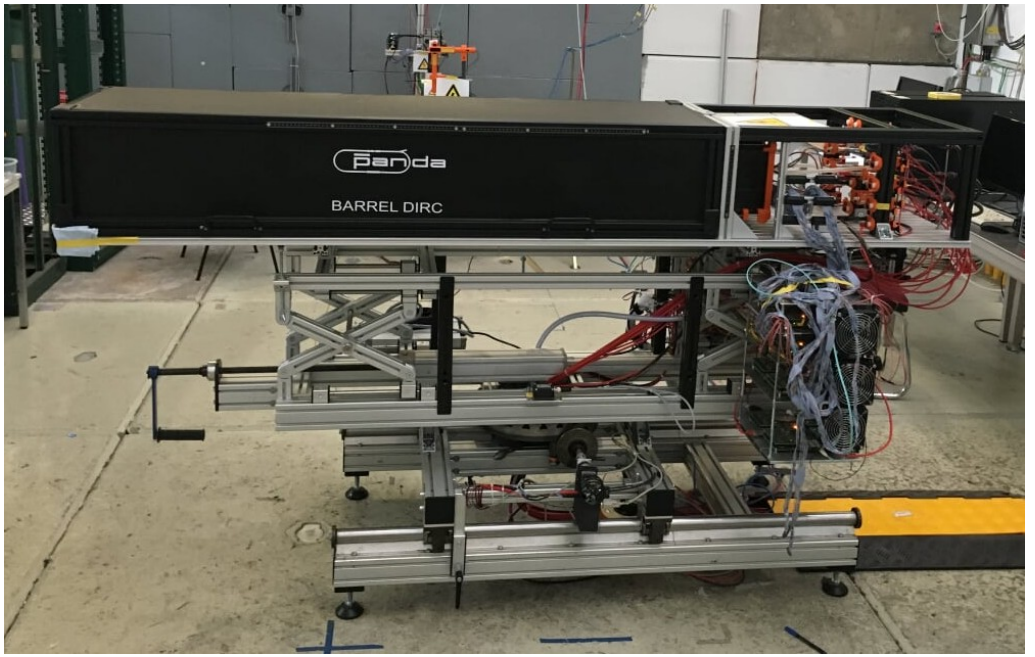
Different configurations:

bar	3Lspher	cookie		no useful data
	3Lspher	air gap	Aug-29	polar scan @ 5 GeV/c
			Aug-30	polar scan @ 7 GeV/c
			Aug-31	polar scan @ 7 GeV/c
	3Lspher	grease	Sep-1	polar scan @ 7 GeV/c
			Sep-2	polar scan @ 7 GeV/c
			Sep-3	polar scan @ 10 deg
			Sep-4	azimuth variation
			Sep-4	momentum scan
			Sep-5	azimuth variation
			Sep-5	polar scan @ 5 deg
			Sep-6	z scan
plate	2Lcyl	grease	Sep-6	polar scan
	3Lcyl	grease	Sep-7	polar scan
			Sep-8	short polar scan @ 5 deg
			Sep-8	X/Z scan
			Sep-8	polar scan @ 5 deg
			Sep-9	systematic studies
			Sep-9	momentum scan
	no focusing	grease	Sep-10	short angle scan
	no focusing	cookie	Sep-10	short angle scan
	no focusing	cookie	Sep-10	short edge/X scan
bar	3Lcyl	grease	Sep-10	polar angle scan @ 7 GeV/c
	2Lcyl	grease	Sep-11	short polar angle scan
	3Lspher	grease	Sep-11	polar angle scan @ 7 GeV/c
	3Lspher	grease	Sep-12	systematic studies
	3Lspher	grease	Sep-12	polar angle scan @ 10 GeV/c

DIRC Prototype Photos

Polar angle
90 degree

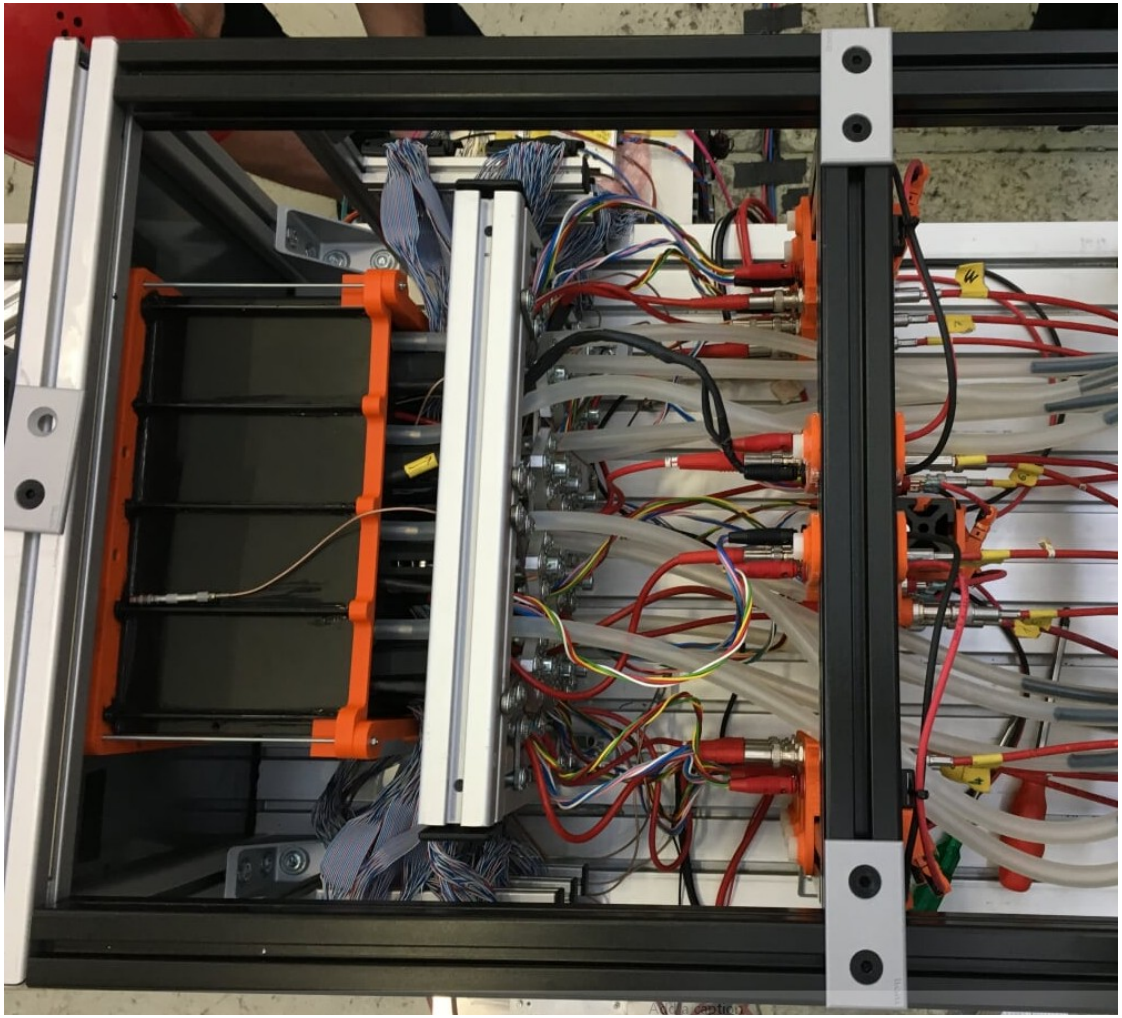
Azimuthal angle
0 deg



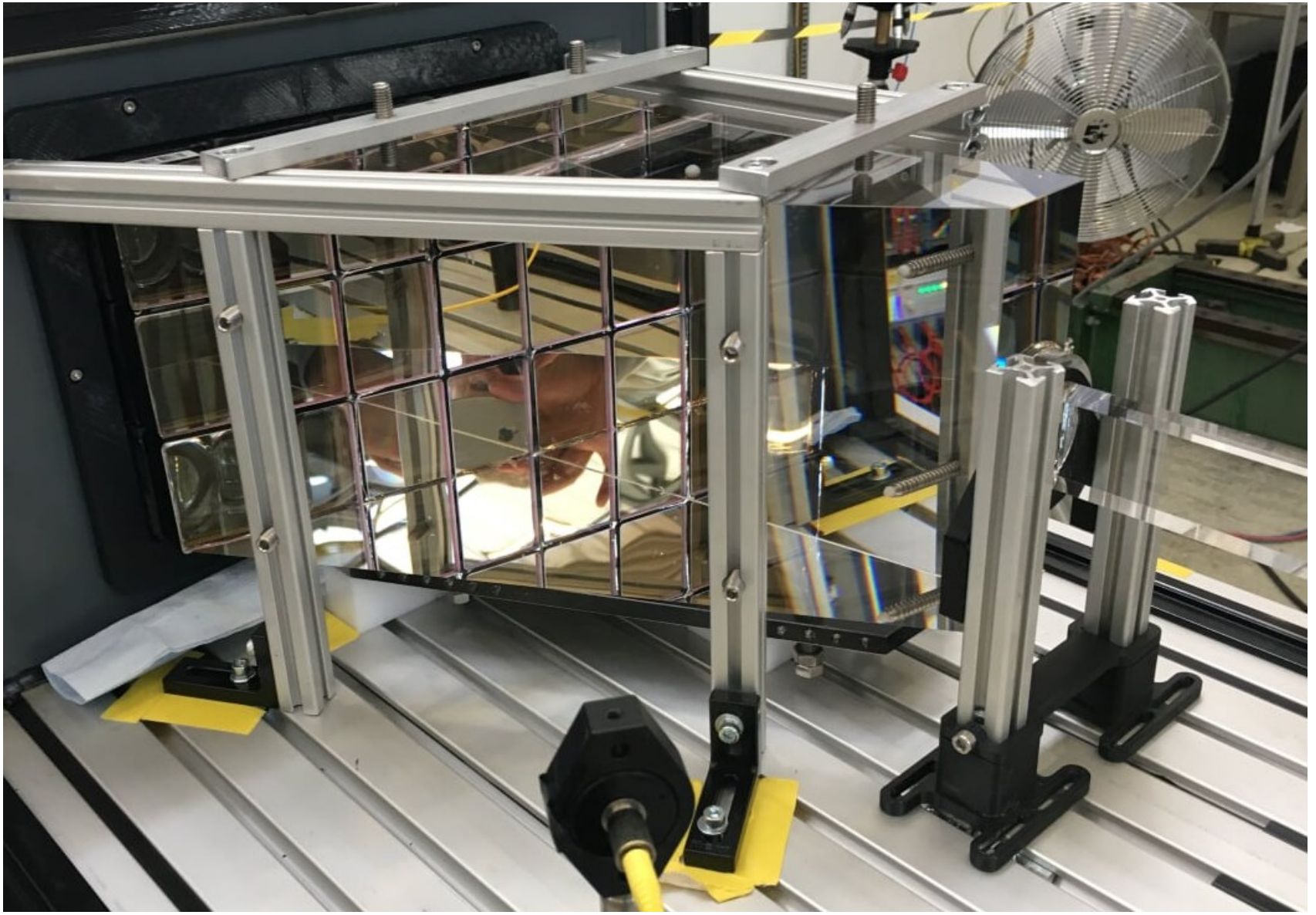
Polar angle
25 degree

Azimuthal angle
10 degree

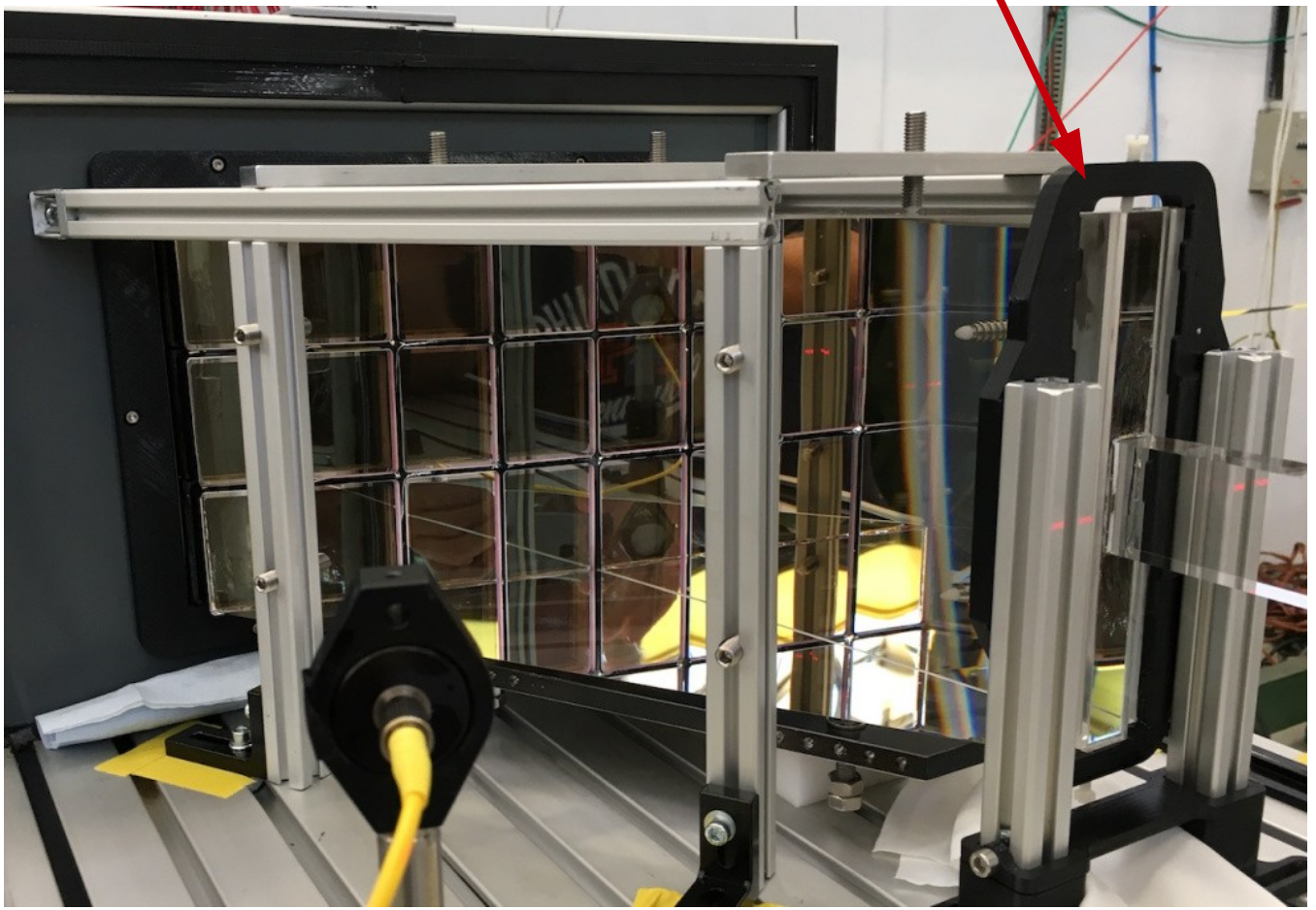
New Readout Modules

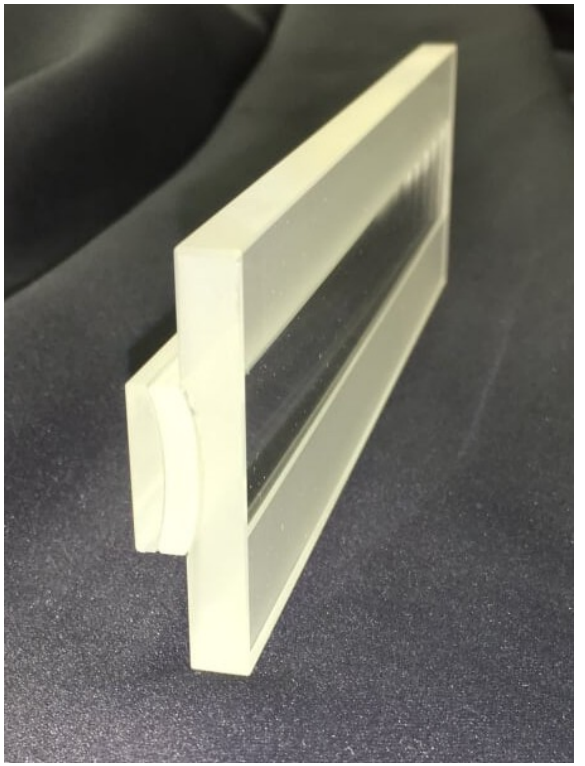


33 Degree Prism



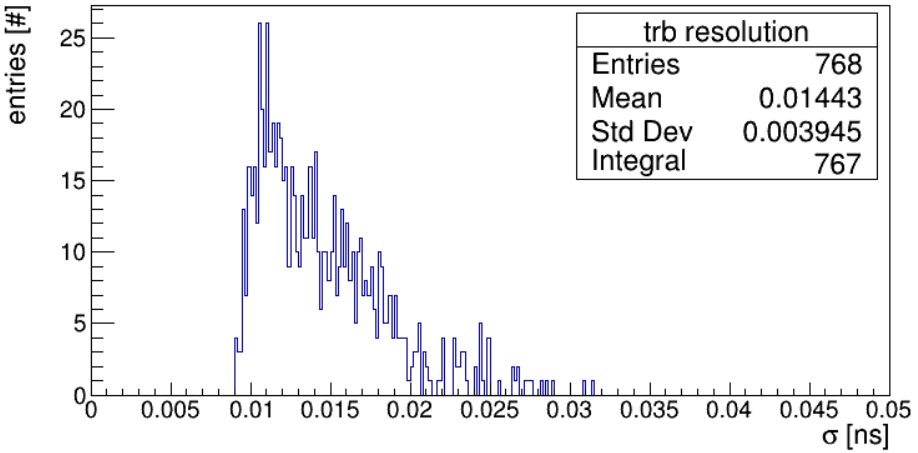
New 3 Layer Cylindrical Lens



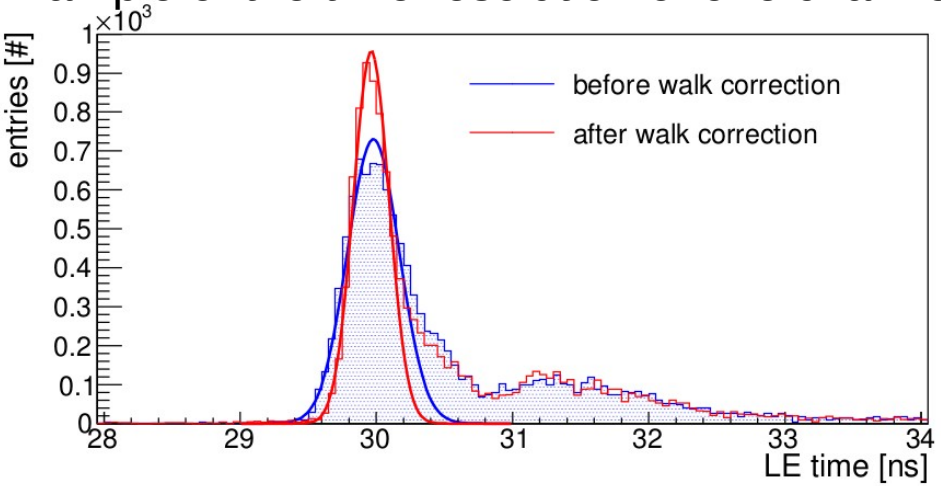


Time Resolution

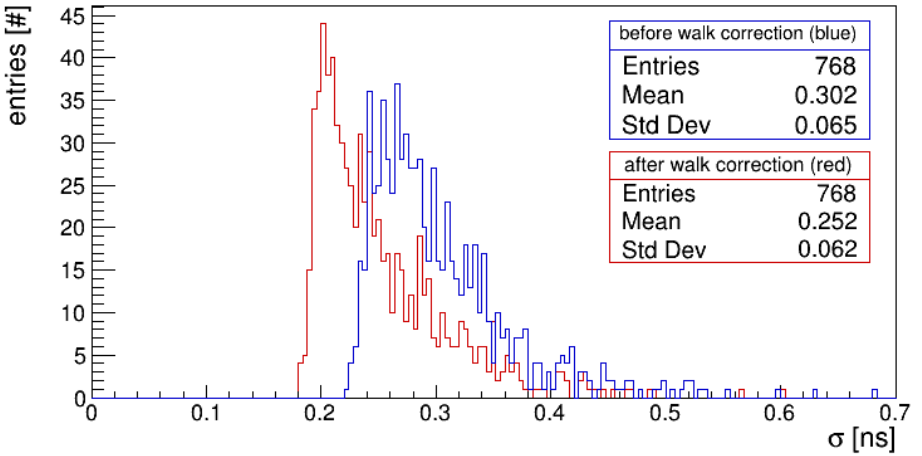
- TRB internal pulses and Pilas laser
- TRB time resolution ~14ps
- Total time resolution ~250ps



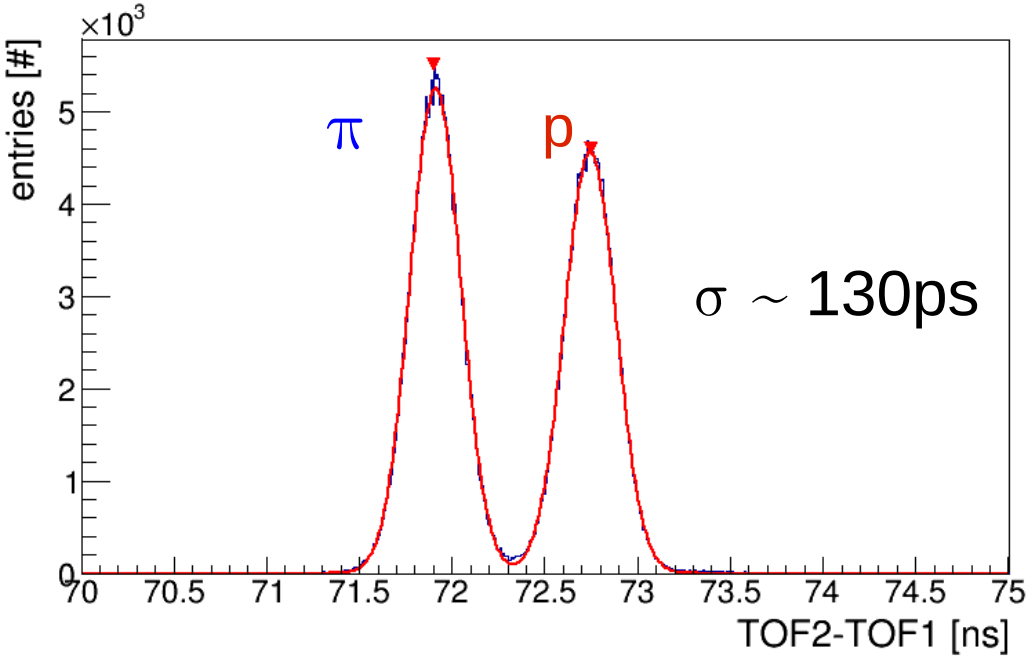
Example of the time resolution of one channel:



Time resolution of all 768 channels:



Momentum and TOF PID



Difference of the MCP-OUT signal of TOF2 and TOF1 counters after walk correction @ 7 GeV/c

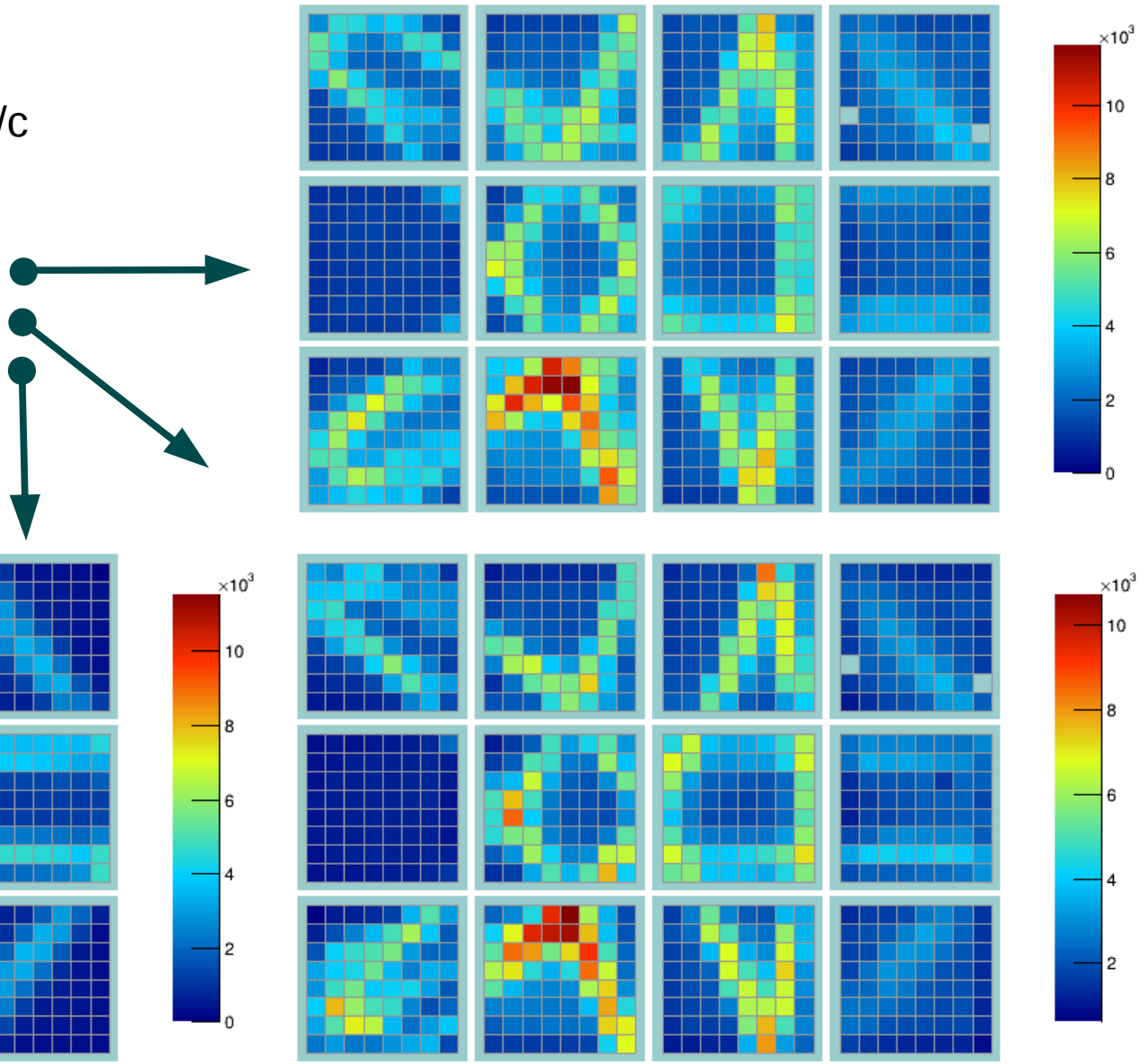
Beam momenta from each run

- stable with time
- p = 6997 +/- 16 MeV/c

Examples of the Hit Pattern

- 20 degree polar angle
- pions and protons @ 7 GeV/c
- bar + 3 layer spherical lens

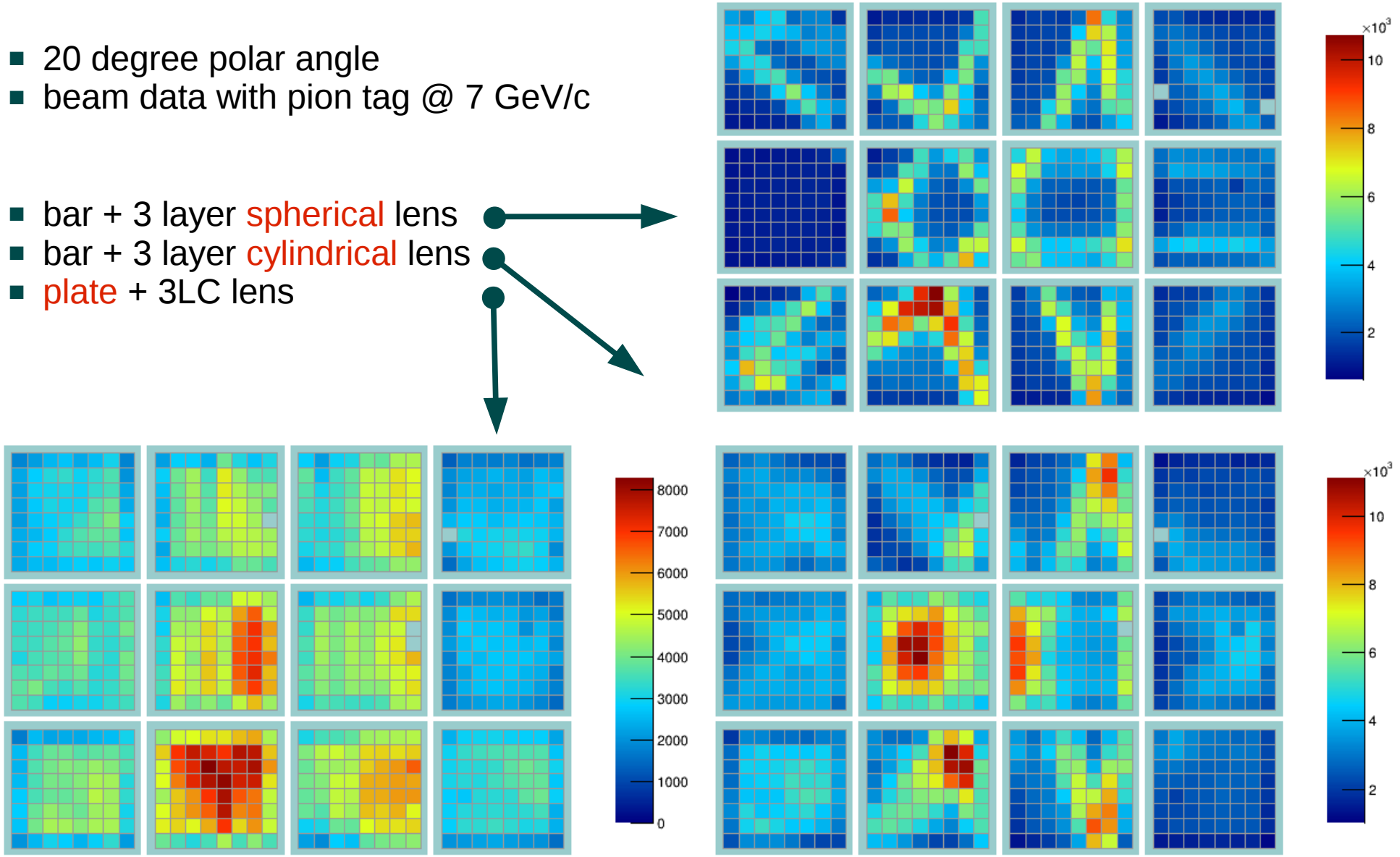
- beam data with proton tag
- beam data with pion tag
- geant simulation for pions



Examples of the Hit Pattern

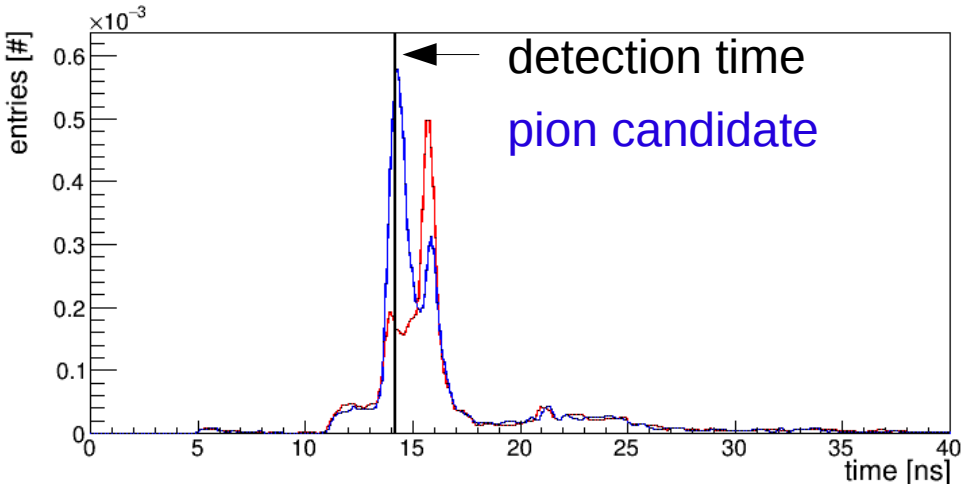
- 20 degree polar angle
- beam data with pion tag @ 7 GeV/c

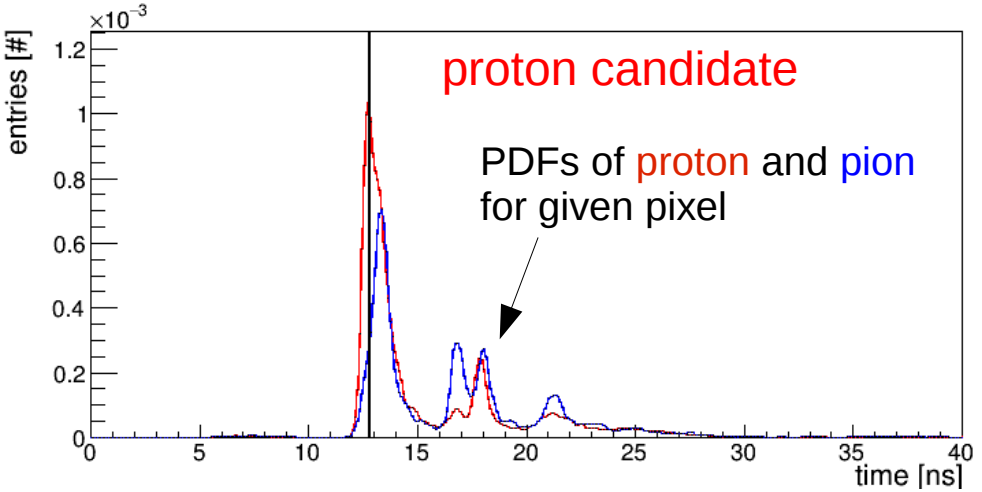
- bar + 3 layer spherical lens
- bar + 3 layer cylindrical lens
- plate + 3LC lens

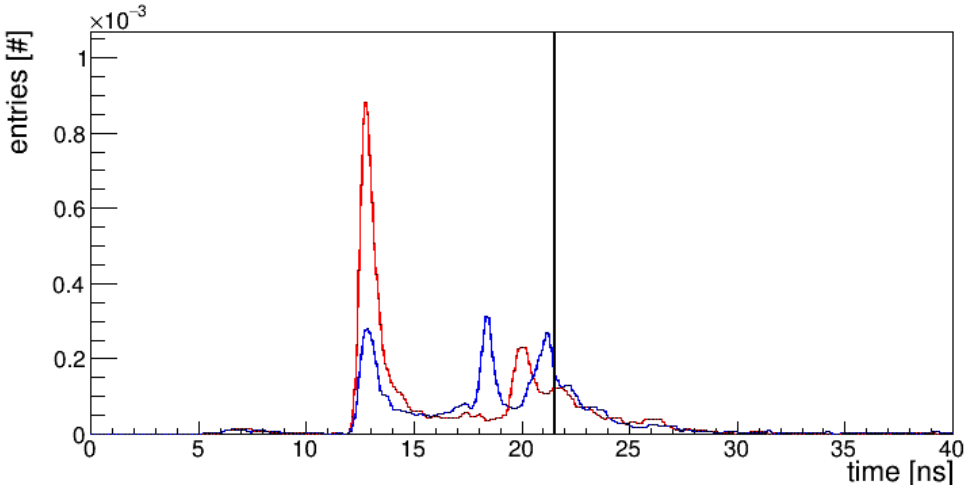


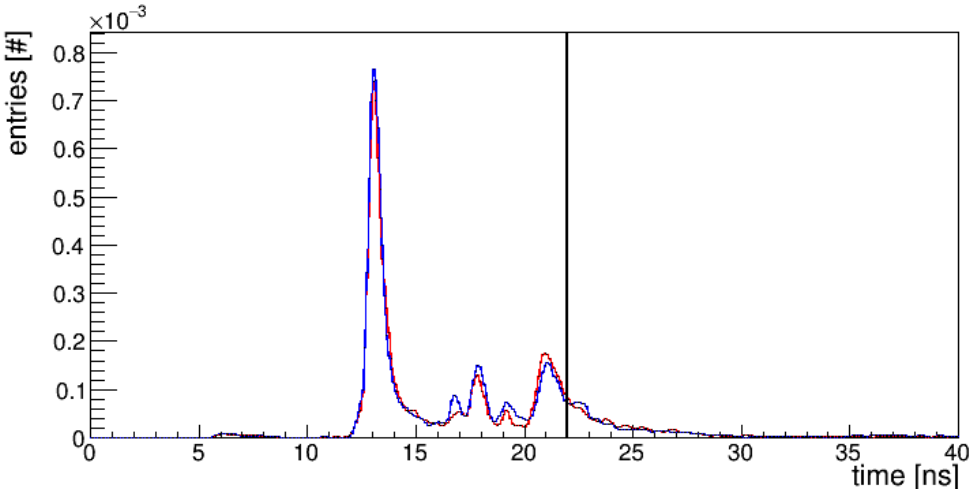
Time Imaging Reconstruction. PDFs

beam data with plate @ 7 GeV/c @ 25 degree



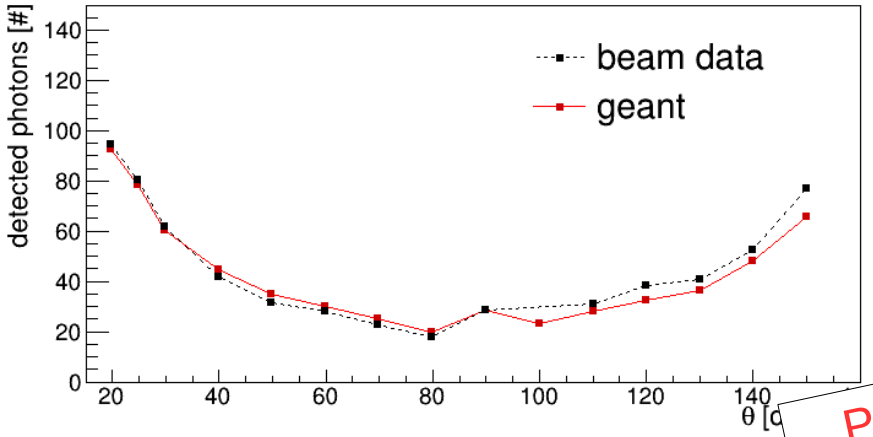




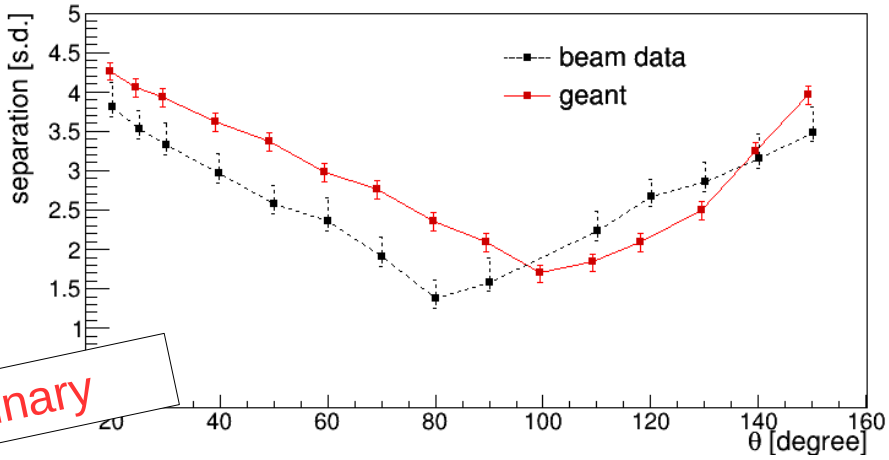


Bar with 3LS Lens @ 7 GeV/c

Photon yield:



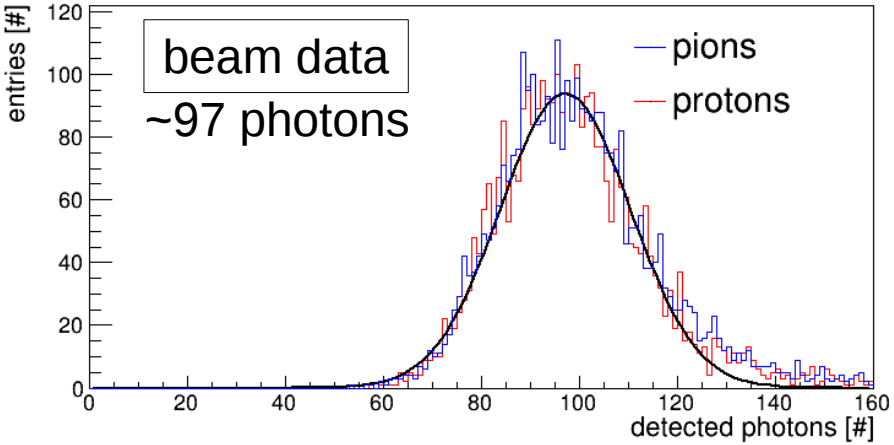
π/p separation power:



Preliminary

$$N_{\text{sep}} = \frac{|\mu_1 - \mu_2|}{0.5(\sigma_1 + \sigma_2)}$$

Example of the fit @ 25 degree:



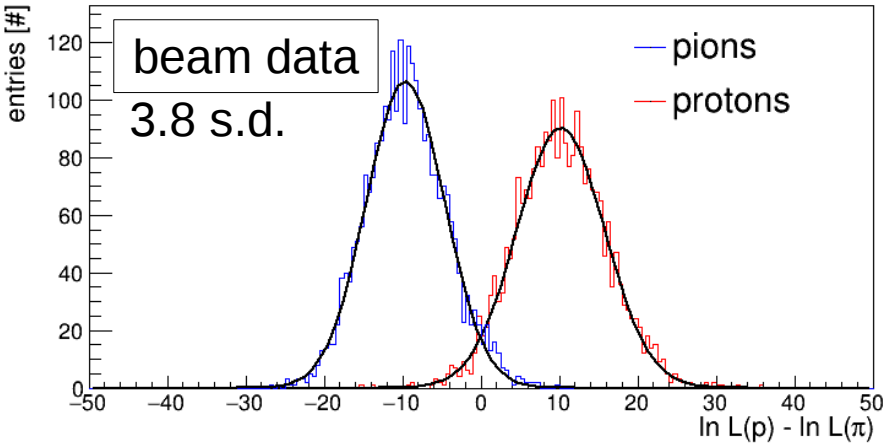
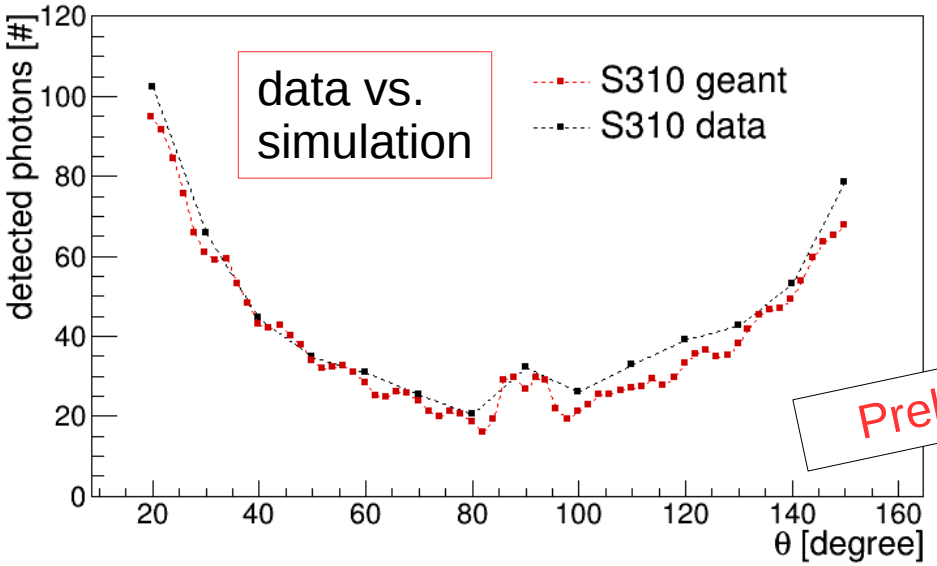
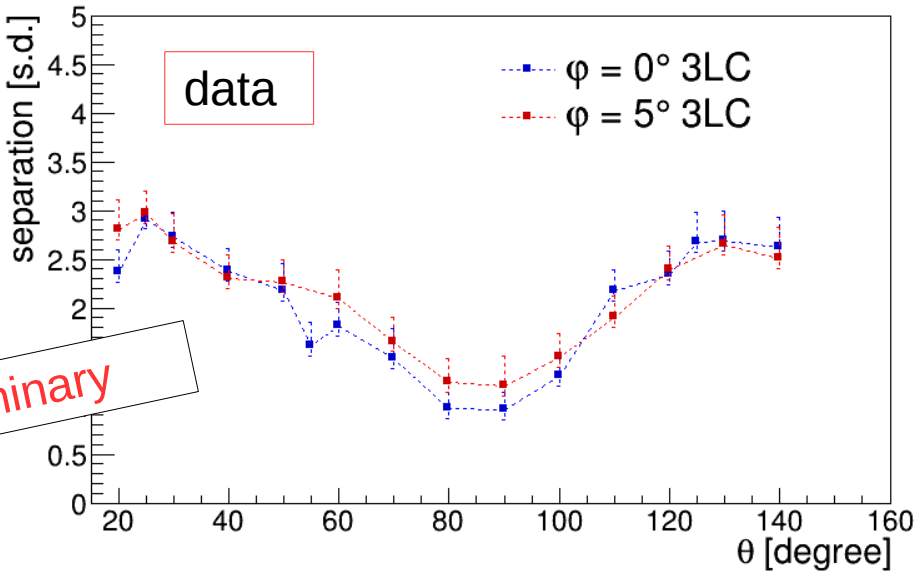


Plate with 3LC Lens @ 7 GeV/c

Photon yield:



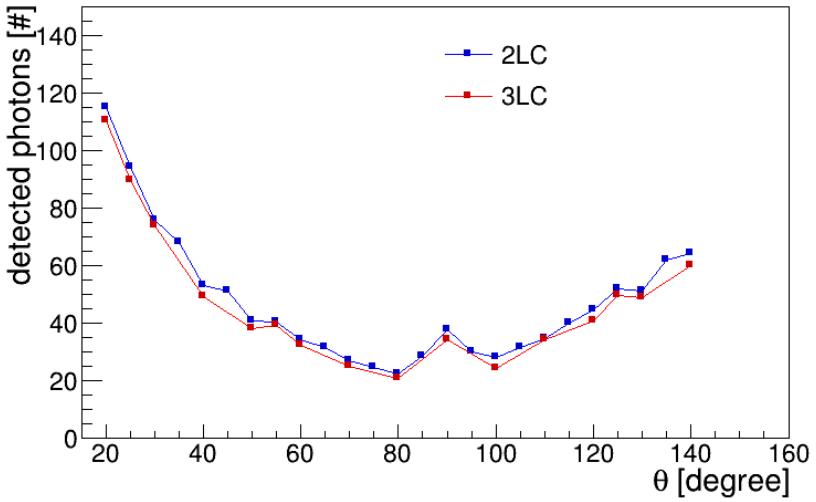
π/p separation power:

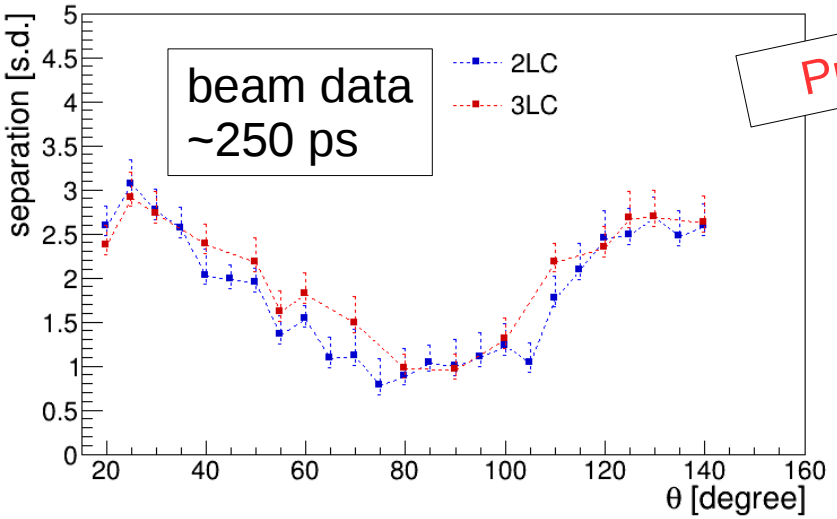


Preliminary

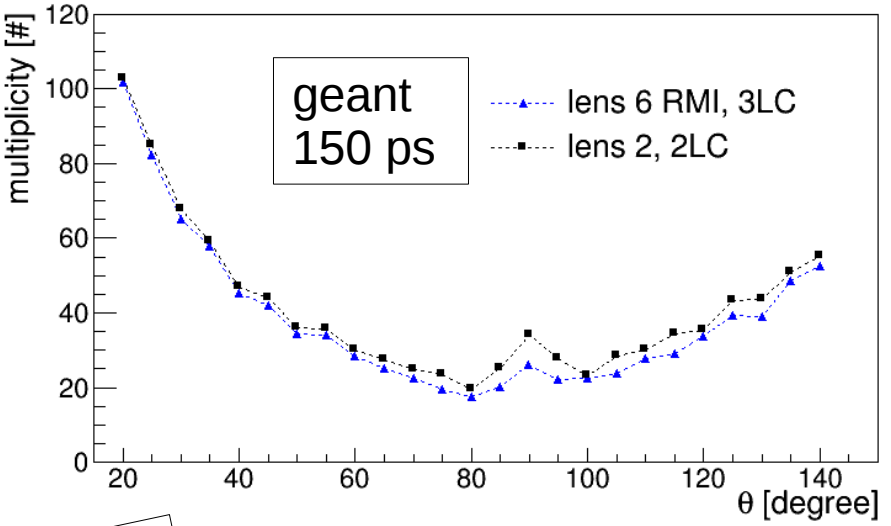
Plate with 2LC vs. 3LC Lens @ 7 GeV/c

Photon yield:

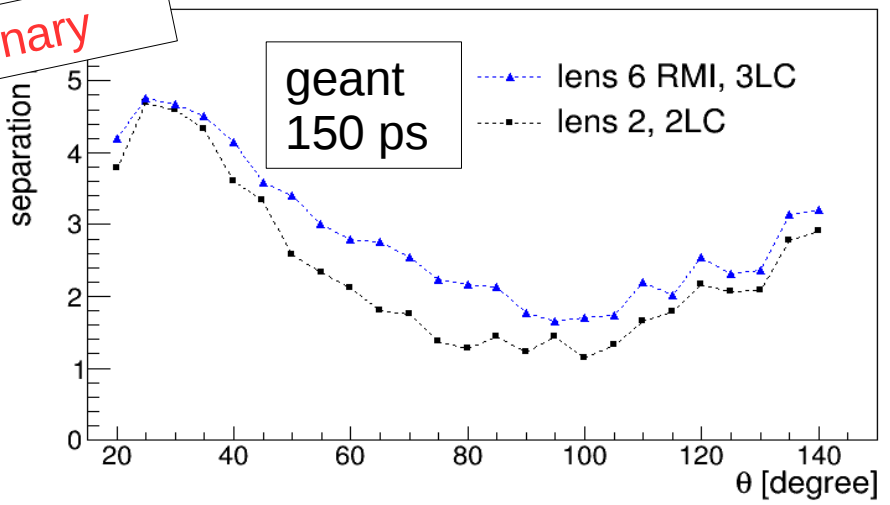




π/p separation power:

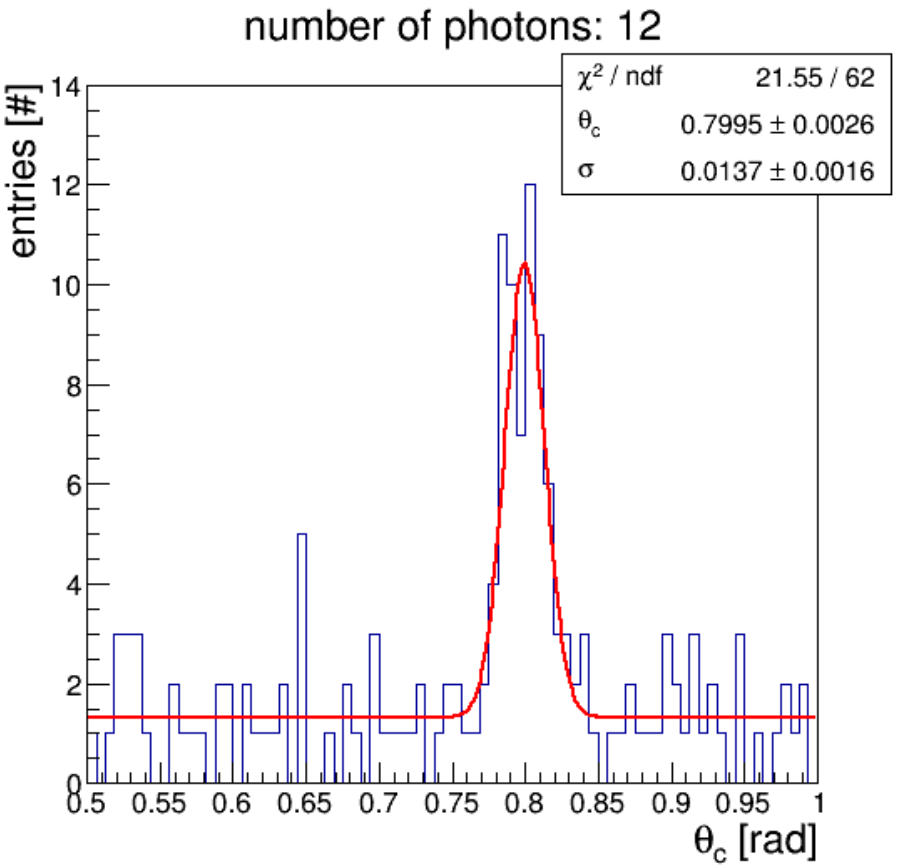


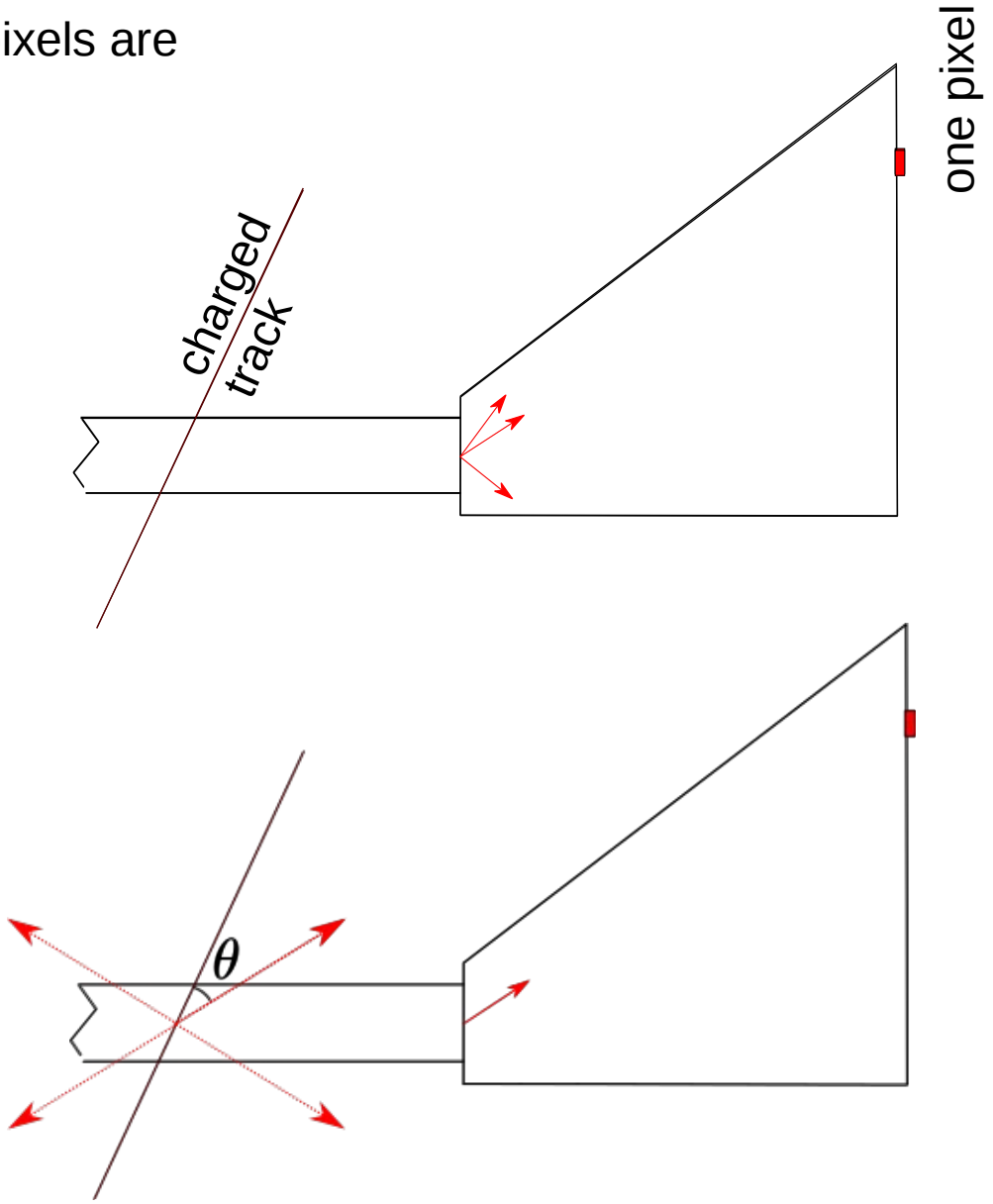
Preliminary



Geometrical Reconstruction

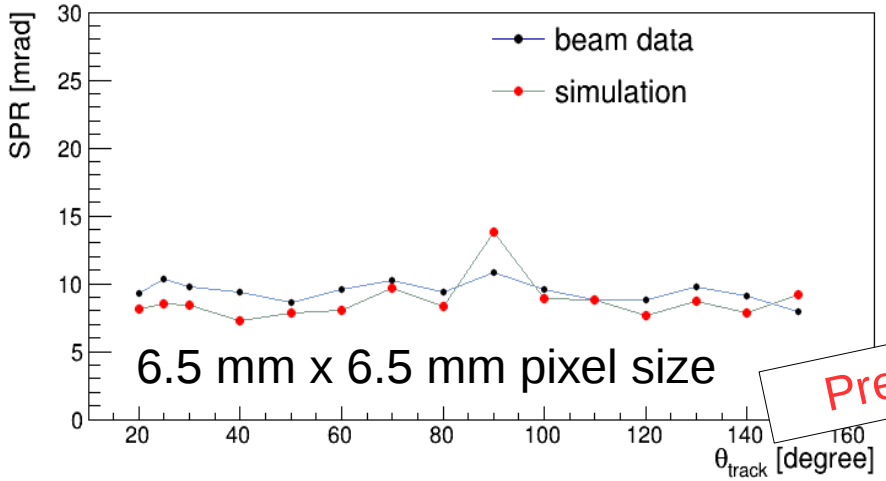
- Reconstruction: direction from LUT for hit pixels are combined with charge track direction





Single Photon Resolution

- bar + 3LS lens
- protons @ 7 GeV/c



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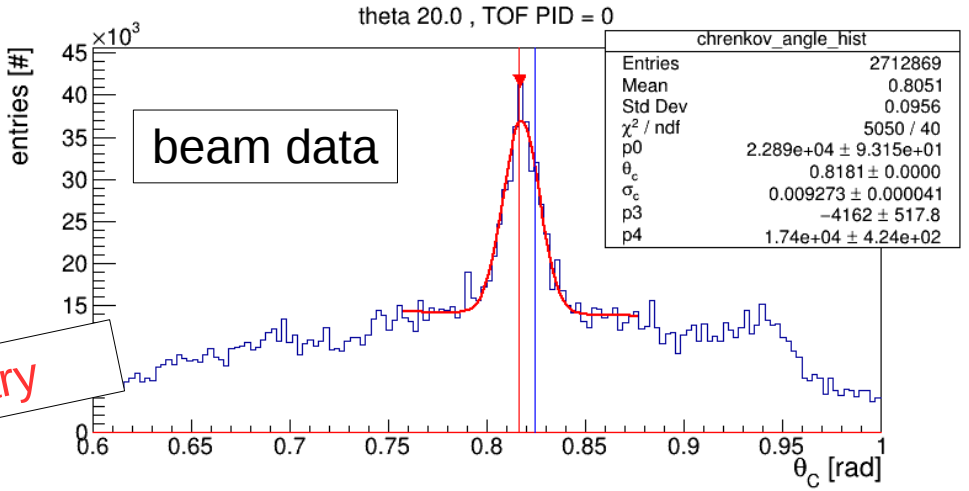
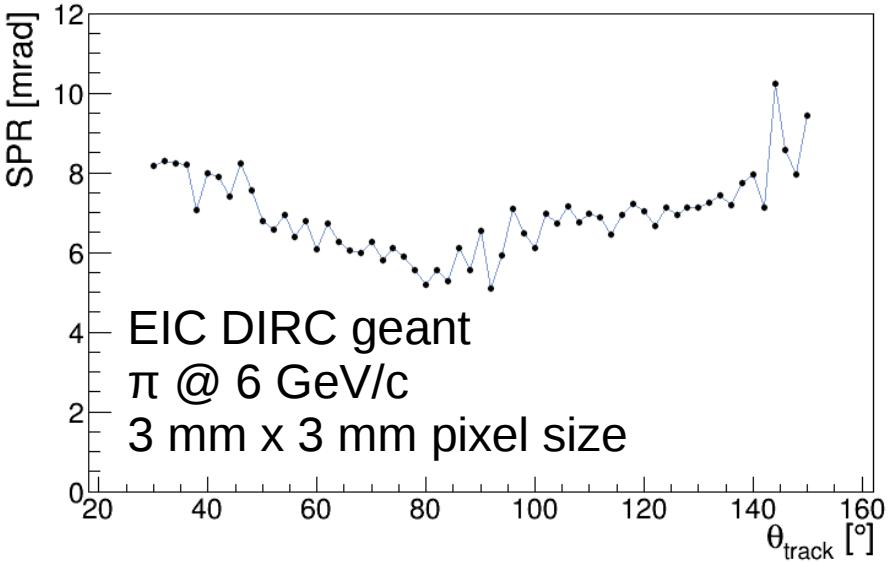
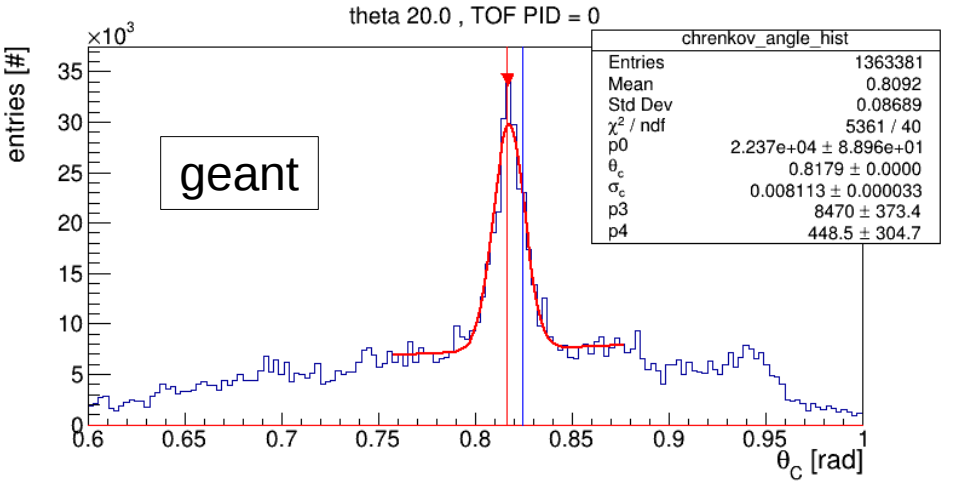






Summary and Outlook

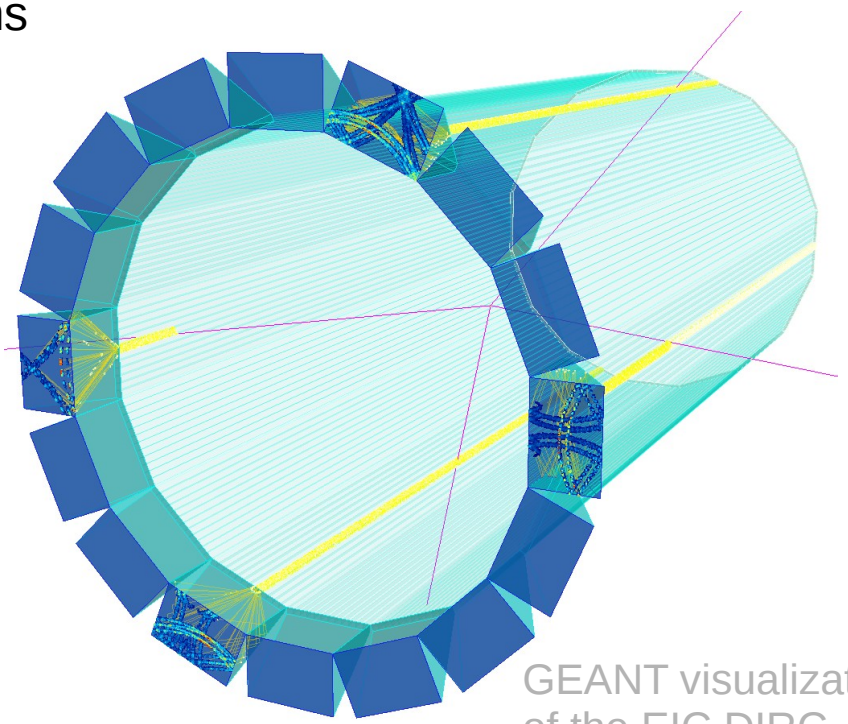
- Test beam was successful (recorded >1B triggers for different prototype config.)
- Time resolution of the system was determined to be ~250 ps
- Preliminary analysis shows improved pi/p separation compared to 2016
- Good agreement between data and simulations
- The 3LC lens performs better than 2LC

Ongoing studies:

- air gap vs. optical grease vs. optical cookies
- x, z scans through the radiator
- momentum scan [2,10] GeV/c
- analytical PDF

Outlook:

- test beam 2018 (already applied)



GEANT visualization of the EIC DIRC

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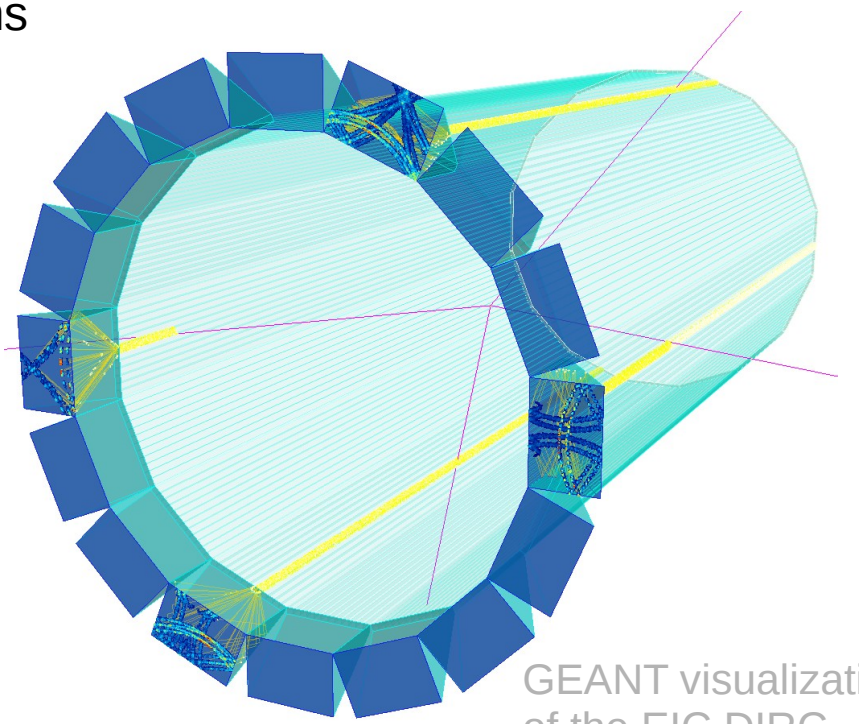

GEANT visualization of the EIC DIRC

Thank you for the attention