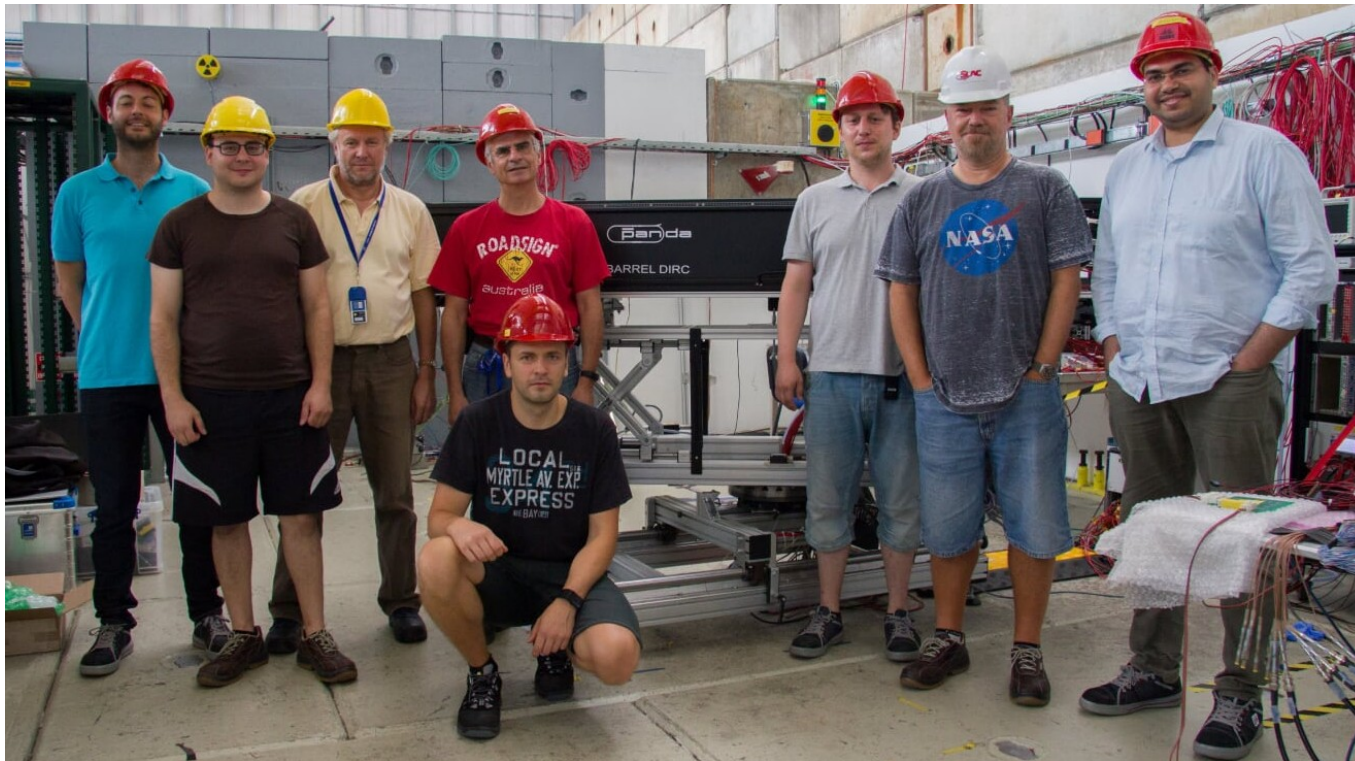


Status of the Barrel DIRC Prototype Test @ CERN Aug 23 – Sep 13, 2017



Panda

FAIR

GSII

THE
CATHOLIC UNIVERSITY
of AMERICA

JG|U

JOHANNES GUTENBERG
UNIVERSITÄT MAINZ

FAU
FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG

PANDA meeting
03.18

Roman Dzhygadlo,
PANDA Cherenkov Group

DIRC Prototype Test 2017

Goal:

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

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- new 3-layer cylindrical lens (eRD14 funding)
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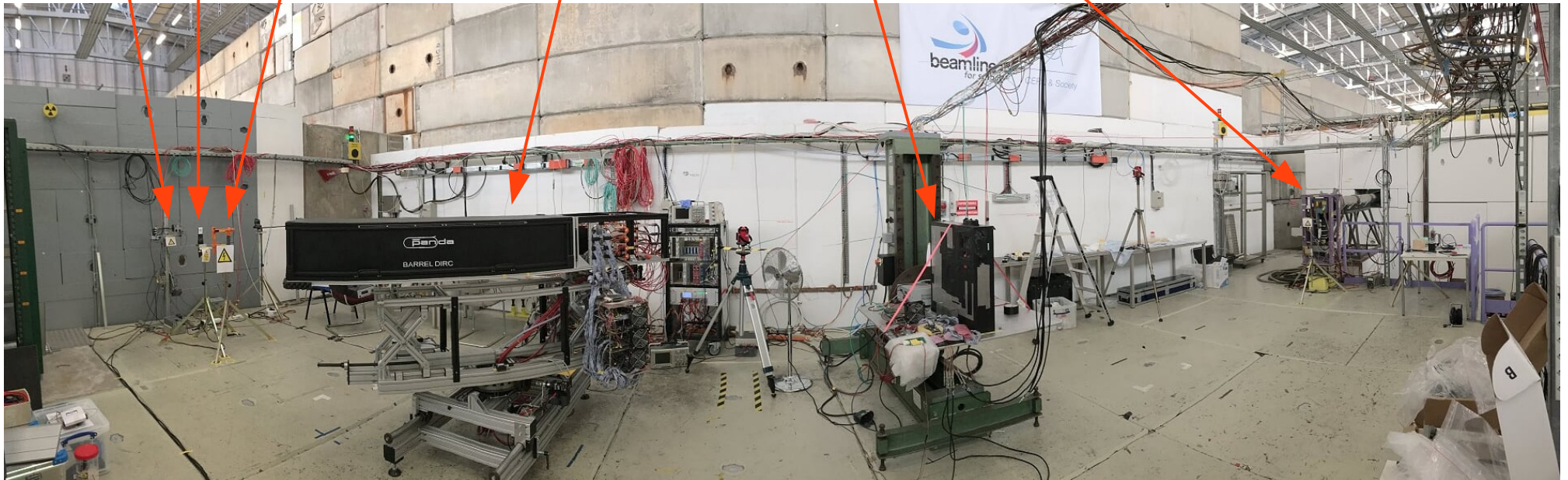
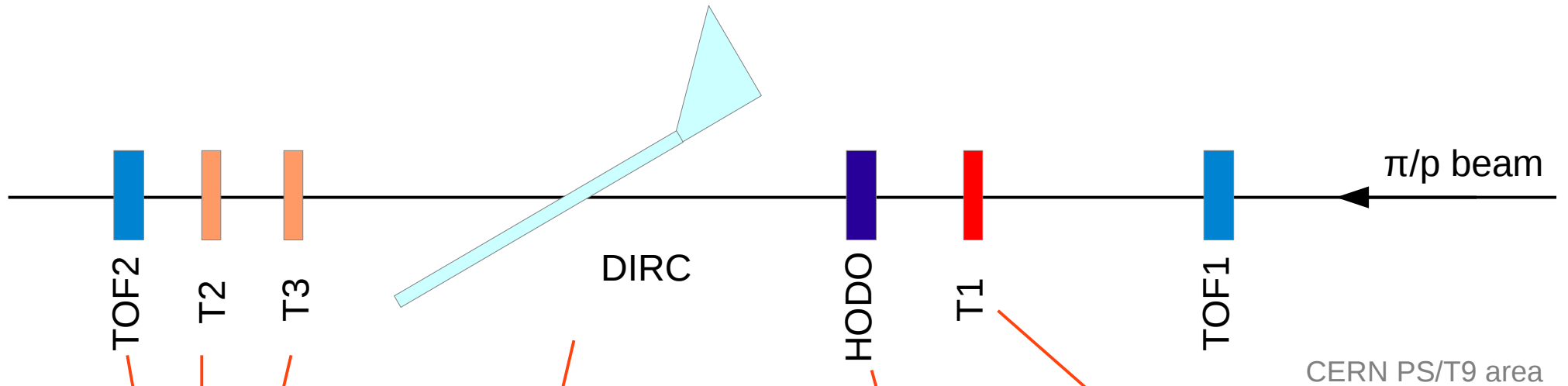
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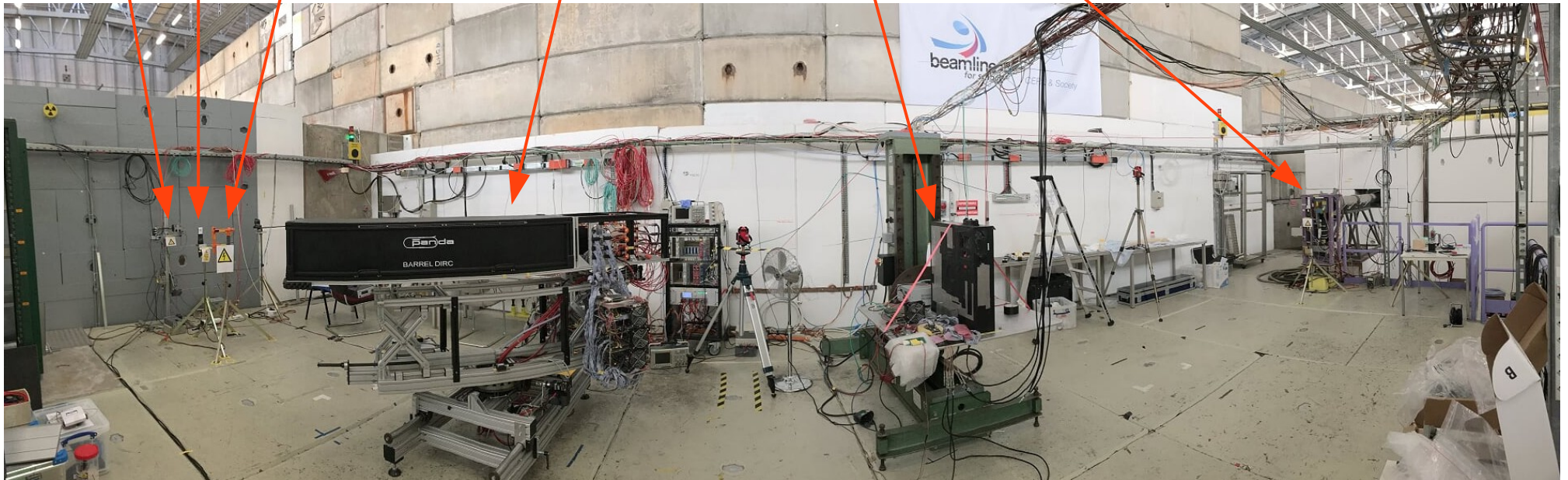
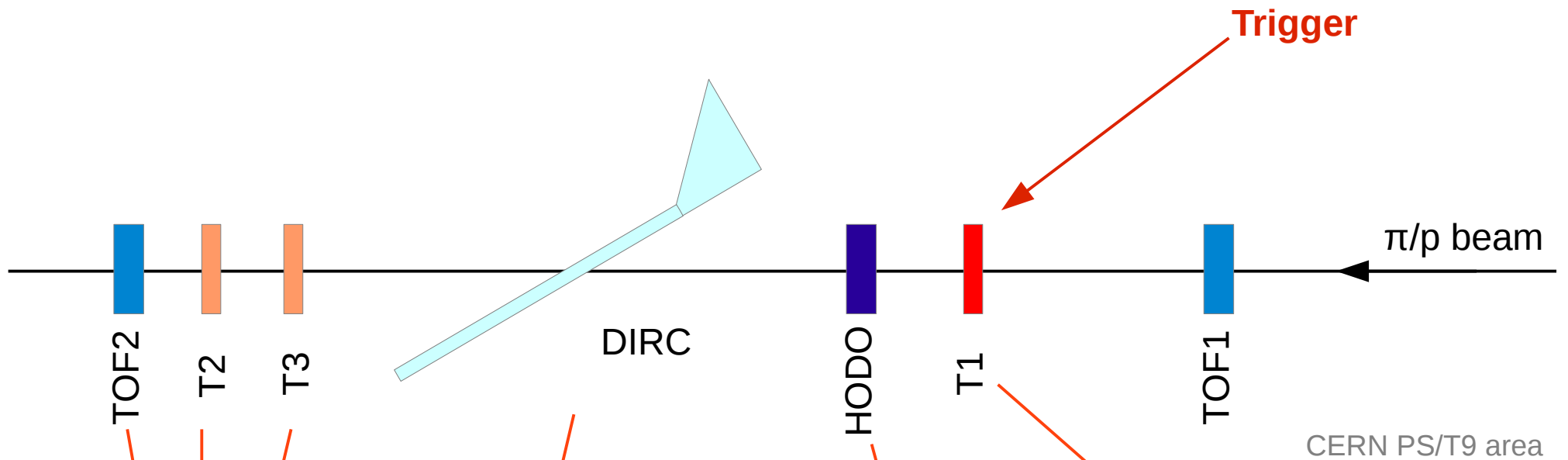
Test conditions:

- 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

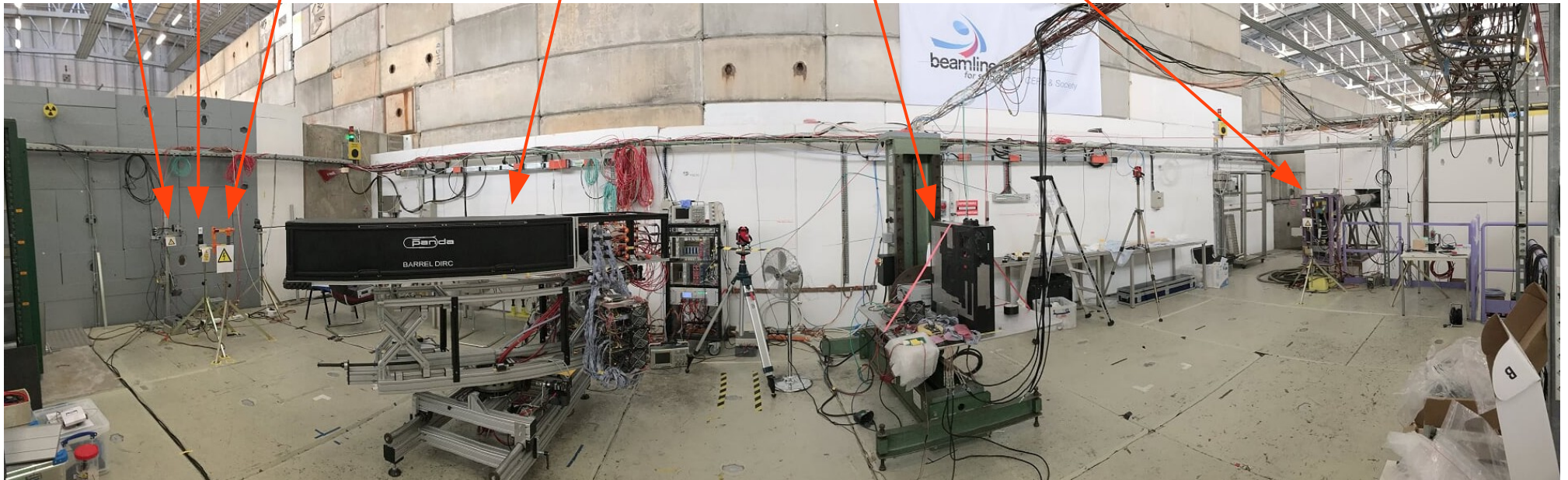
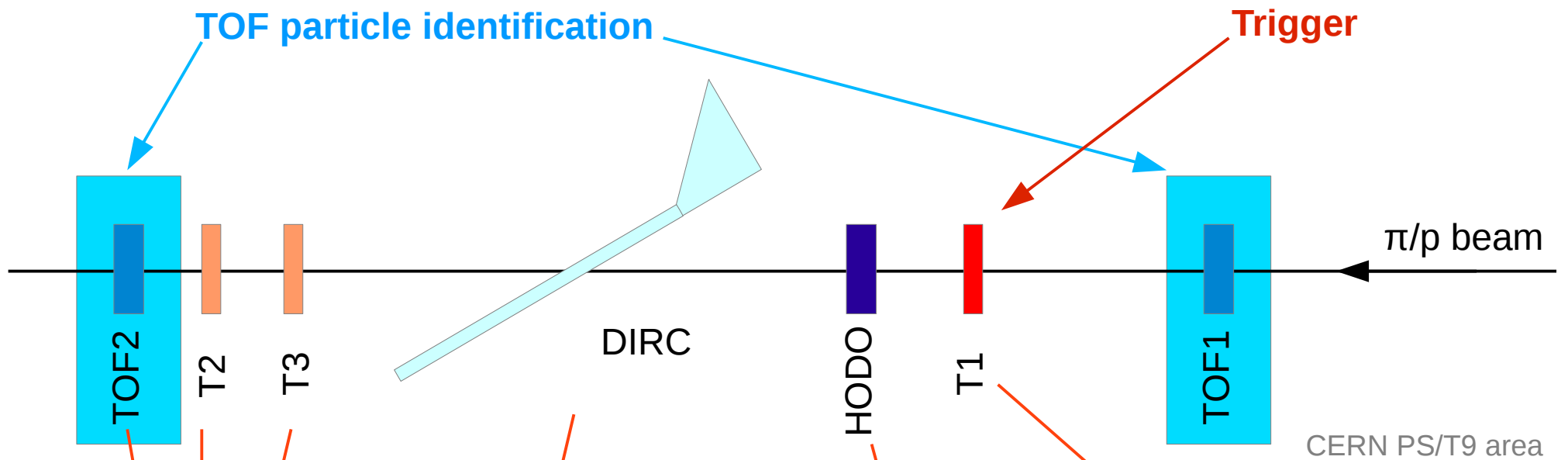
CERN 2017 Prototype Test



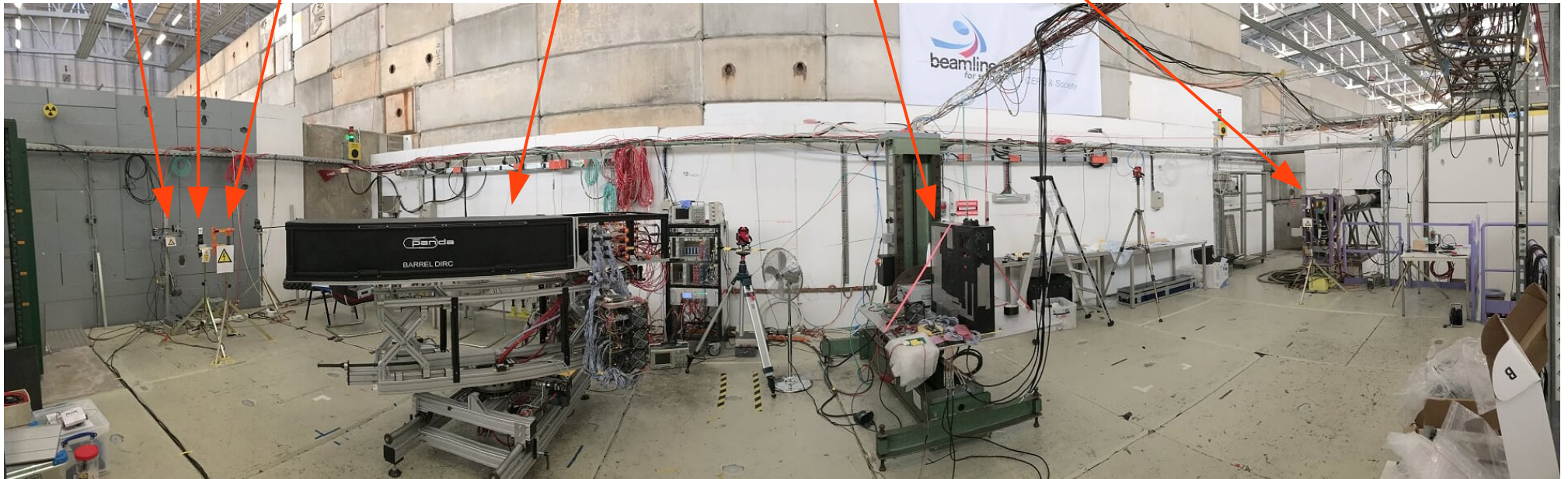
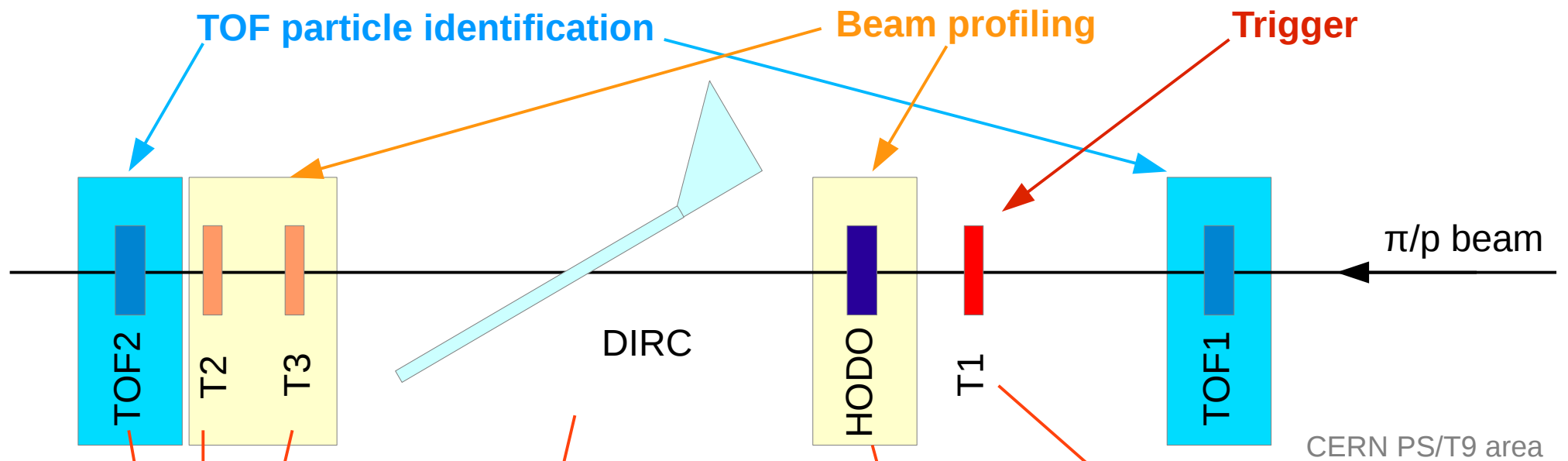
CERN 2017 Prototype Test



CERN 2017 Prototype Test

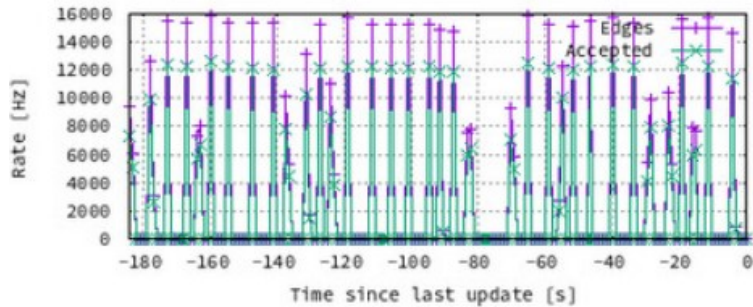


CERN 2017 Prototype Test

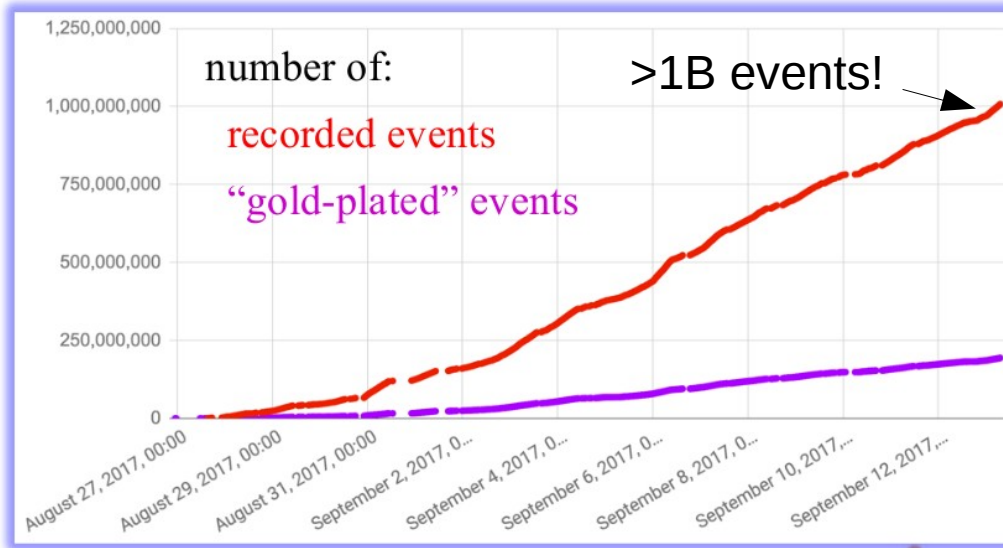


Data Set

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



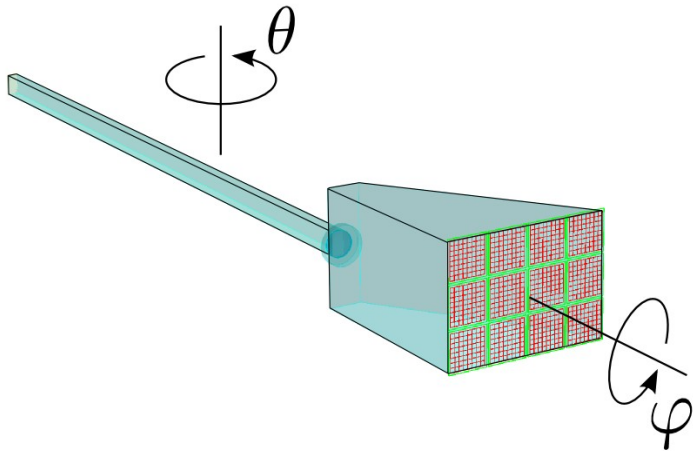
Sometimes 4-6 spills – that is a lot



Different configurations:

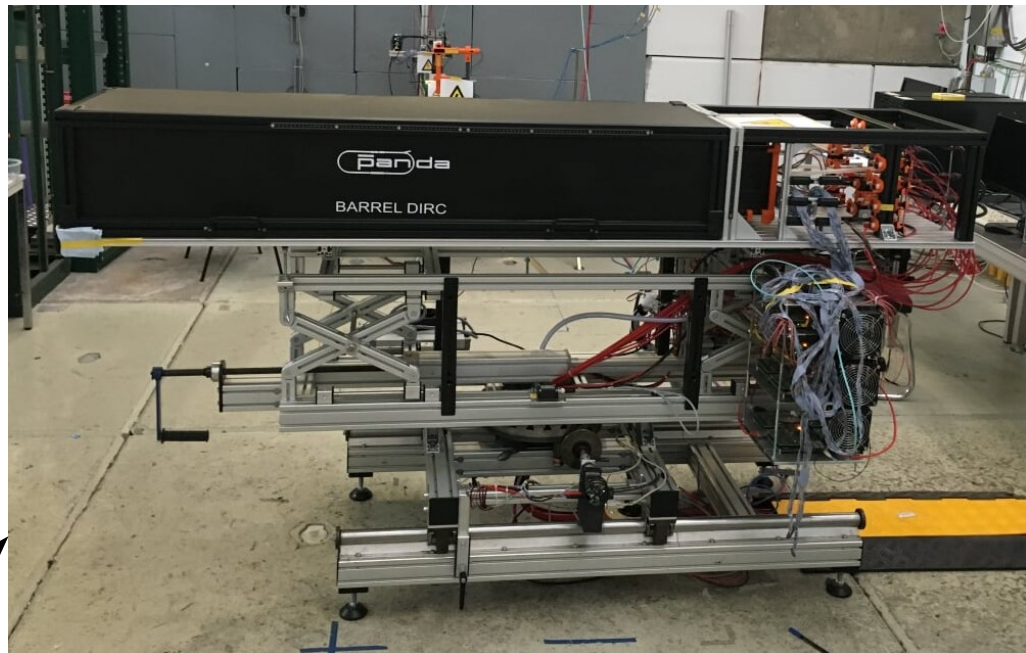
bar	3Lspher	cookie		no useful data
	3Lspher	air gap	Aug-29	polar scan @ 5 GeV/c
			Aug-30	polar scan @ 7 GeV/c
			Aug-31	polar scan @ 7 GeV/c
	3Lspher	grease	Sep-1	polar scan @ 7 GeV/c
			Sep-2	polar scan @ 7 GeV/c
			Sep-3	polar scan @ 10 deg
			Sep-4	azimuth variation
			Sep-4	momentum scan
			Sep-5	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

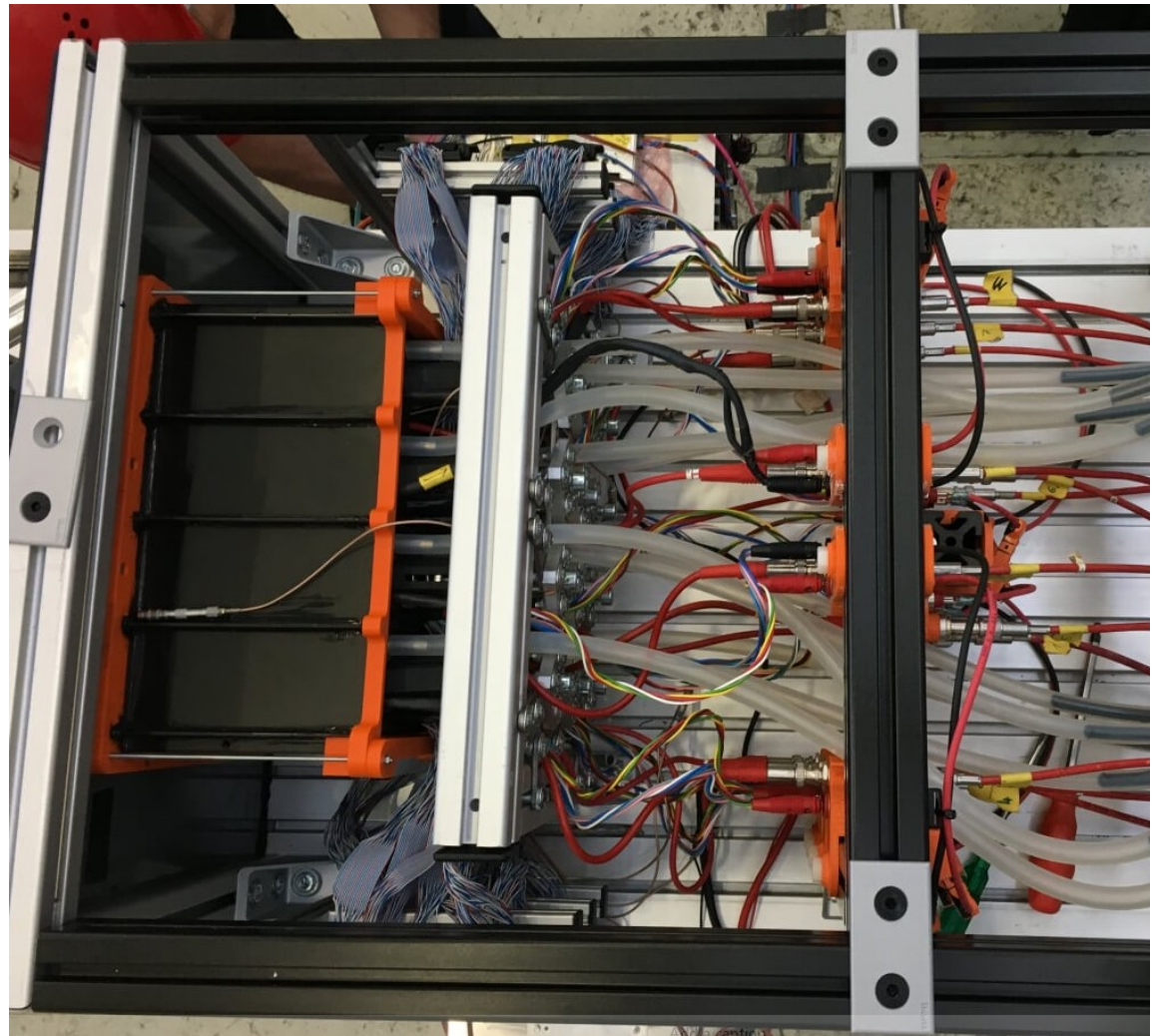


Polar angle 90°
Azimuthal angle 0°

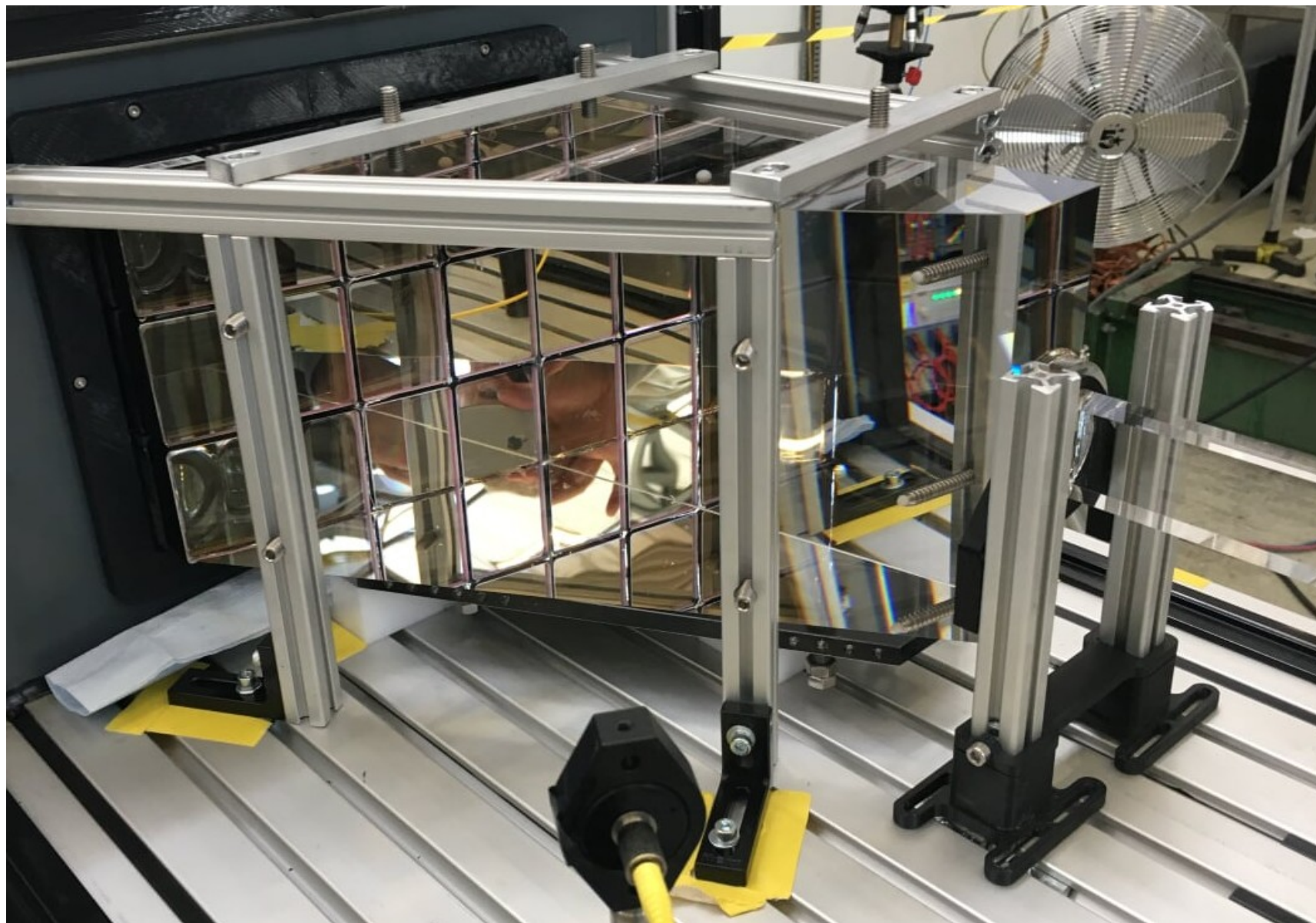
Polar angle 25°
Azimuthal angle 10°



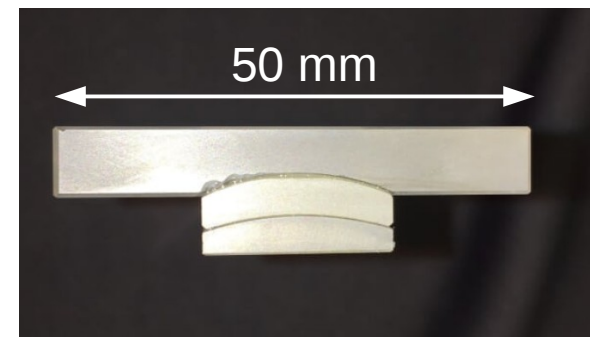
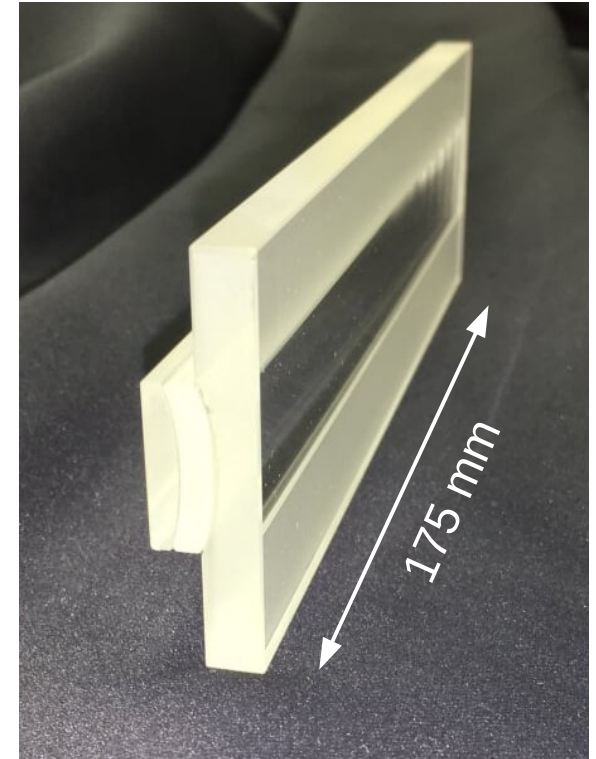
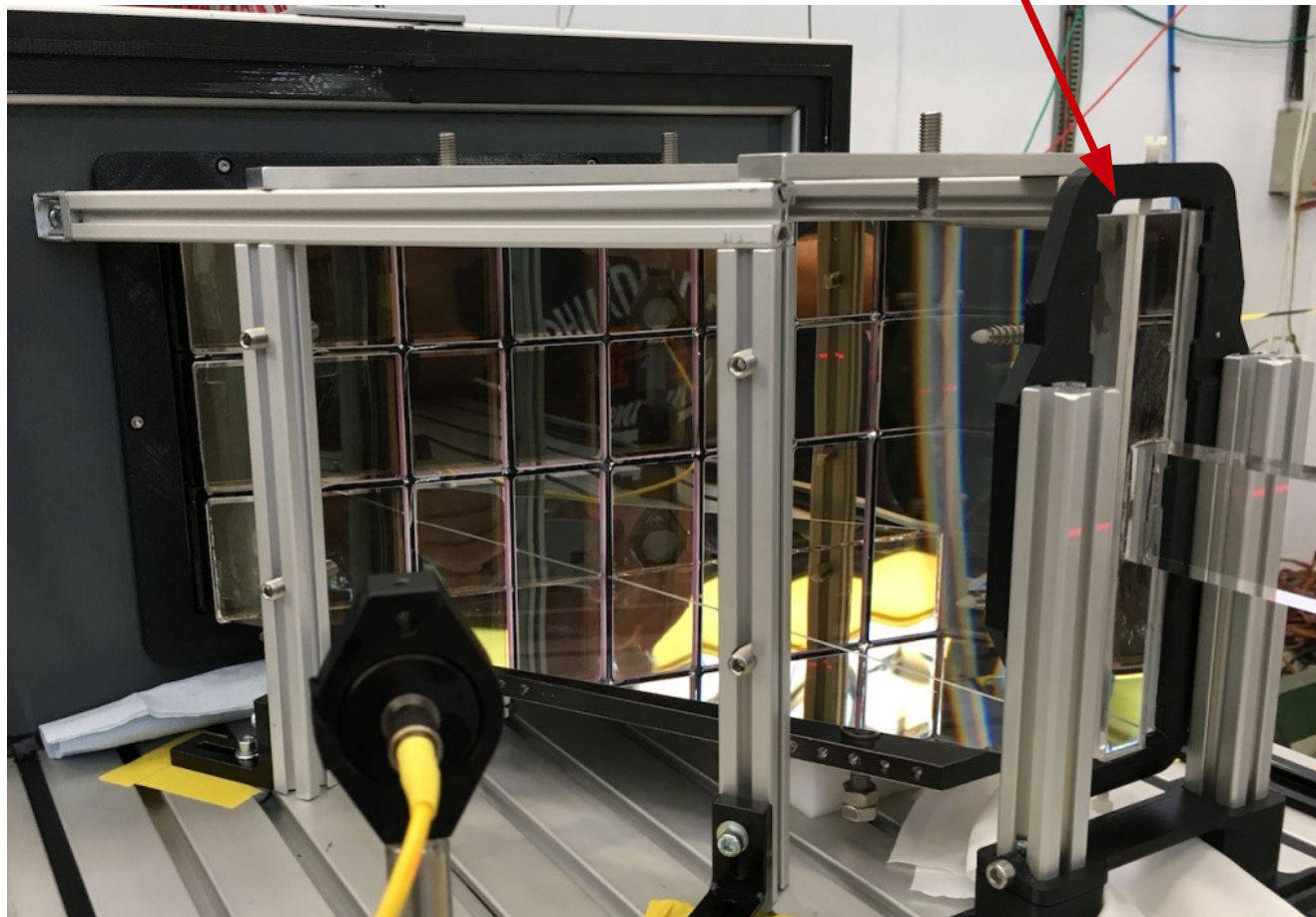
New Readout Modules



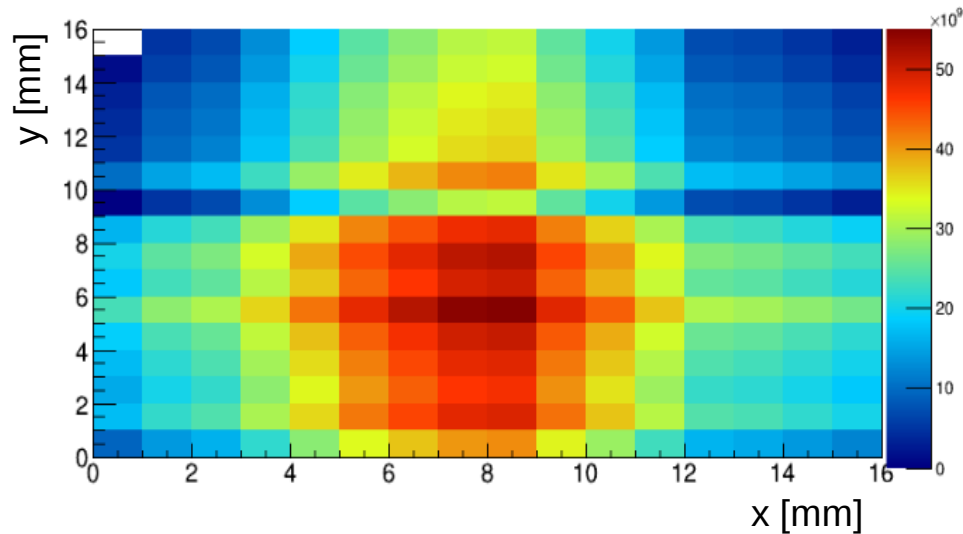
33 Degree Prism



New 3 Layer Cylindrical Lens



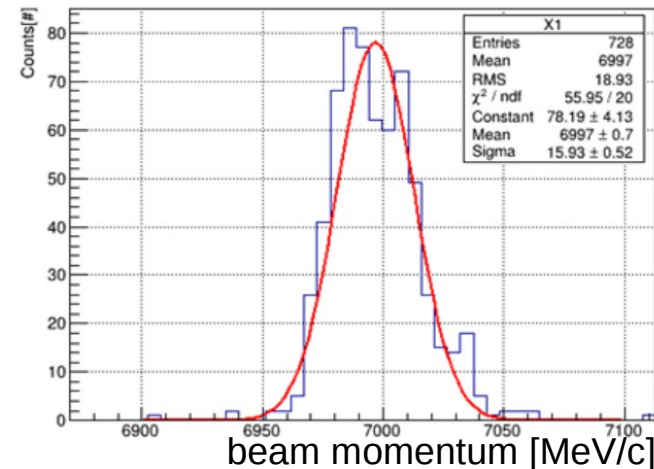
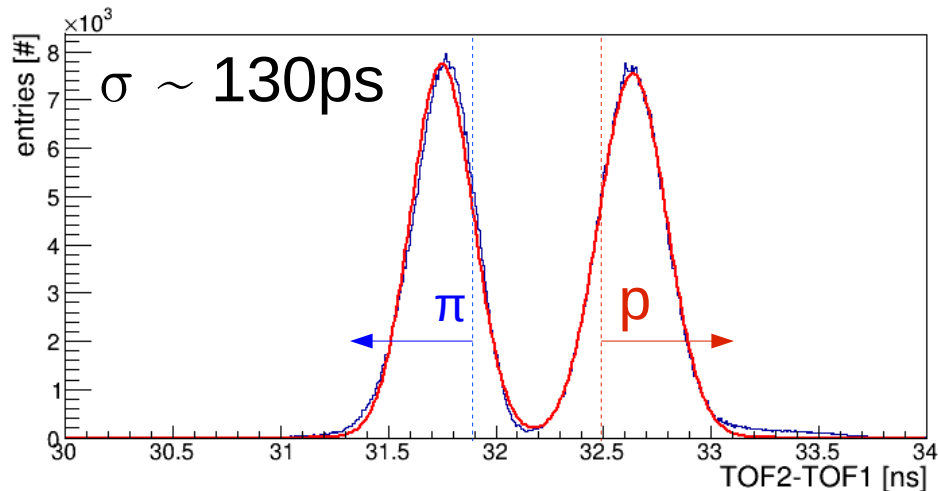
Beam Profile, Momentum and TOF PID



Beam profile from hodoscope selection: 4 mm x 4 mm

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

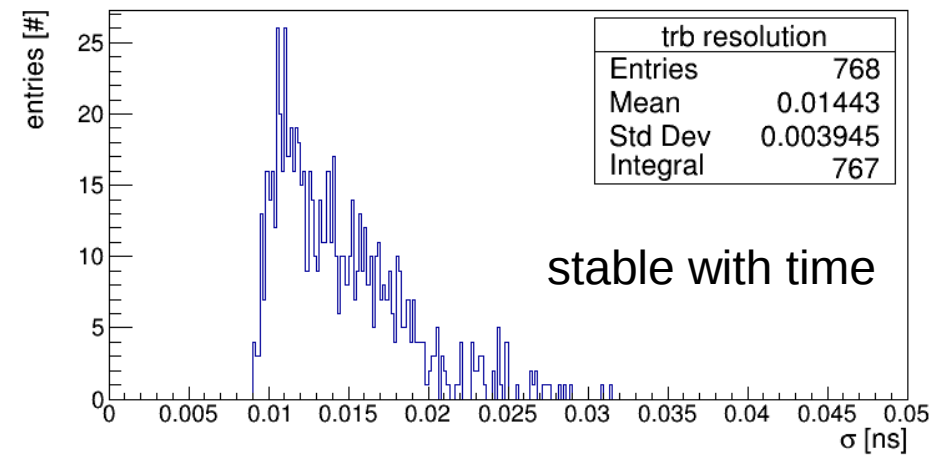
Beam momenta from each run:
■ stable with time
■ $p = 6997 \pm 16$ MeV/c



Time Resolution

TRB internal pulses:

- TRB time resolution ~14ps



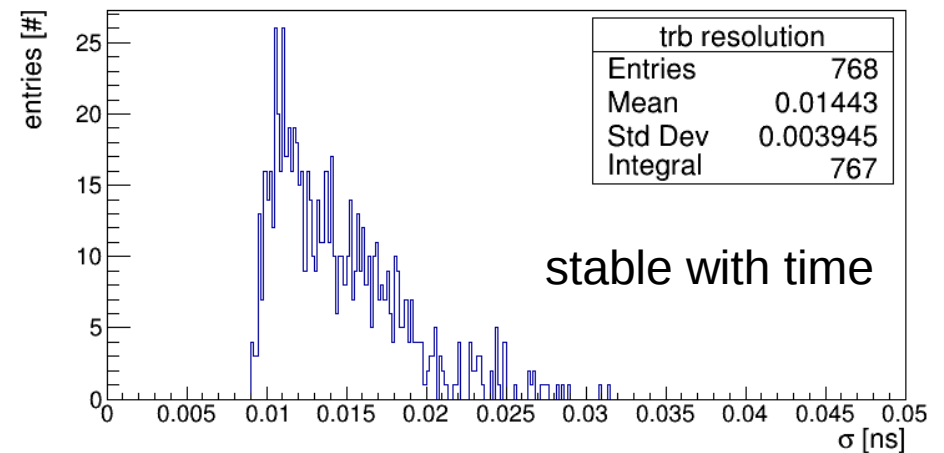
Time Resolution

TRB internal pulses:

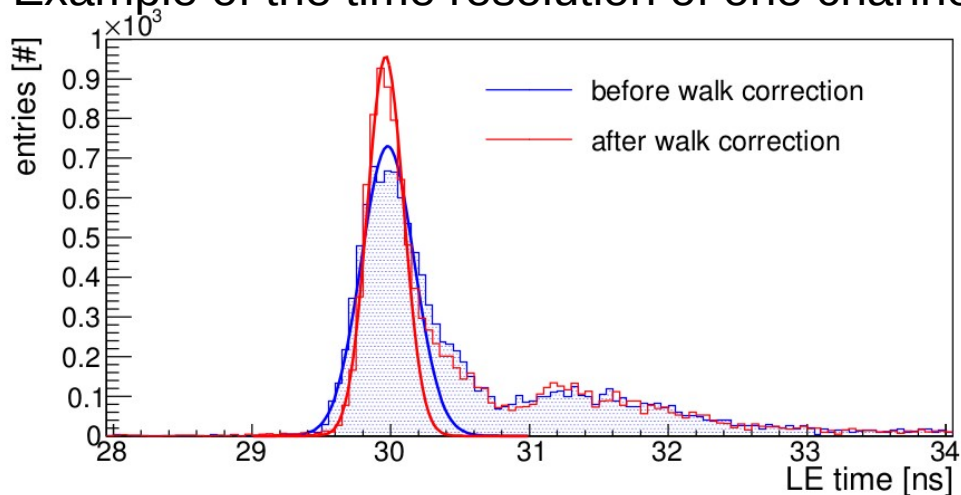
- TRB time resolution $\sim 14\text{ps}$

Pilas laser:

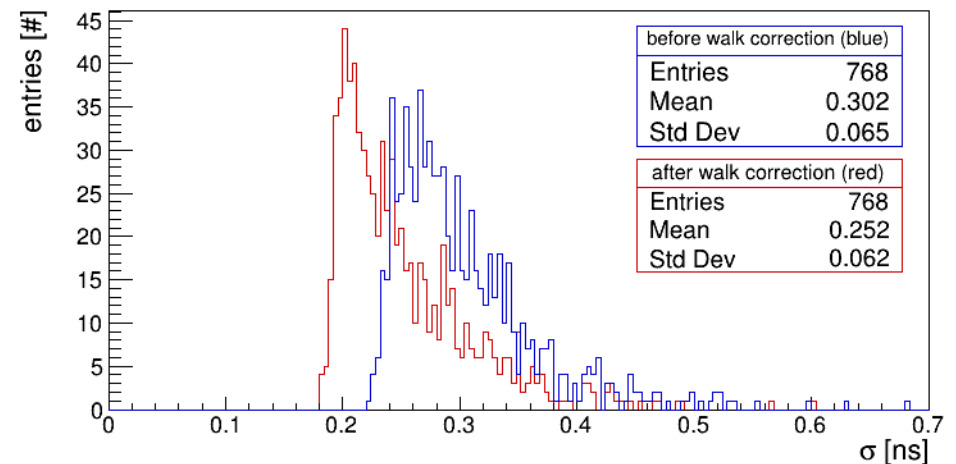
- Total time resolution $\sim 250\text{ps}$



Example of the time resolution of one channel:

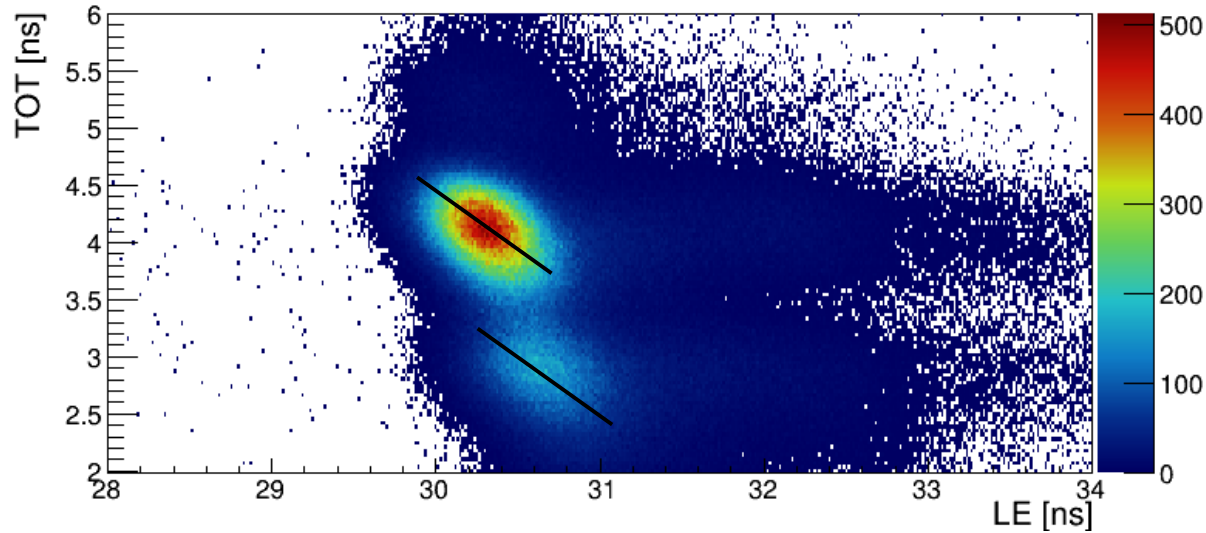


Time resolution of all 768 channels:

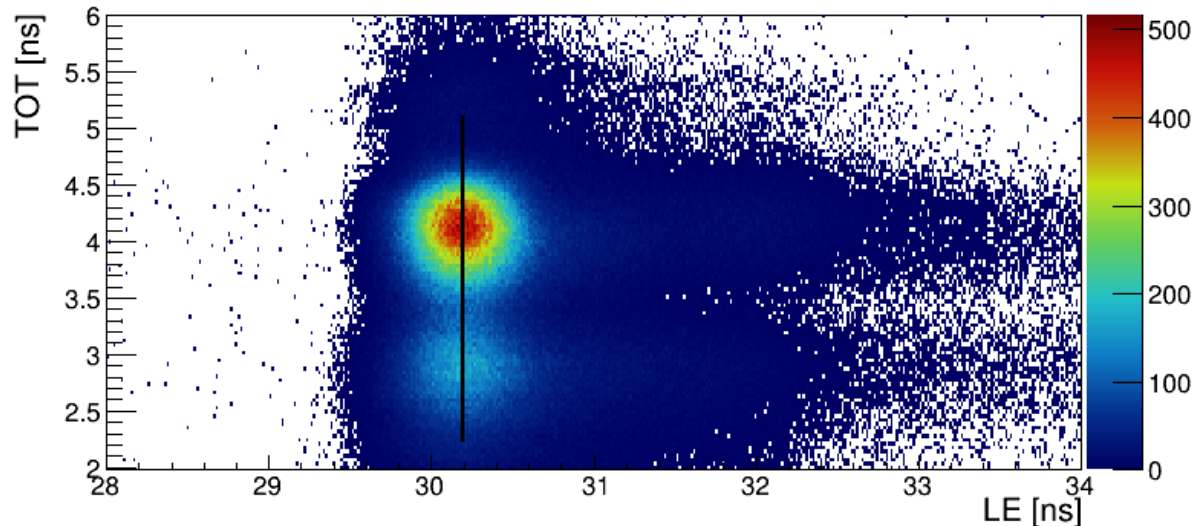


Time Walk Correction of the DIRC ch.

ch 310 before correction:



ch 310 after correction:

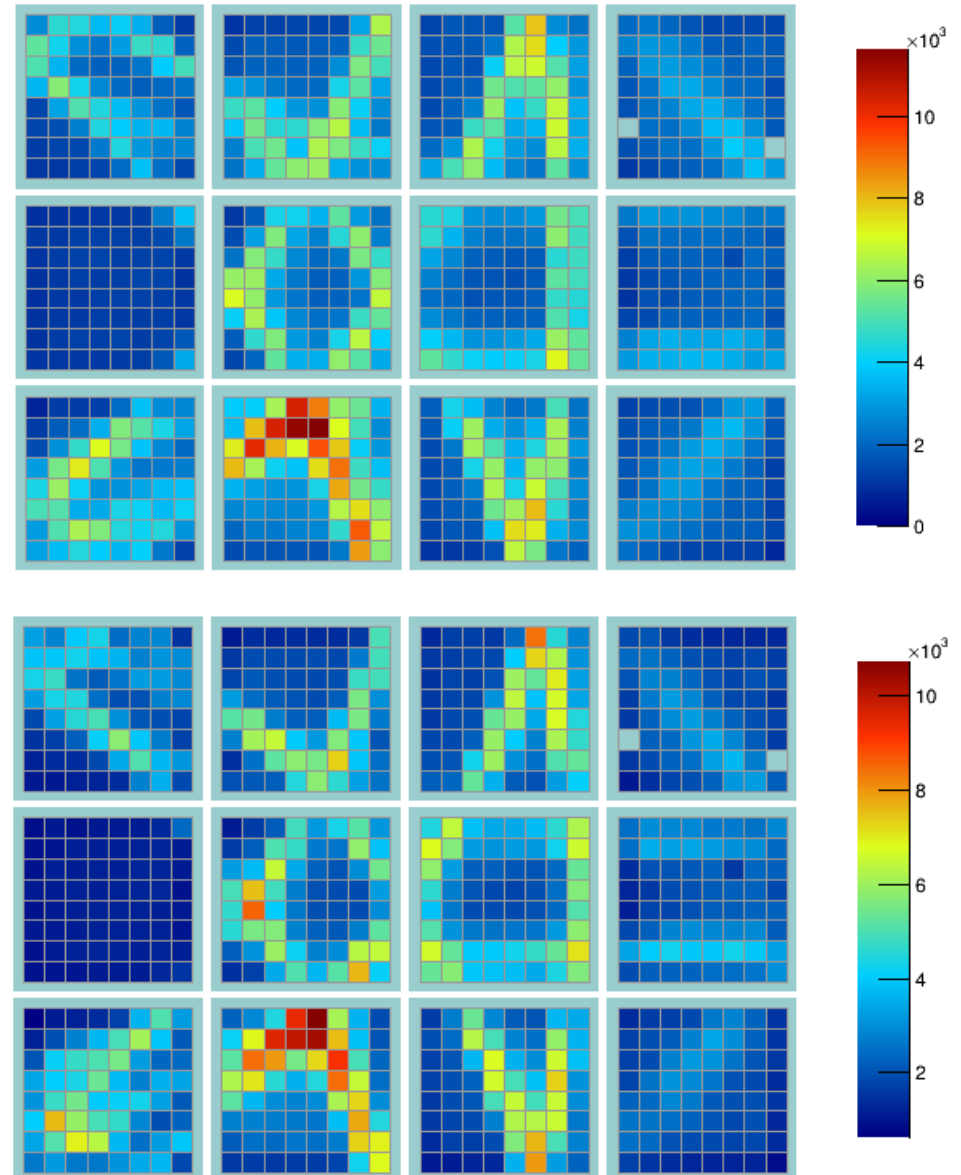
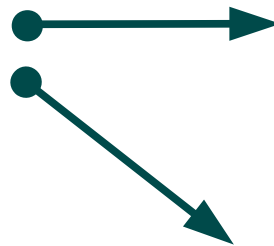


15-20 %
improvement in
time resolution

Examples of the Hit Pattern

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

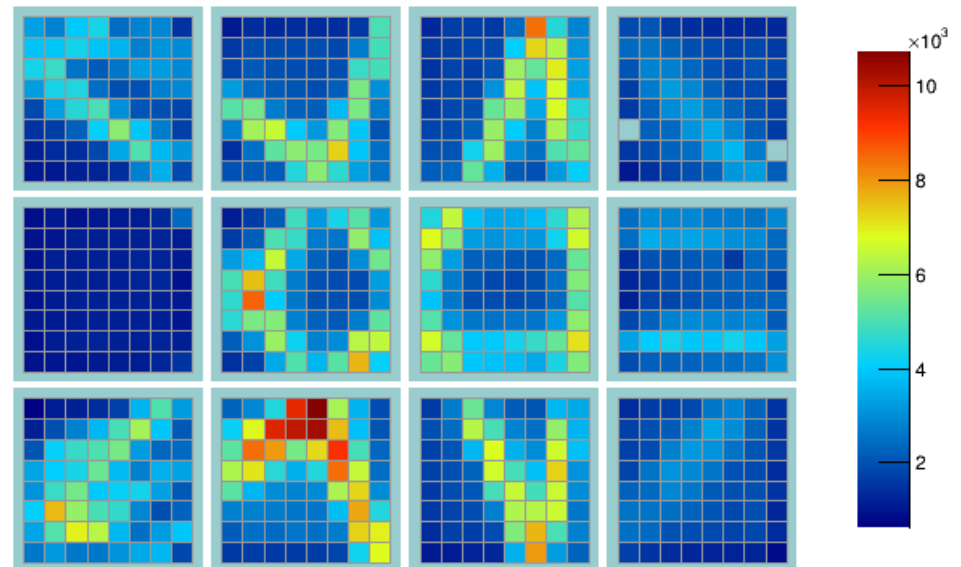
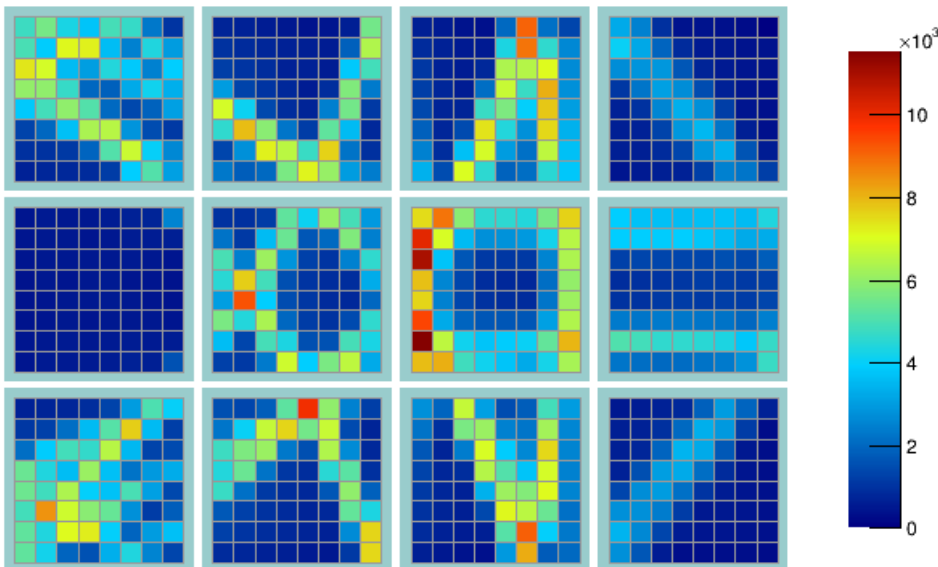
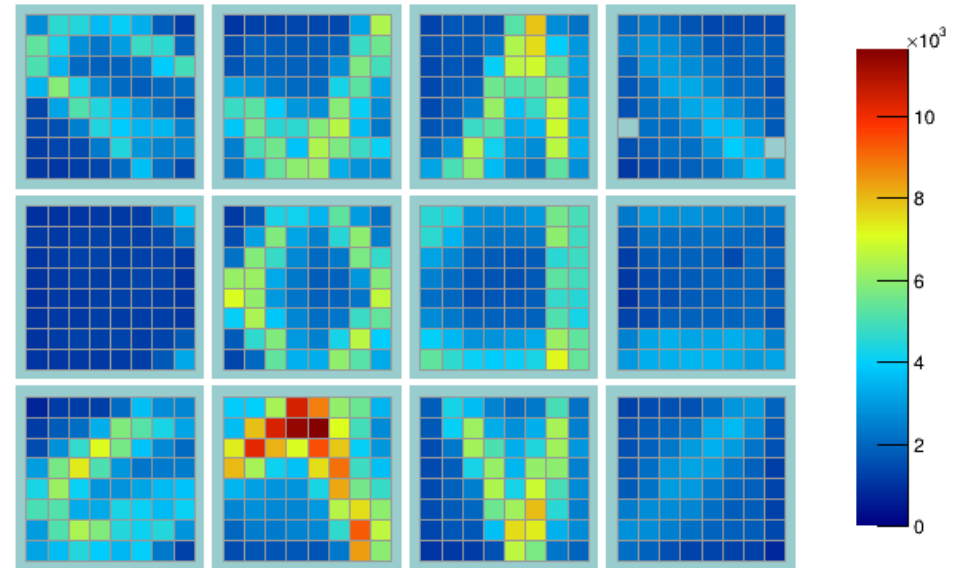
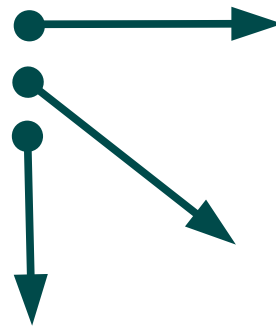
- beam data with proton tag
- beam data with pion tag



Examples of the Hit Pattern

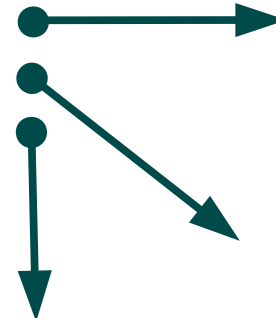
- 20 degree polar angle
- pions and protons @ 7 GeV/c
- bar + 3 layer spherical lens

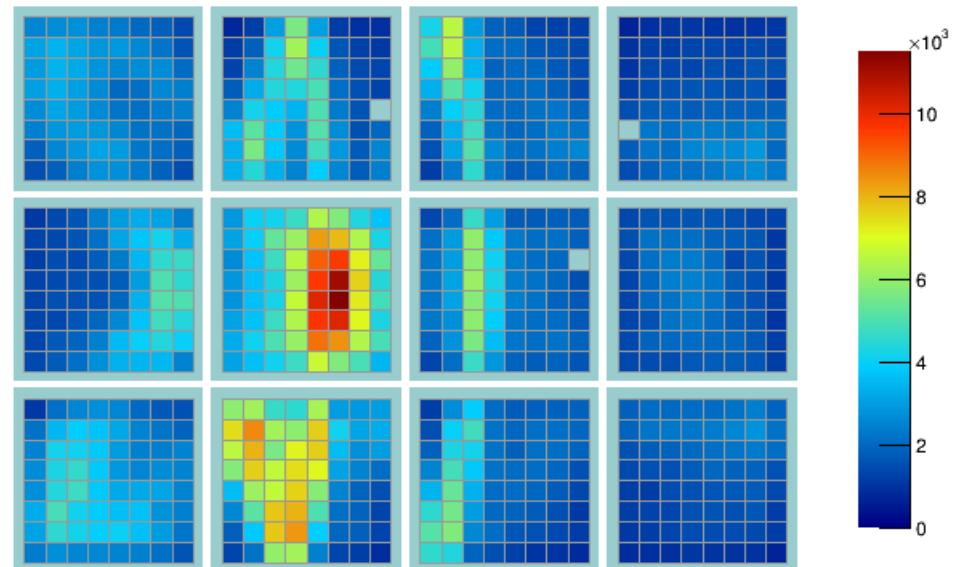
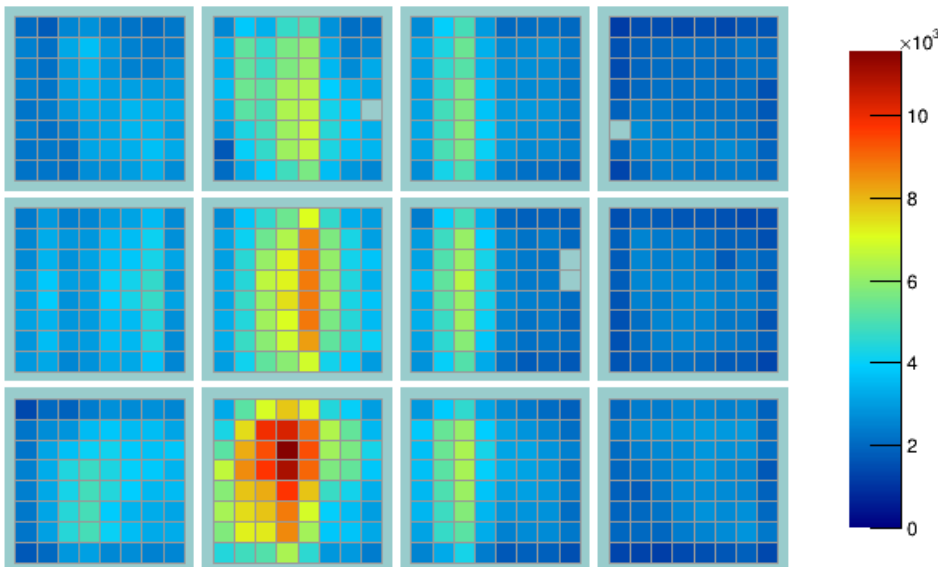
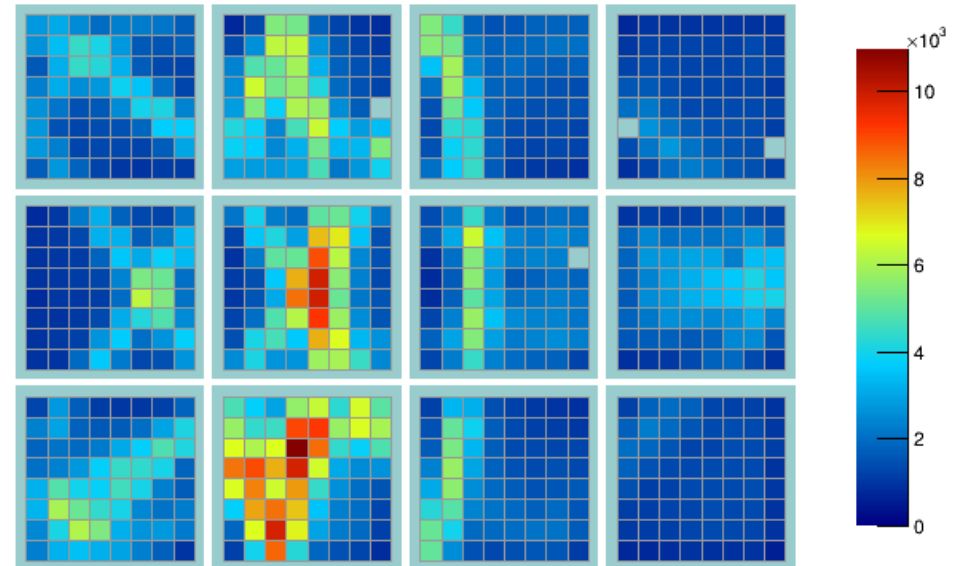
- beam data with **proton** tag
- beam data with **pion** tag
- **geant** simulation for pions



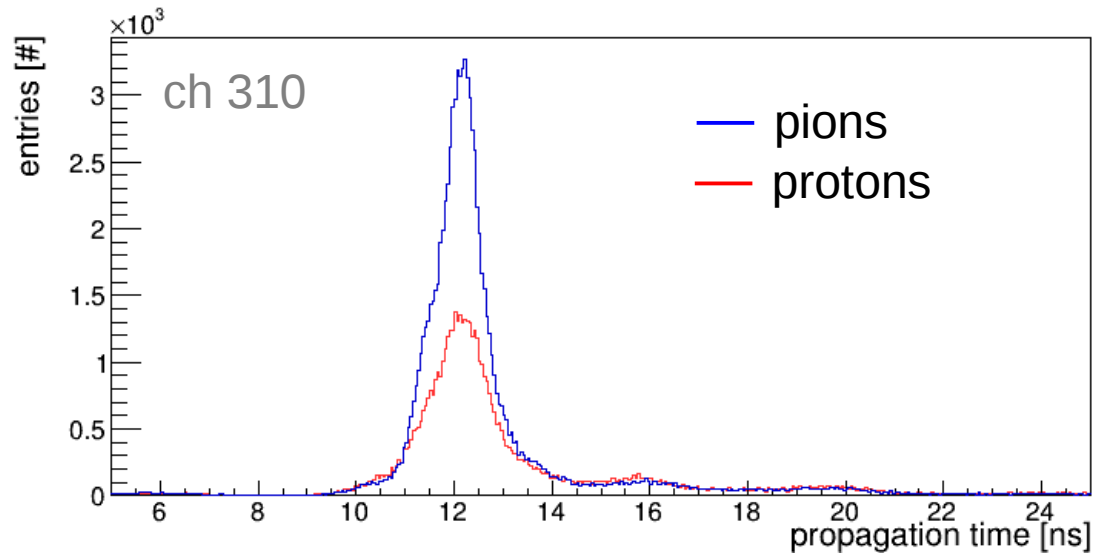
Examples of the Hit Pattern

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

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

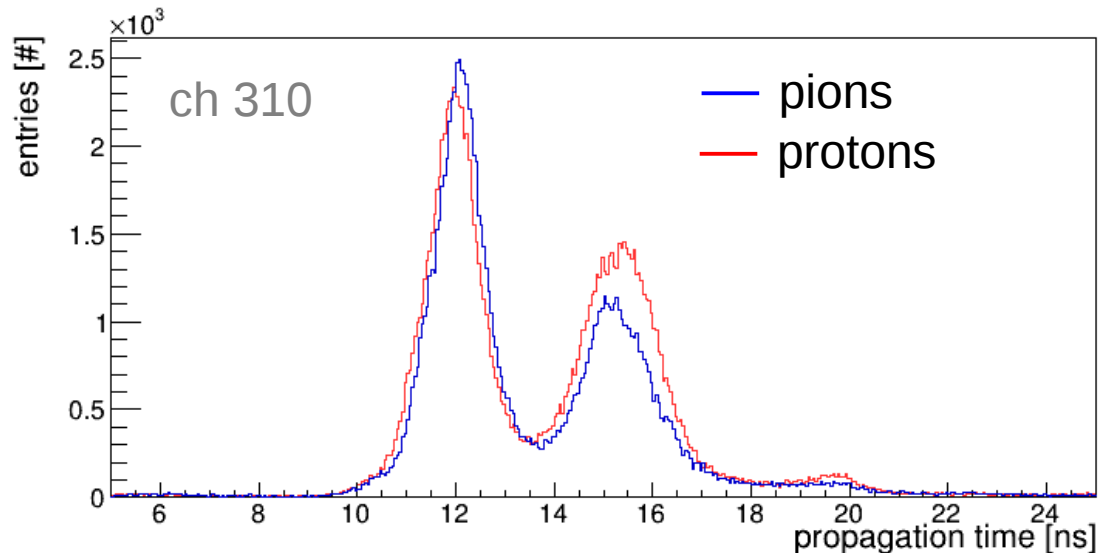


Propagation Time of the Cherenkov Ph.



beam data @ 7 GeV/c
@ 20° polar angle

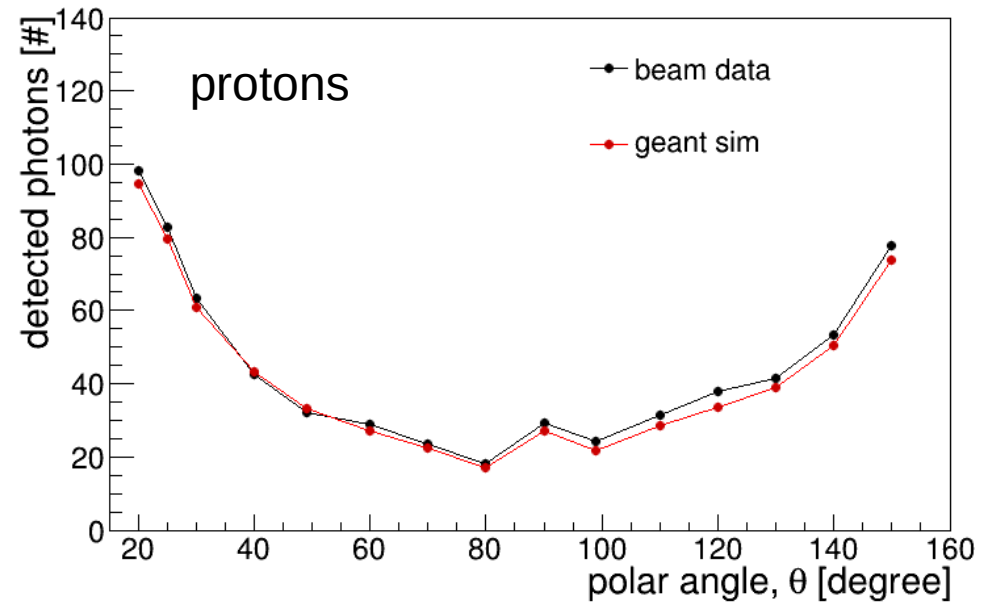
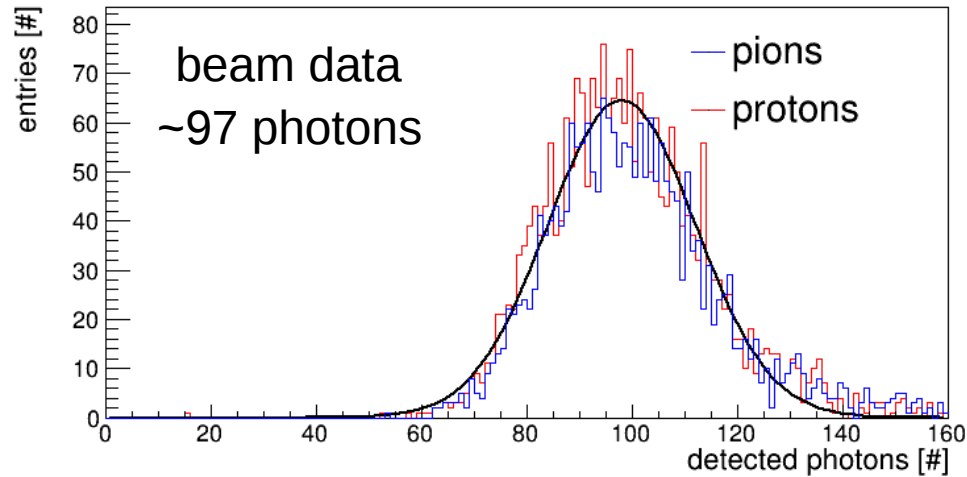
3 layer spherical lens



3 layer cylindrical lens

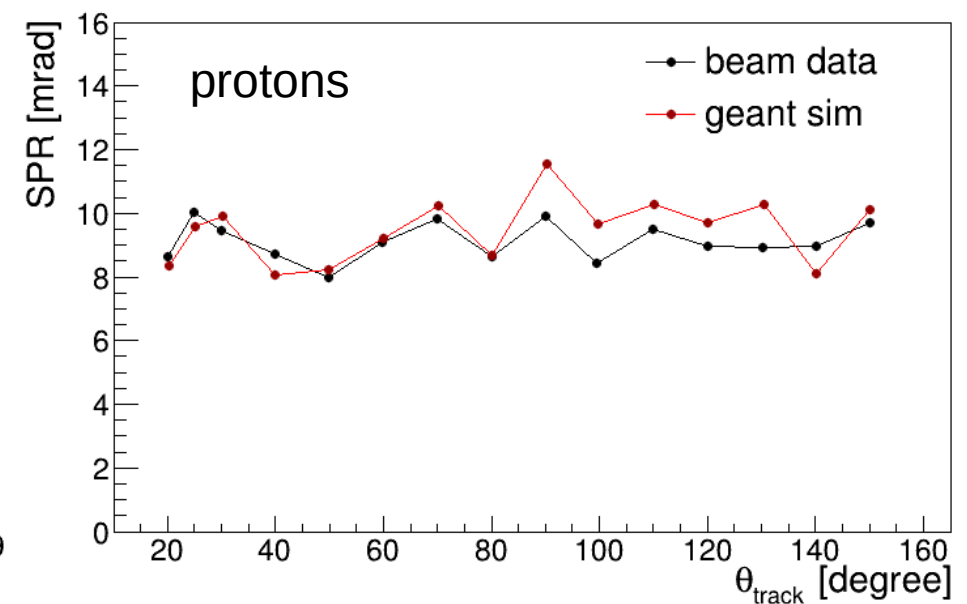
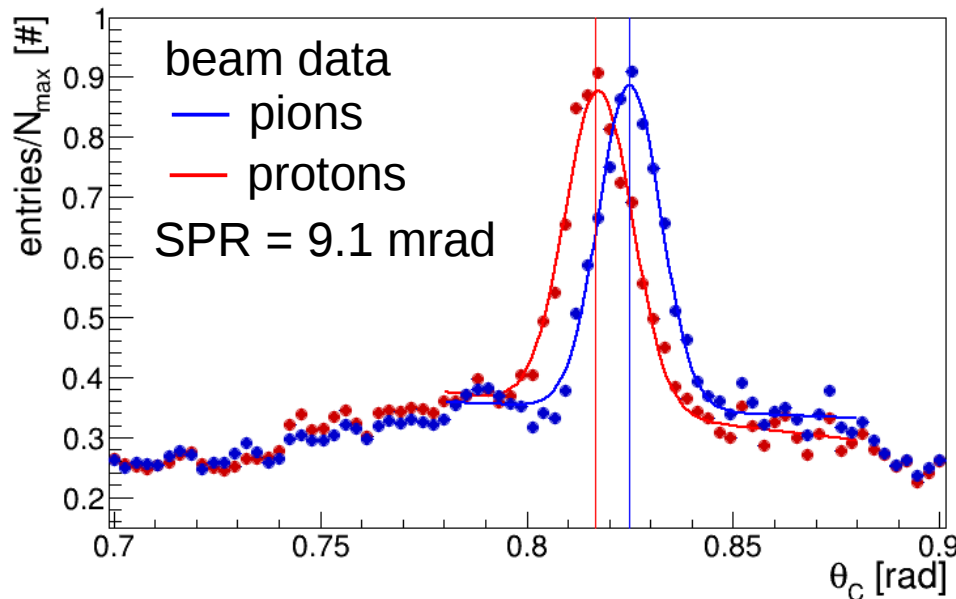
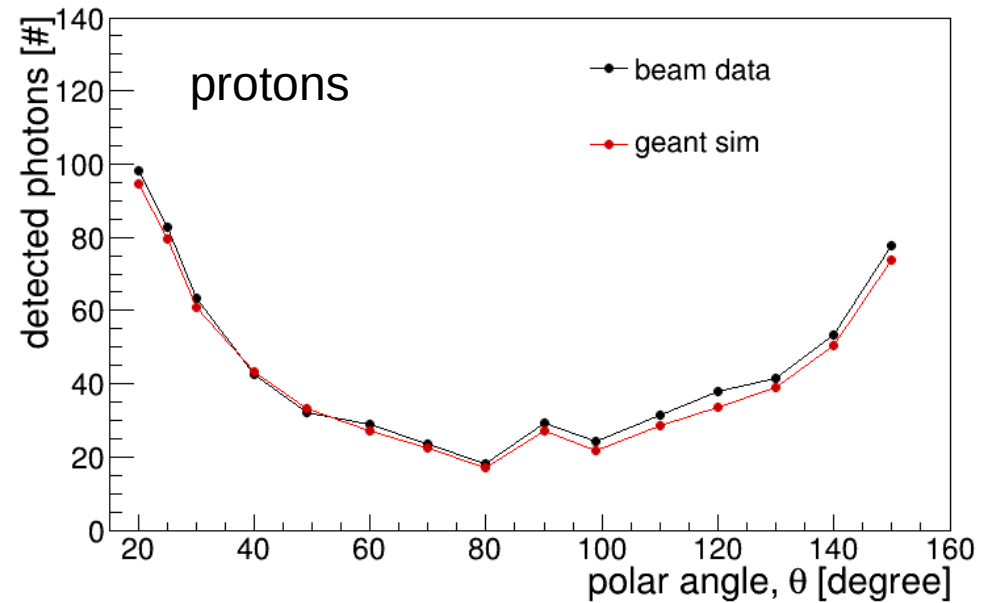
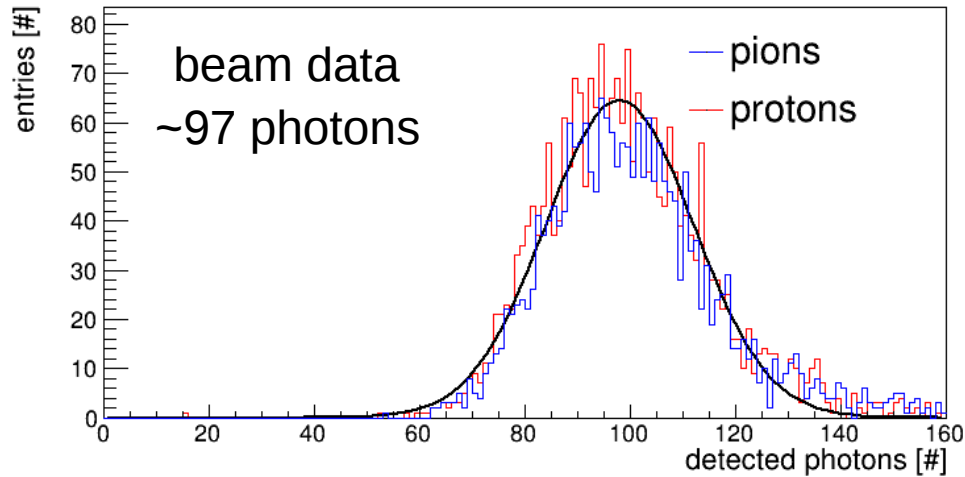
Geometrical Reconstruction

- bar + 3LS lens
- π/ρ @ 7 GeV/c



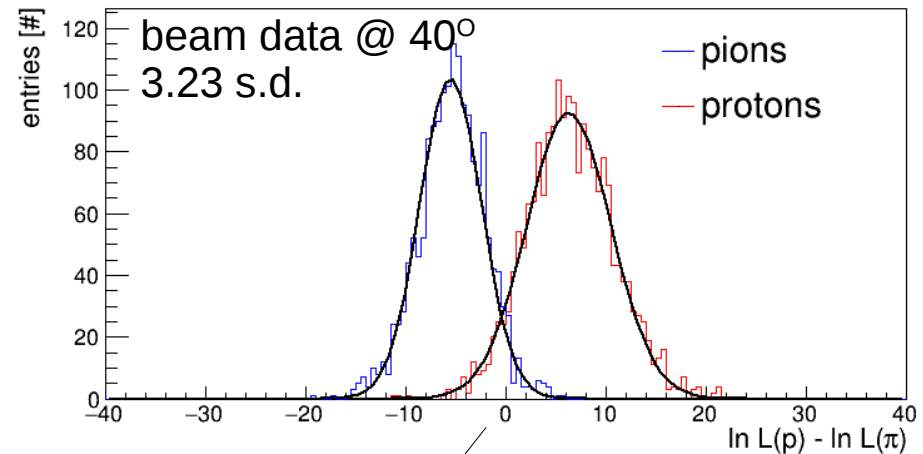
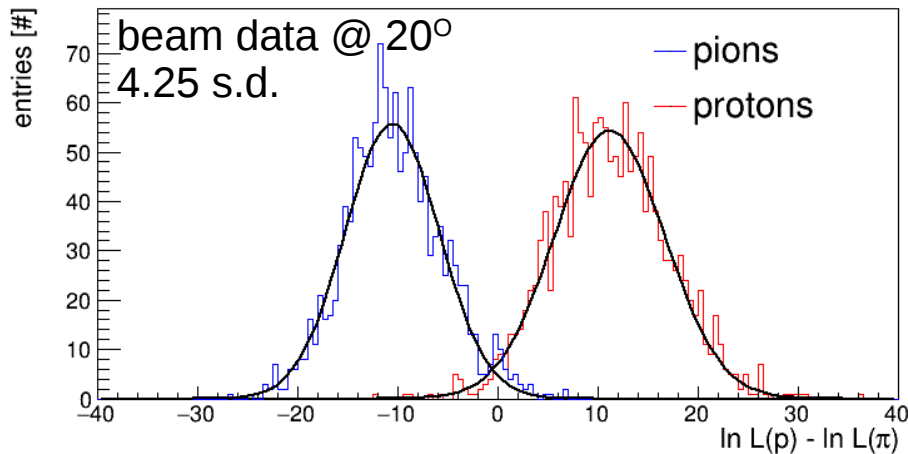
Geometrical Reconstruction

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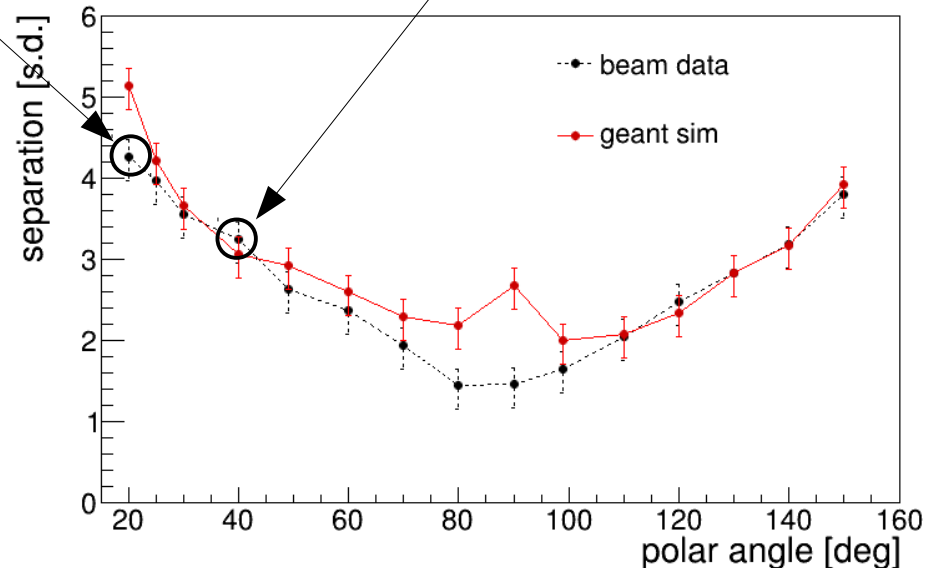


Bar with 3L Spherical Lens @ 7 GeV/c

π/p separation power (using time imaging reconstruction):

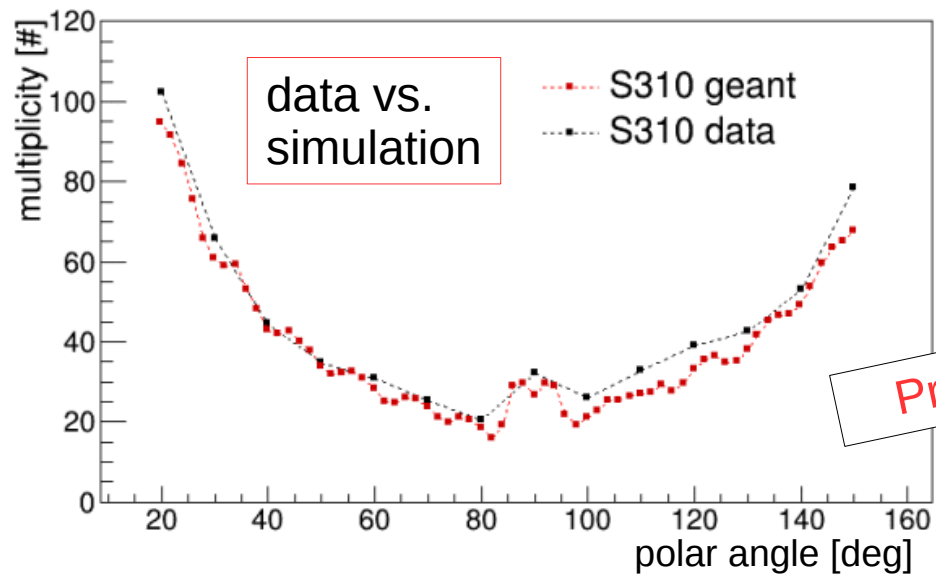


$$N_{\text{sep}} = \frac{|\mu_1 - \mu_2|}{0.5(\sigma_1 + \sigma_2)}$$

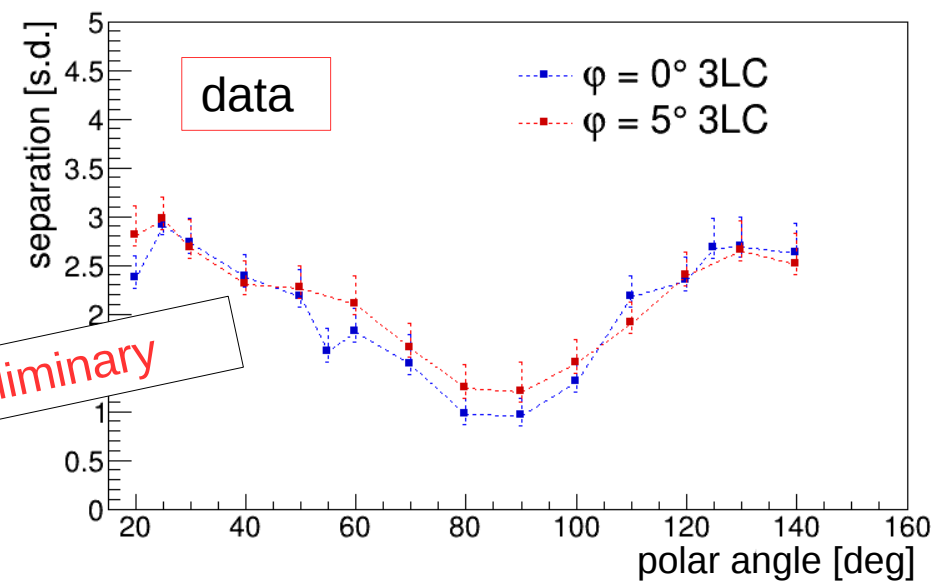


Bar with 3L Cylindrical Lens @ 7 GeV/c

Photon yield:



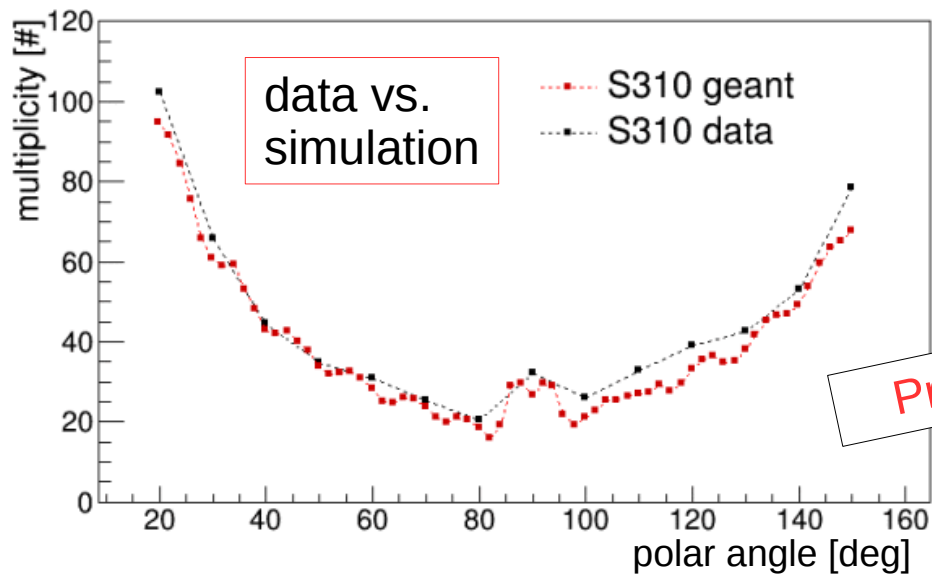
π/ρ separation power:



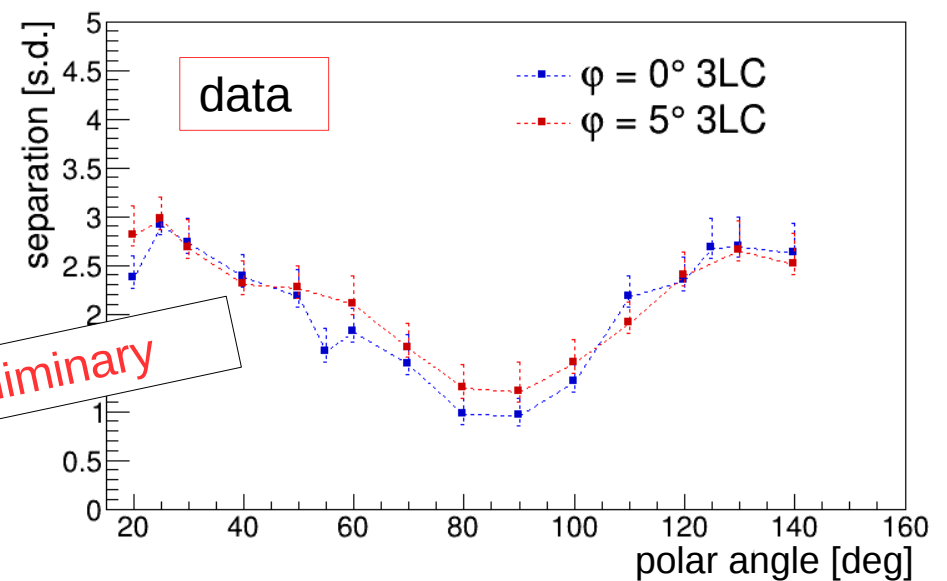
Preliminary

Bar with 3L Cylindrical Lens @ 7 GeV/c

Photon yield:



π/ρ separation power:



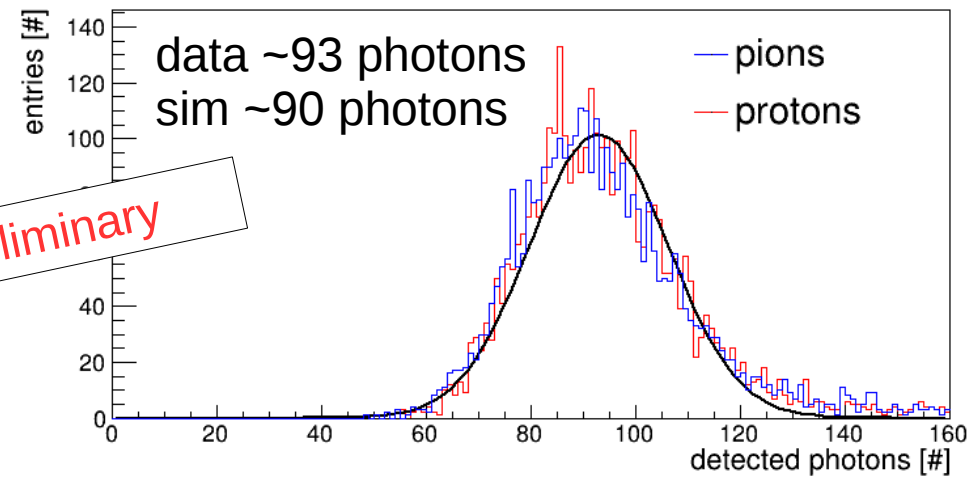
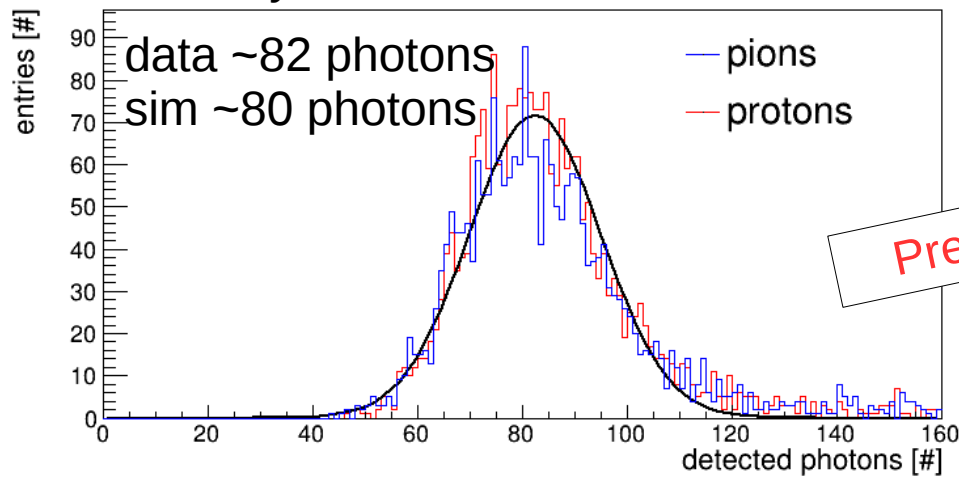
non zero azimuthal angle only improves π/ρ separation

Results for Beam Data @ 7 GeV/c @ 25°

bar + 3 layer spherical lens

plate + 3 layer cylindrical lens

Photon yield:

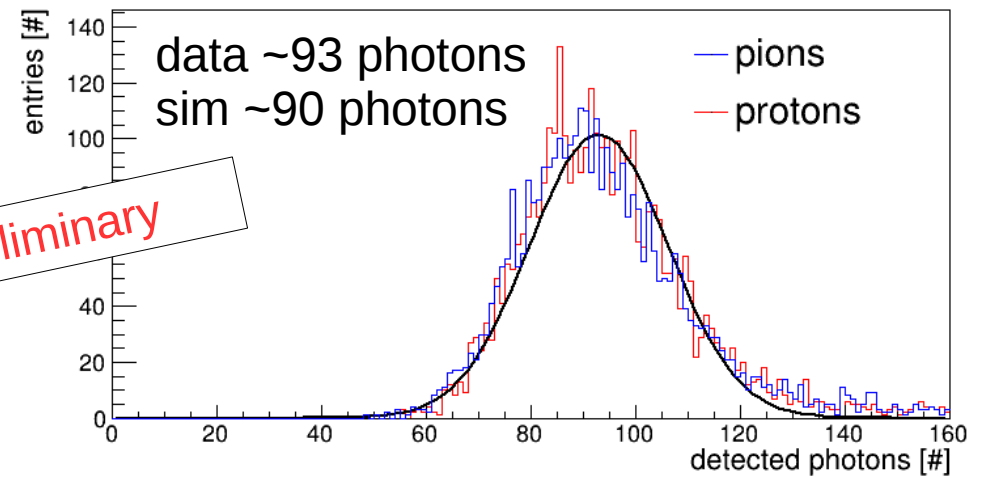
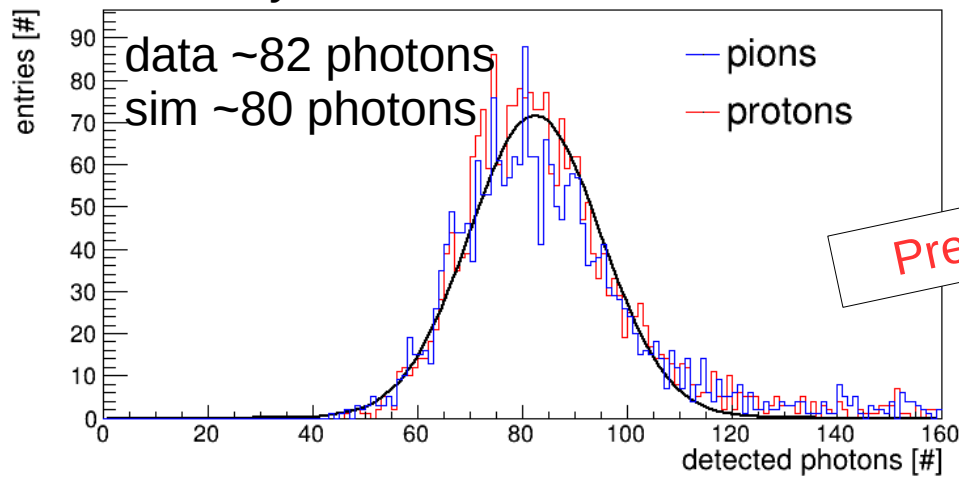


Results for Beam Data @ 7 GeV/c @ 25°

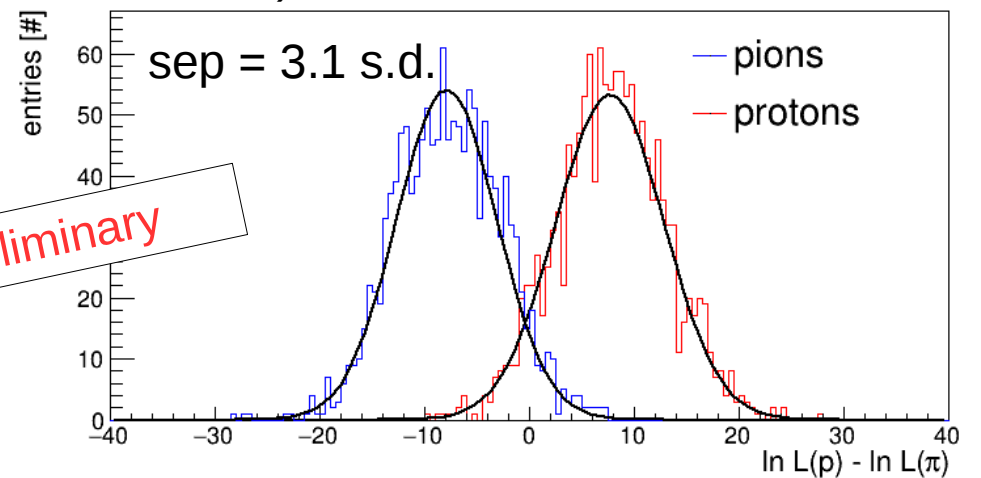
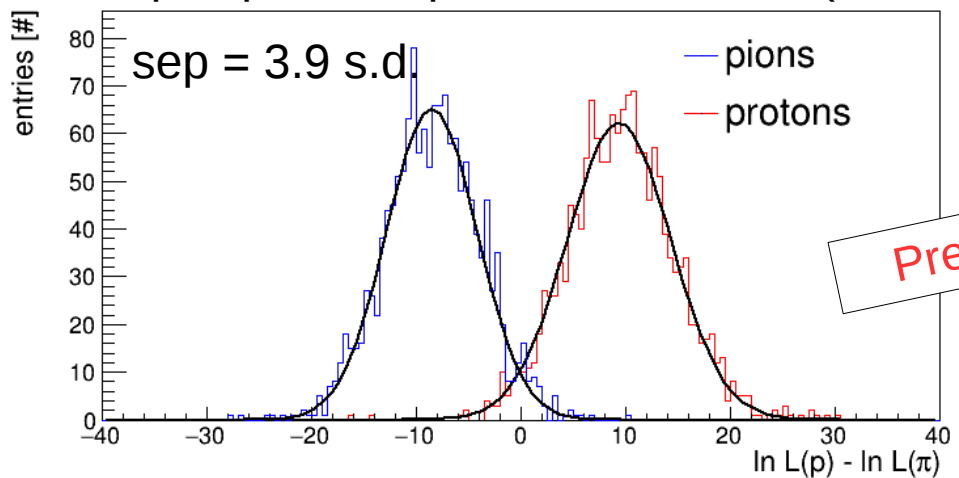
bar + 3 layer spherical lens

plate + 3 layer cylindrical lens

Photon yield:



π/p separation power @ 7 GeV/c ($\sim \pi/K$ @ 3.5 GeV/c):

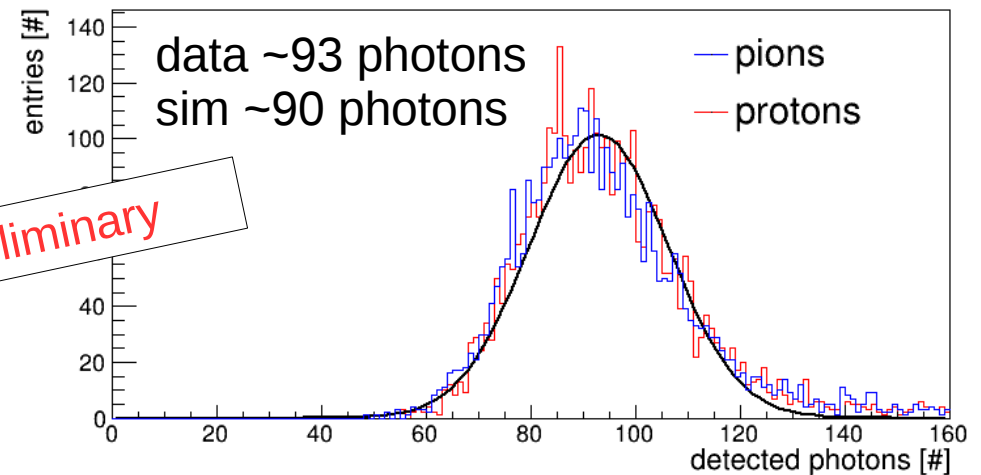
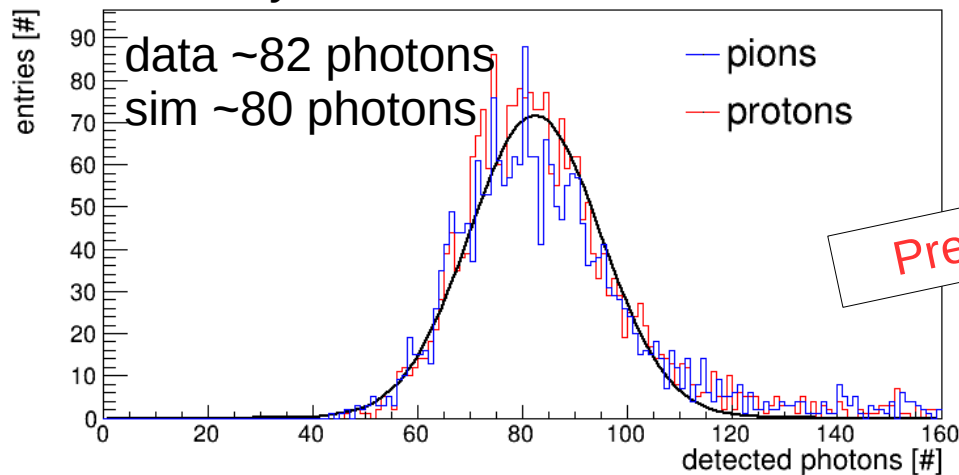


Results for Beam Data @ 7 GeV/c @ 25°

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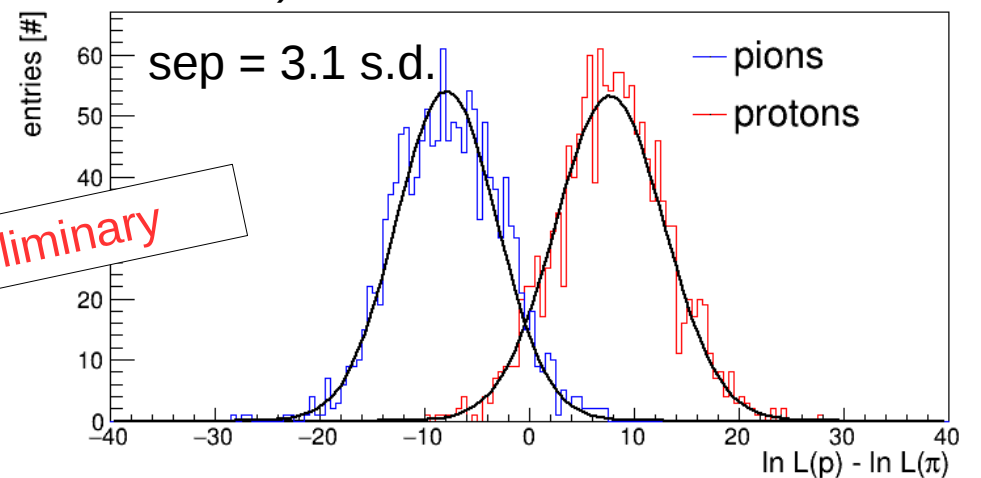
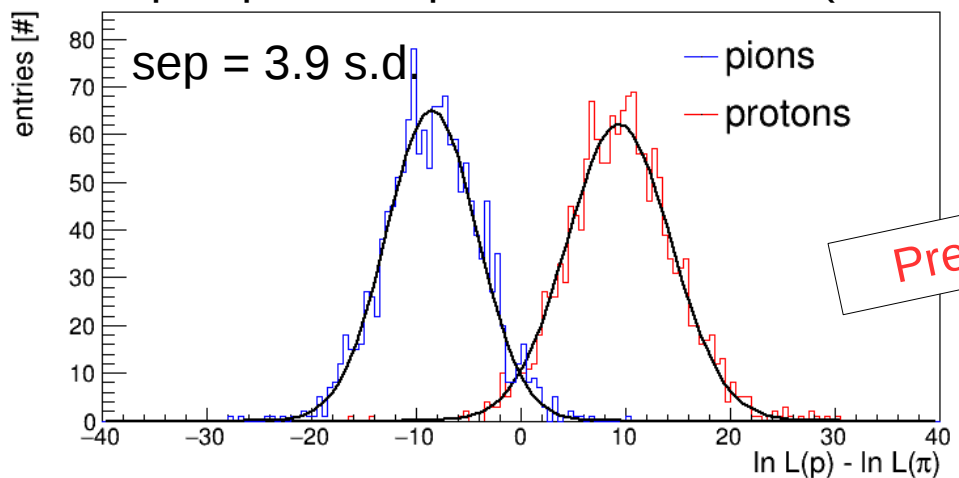
plate + 3 layer cylindrical lens

Photon yield:



Preliminary

π/p separation power @ 7 GeV/c ($\sim \pi/K$ @ 3.5 GeV/c):



Preliminary



configuration with spherical lens is better than with cylindrical despite smaller photon yield

Summary and Outlook

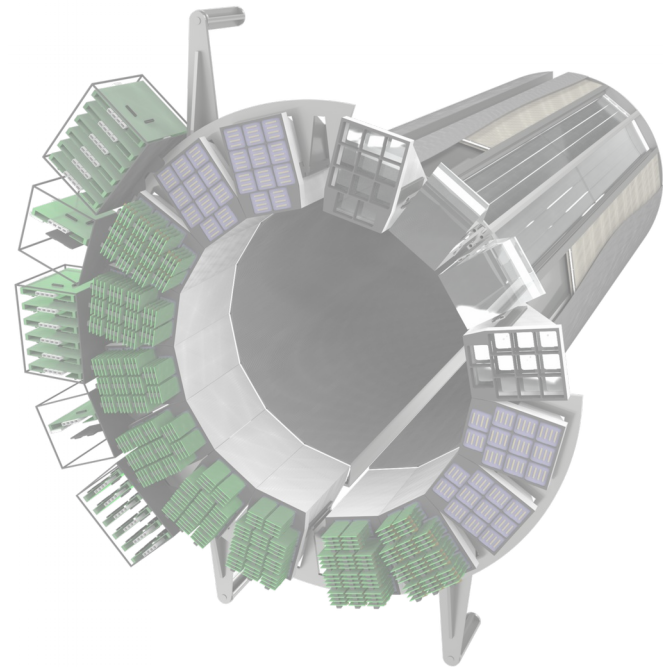
- Test beam was successful (recorded >1B triggers for different prototype config.)
- Time resolution of the system was determined to be ~250 ps
- Improved pi/p separation compared to 2016
- Validated 3LC lens
- Good agreement between data and simulations

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:

- prototype test at CERN 2018 (new lens)



Summary and Outlook

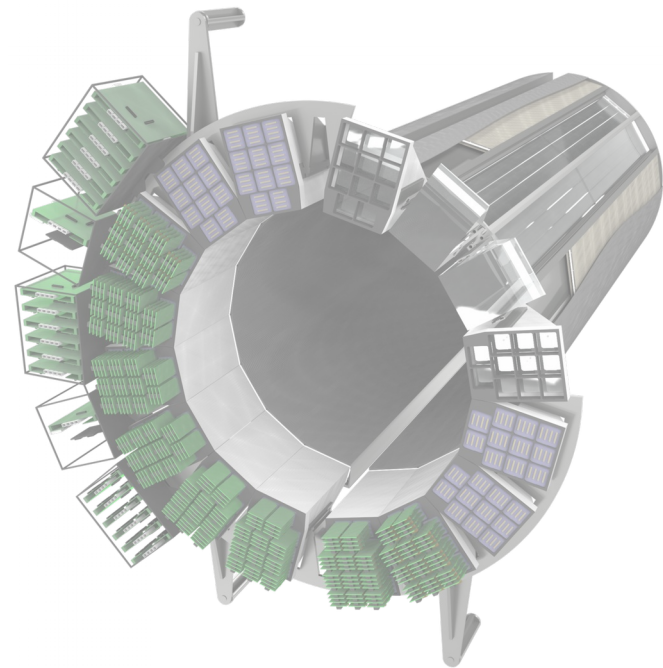
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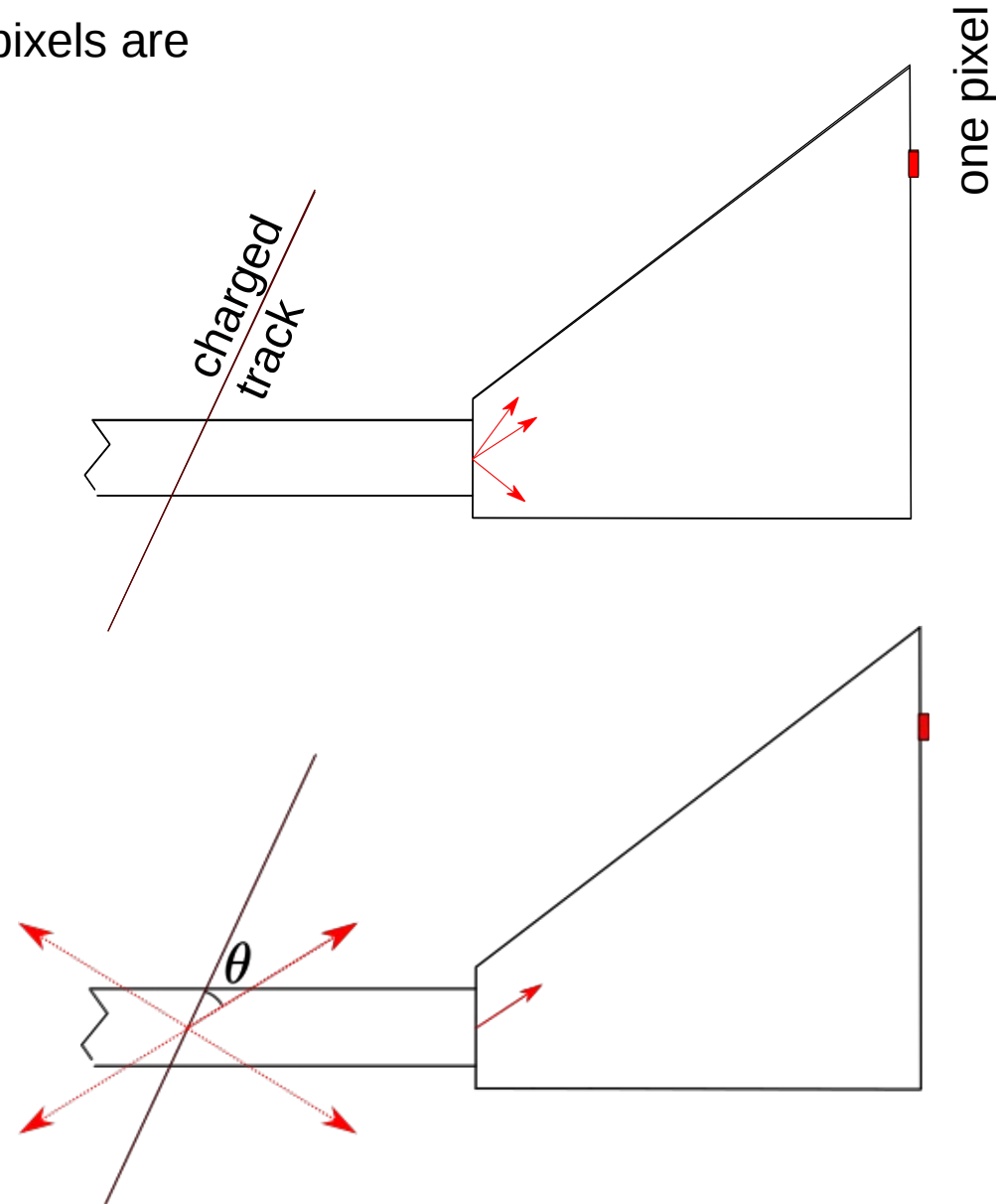
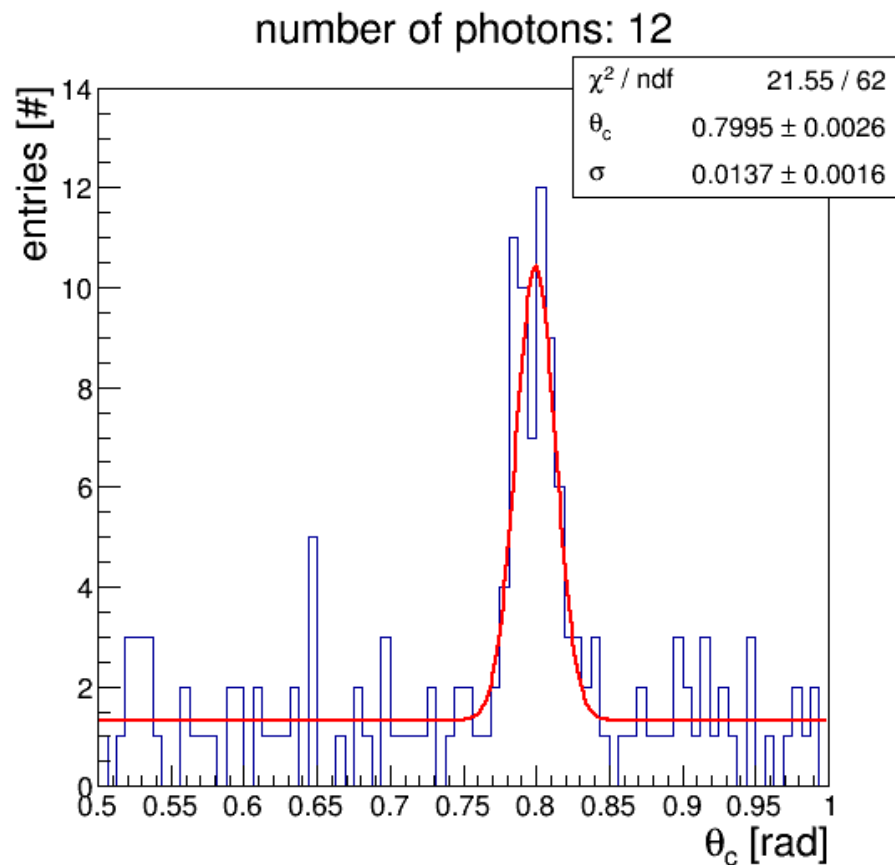


Thank you for your attention

Backup

Geometrical Reconstruction

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



Time Imaging Reconstruction. PDFs

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

