



# CERN Beam Test 2026 Simulation

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# To-do list

	Hardware measurements	Simulation update	Time scale
HRPPD	<ul style="list-style-type: none"> <li>✓ QE uniformity               <ul style="list-style-type: none"> <li>✓ HRPPD 15, 16, 17</li> <li>× HRPPD 23 (at Incom), 27</li> </ul> </li> <li>❑ Gain uniformity analysis pipeline: Get scanning and analysis macros ready</li> </ul>		By May 27 <sup>th</sup>
		<ul style="list-style-type: none"> <li>✓ Implement updated <math>QE(\lambda)</math> in simulation using photocurrent from Chandra</li> </ul>	
Aerogel		<ul style="list-style-type: none"> <li>✓ Thickness</li> <li>✓ Absorption length</li> <li>✓ Refractive index</li> </ul>	
UV filter		<ul style="list-style-type: none"> <li>✓ Material definition (change from acrylic to borosilicate)</li> <li>✓ Absorption length</li> <li>✓ Refractive index</li> </ul>	
	<ul style="list-style-type: none"> <li>✓ Remeasure absorption length</li> </ul>		
Mirror		<ul style="list-style-type: none"> <li>❑ Update mirror configuration and optical properties (Need measured reflectivity from Jihee)</li> </ul>	
Beam spread		<ul style="list-style-type: none"> <li>❑ Option for beam spread angle</li> <li>❑ Option for beam diameter</li> </ul>	
Analysis macros		<ul style="list-style-type: none"> <li>✓ Hit maps</li> <li>❑ QA plots               <ul style="list-style-type: none"> <li>❑ HRPPD QE</li> <li>❑ UV filter transmittance</li> <li>❑ Mirror reflectivity</li> </ul> </li> </ul>	
Large scale simulation		<ul style="list-style-type: none"> <li>❑ Read in events from hepMC files (in progress)</li> <li>✓ Options for particle species (<math>\pi</math>, K), and momentum</li> <li>❑ Run script, condor script</li> <li>❑ Estimate statistics and the corresponding runtime</li> </ul>	

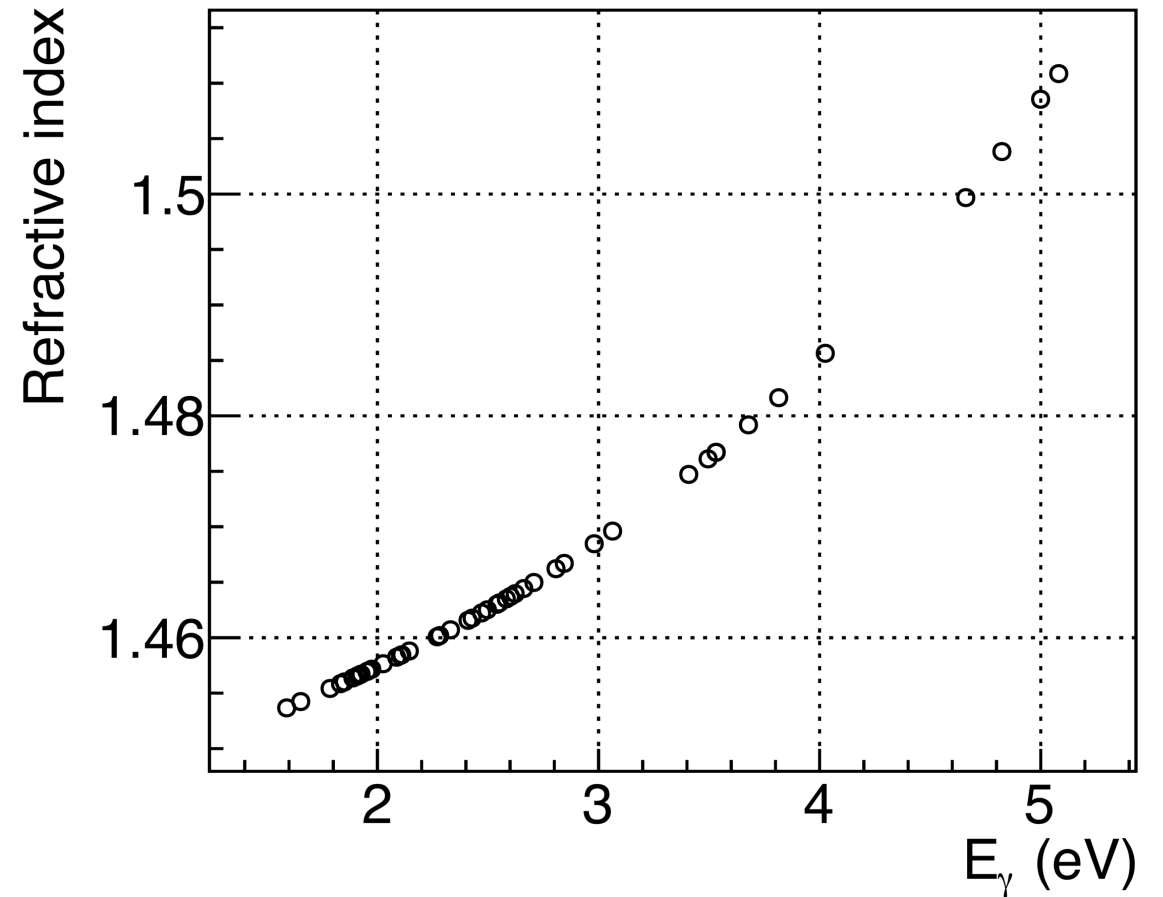
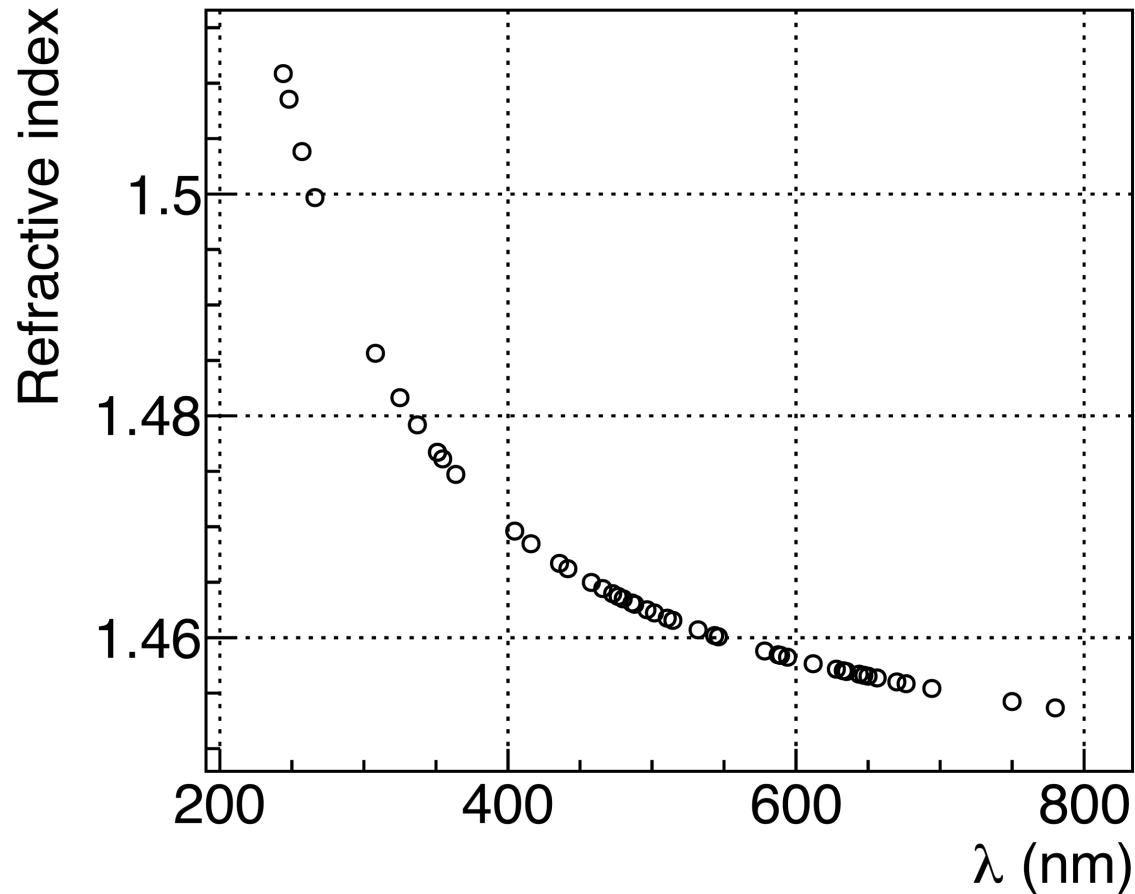
# Borosilicate UV Filters

## BOROFLOAT UV filters

LP285	LP330
Thickness = 2.007 mm	1.854 mm
Density = 2.2 g/cm <sup>3</sup>	2.23 g/cm <sup>3</sup>
Refractive thickness = 1.47	1.47

```
m_BorosilicateFilter[iUV]->AddElement(m_Si, 0.377); // from SiO2  
m_BorosilicateFilter[iUV]->AddElement(m_O , 0.535); // total oxygen  
m_BorosilicateFilter[iUV]->AddElement(m_B , 0.040); // from B2O3  
m_BorosilicateFilter[iUV]->AddElement(m_Na, 0.028); // from Na2O  
m_BorosilicateFilter[iUV]->AddElement(m_Al, 0.020); // from Al2O3
```

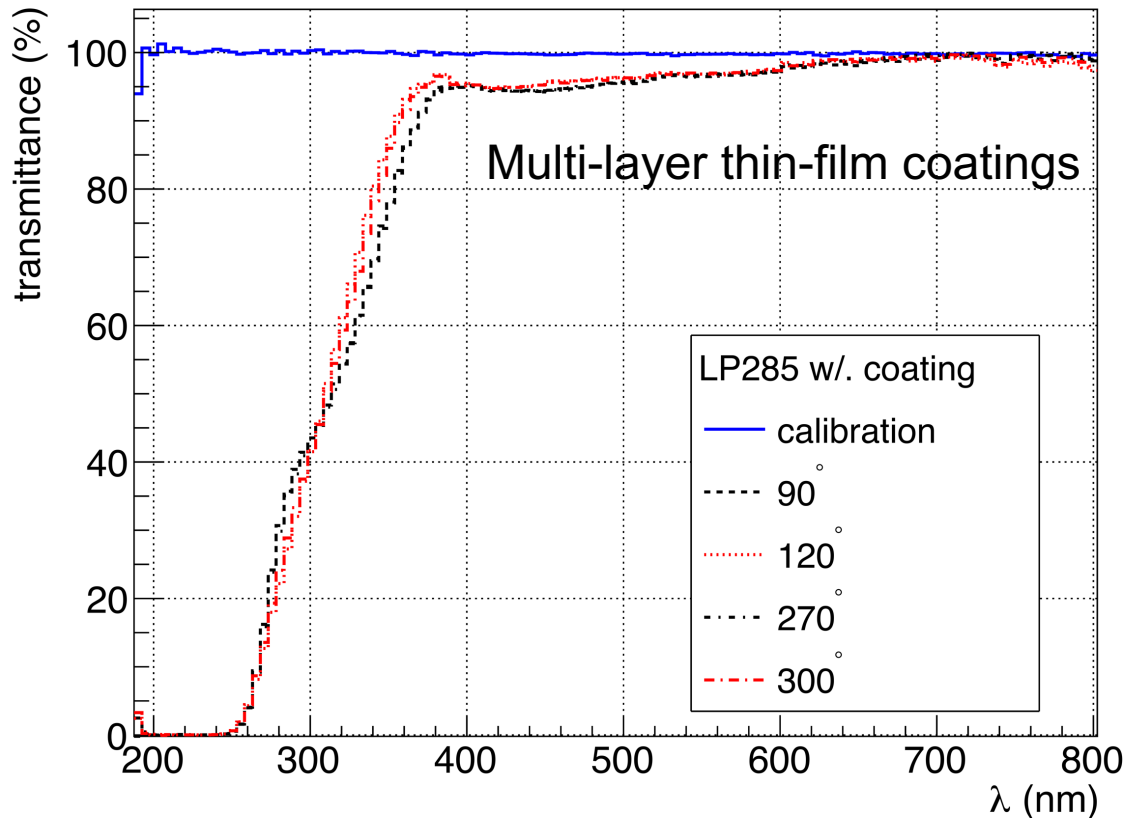
# UV Filter Refractive Index



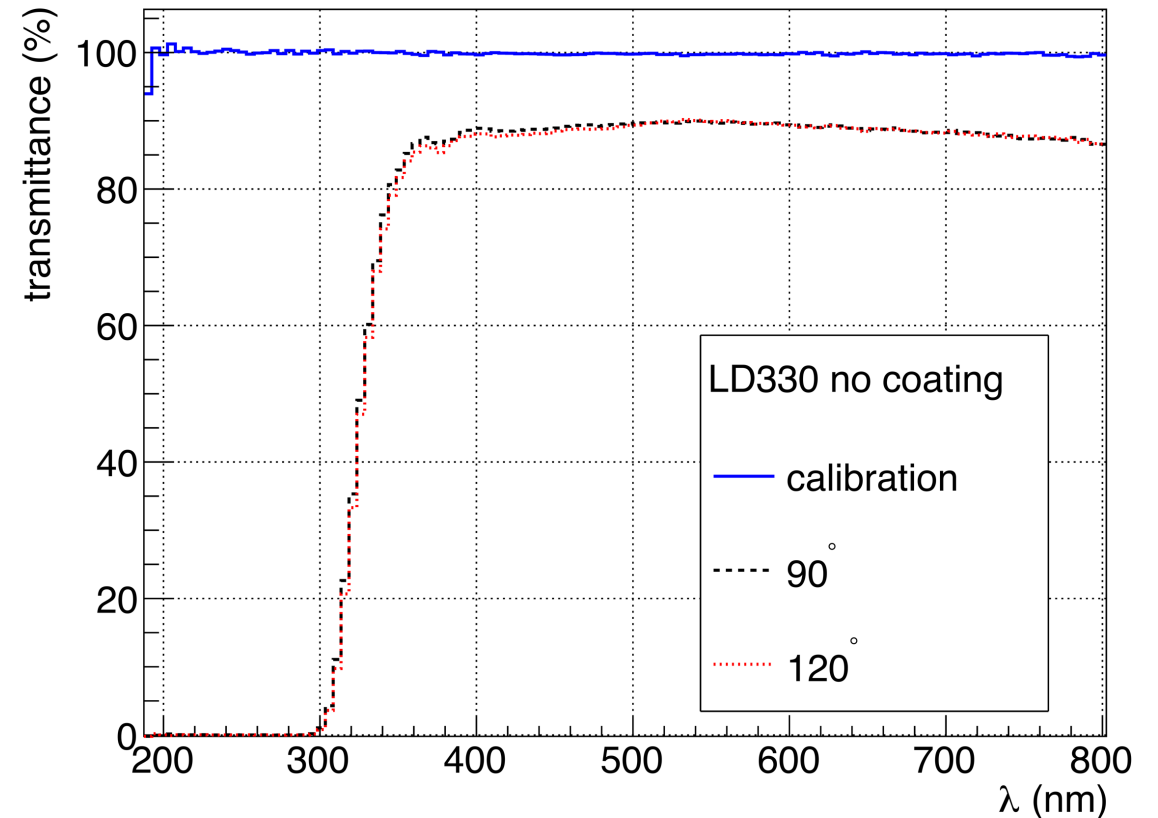
- Simulation time increases significant after implementing UV filter refractive index  
~2.5 min per incident particle
- Really need a condor script

# UV Filter Transmittance

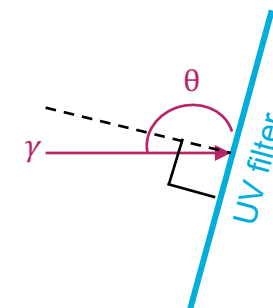
Thickness = 2.007 mm



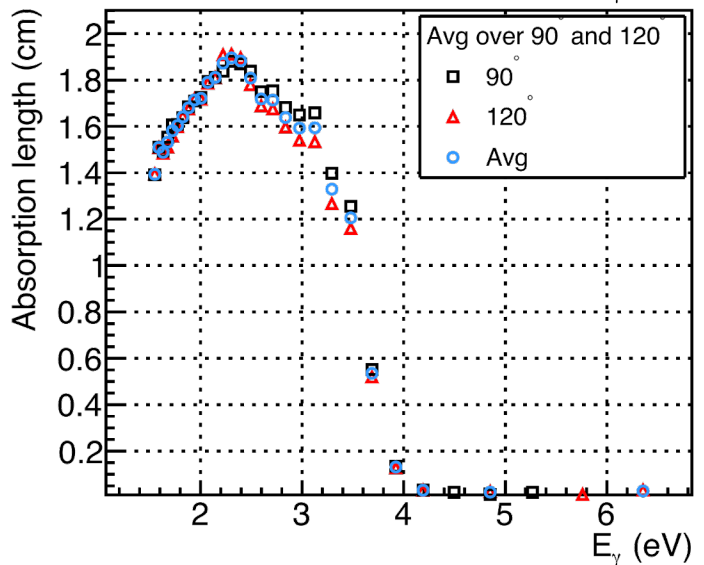
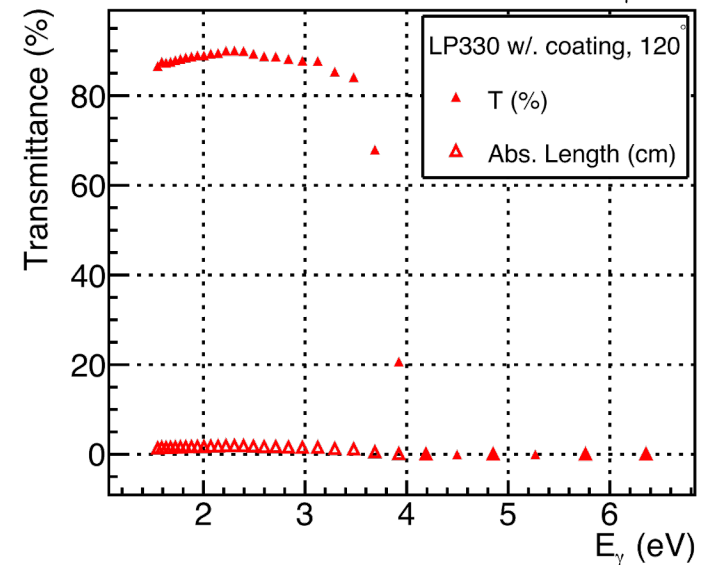
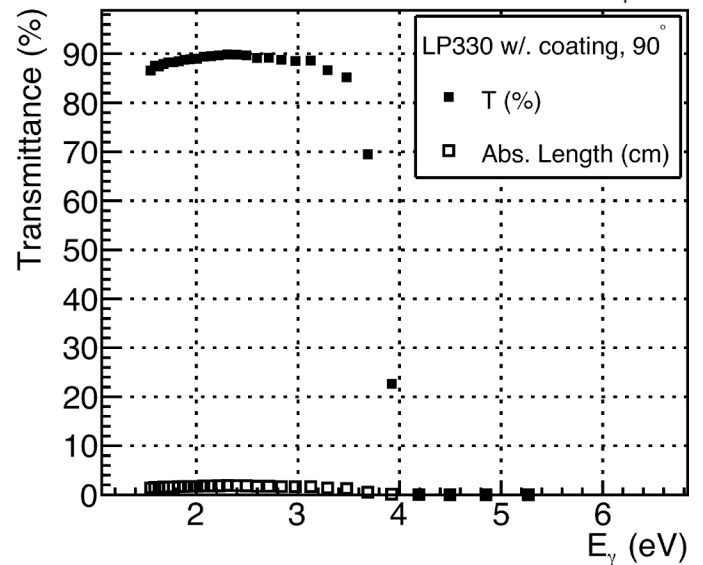
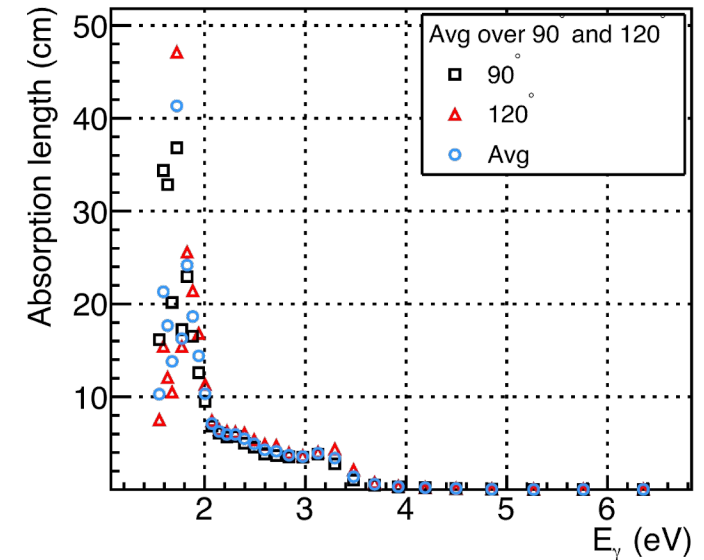
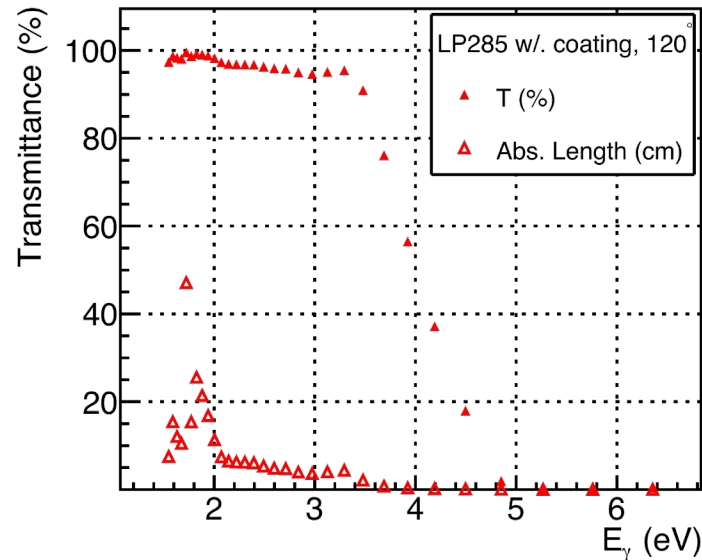
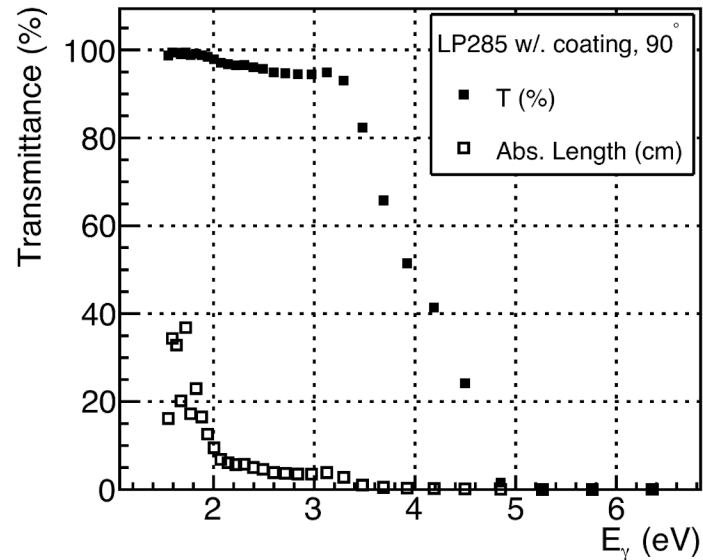
Thickness = 1.854 mm



- Measured by the Hitachi spectrophotometer
- Cut off wavelengths: ~250nm, ~300nm
- LP 285: higher transmittance at certain wavelength regions due with interference because of the coating
- LP 285: No significant difference in transmittance when flipping the filter backward

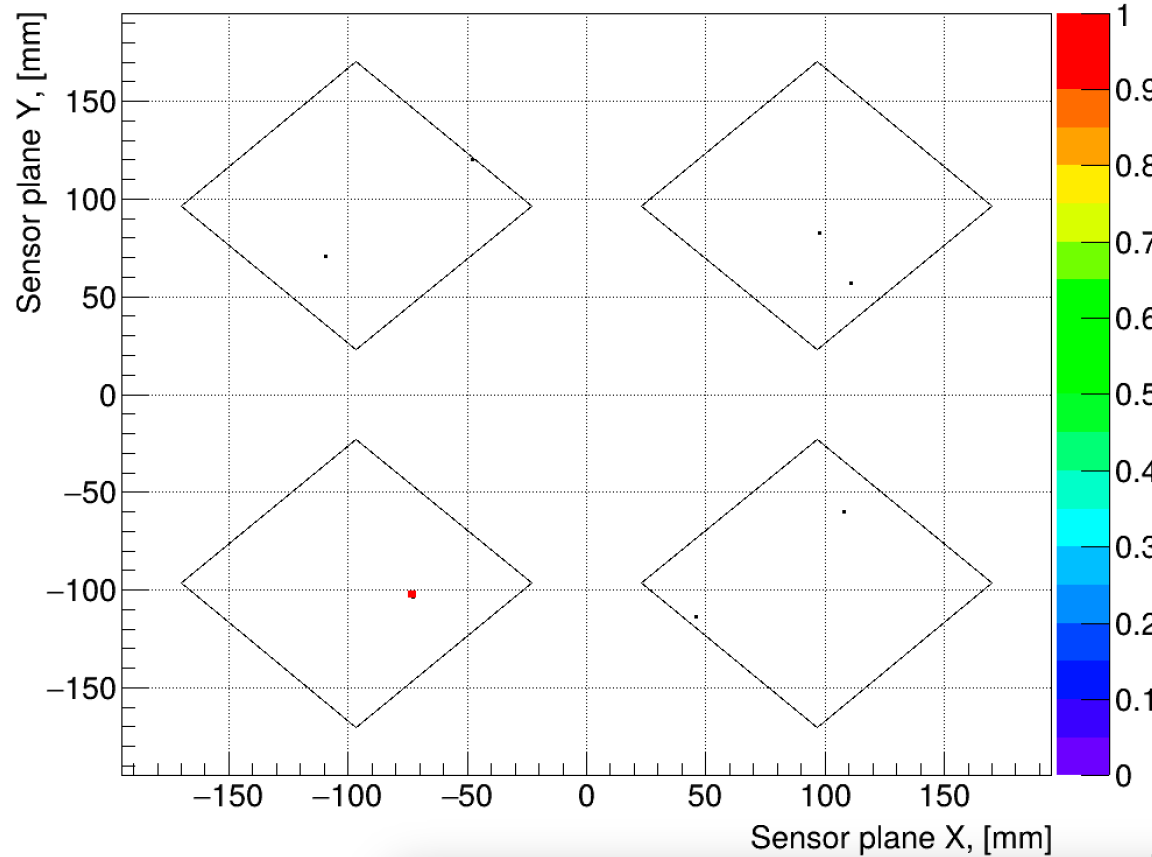


# UV Filter Absorption Length

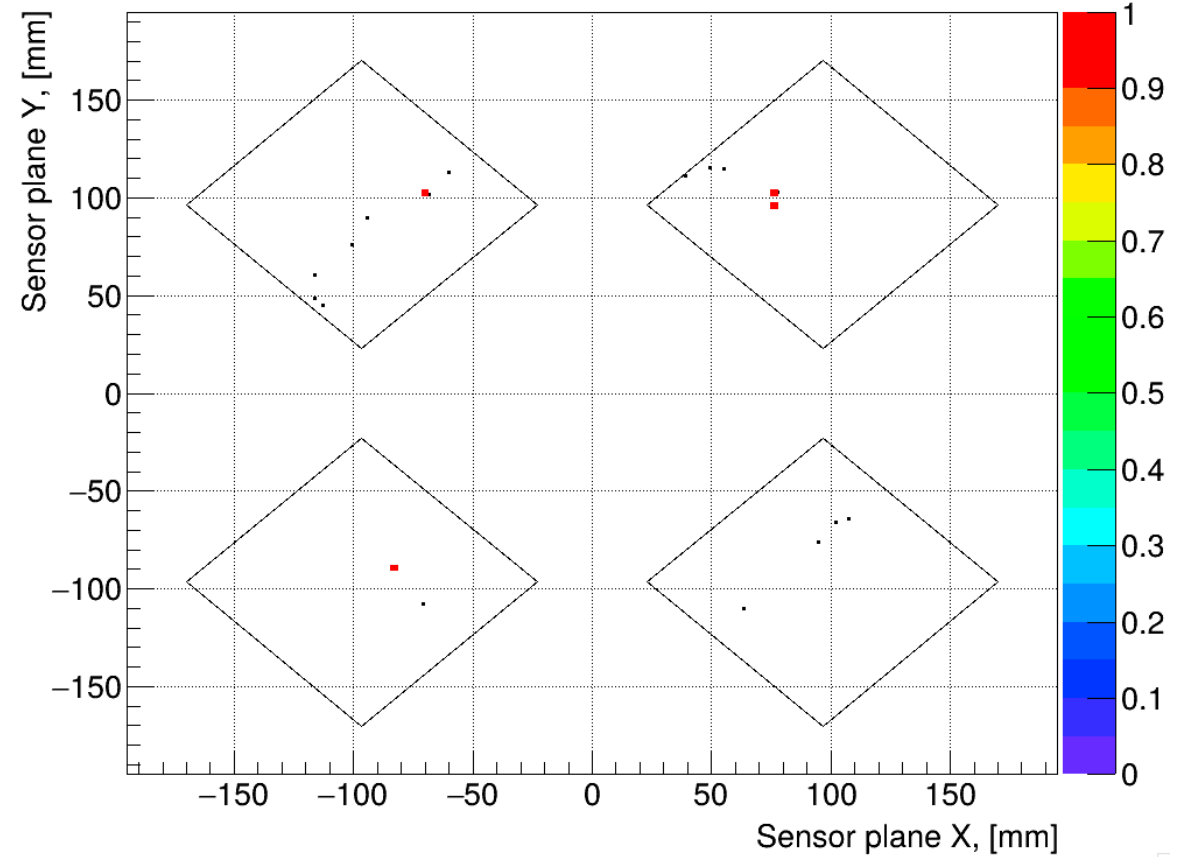


# Hit Maps

Single  $\pi^+$  at 6 GeV/c



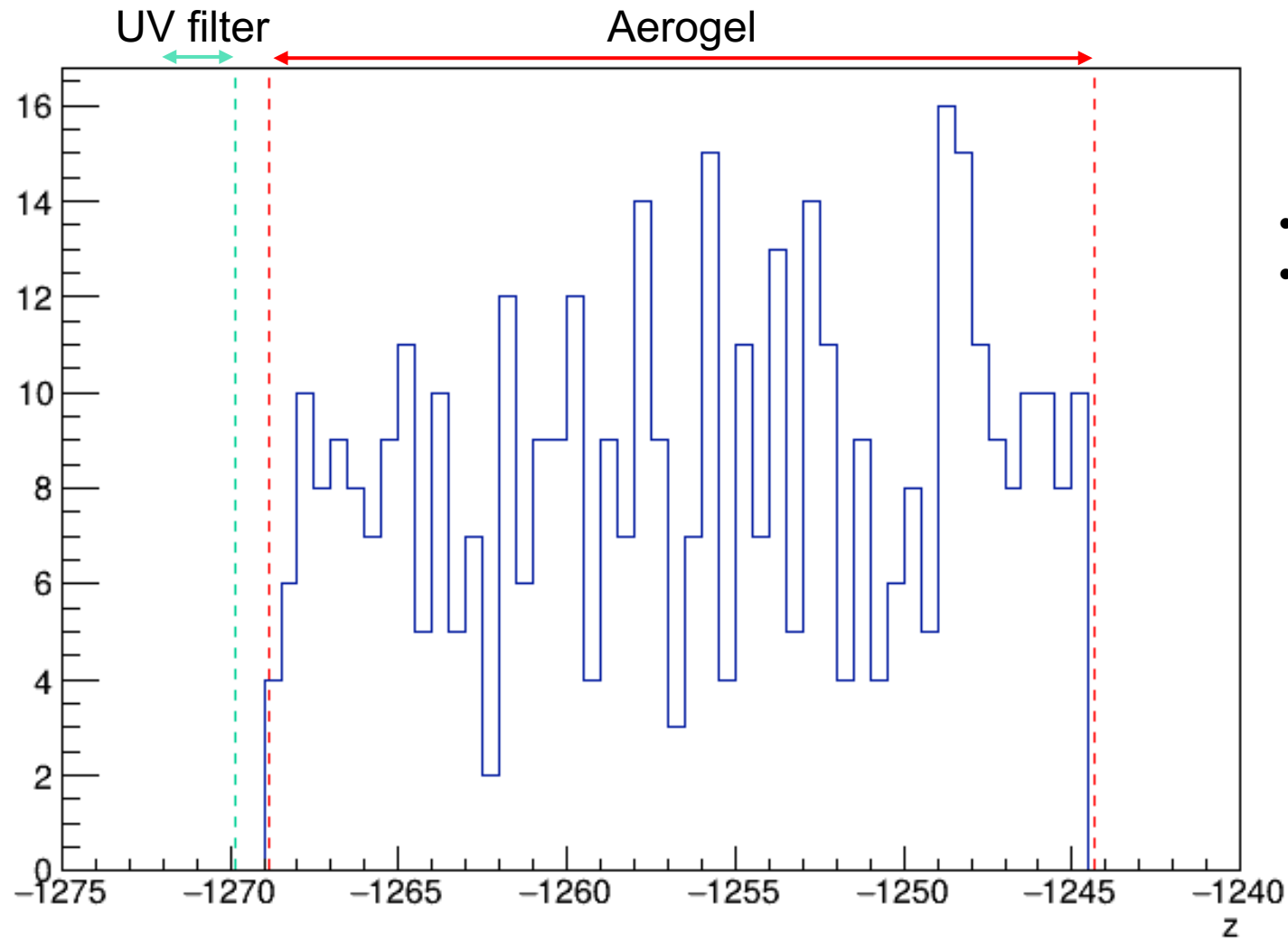
3 $\pi^+$  + 1Kaon event at 5-7 GeV/c



However, IRT current does not support multi-particle event

# Back Up

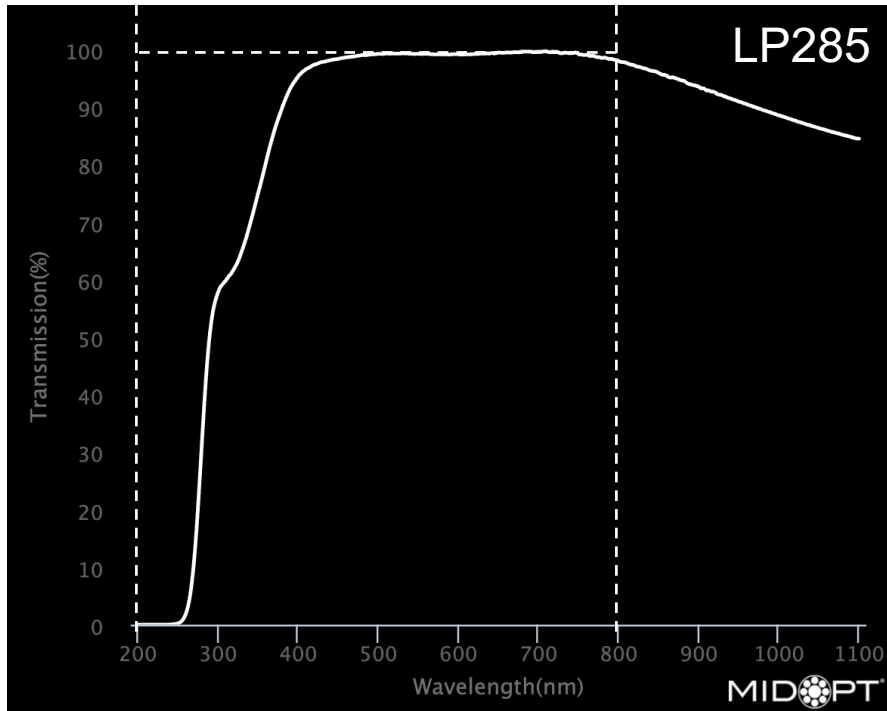
# Photon Vertex Distribution



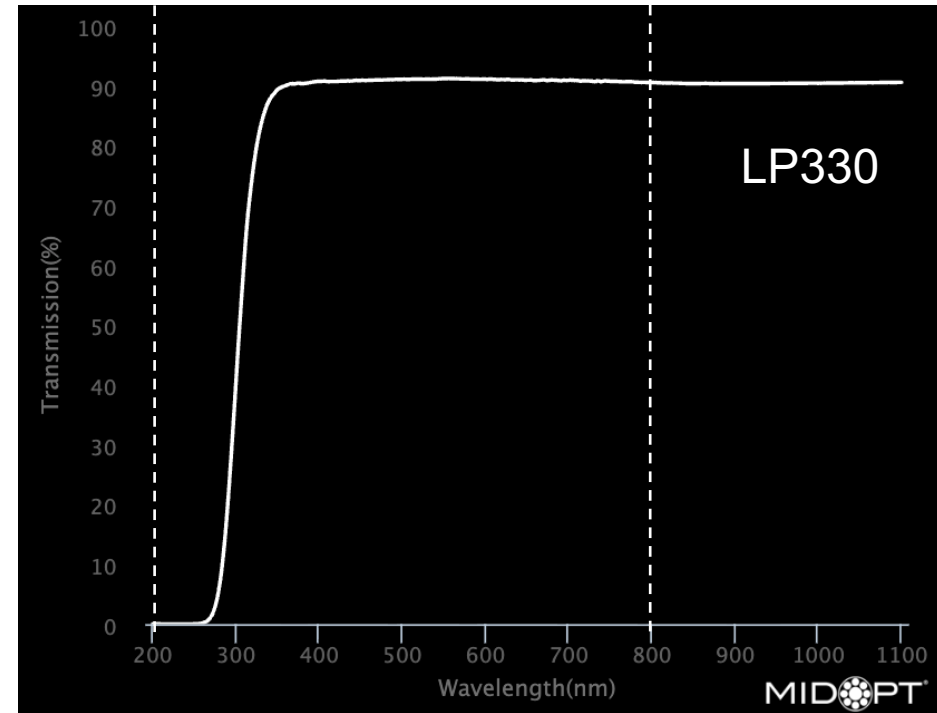
- Single pion event
- No photon generated inside the UV filter

# Transmittance Provided by MIDOPT

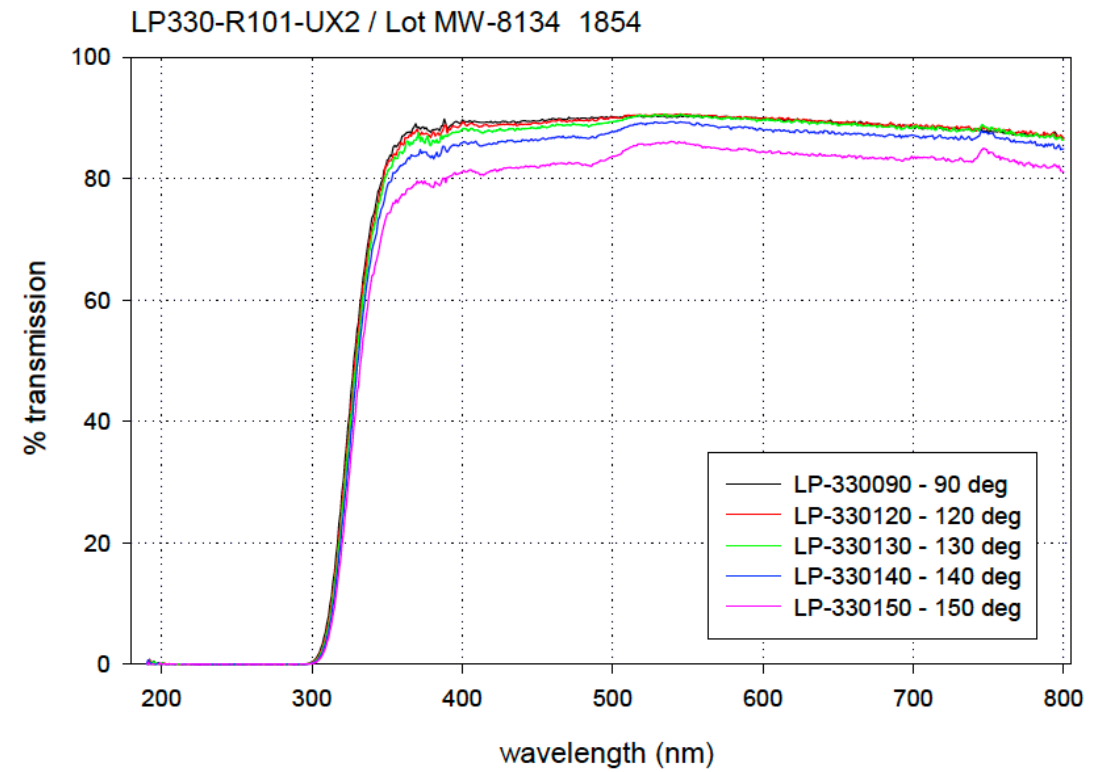
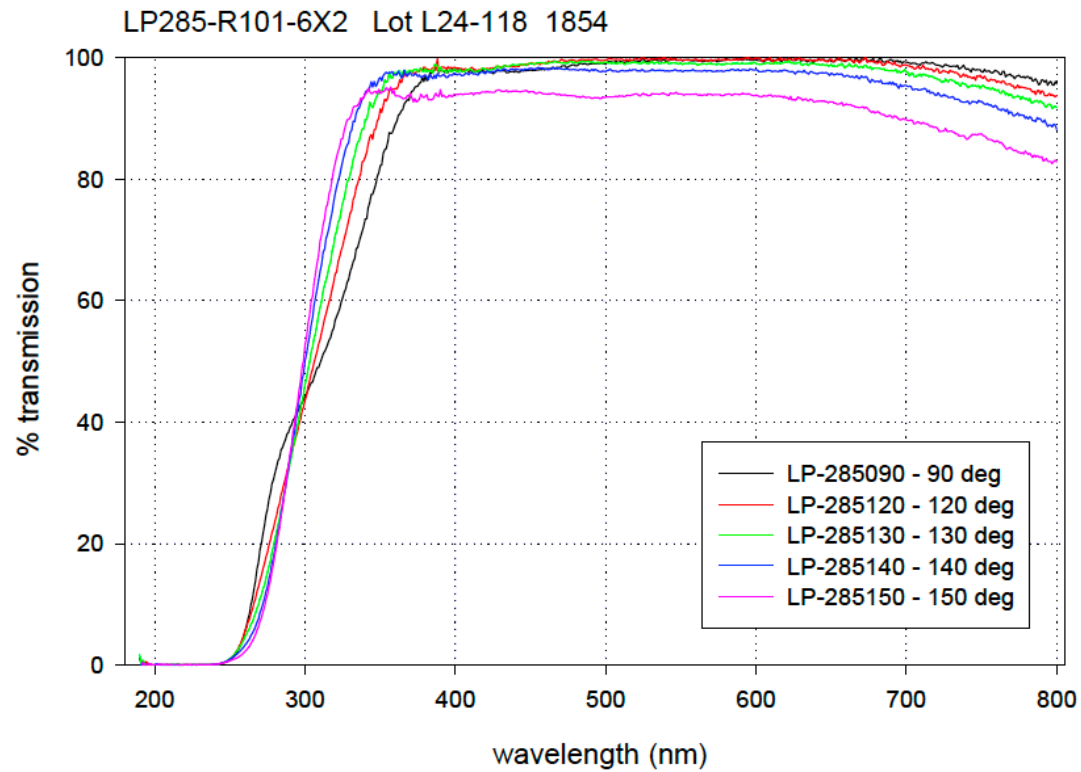
<https://midopt.com/filters/lp285/>



<https://midopt.com/filters/lp330/>



# Transmittance Measured by Sean



# Beamlines

<https://be-dep-ea.web.cern.ch/experimental-areas>

	particle type	Maximum beam momentum	$\Delta p/p_{max}$	$\Delta\theta$	Maximum intensity per spill	Spill length	Spill cycle
H8	Electrons Hadrons Positrons Muons Ions	Primary proton beam: 400 GeV/c Secondary beam: 360 GeV/c	1.5%		Hadrons: $10^6$ Electrons: $10^4$ Ions: $10^5$	4.8s	2 spills per 16.8s [1]
T10	Electron Hadron Muon	1-11.5 GeV/c	0.6% / 15%	35mrad	Electron: $10^6$ - $10^7$ Hadron: $10^6$ - $10^7$	0.4 s	1-2 spills per min [2]

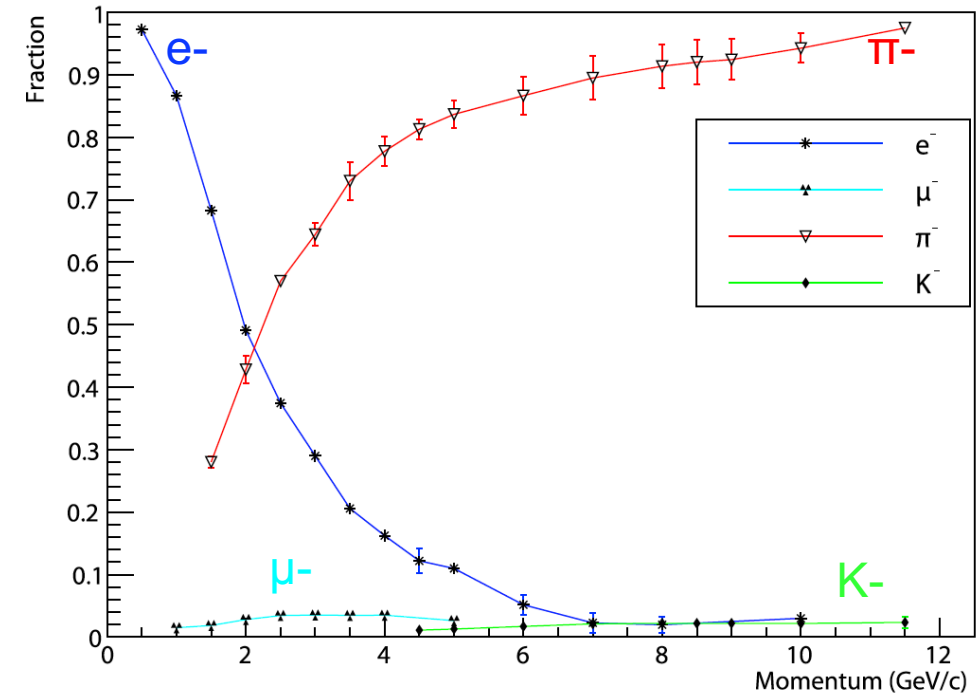
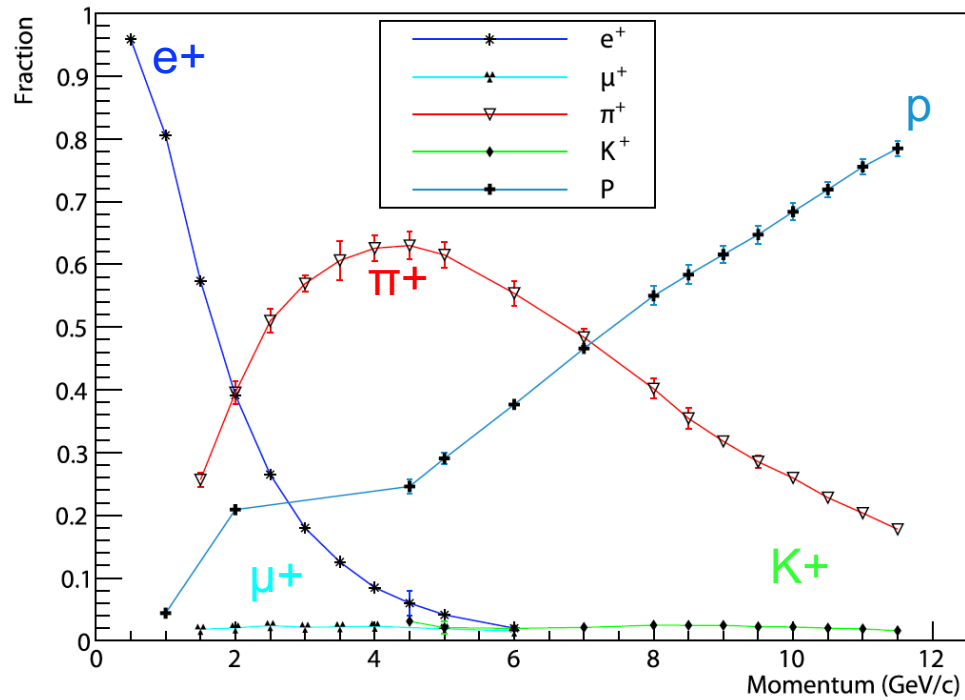
0.5 GeV/c increment in momentum is possible <https://doi.org/10.1016/j.nimb.2025.165907>

[1] [https://cds.cern.ch/record/2923184/files/PBC\\_Note\\_NA60\\_Proton\\_Beam\\_Delivery.pdf](https://cds.cern.ch/record/2923184/files/PBC_Note_NA60_Proton_Beam_Delivery.pdf)

[2] [https://indico.cern.ch/event/1642114/contributions/6906952/attachments/3207561/5714520/260128\\_T10\\_introduction\\_v2.pdf](https://indico.cern.ch/event/1642114/contributions/6906952/attachments/3207561/5714520/260128_T10_introduction_v2.pdf)

# T-10 Beam Composition vs Momentum

<https://doi.org/10.1016/j.nimb.2025.165907>



particle	Threshold momentum (GeV/c)	
	n=1.033	n=1.04
e	~0	~0
$\pi$	0.539	0.489
K	1.91	1.73
p	3.62	3.28