2026 Annual Meeting, The Physical Society of Japan @Komaba Campus, UTokyo
14pE512 / September 14, 2026

Development of an Aerogel Čerenkov Detector for the "K^-ppn" Bound State Search

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School of Science, The University of Tokyo

for the J-PARC E80 collaboration

Outline

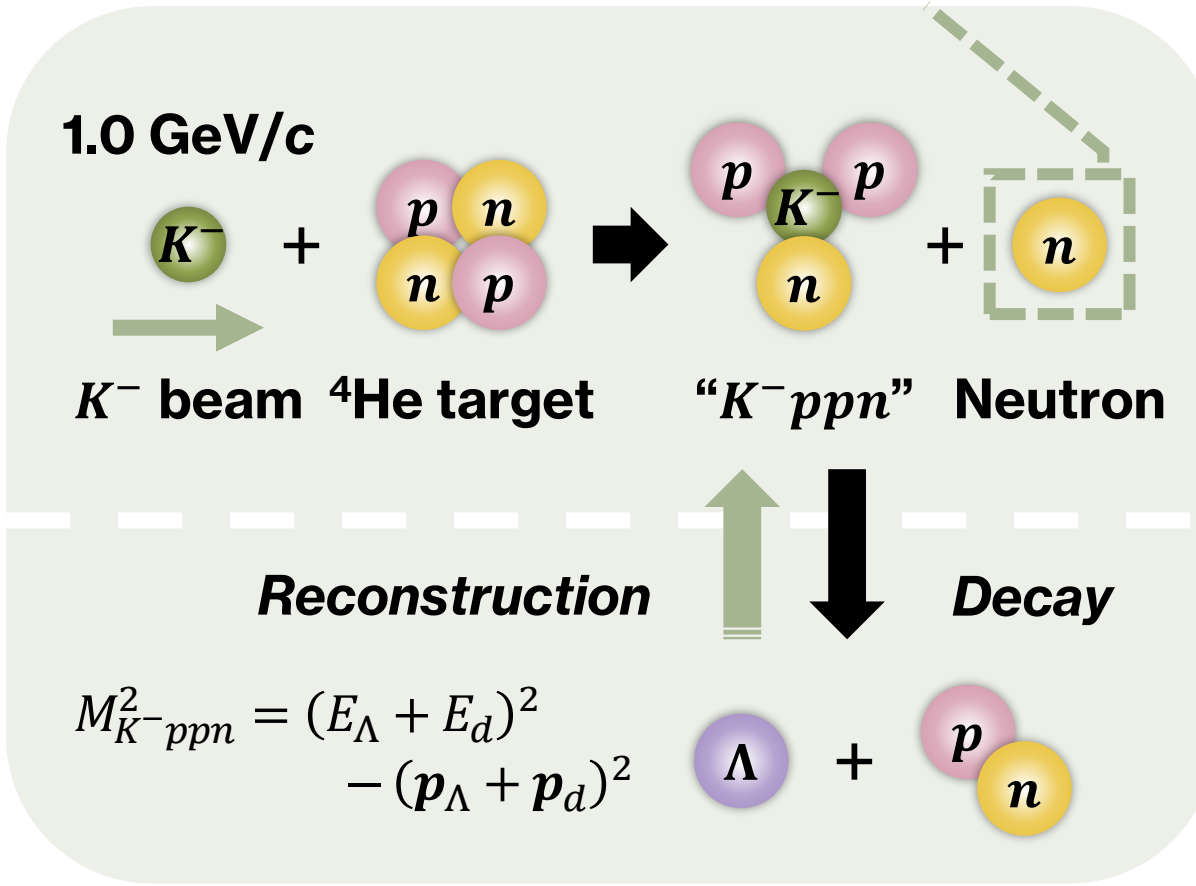
1. Search for "$K^- ppn$" – J-PARC E80 Experiment –
2. New Aerogel Čerenkov Detector
3. Performance Evaluation
    I. *Results of Beam Test*
    II. *Areas for Improvement*
4. Optimization Studies
    I. *Reflective Materials*
    II. *Readout Methods*
    III. *Performance Estimation*

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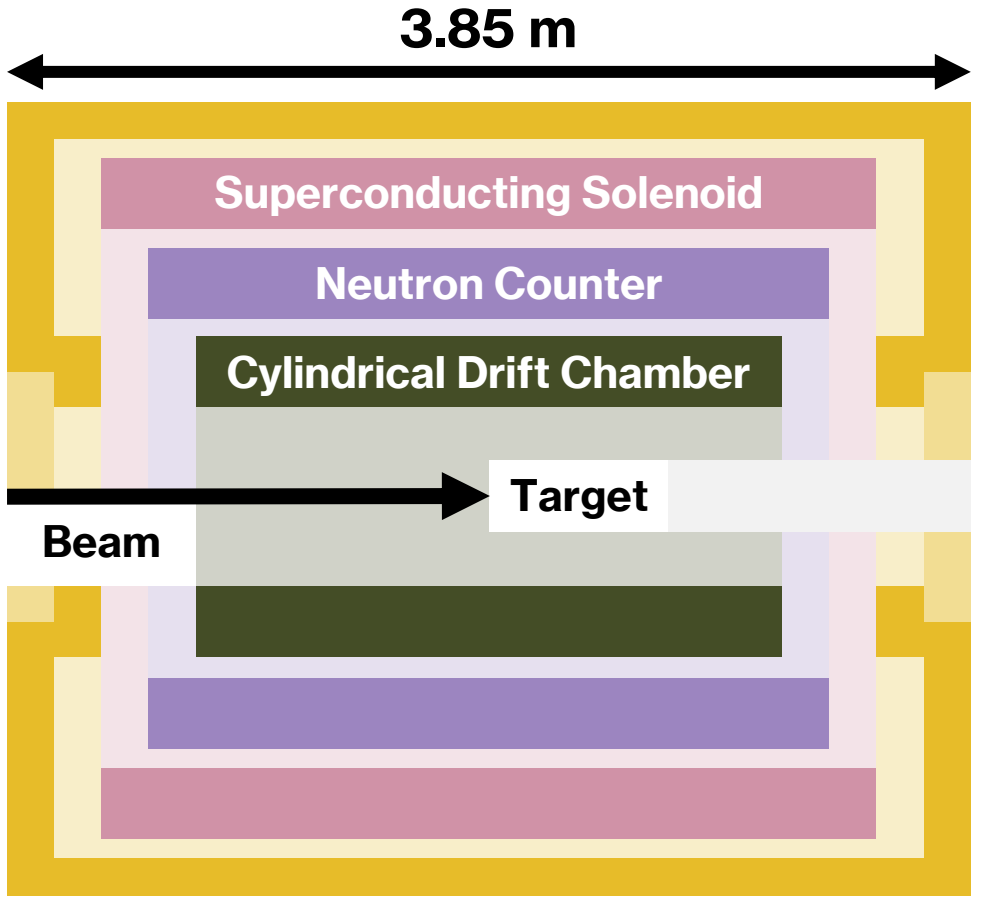
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Search for "K^-ppn" – J-PARC E80 Experiment –

Exclusive Measurement via n detection



Invariant Mass Spectroscopy



Cylindrical Detector System

provides ~ 4π acceptance

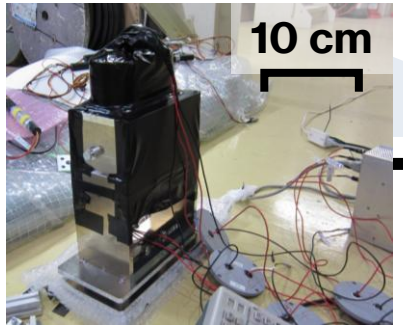
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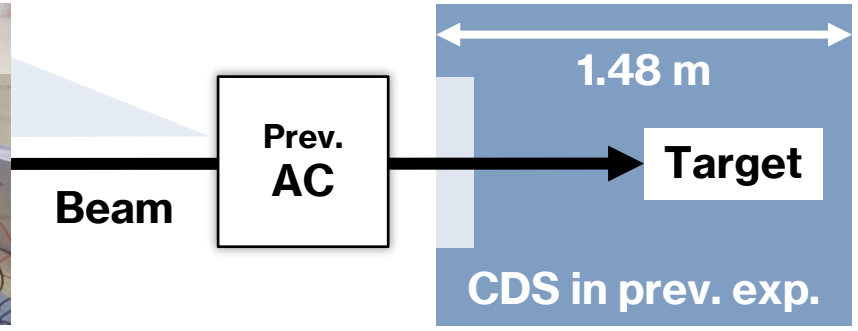
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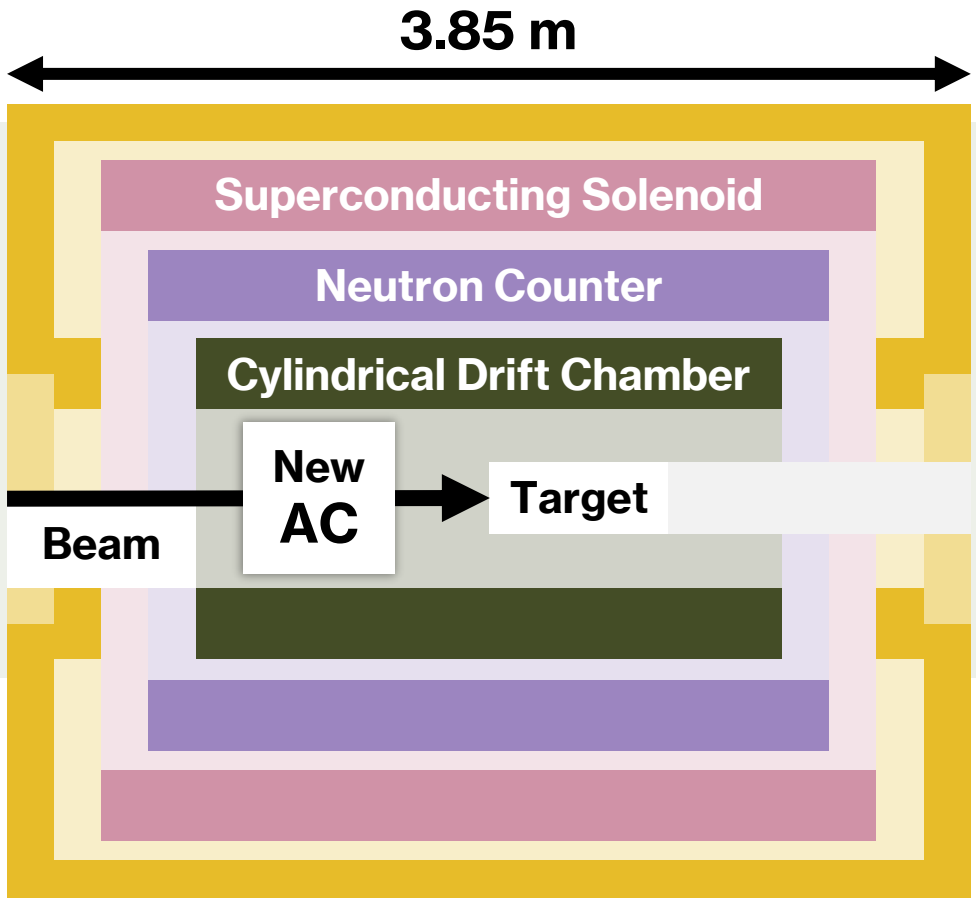
New Aerogel Čerenkov Detector

Aerogel Čerenkov Detector

- Identifying K/π in the beam
  - Using Čerenkov radiation from π
  - With aerogel radiator ($n = 1.05$)
- Operating inside the magnet
  - To be placed near the target
  - To suppress kaon decay events







Cylindrical Detector System

provides ∼ 4π acceptance

New Aerogel Čerenkov Detector

Aerogel Čerenkov Detector

» Detecting photons by MPPCs
› Instead of fine-mesh PMTs

Required Specifications

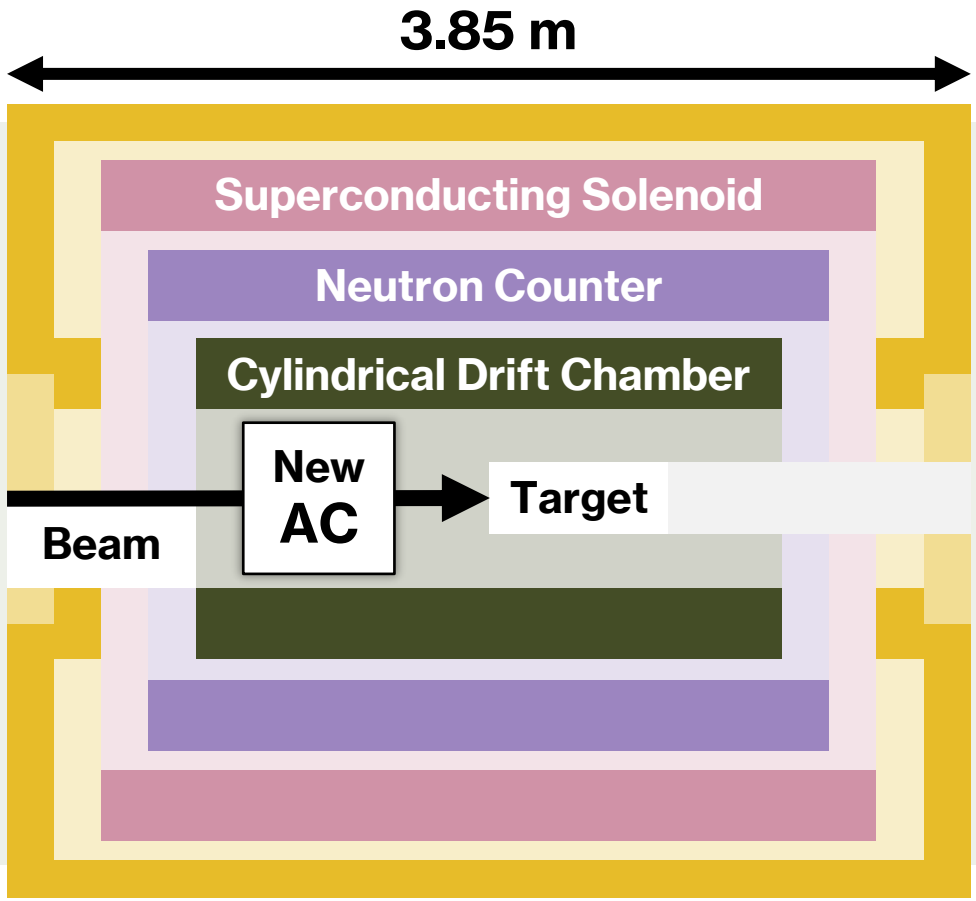
- 0.7 T magnetic field tolerance
- Compact body within the CDS

Target Performance

- π efficiency ～ 99%
- K misID prob. ～ 1%

Compatible to Prev. AC

➡ Evaluation of K/π discrimination performance with the New AC



Cylindrical Detector System
provides ～ 4π acceptance

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Performance Evaluation ➤ *Results of Beam Test*



New AC Prototype

0.7 GeV/*c*

New AC

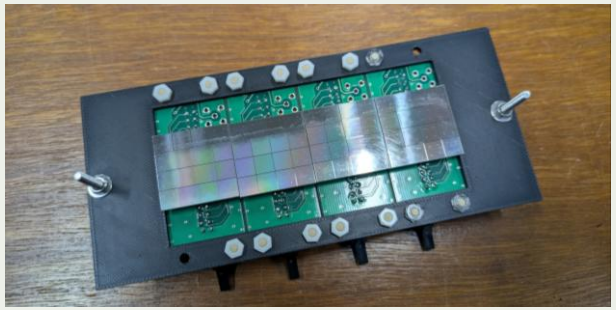
K^-/π^- **Beam**

@ J-PARC K1.8BR beamline

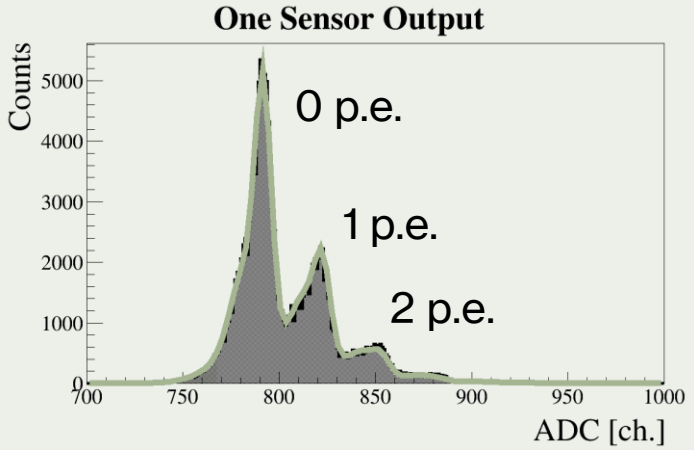
- **Aerogel** (Aerogel Factory)
  10 × 10 cm², 4 cm-thick
  with ESR reflector



- **MPPC** (HAMAMATSU)
  S13361-6050AS-04
  16 sensors × 8 arrays



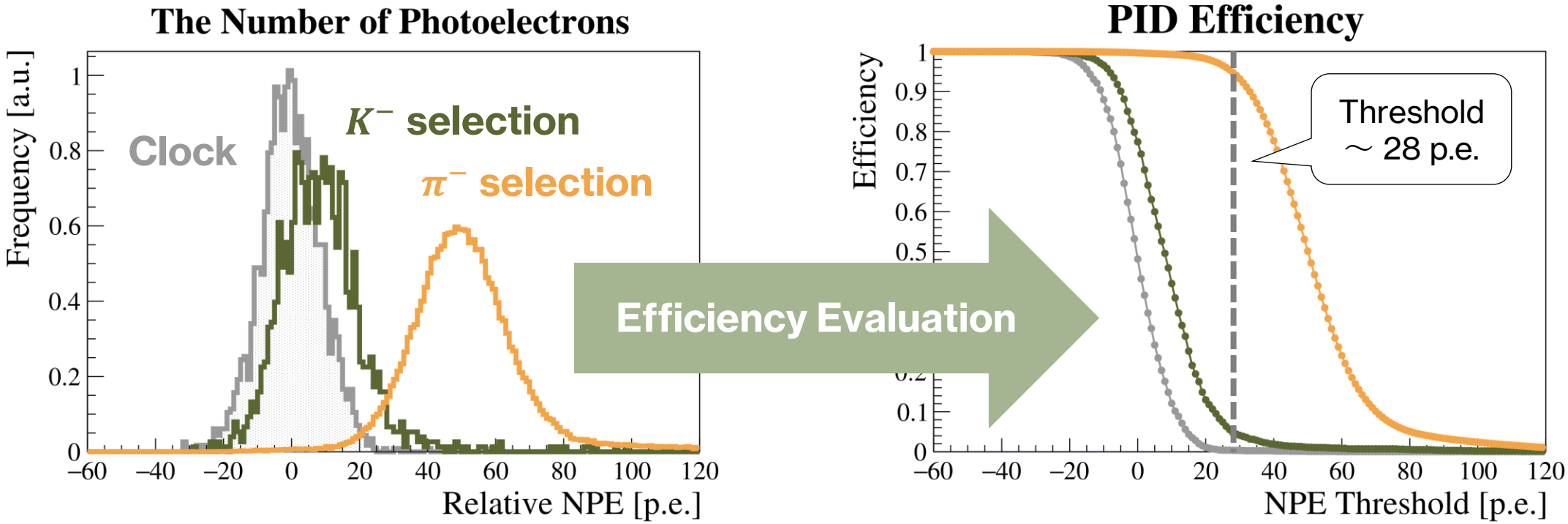
- **NIM-EASIROC** (OMEGA)
  Sensor-by-sensor readout
  128 ch. ADC data taking



ADC-to-NPE Conversion by peak fitting

Sum across All Channels

Performance Evaluation ➤ *Results of Beam Test*



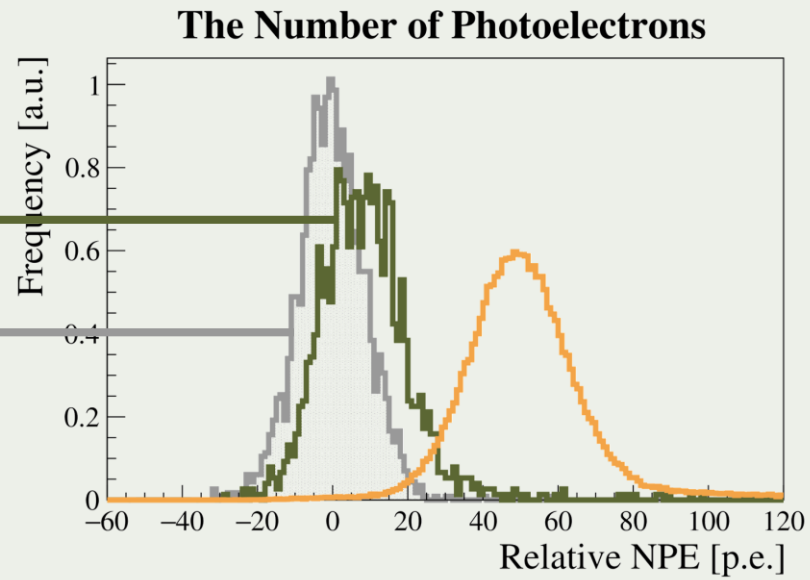
π^- light yield	K^- light yield
~ 49 p.e.	**~ 7 p.e.**
Prev. AC: 15 p.e.	*Prev. AC: 0 p.e.*

π^- efficiency	K^- misID prob.
~ 95%	**~ 5%**
Prev. AC: 99%	*Prev. AC: 1%*

Performance Evaluation ➤ *Areas for Improvement*

Possibility of Improvement

- Some photoelectrons from K events
  - **Different types of reflectors**
    - ➡ Suppression of light emission
- Somewhat broad pedestal peak
  - **Modification of readout method**
    - ➡ Suppression of signal fluctuations



To what extent will these approaches improve K/π discrimination performance of the New AC?

Investigation

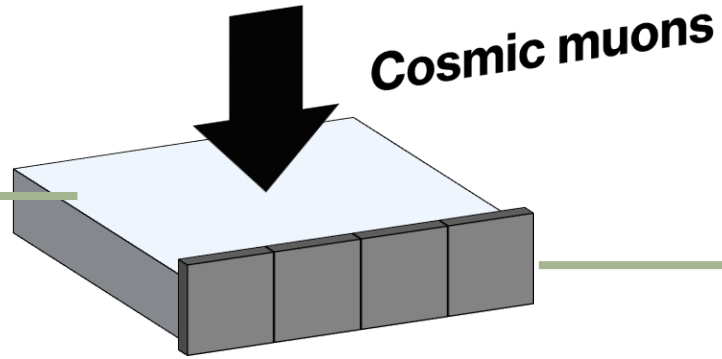
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Optimization Studies ➤ *Reflective Materials*

Reflector w/o Aerogel

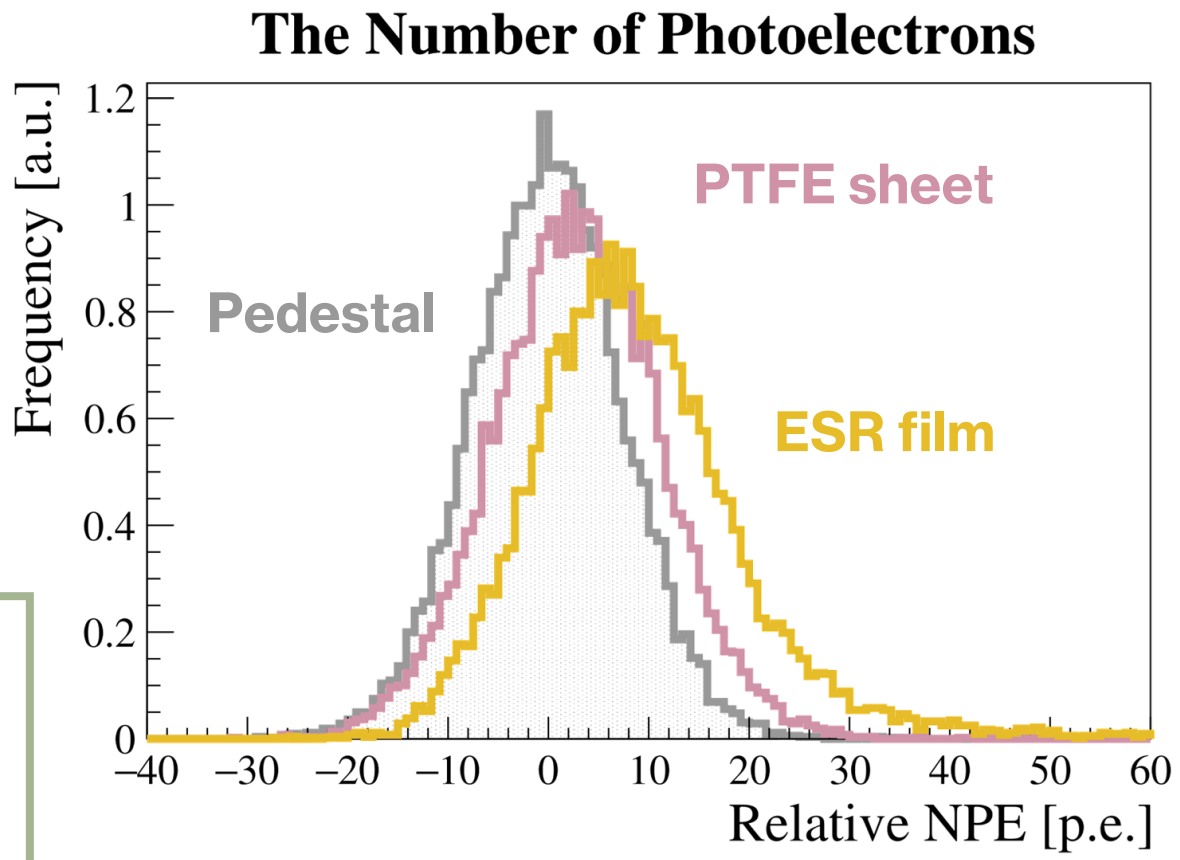
- ESR film (65 μm-thick)
- PTFE sheet (100 μm-thick)



MPPC arrays x4

➥ ADC readout by NIM-EASIROC

➥ ADC-to-NPE conversion



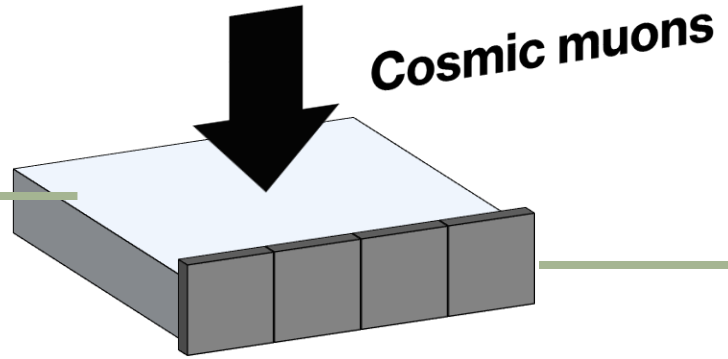
- ESR: Some photoelectrons
- PTFE: Only a few photoelectrons

x0.4

Optimization Studies ➤ *Reflective Materials*

Reflector w/ Aerogel

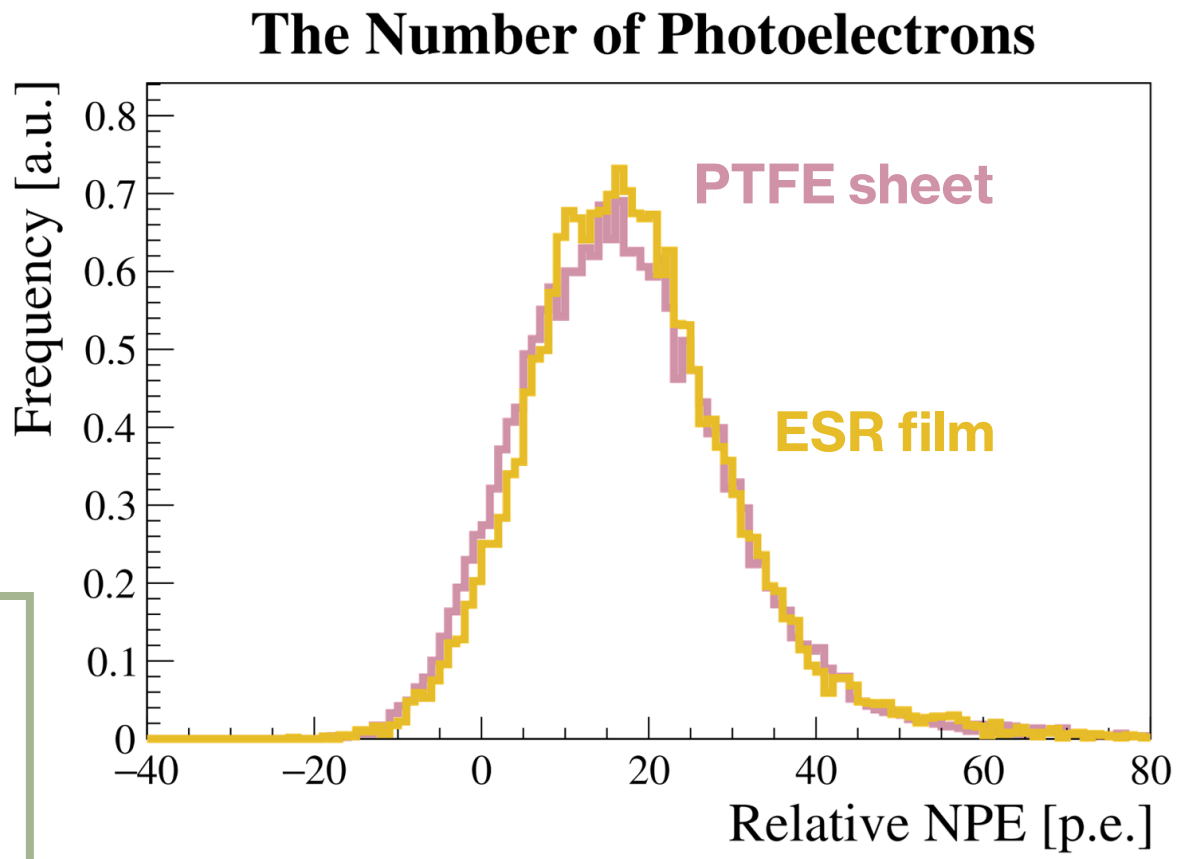
- ESR film (65 μm-thick)
- PTFE sheet (100 μm-thick) x3



MPPC arrays x4

➥ ADC readout by NIM-EASIROC

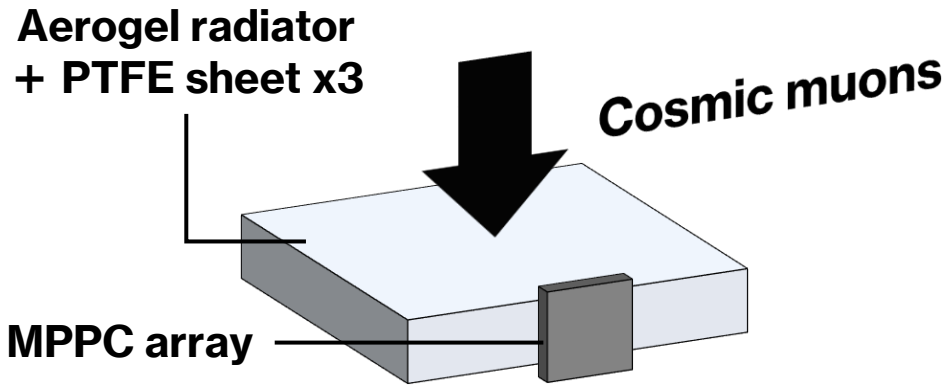
➥ ADC-to-NPE conversion



■ Almost the same light yield obtained

➥ **“PTFE” is a superior material!**

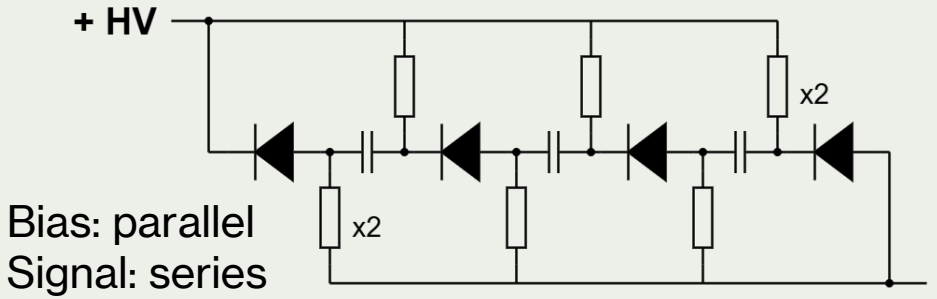
Optimization Studies ➤ *Readout Methods*



Readout Methods

- ◆ **Channel-by-channel**
  - ➥ ADC readout by NIM-EASIROC
  - ➥ ADC-to-NPE conversion
- ◆ **Analog-sum**
  - ➥ 16 ch. sum on amp. board
  - ➥ ADC readout by V792

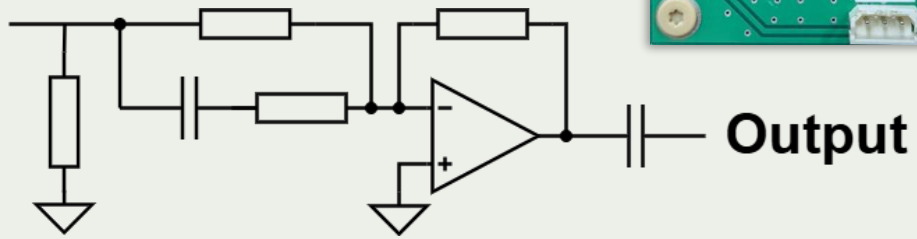
MPPC (4 ch. hybrid connection)



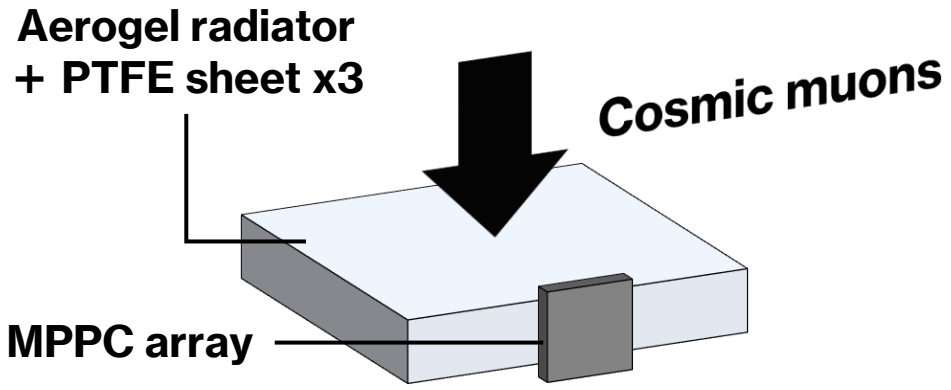
x4 (16 ch. sum)



Inverting Amplifier

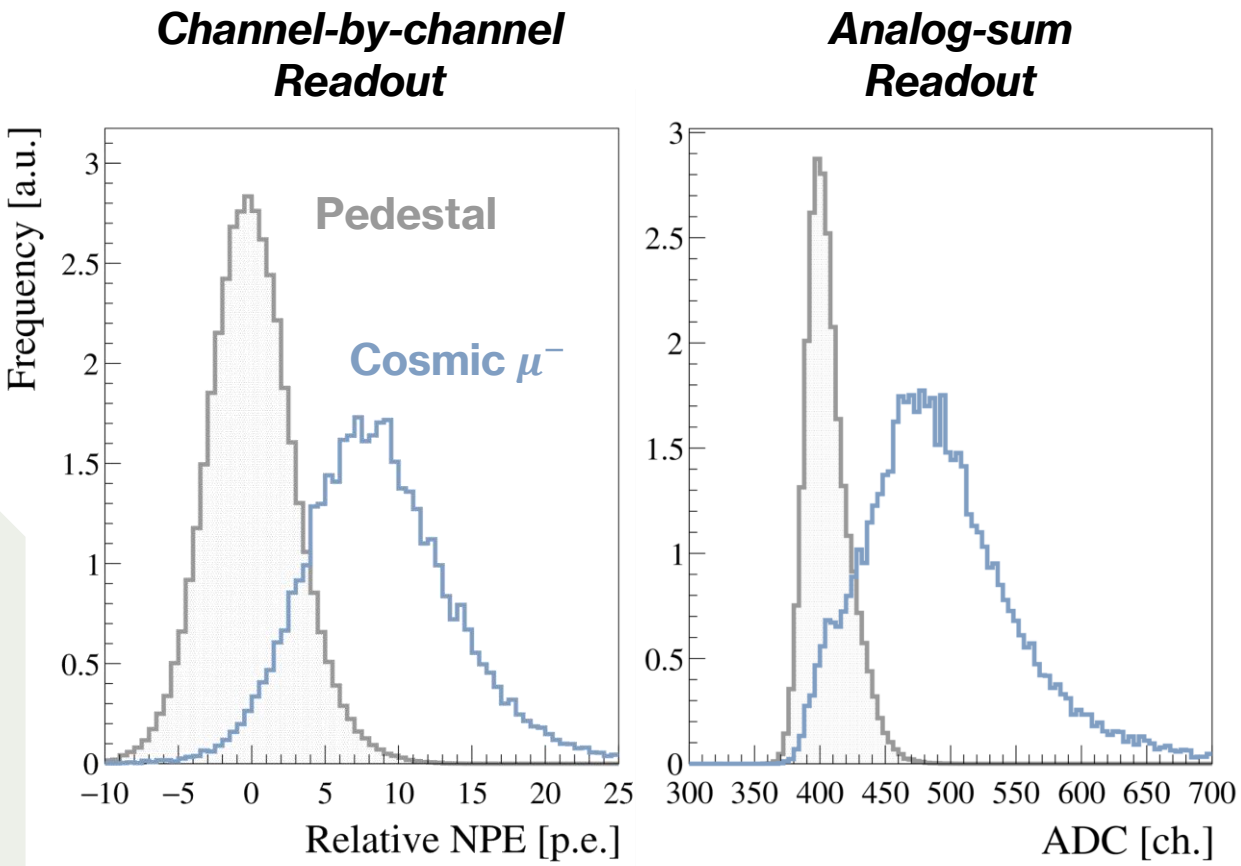


Optimization Studies ➤ *Readout Methods*



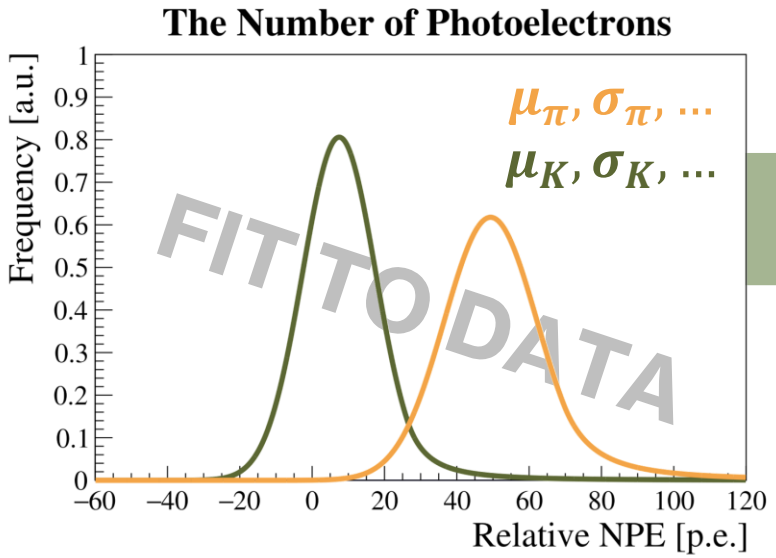
Readout Methods

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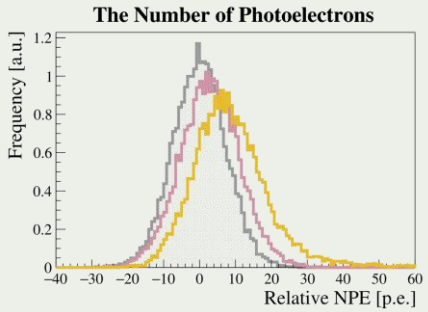


- ■ Difference in peak separation
  - ➥ **“Analog-sum” is a superior method!**

Optimization Studies ➤ *Performance Estimation*



[Correction 1] Reflective Materials



ESR film

$\mu'_\pi = \mu_\pi$ $\quad$ $\mu'_K = 0.4\mu_K$

PTFE sheet

[Correction 2] Readout Methods

Assumption

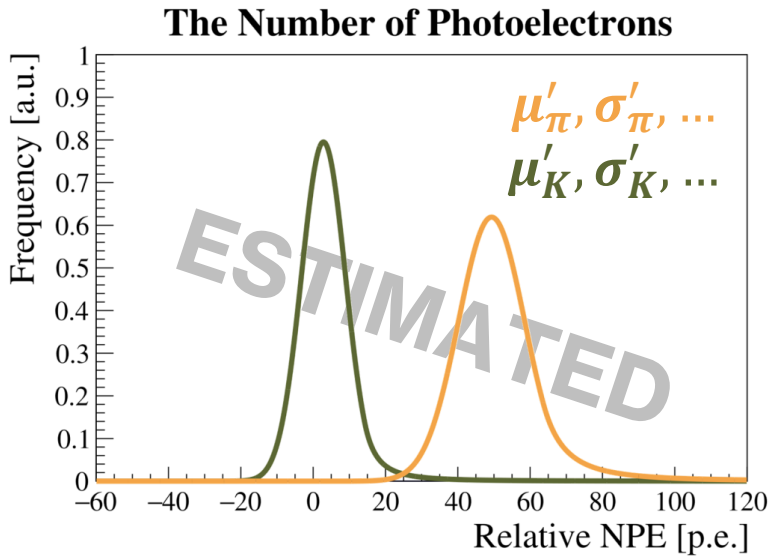
$\sigma^2 = \lambda + \omega^2$

λ : Mean of Poisson distribution
ω : SD of Gaussian distribution

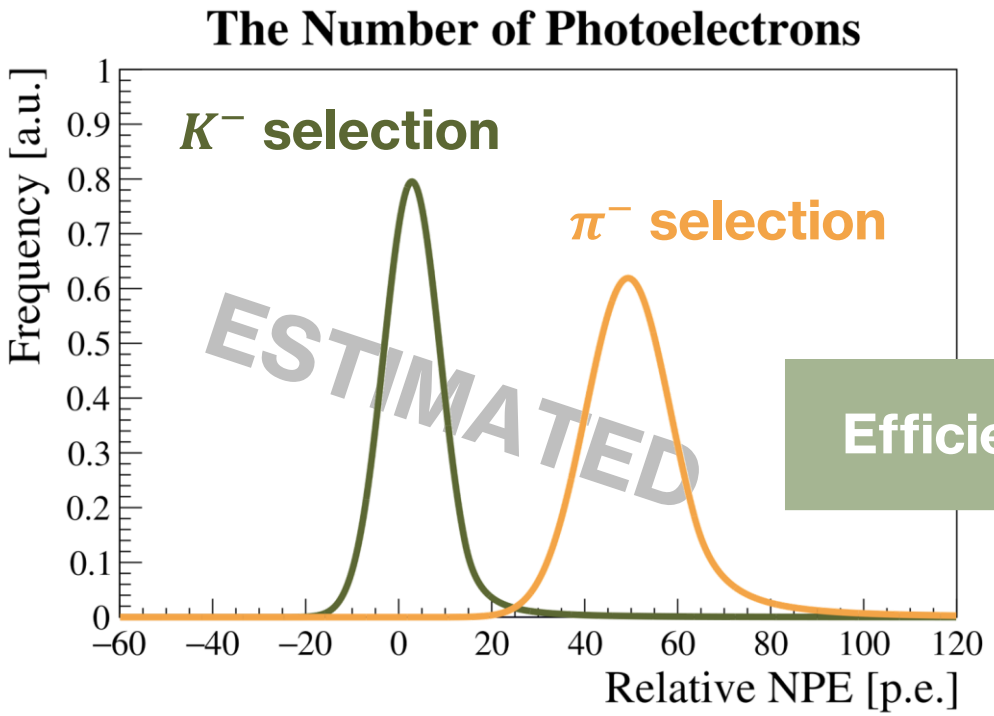
Negligible with Analog-sum

$\sigma'_\pi = \sqrt{\lambda_\pi}$

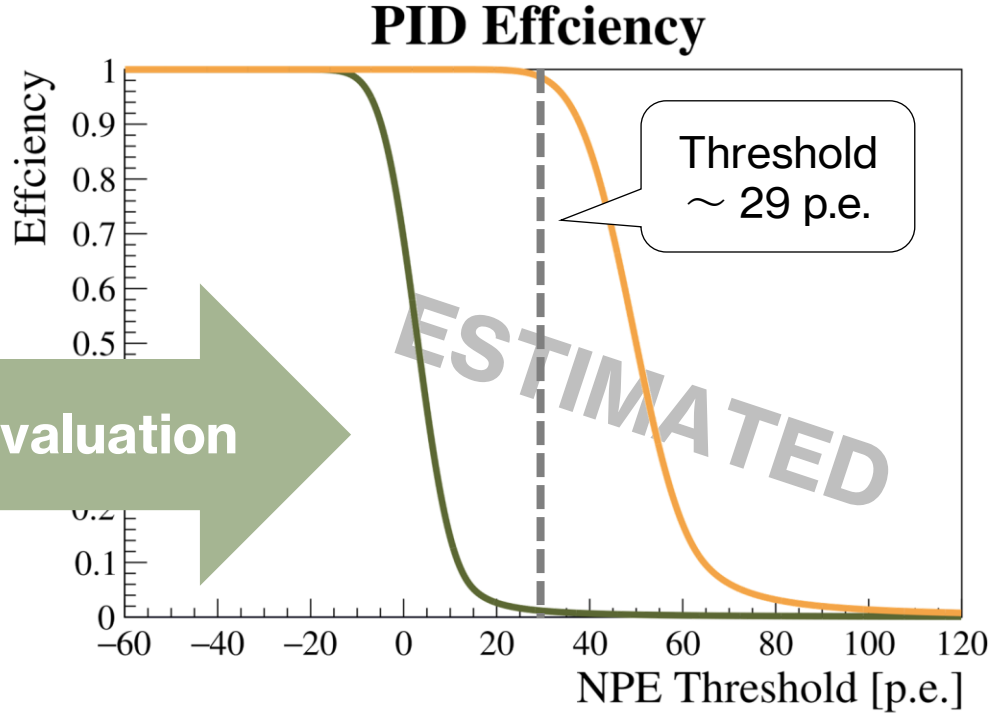
$\sigma'_K = \sqrt{\lambda_K}$



Optimization Studies ➤ *Performance Estimation*



Efficiency Evaluation



π^- light yield	K^- light yield
~ 49 p.e.	**~ 3 p.e.**
Prev. AC: 15 p.e.	*Prev. AC: 0 p.e.*

π^- efficiency	K^- misID prob.
~ 99%	**~ 1%**
Prev. AC: 99%	*Prev. AC: 1%*

Summary

New Aerogel Čerenkov Detector with MPPC Readout

» Compact and magnetic-field tolerant for "$K^- ppn$" search

Performance Evaluation of New AC

» Revealing room for improvement in K/π peak separation

Optimization Studies of Reflective Materials & Readout Methods

» Suggesting improvement with revised configurations

Further Investigation

» Assessing the achievable performance during the next beam time