Use of Artificial Neural Network for Event Reconstruction in FARICH detector

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Event reconstruction using Neural Networks

Motivation

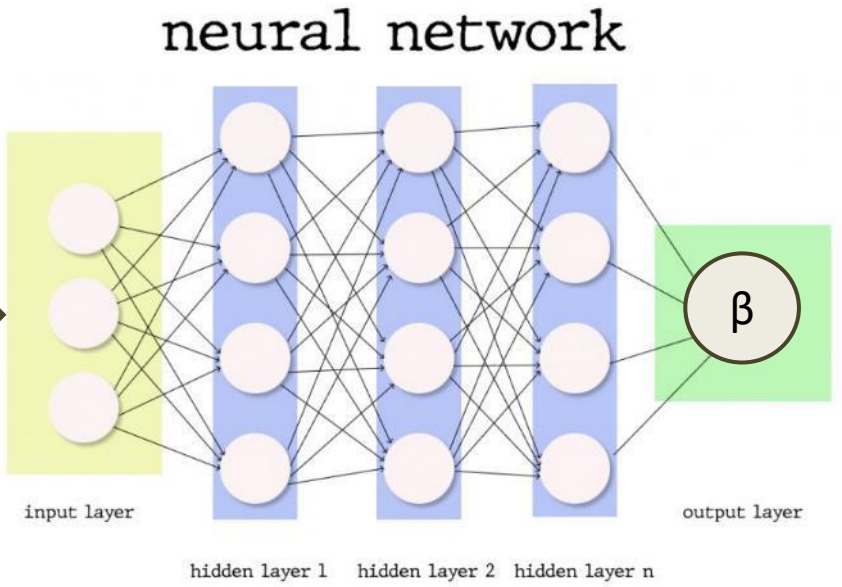
- Alternating approach to event reconstruction with a potential to include all observed data without knowing PDFs → flexibility
- More straightforward and attractive for developer

Implementation

- Python with Pandas, TensorFlow, etc. packages
- Geometrical reconstruction of hit θ_c, φ_c, then NN training
- Obtain particle's β from a single NN output

N_{hits} (i, j, k)
i – bin on ϕ_c
j – bin on θ_c
k – bin on time

particle inc. angle



SCTF FARICH simulated configuration

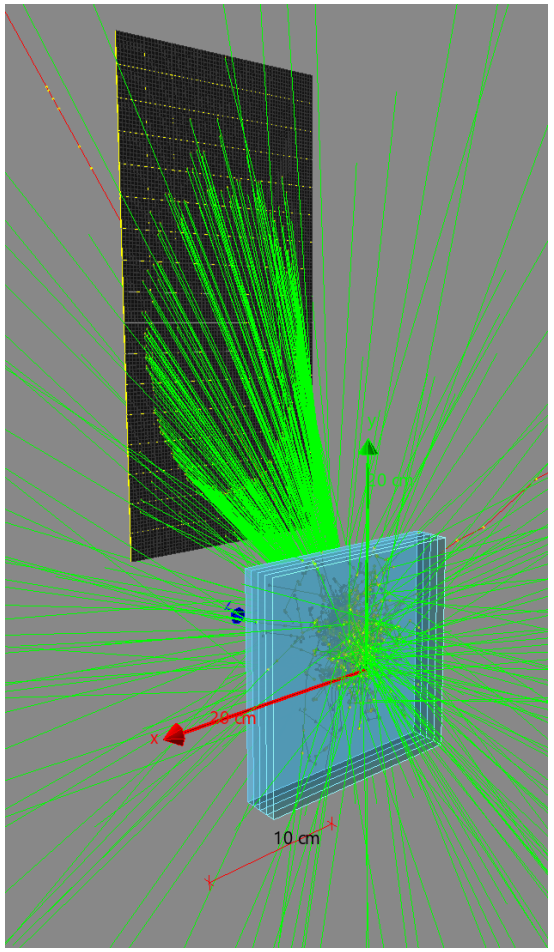
Photon detector

- ON Semiconductor (SensL) ArrayJ-30020-64P-PCB
- Pixel size 3.16×3.16 mm^2
- Pixel pitch 3.36 mm
- U_{bias} = 2.5V
- λ_{max}≈400 nm, PDE_{max}≈ 38%
- Sensor geom. fill factor ≈ 88%

Radiator

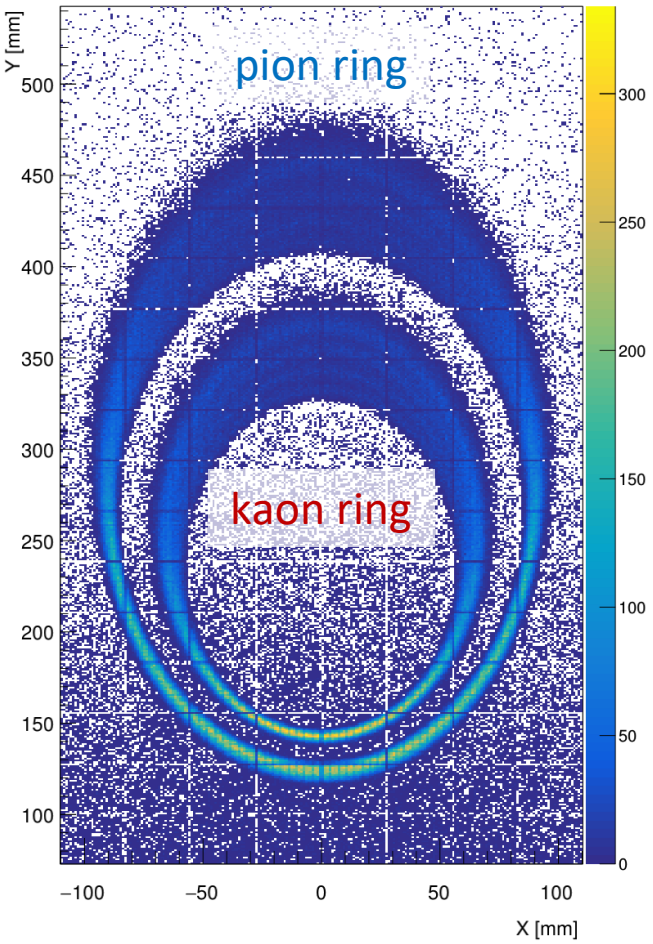
- 4-layer focusing aerogel
- n_{max} = 1.05
- 35 mm thickness

PD-Radiator distance: 200 mm

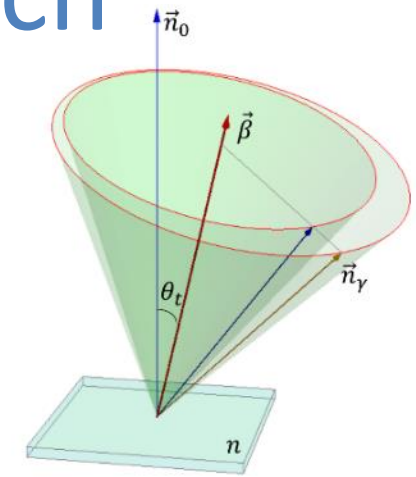


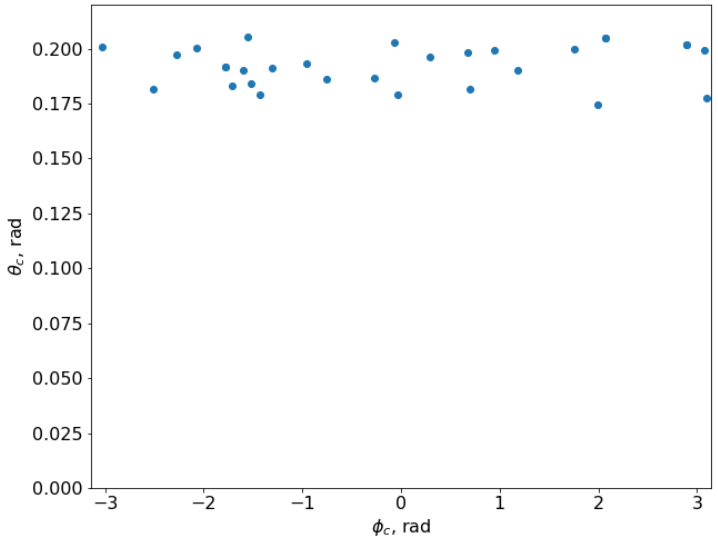
Event reconstruction using geometric approach

Accumulated hit map
P = 2.4 GeV/*c*, θ_p = 45°



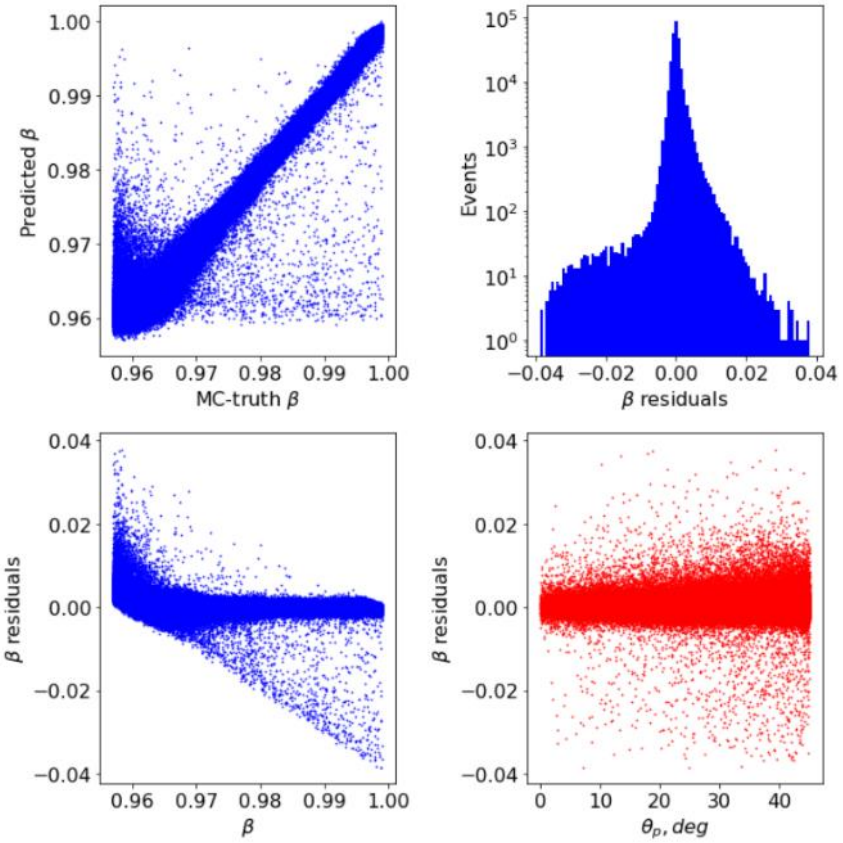
θ_c, ϕ_c – photon angles in the nominal point of origin w.r.t. particle direction

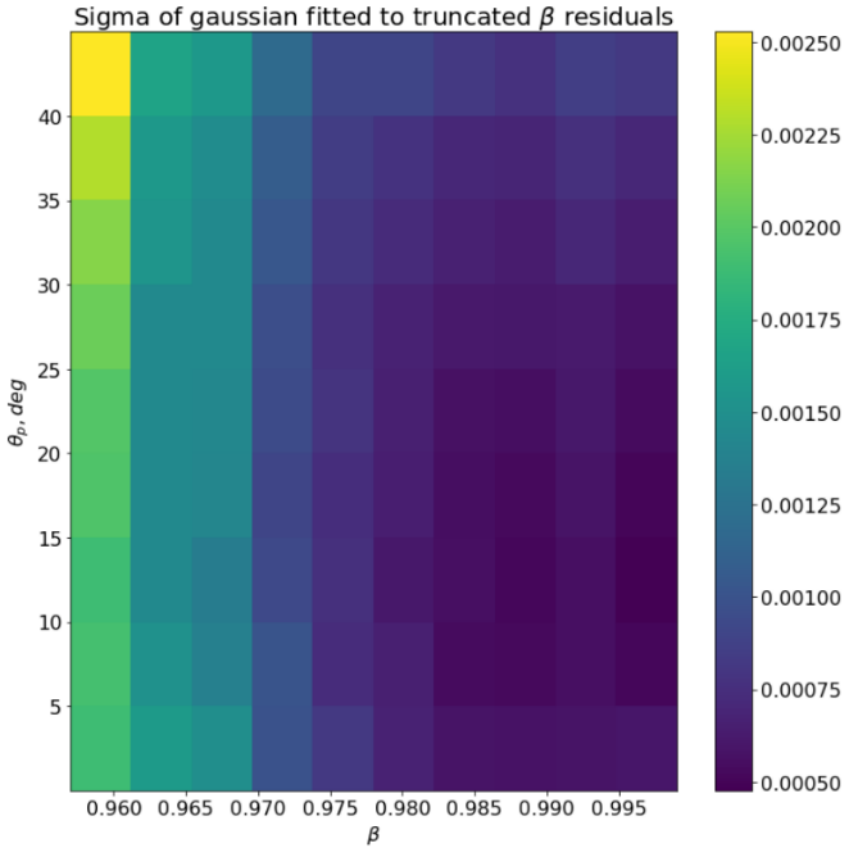




Results of NN event reconstruction

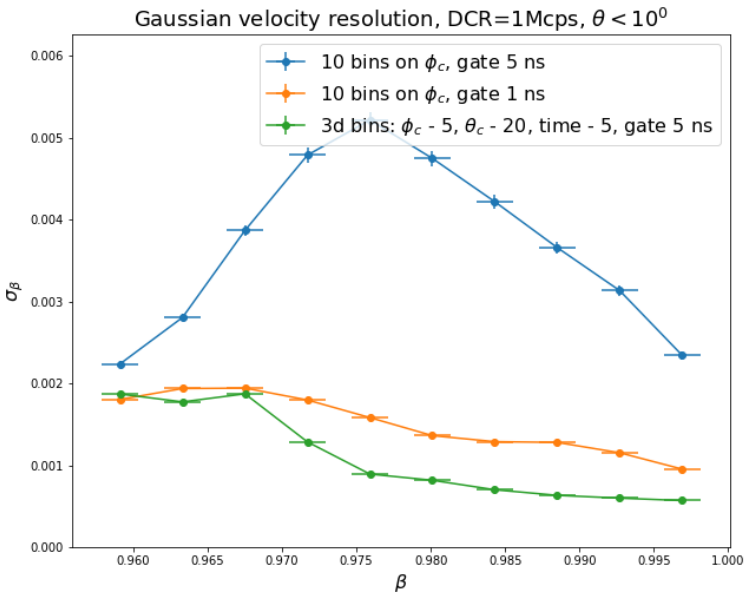
Scatter plots for β residuals

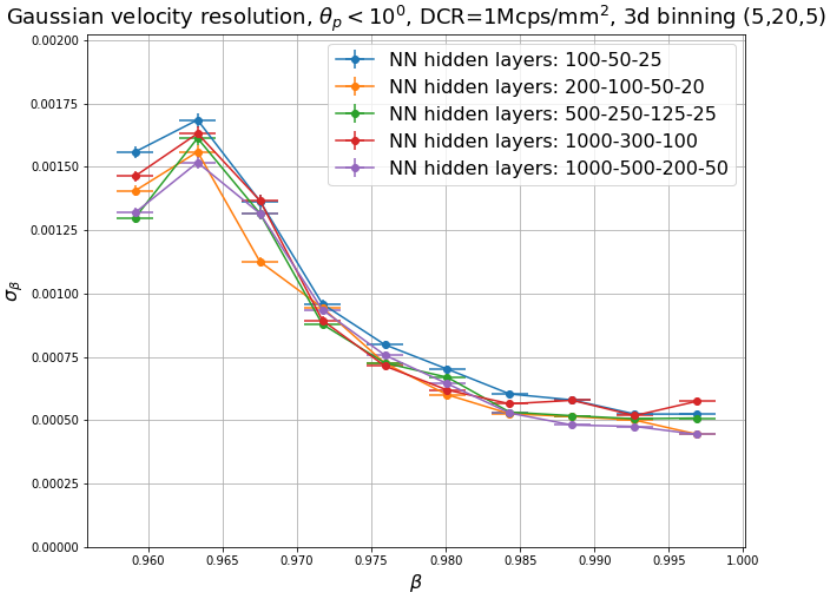




≥ $5 \cdot 10^{-4}$ β resolution for 1 Mcps/mm^2 dark count rate

Comparison of reconstruction approaches

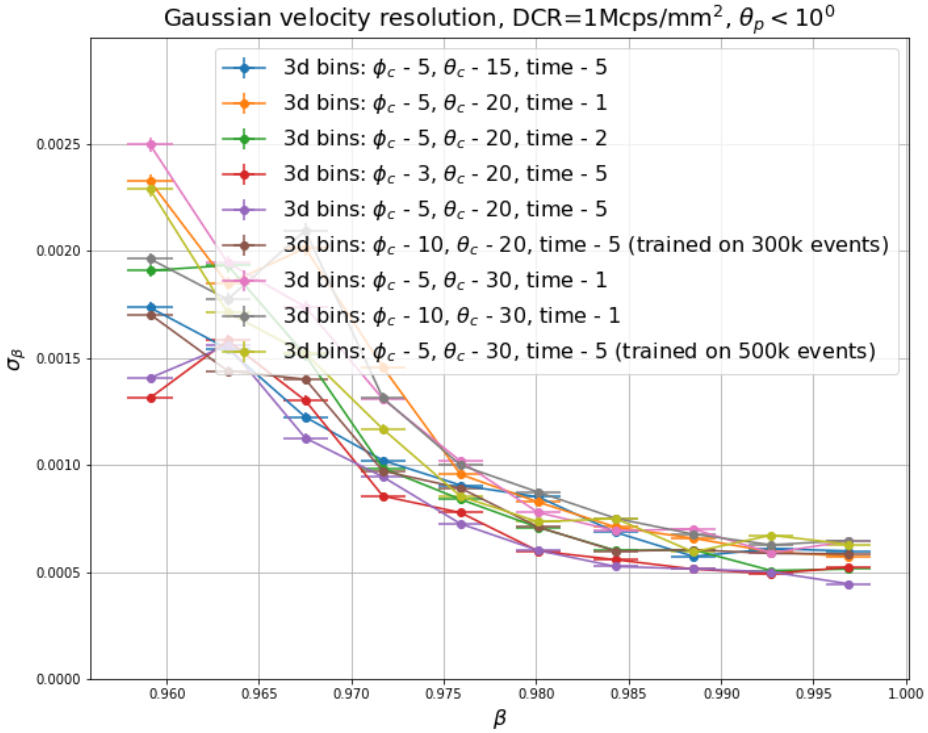




- Geometrical reconstruction with a fit to θ_c (ϕ_c) dependence gives $\sigma_\beta \approx 4 \cdot 10^{-4}$ (θ_p=0°, no DCR)
- Evaluation from SPE radius resolution gives $\sigma_\beta \approx 3 \cdot 10^{-4}$

NN performance

Different binning of hits



Dependance on DCR