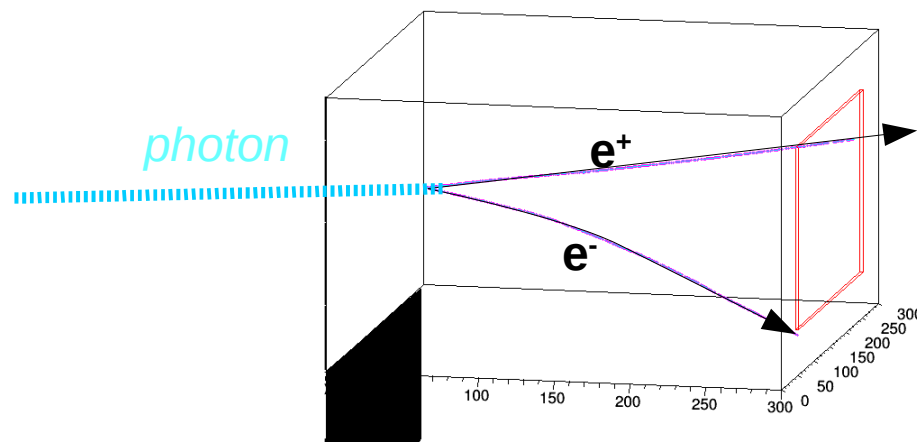


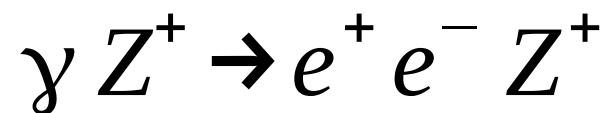


- Event configuration
- Reconstructions v1 & v2
- Reconstruction v3
 - details
 - results
- New Kalman tracking

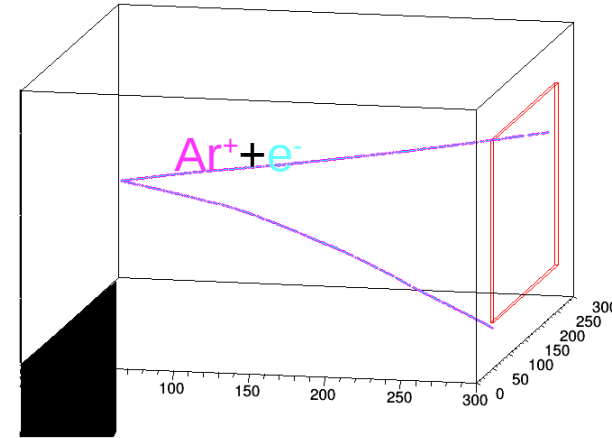
TPC: photon conversion



The incoming photon interacts with the gas and decays into an electron-positron pair

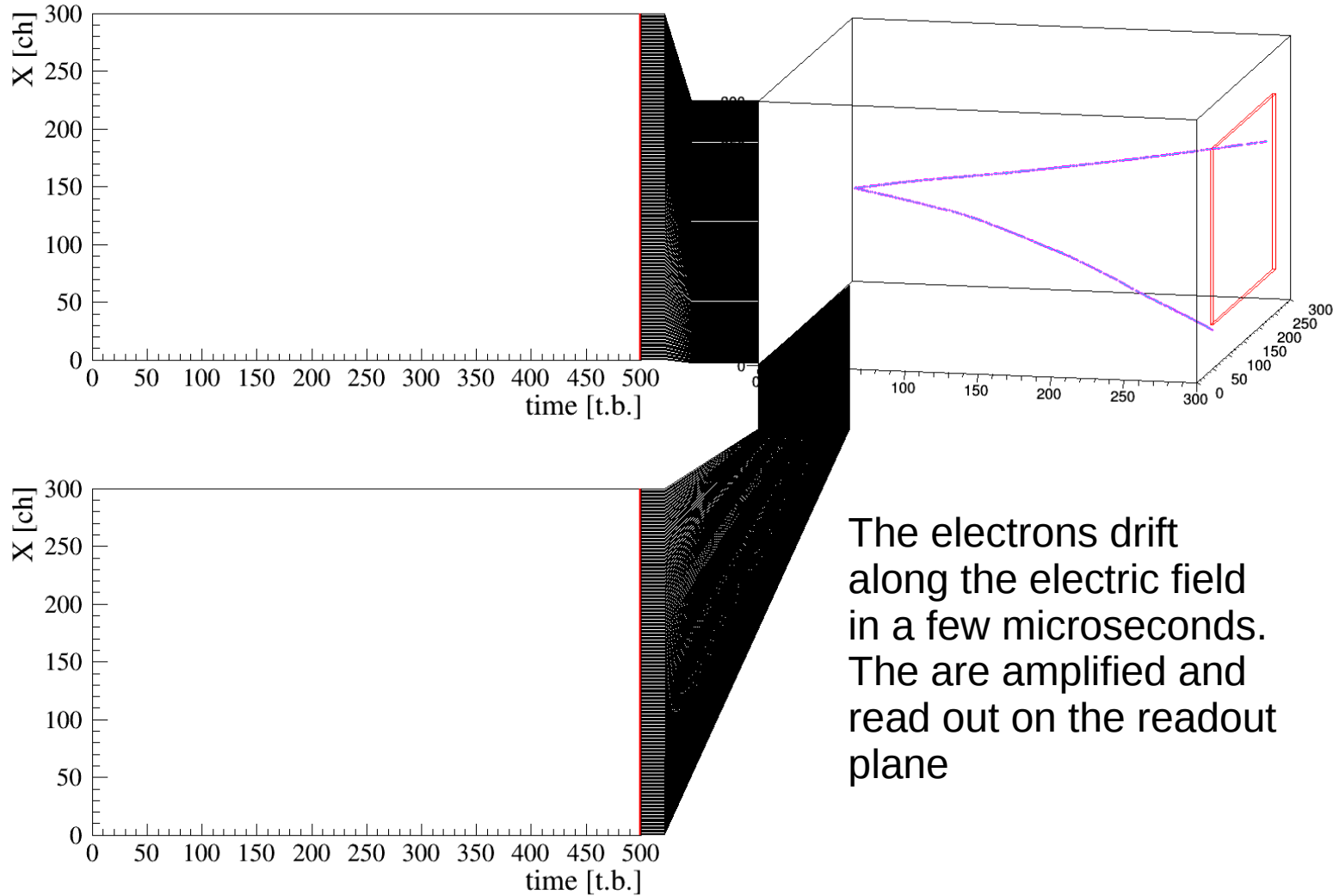


TPC: Gas ionisation



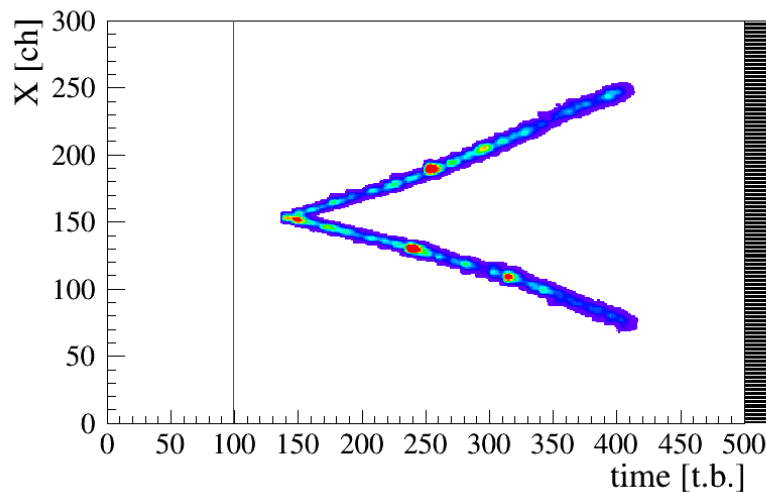
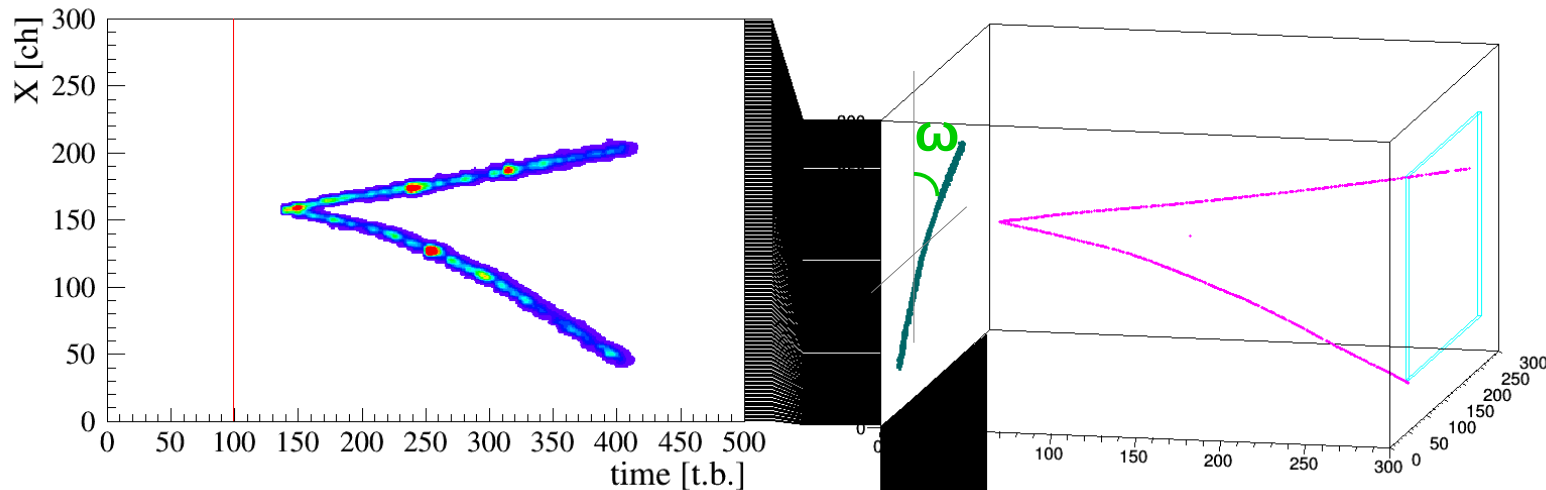
The electron and positron travel through the gas (mostly Argon) and ionises it, freeing many electrons and positive ions
This takes a few nanoseconds

TPC: Drift and Readout



The electrons drift along the electric field in a few microseconds. They are amplified and read out on the readout plane

Polarisation measurement



The azimuthal angle ω is related to the polarisation direction ω_0

$$\frac{d\Gamma}{d\omega} \propto 1 + AP \cos(2(\omega - \omega_0))$$

A : polarisation asymmetry

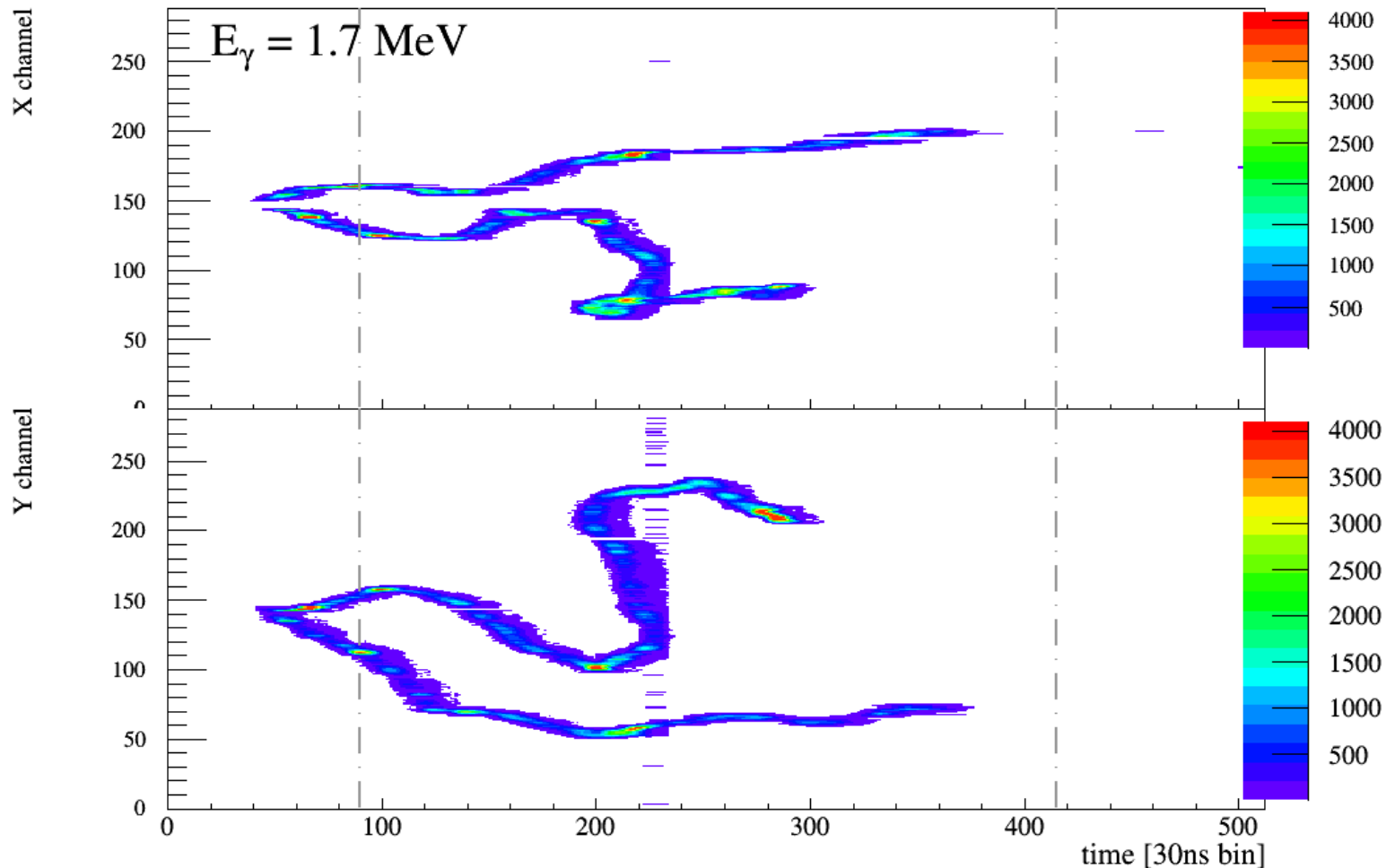
P : polarisation fraction

Examples of events

13 Energy points, 1.74 to 74 MeV



- *Experimental setup presented at TeVPA 2015 in Kashiwa*



Polarimetry in the pair regime with HARPO

Philippe Gros, LLR, CNRS/IN2P3, France

TeVPA2016, CERN



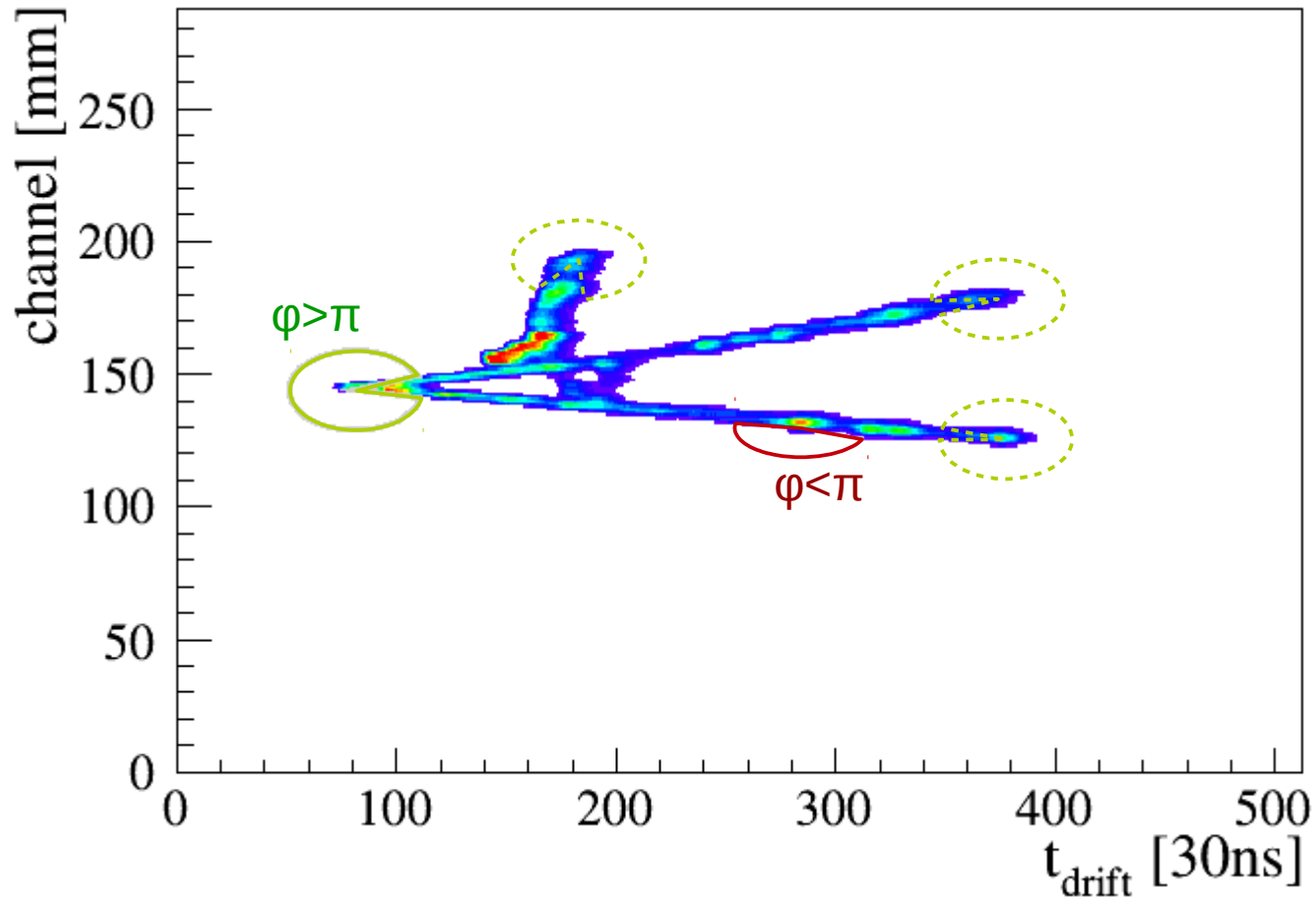
- Developed on cosmic-ray data
- Classic 1D clustering
 - C-clusters (for each Channel)
 - T-cluster (for each Time bin)
- Hough tracking (straight lines)
 - works well for separated straight tracks (cosmics)
 - fails with vertexes and multiple scattering
- X-Y track matching
- Vertexes from POCA



- Adaptation for gamma events
- Same clustering
- Home-made Kalman-like tracking
 - Seed on edges
 - Look for closest neighbour
 - Choose C or T cluster depending on local track angle
 - Unreliable close to vertex => straight line fit
 - Very unstable...
- Same matching and vertexing

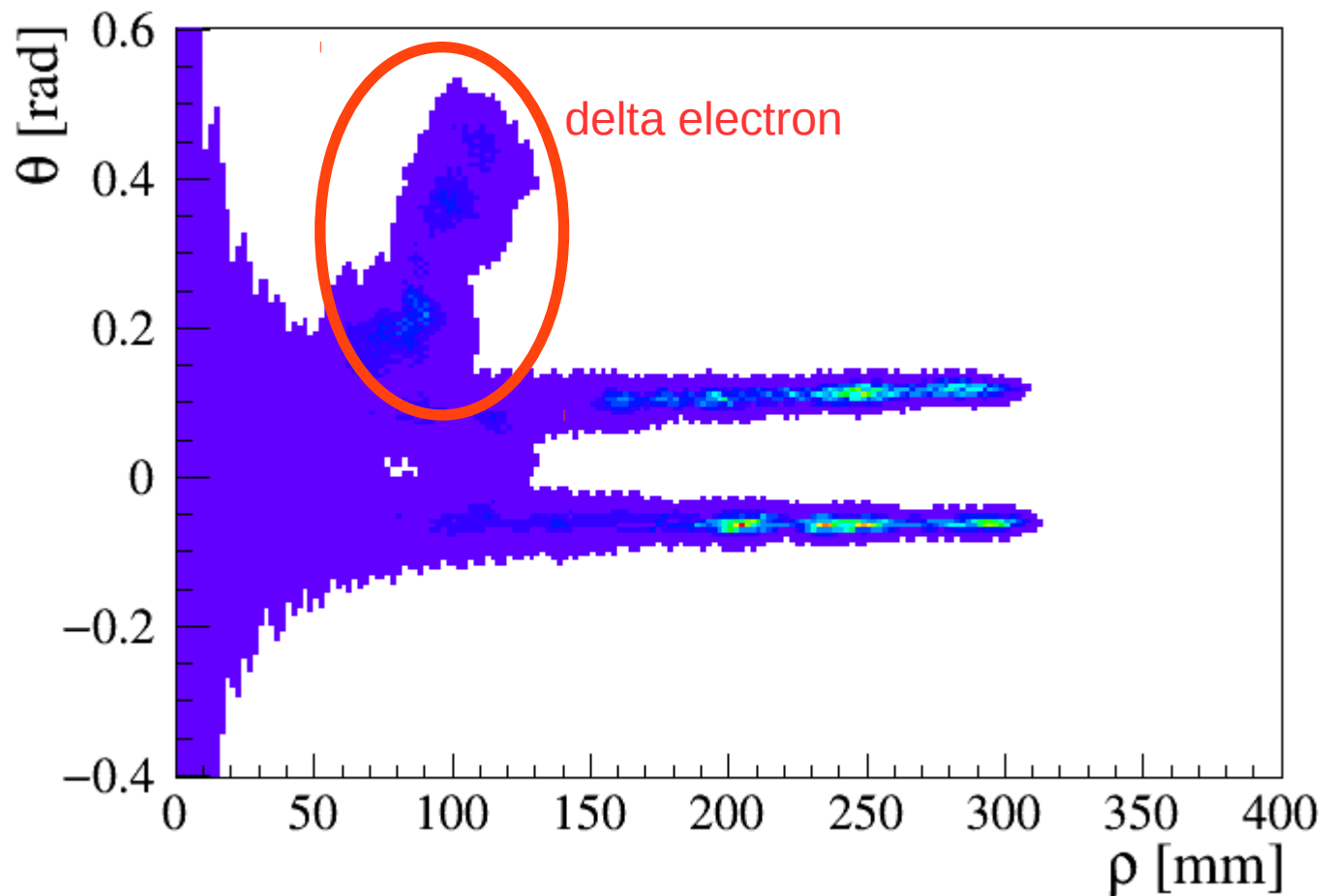


- Developed for pair events
- Relies on low noise
- Local geometry
- No clustering, no tracking



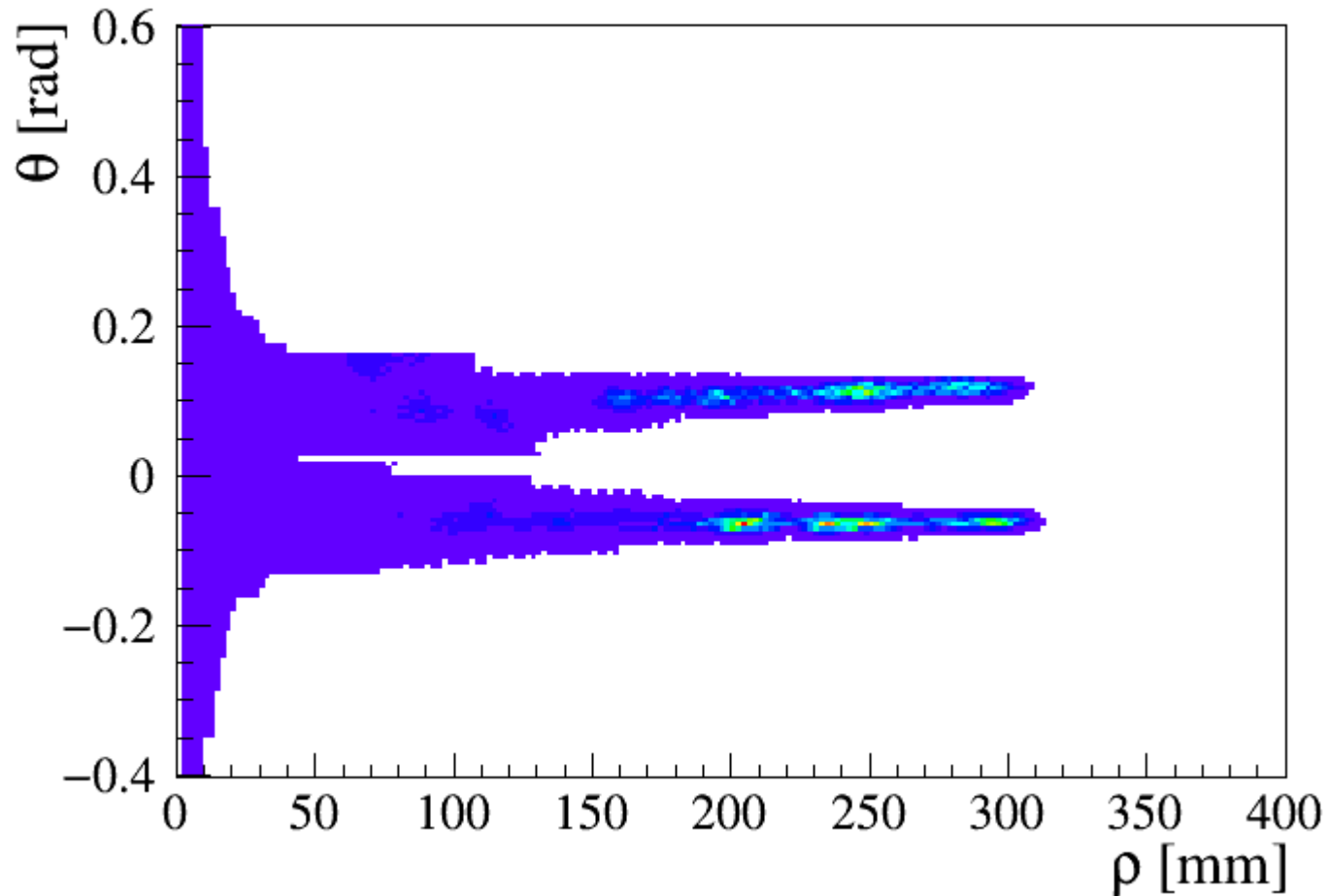


- Polar charge distribution around vertex

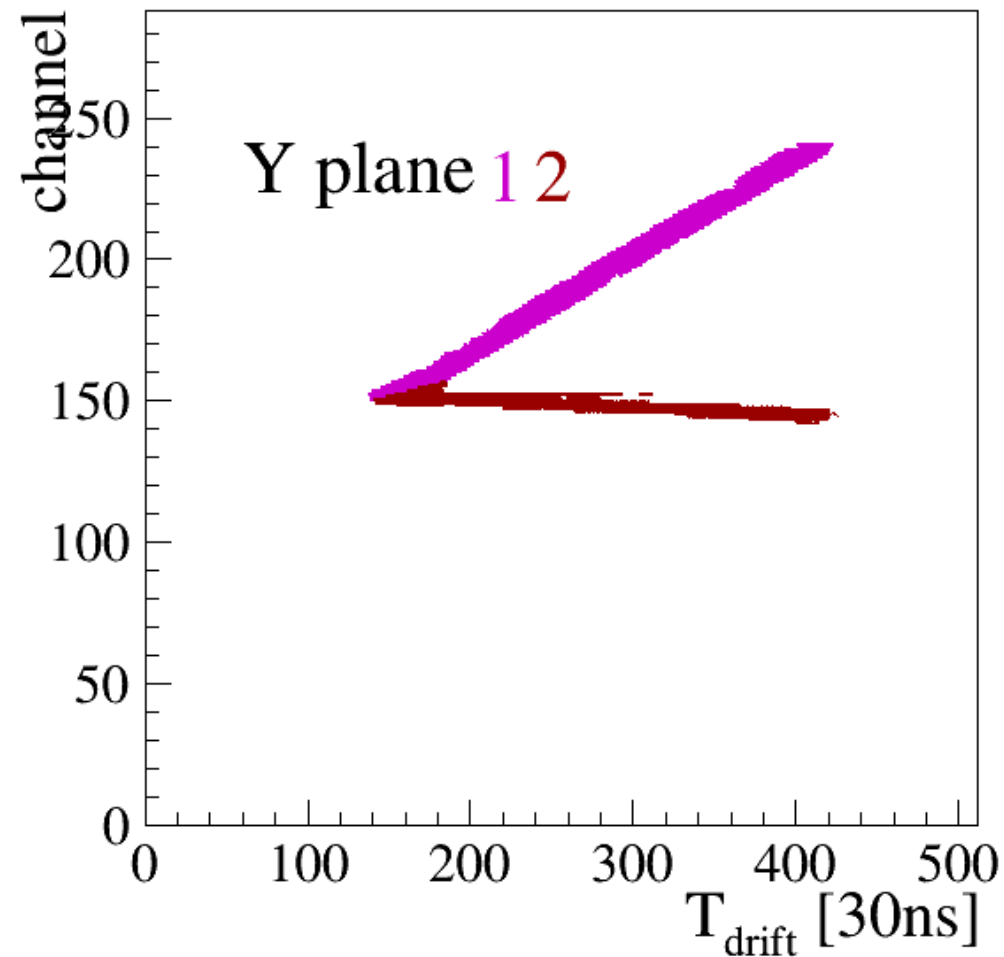
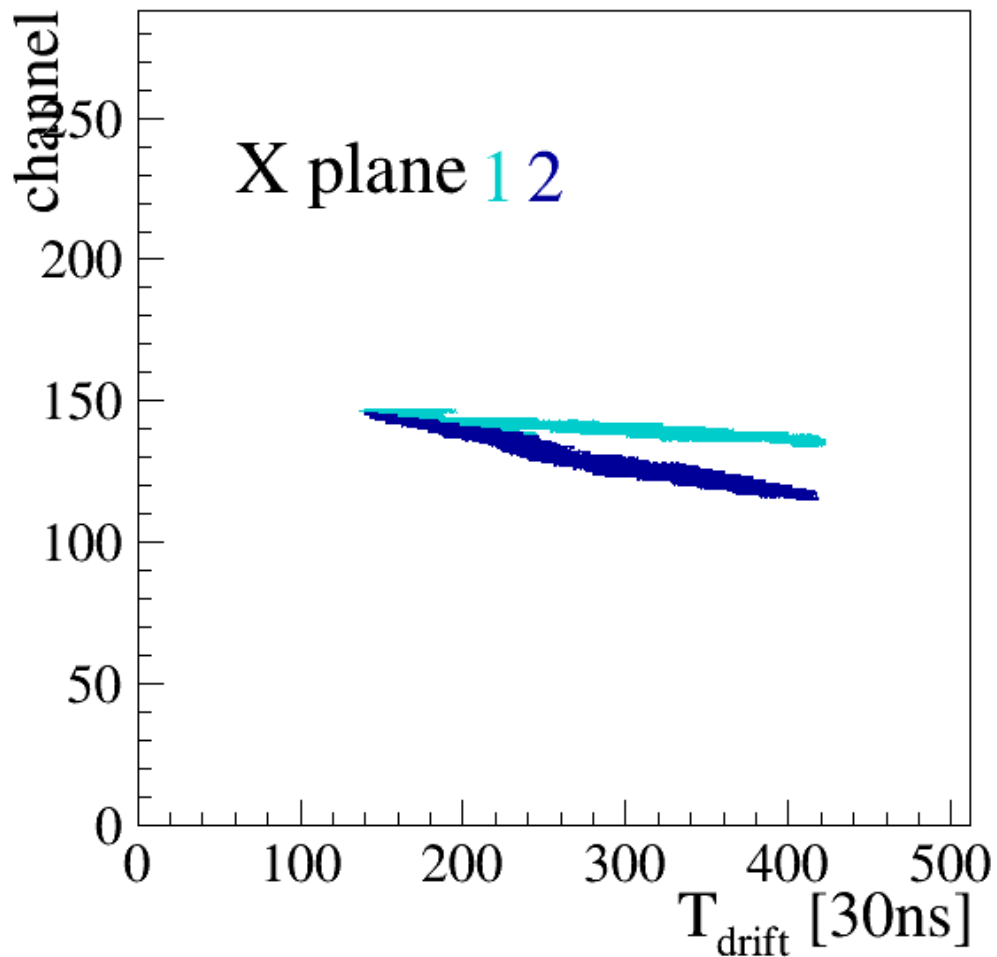




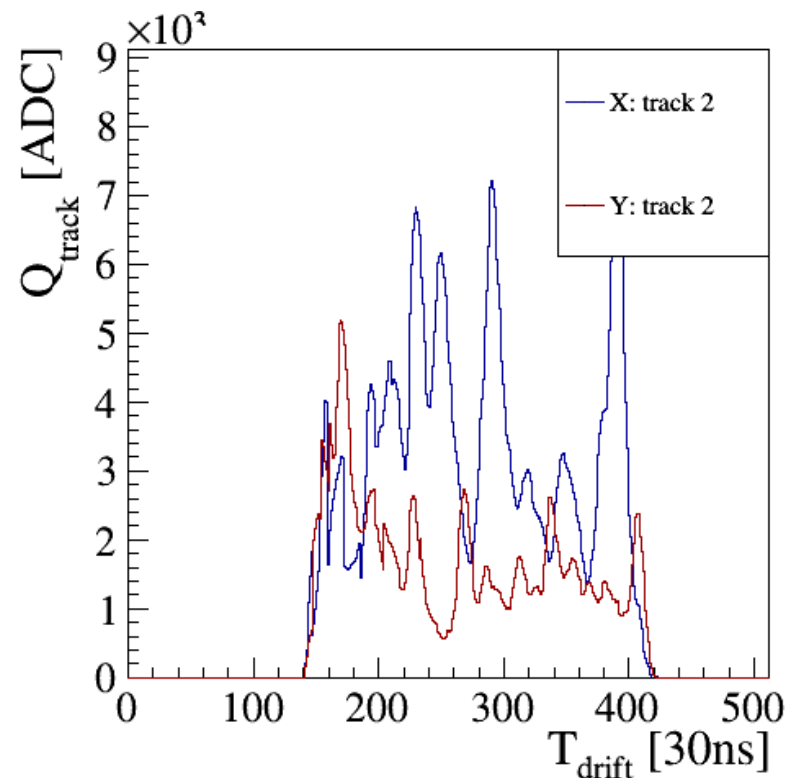
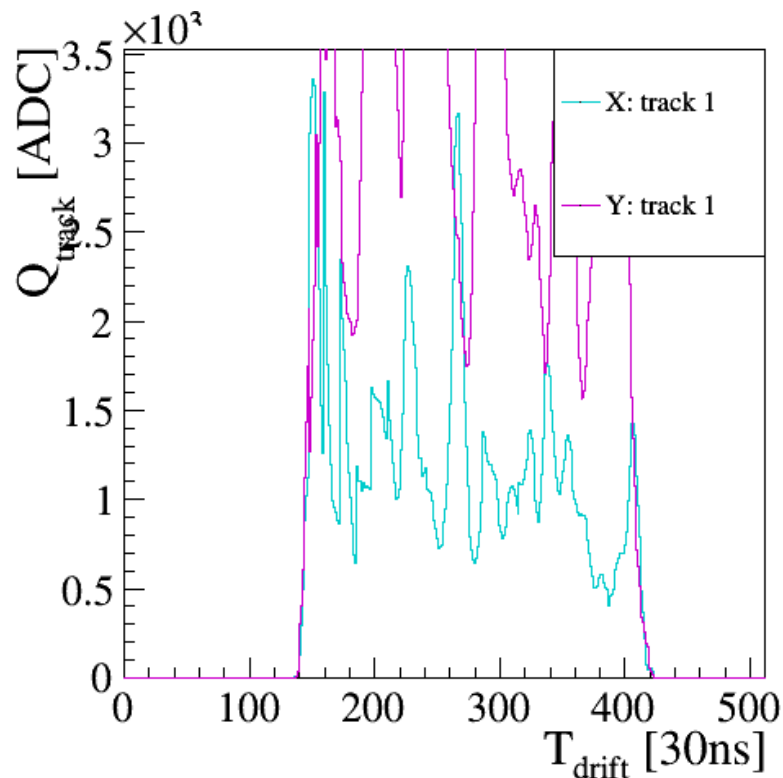
- Clean up: keep only straight lines



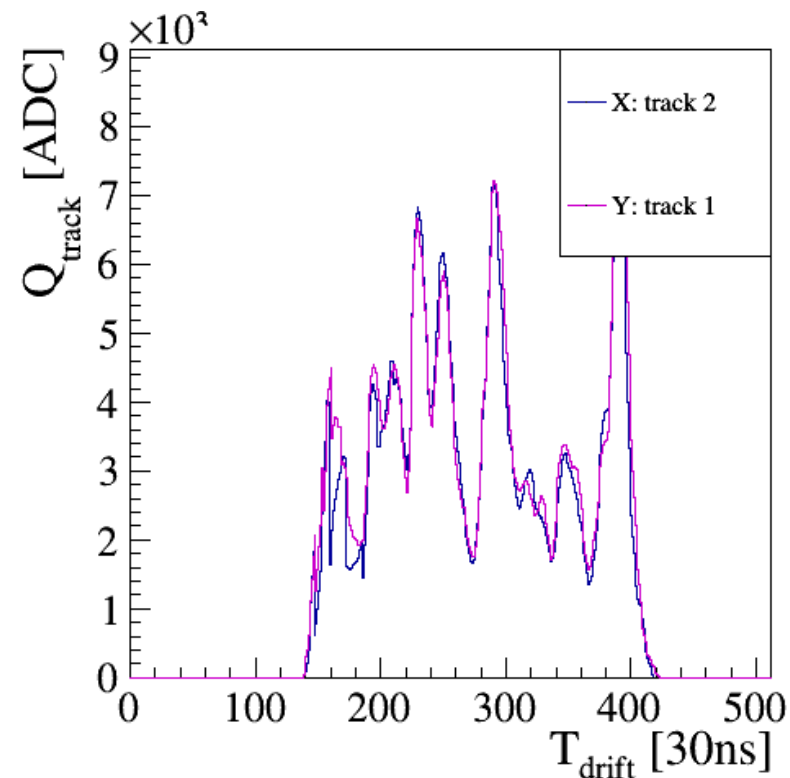
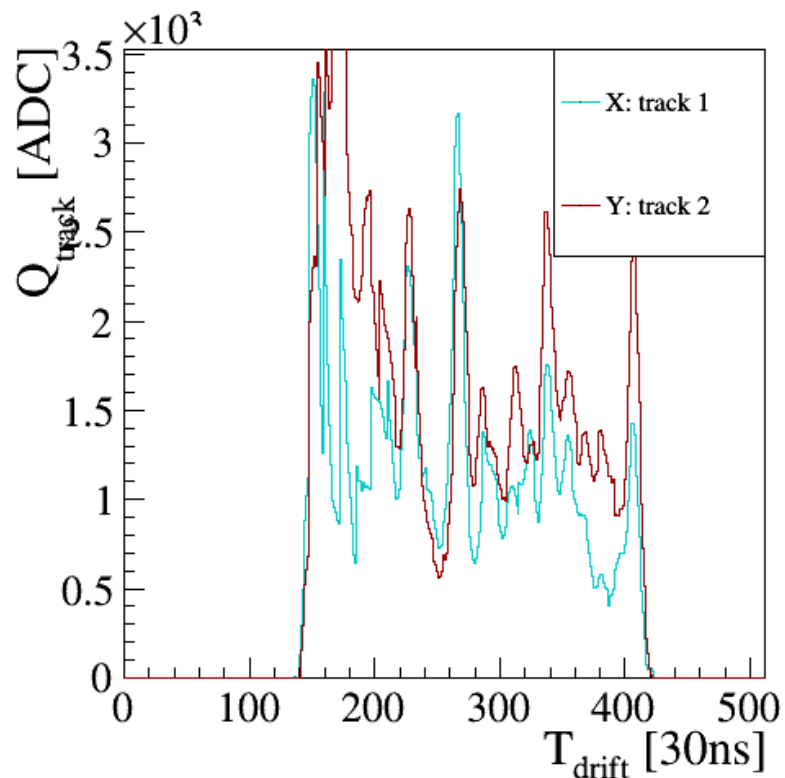
- Assign signal to tracks



- Compare profiles: $X(1,2) \leftrightarrow Y(1,2)$ “same”

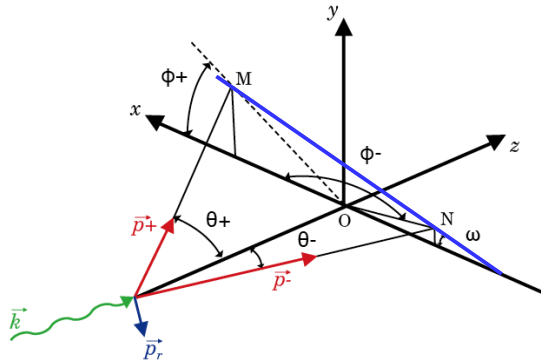


- Compare profiles: $X(1,2) \leftrightarrow Y(2,1)$ “switch”

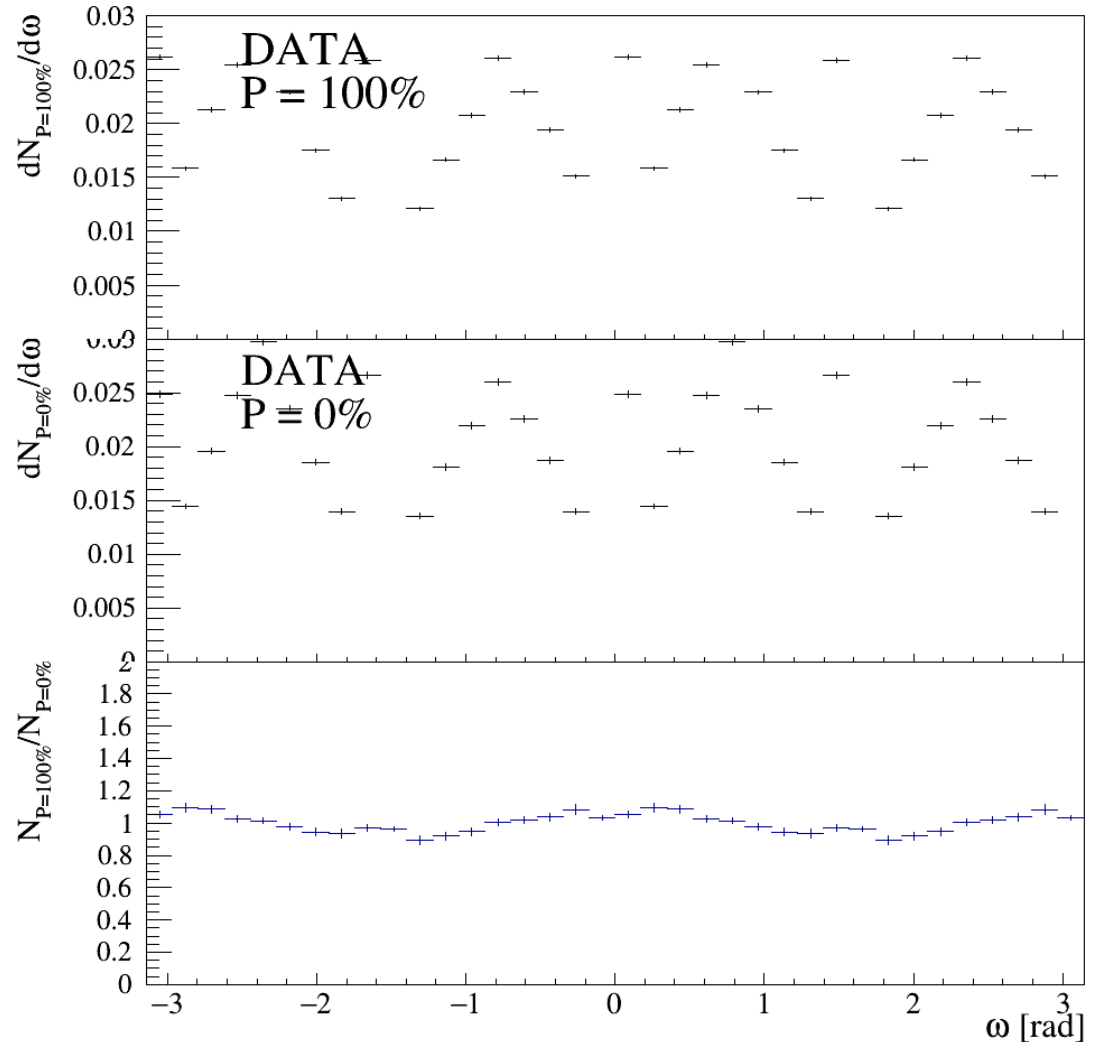


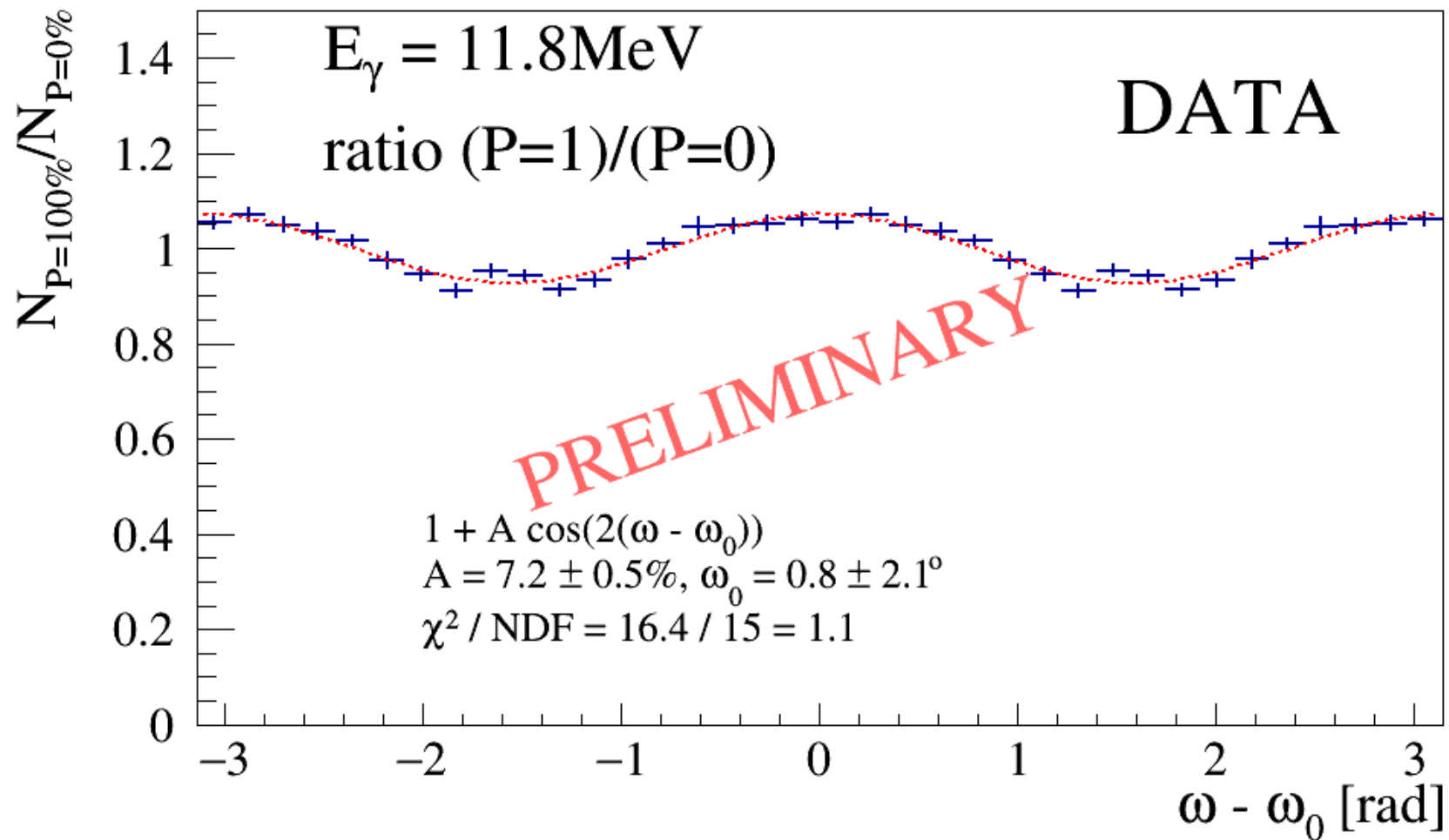


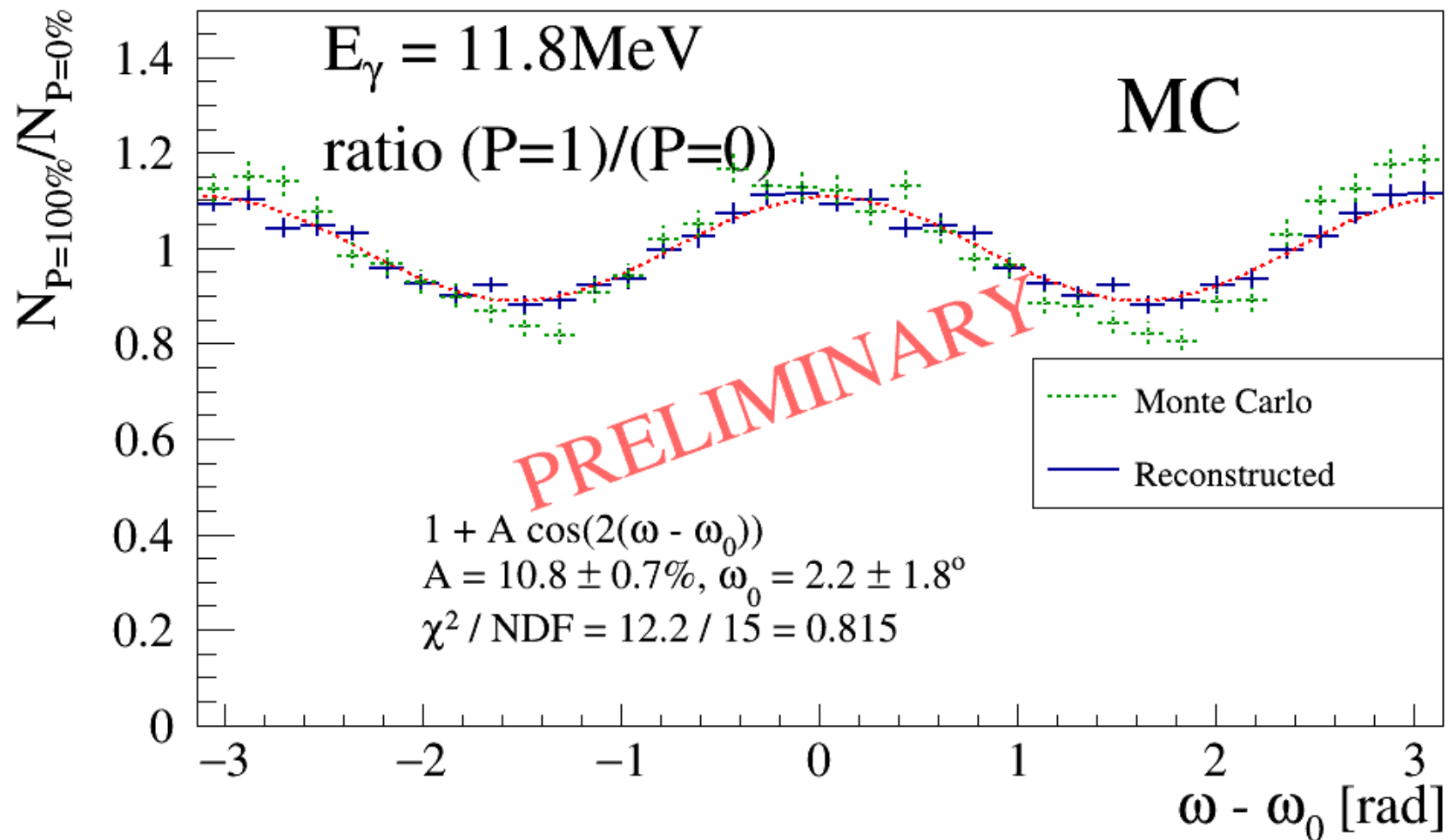
- Simple and robust
- Good vertex reconstruction
- No vertex selection
 - currently: use beam position
 - need better track/vertex identification
- Plan: Kalman tracking from vertex seed
 - better vertex ID
 - possible momentum estimate (from scattering)

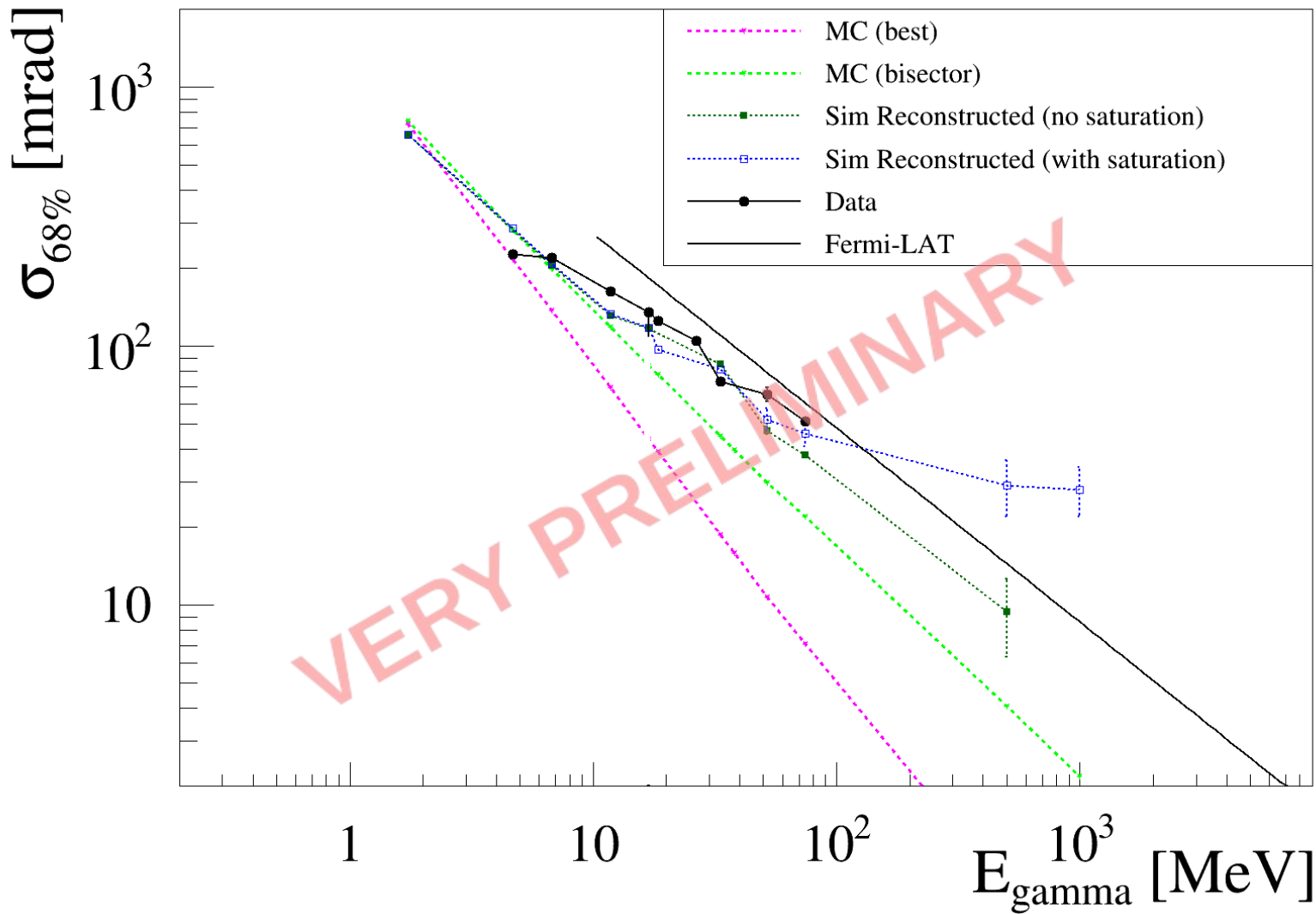


- Large systematics due to cubic geometry
- Cancel systematic errors by taking the ratio between $P=100\%$ and $P=0\%$









- Unusual TPC configuration
- Random direction \Rightarrow clustering difficult
- Large scattering \Rightarrow tracking difficult
- Vertex reconstruction from local geometry
 - simple, robust and good performance
 - high fake rate

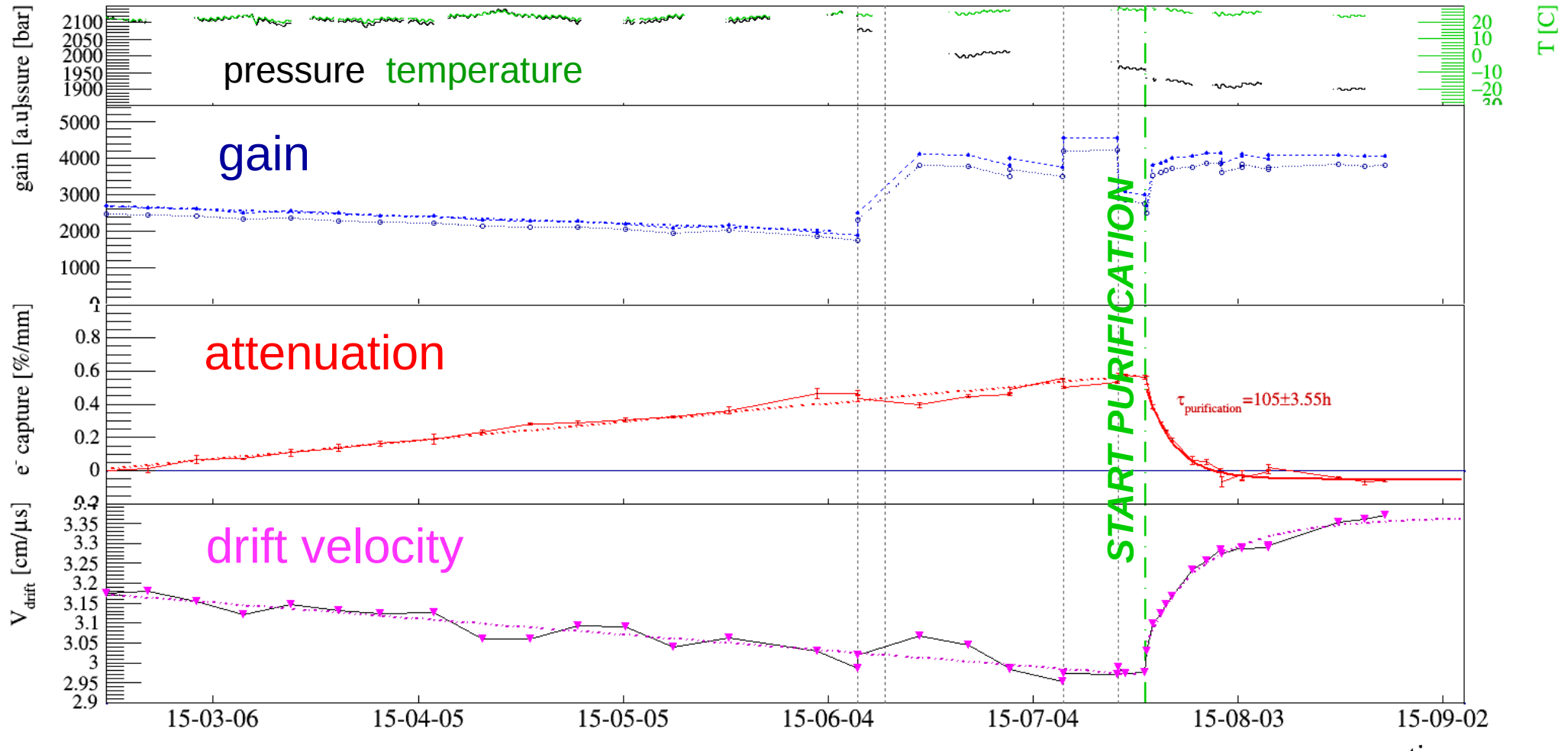


- Simple “bloc” clustering
 - CoG of rectangles (size \sim PRF x shaping)
 - merge if distance $<$ size
- Kalman tracking
 - look for closest neighbour in track direction
 - use distance along direction for Kalman projection

Backup



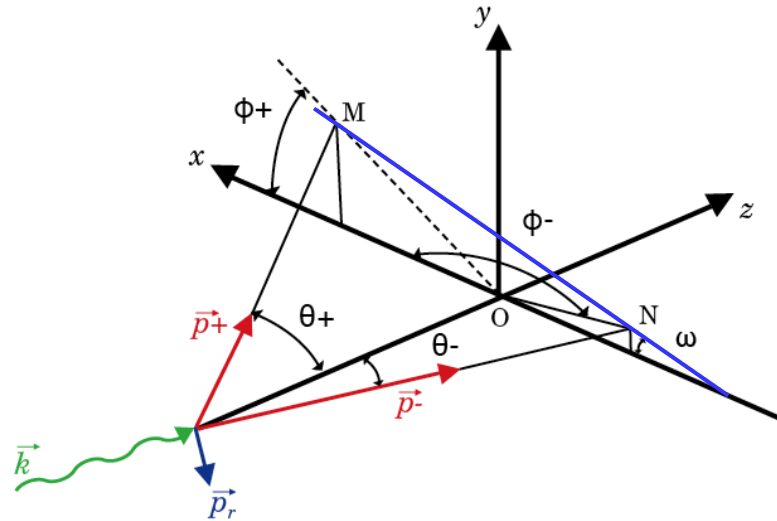
Gas stability



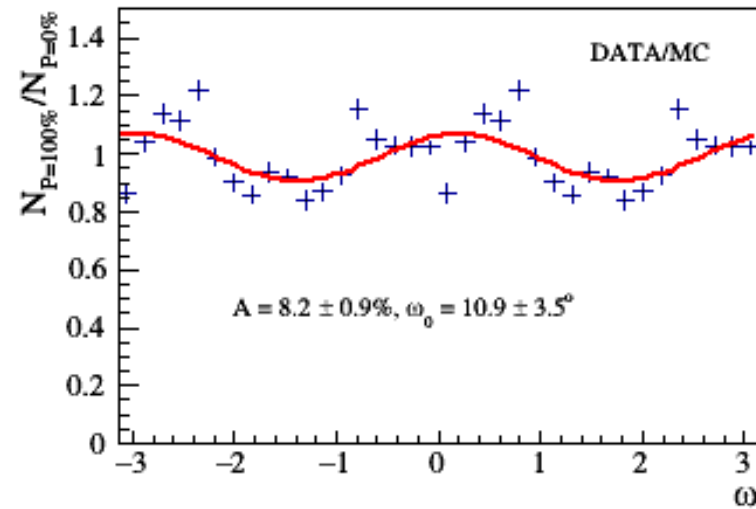
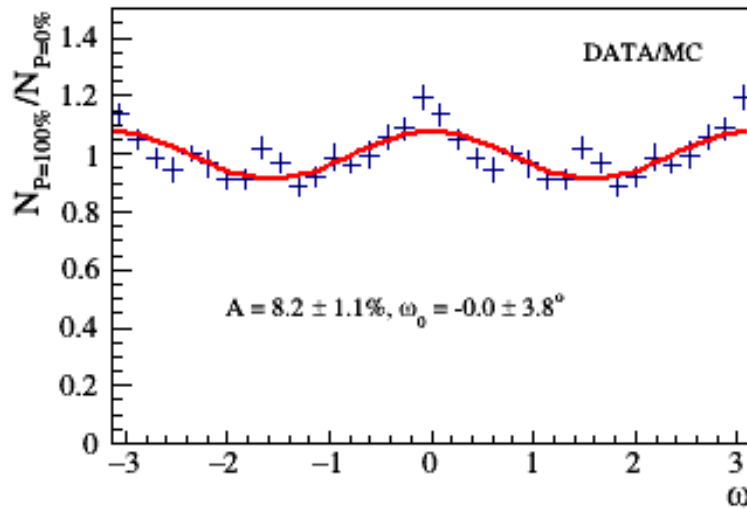
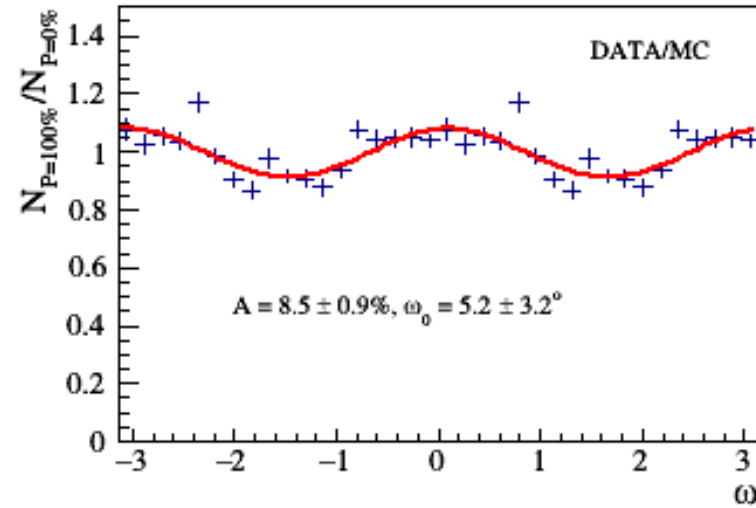
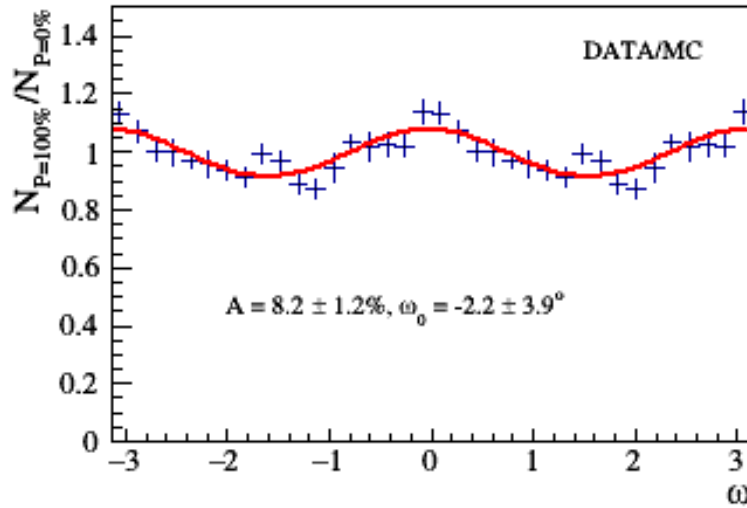
Recovery of full performance after 6 month sealed

Frotin et al.,
arXiv:1512.03248

- Modulation of the azimuthal angle ω



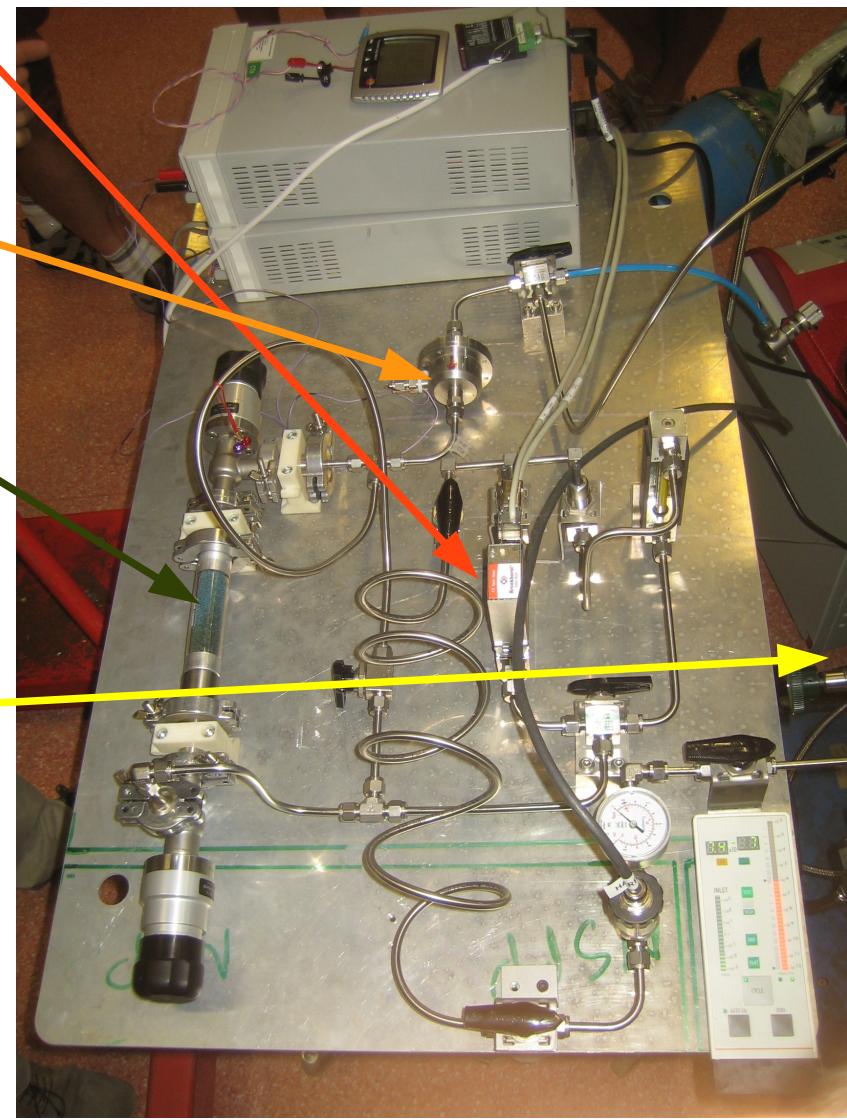
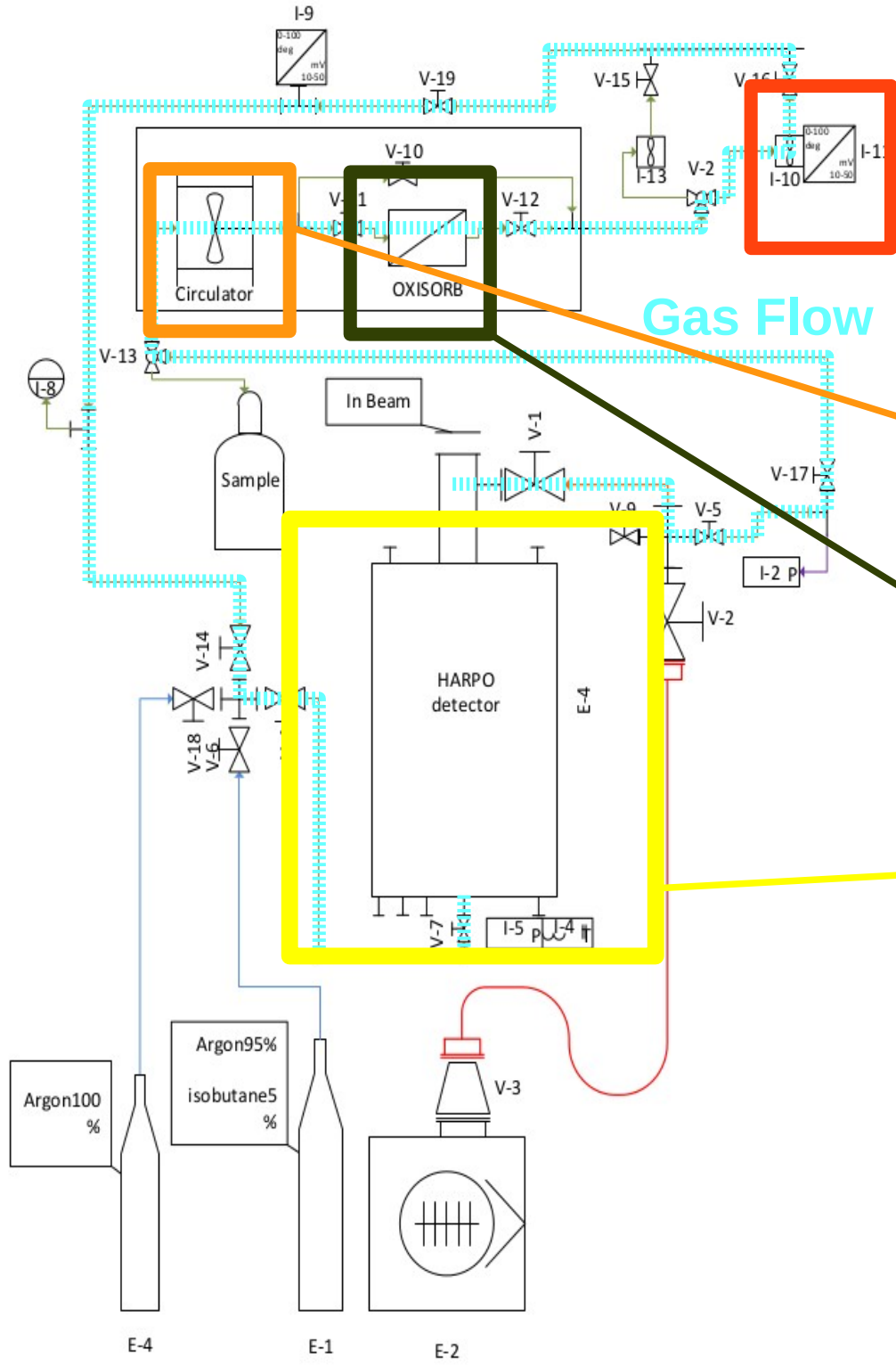
$$\frac{d\Gamma}{d\omega} \propto 1 + A \cos(2(\omega - \omega_0))$$





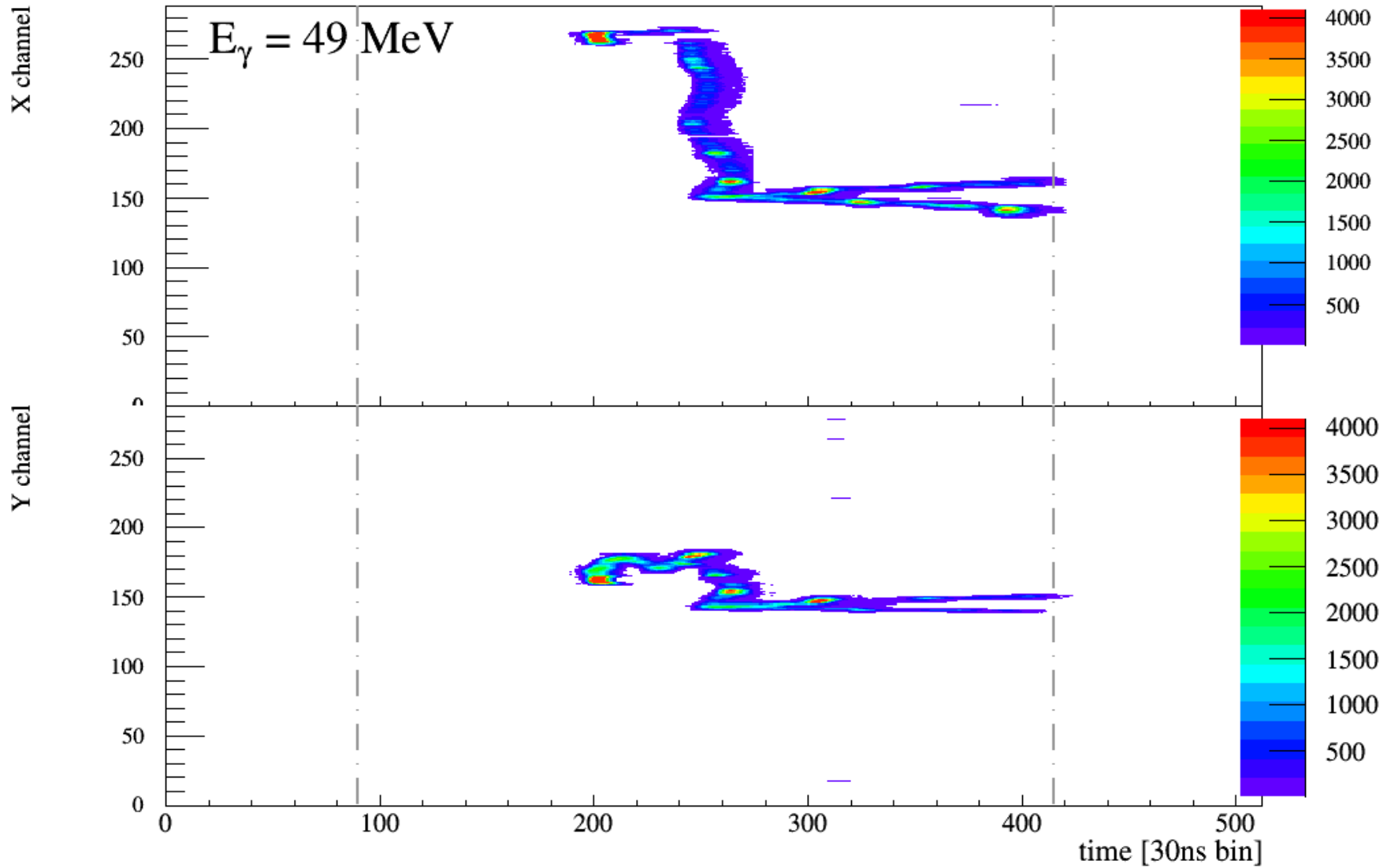
- Agreement with theoretical prediction
 - relatively small contribution of tracking
- Excellent agreement with simulation
 - effect of saturation dominates at high energy
- Potential for improvement
 - estimation of track momentum
 - even 100% resolution should significantly improve

UM



with HARPO
2P3, France
LN

Triplet event





- Simple
- Robust:
 - ignores obvious scattering and background
 - potential for small opening angle
- Potential for improvement
 - better peak finding
 - use of distance info (focus on short distance for large opening angle, long distance for small)



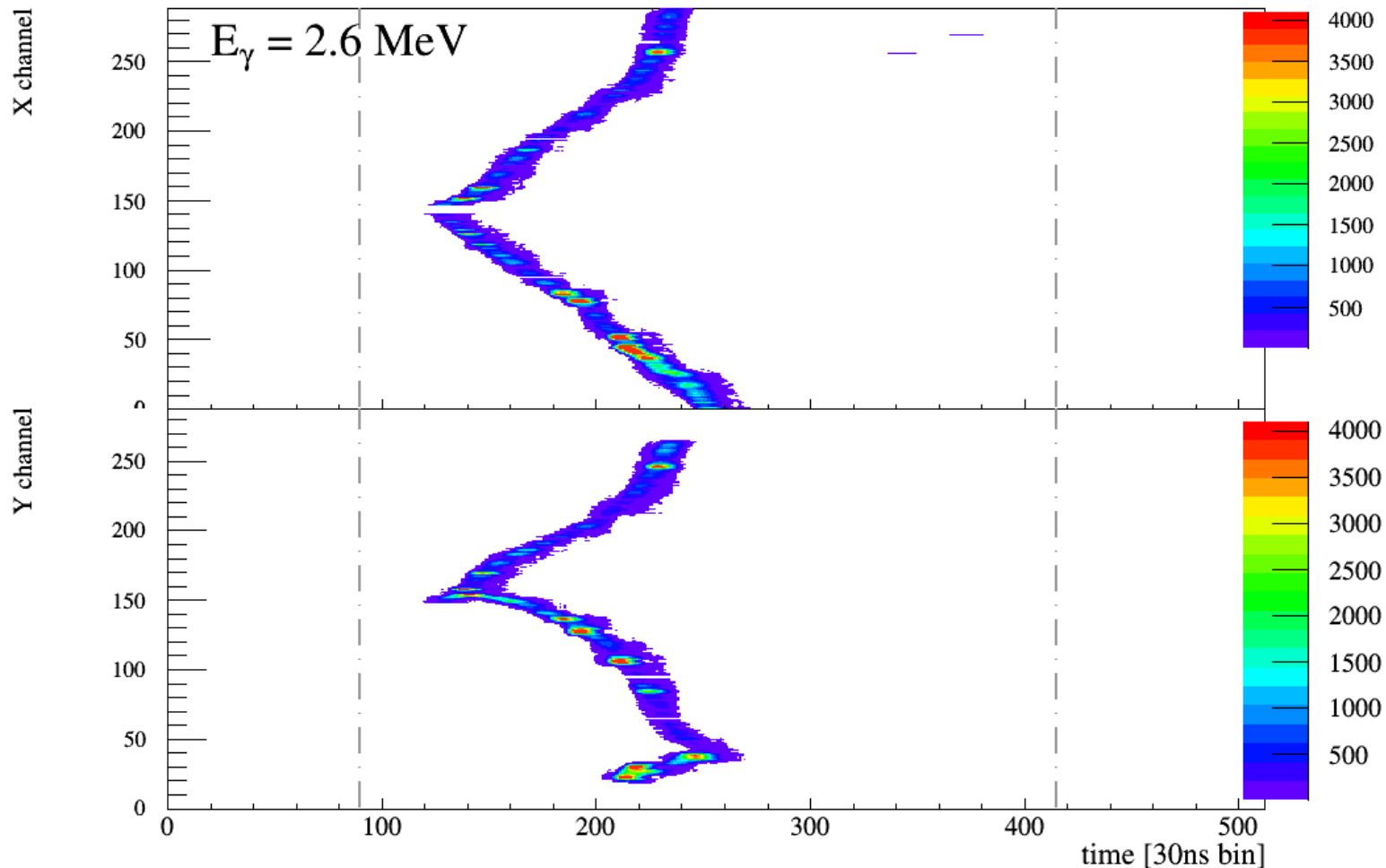
- As before: compare charge profile
 - 1: match vertexes if there are several with same Z position
 - 2: match the tracks in the vertex (simple: only 2 possibilities)

Examples of events

13 Energy points, 1.74 to 74 MeV



- *Experimental setup presented at TeVPA 2015 in Kashiwa*



Polarimetry in the pair regime with HARPO

Philippe Gros, LLR, CNRS/IN2P3, France

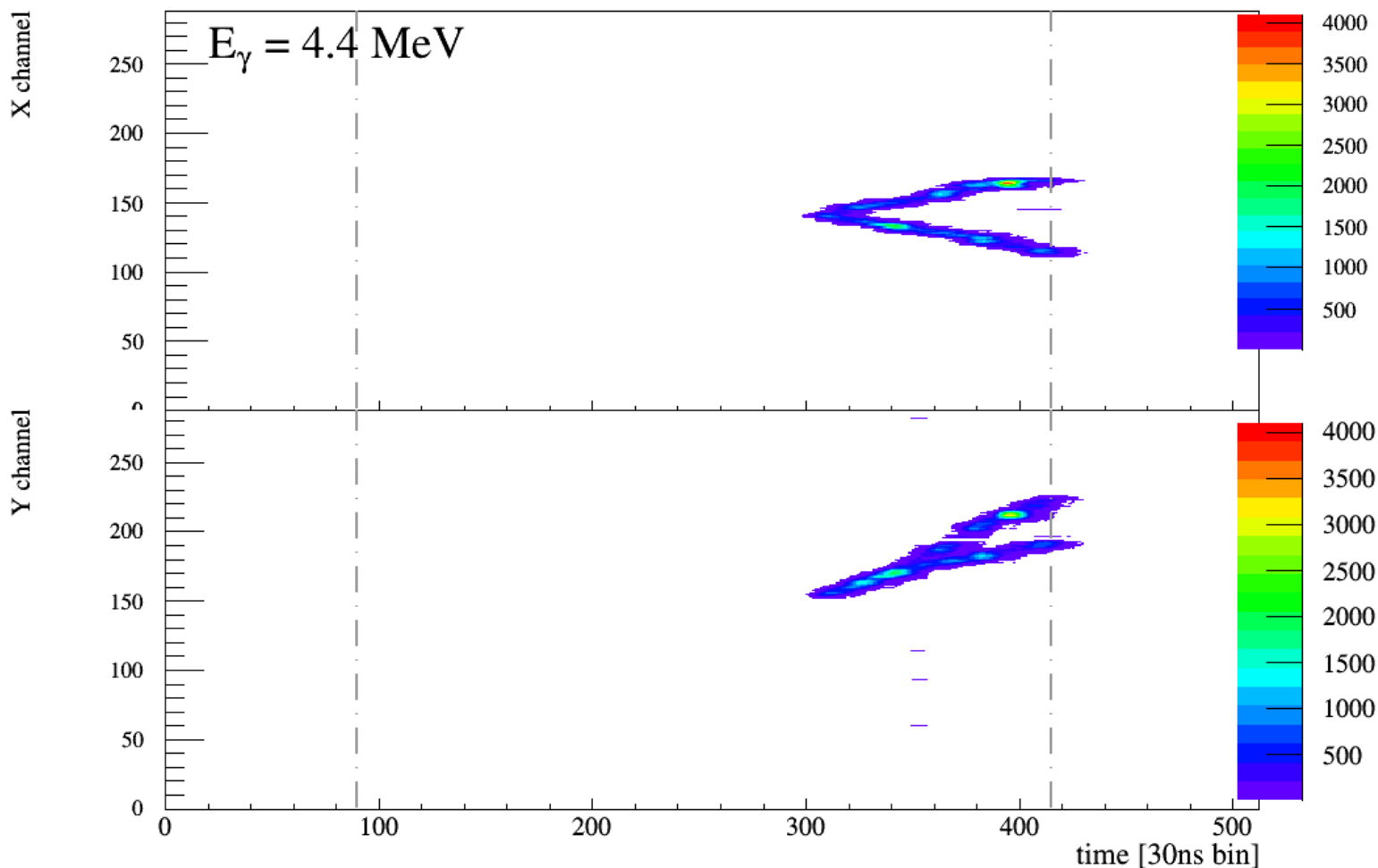
TeVPA2016, CERN

Examples of events



13 Energy points, 1.74 to 74 MeV

- *Experimental setup presented at TeVPA 2015 in Kashiwa*

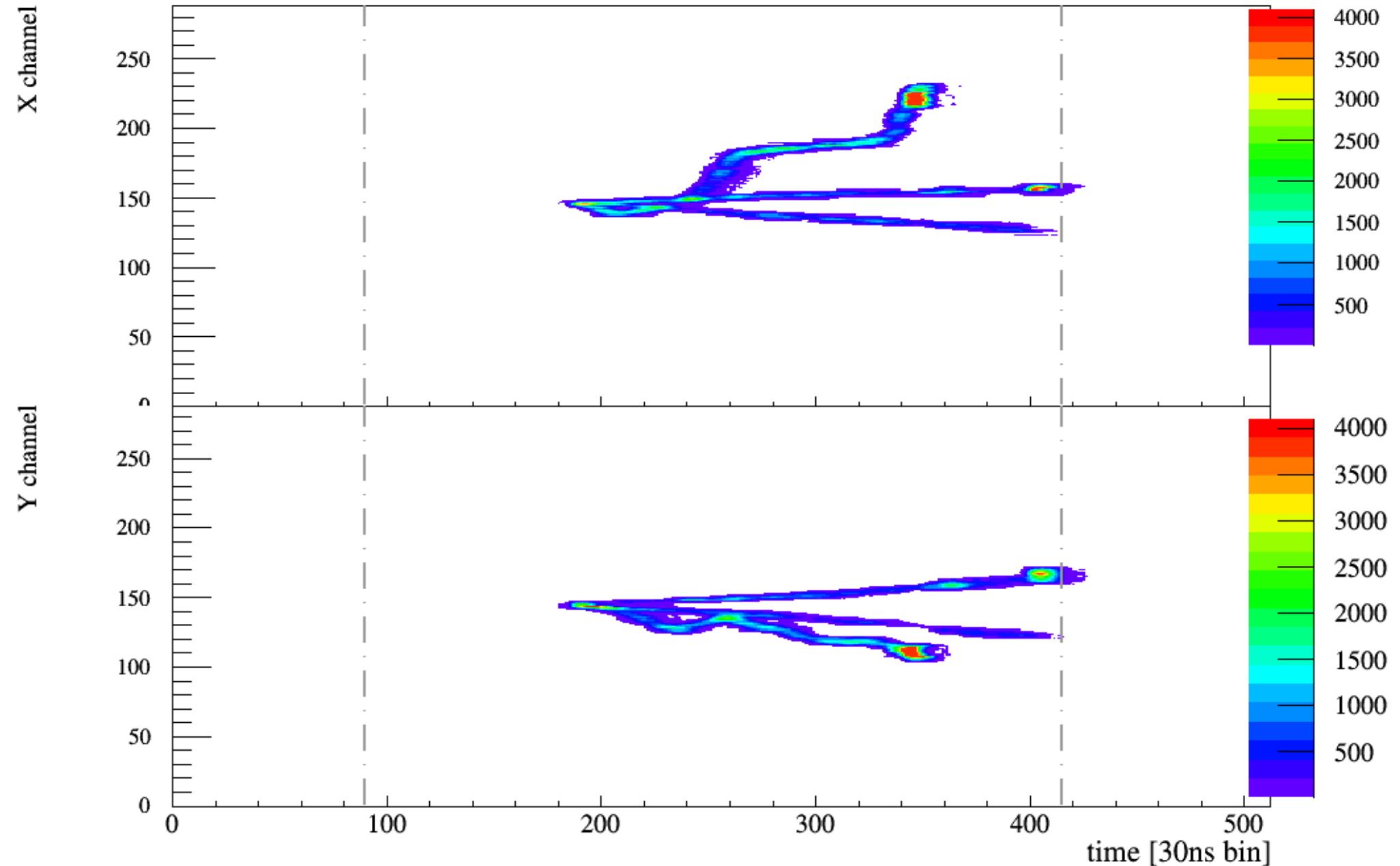


Polarimetry in the pair regime with HARPO

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TeVPA2016, CERN

Examples of events

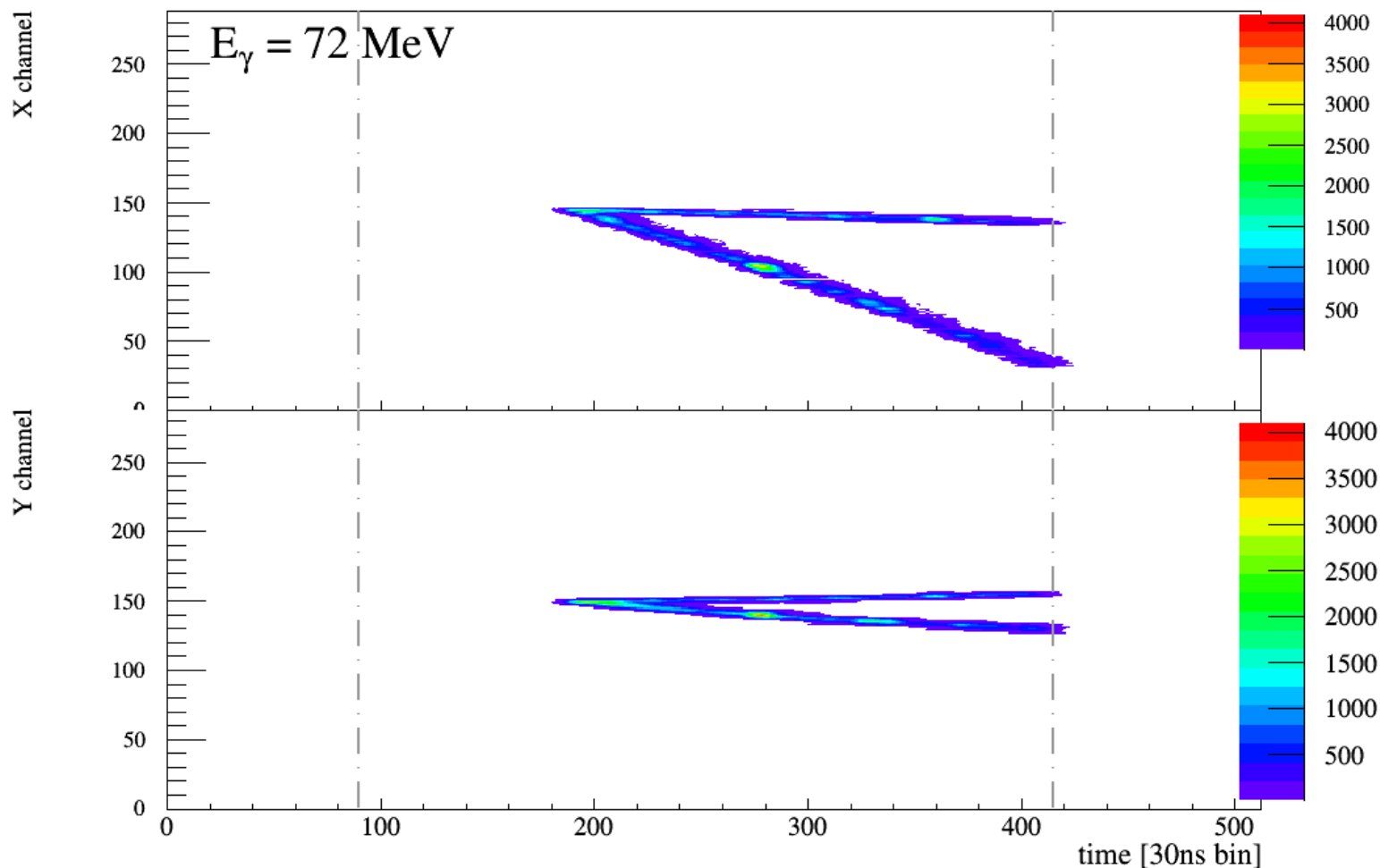


Examples of events

13 Energy points, 1.74 to 74 MeV



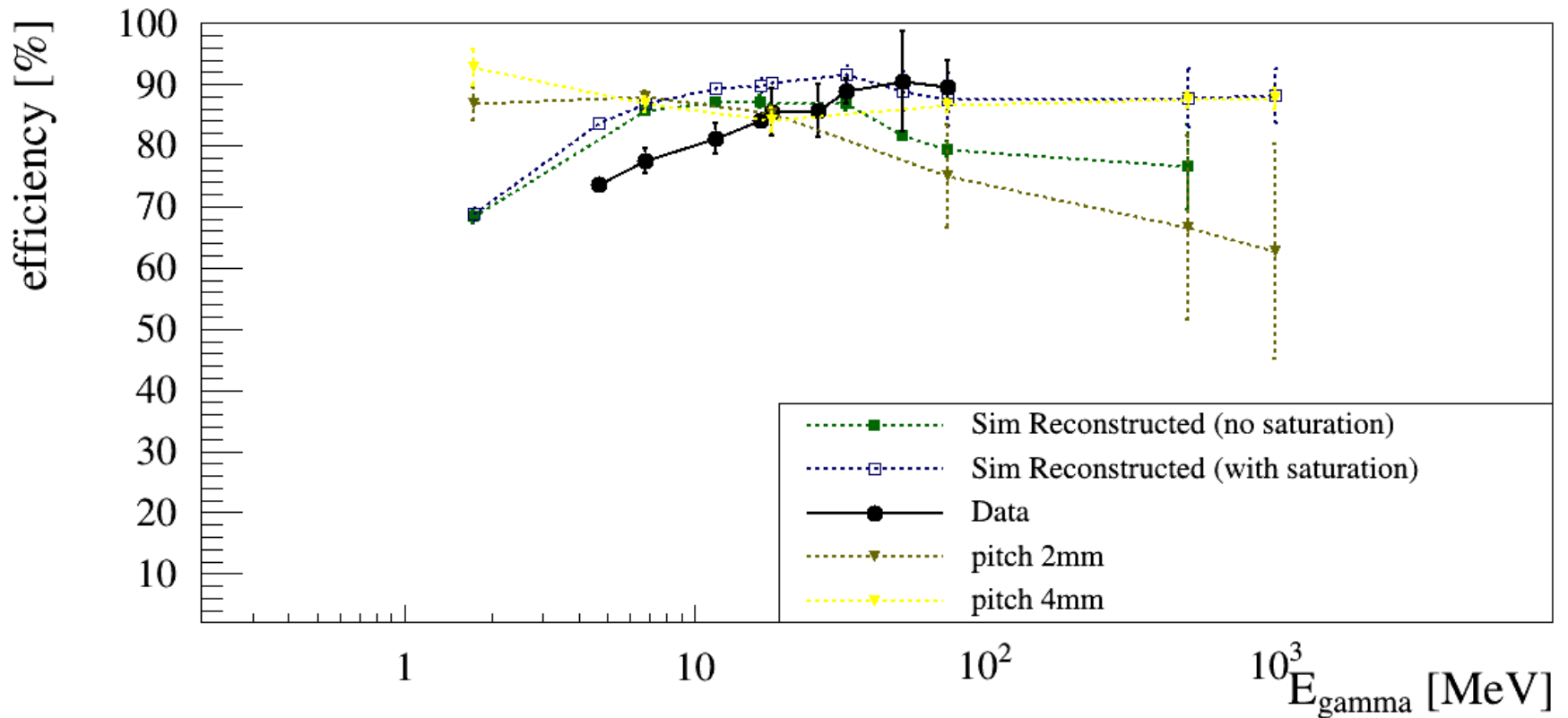
- *Experimental setup presented at TeVPA 2015 in Kashiwa*

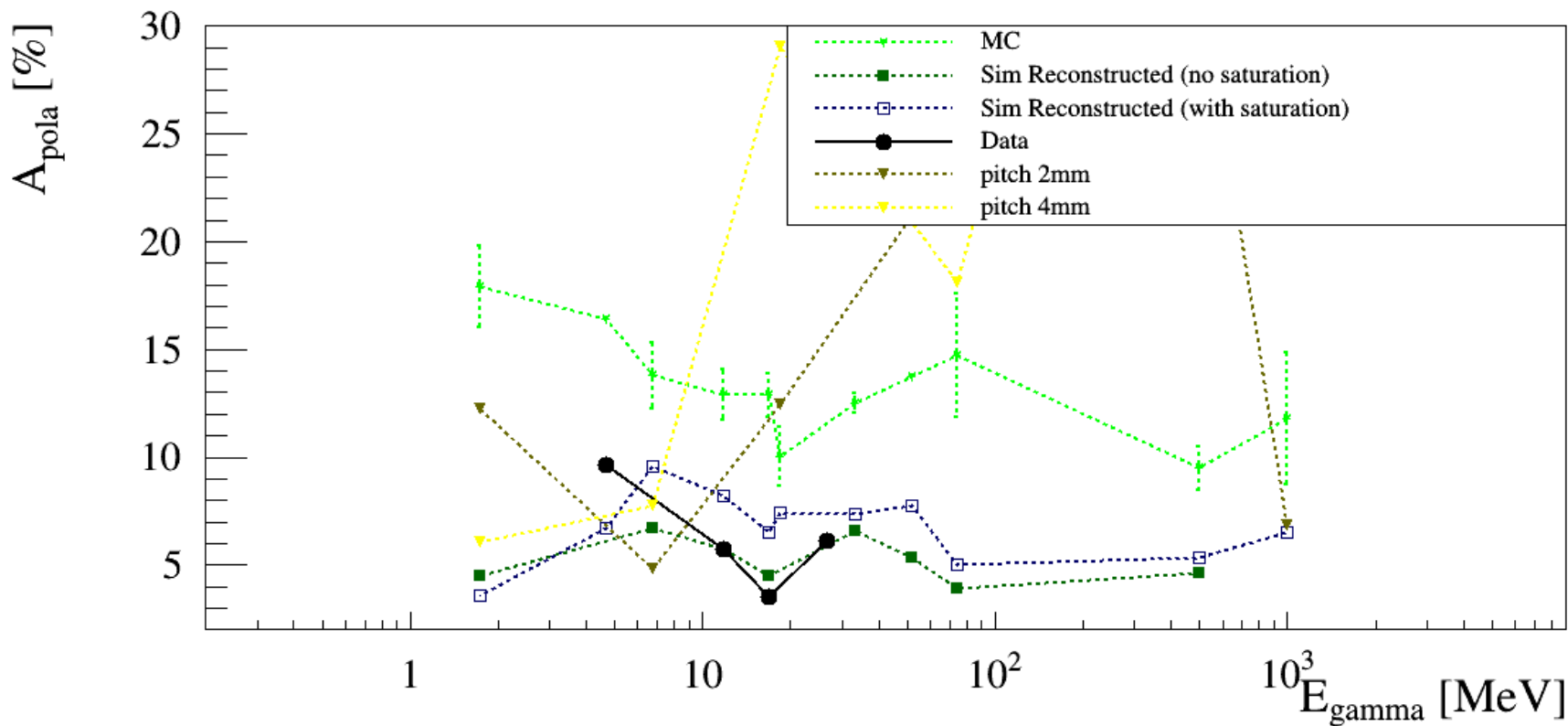


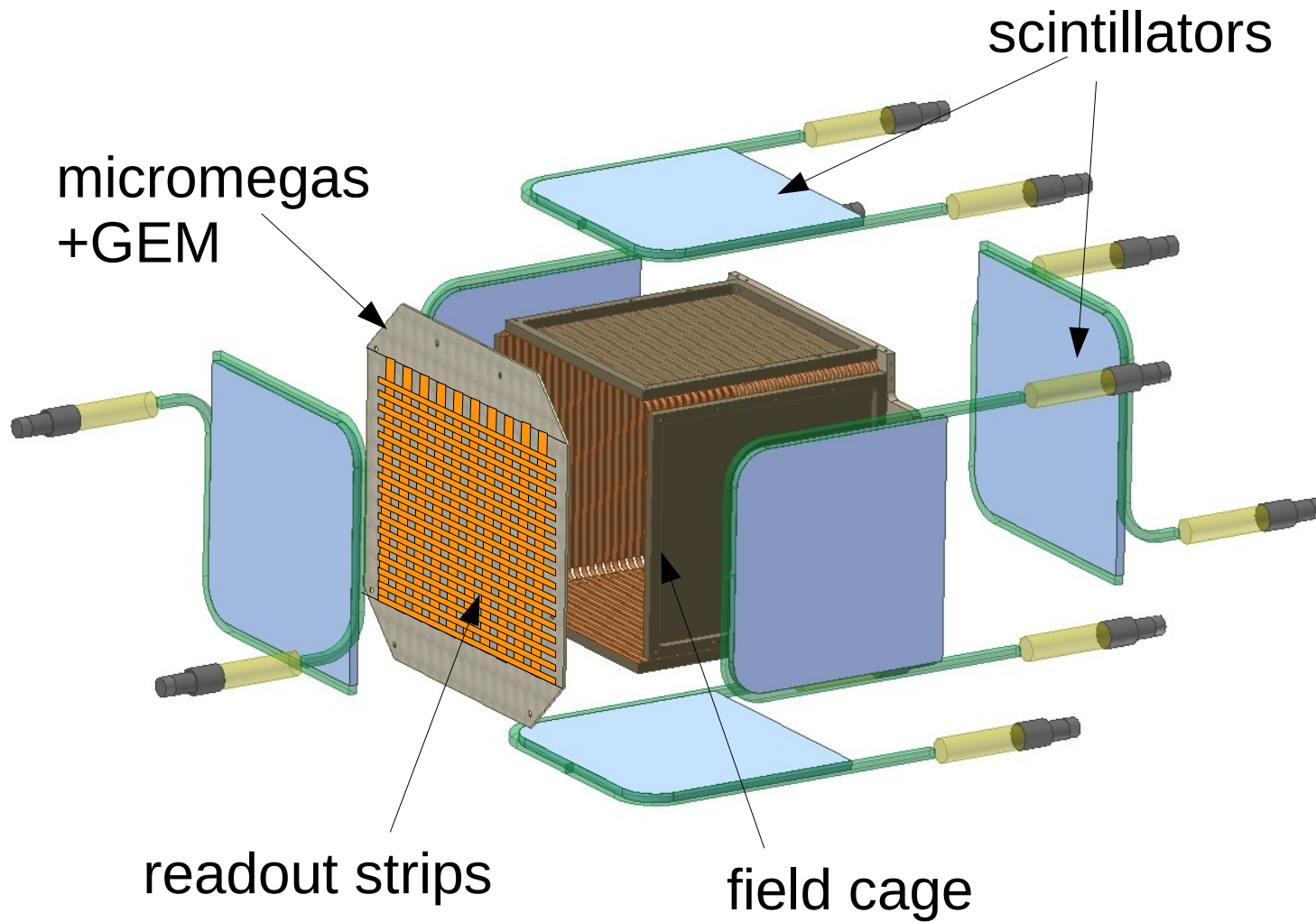
Polarimetry in the pair regime with HARPO

Philippe Gros, LLR, CNRS/IN2P3, France

TeVPA2016, CERN

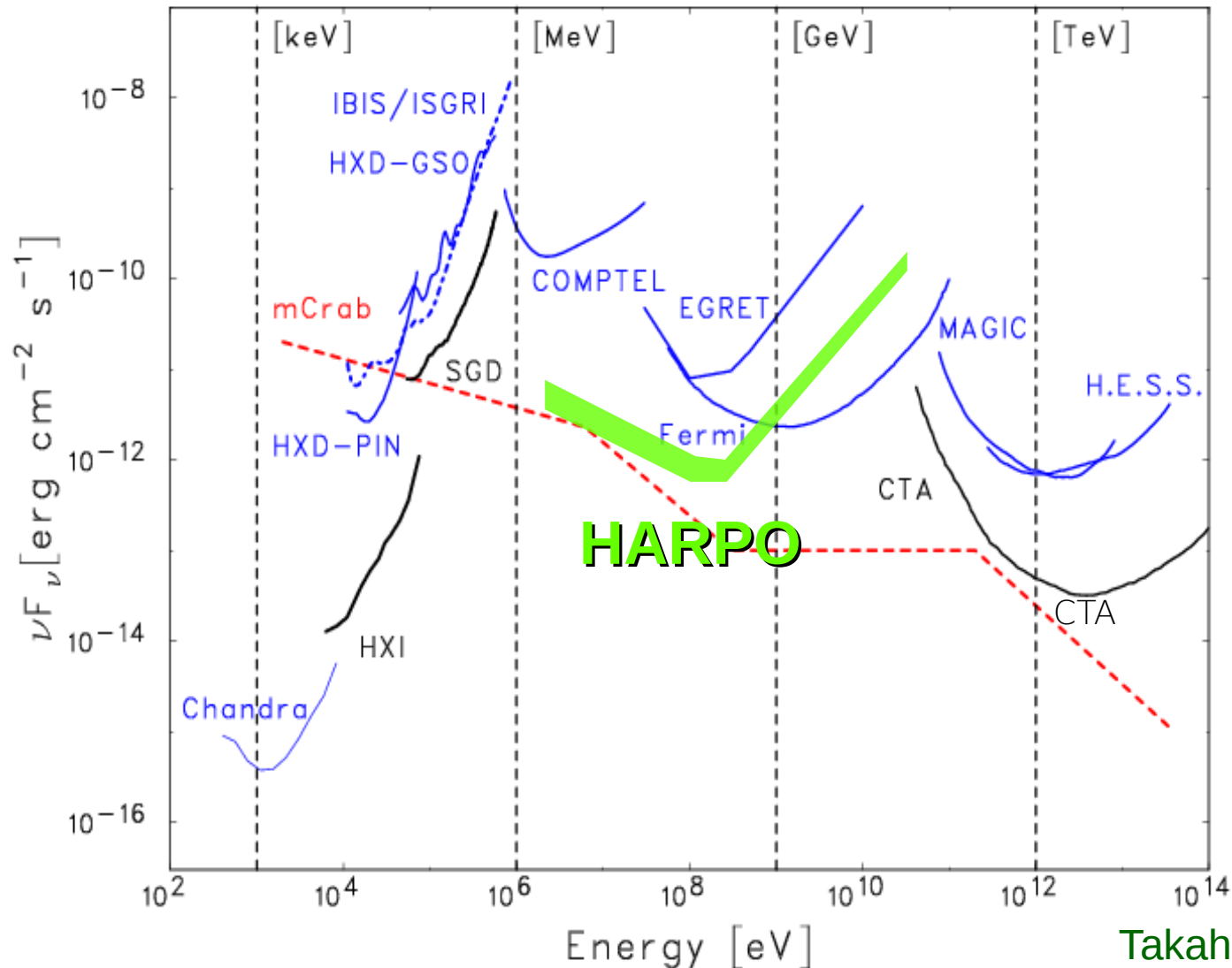








Gamma source sensitivity

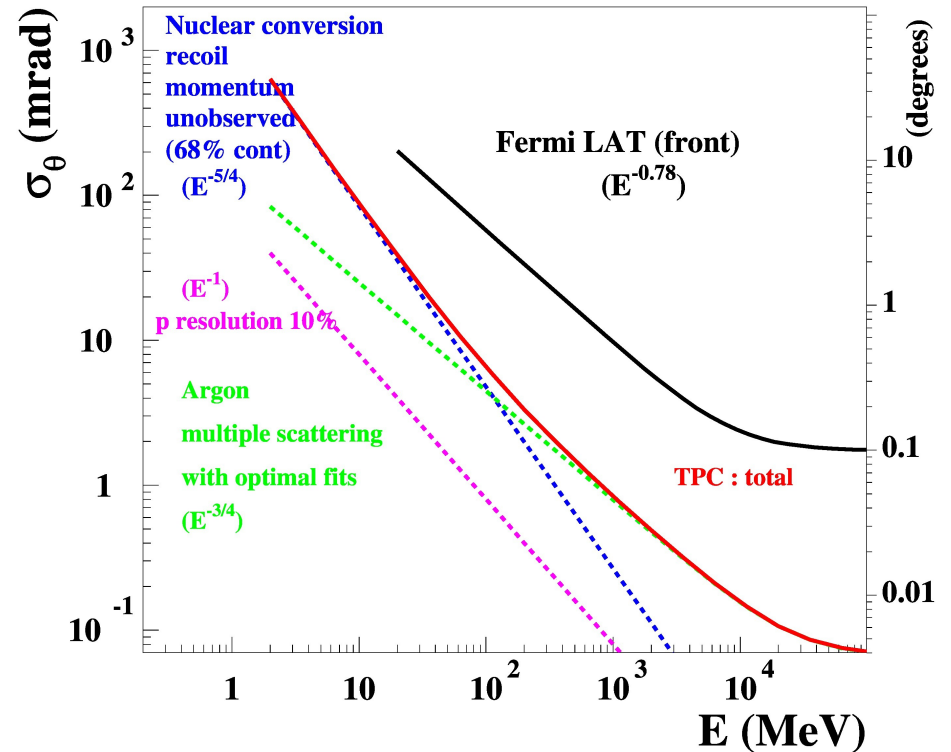
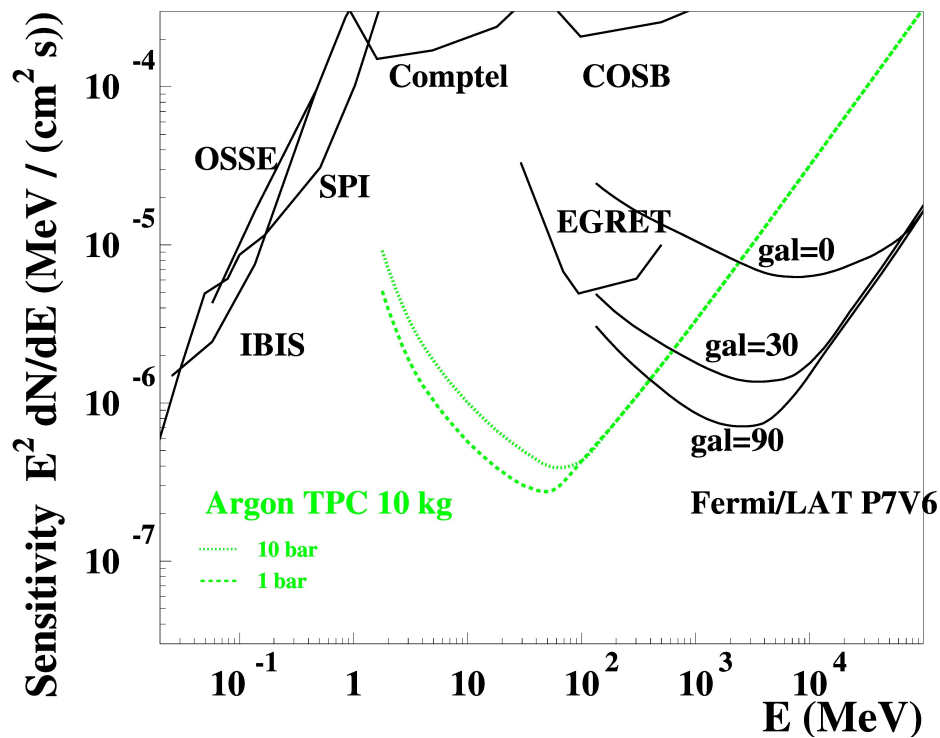


Takahashi 2012

Polarimetry in the pair regime with HARPO
Philippe Gros, LLR, CNRS/IN2P3, France
TeVPA2016, CERN

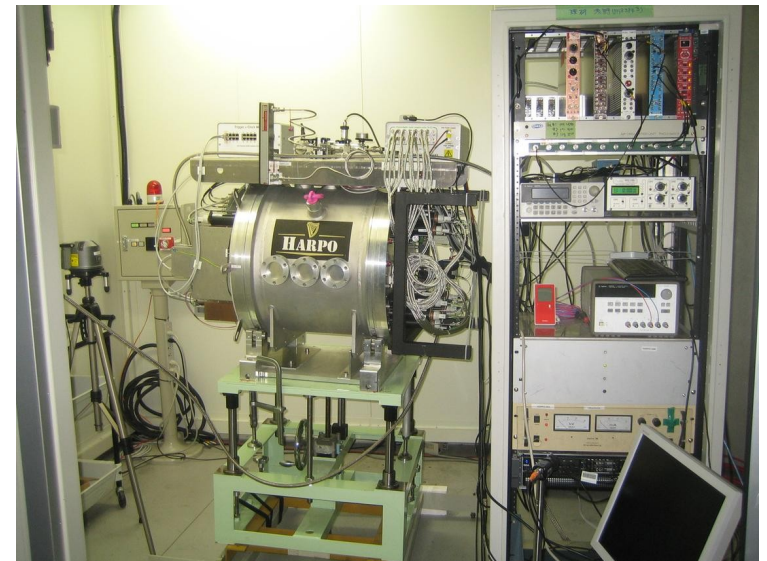
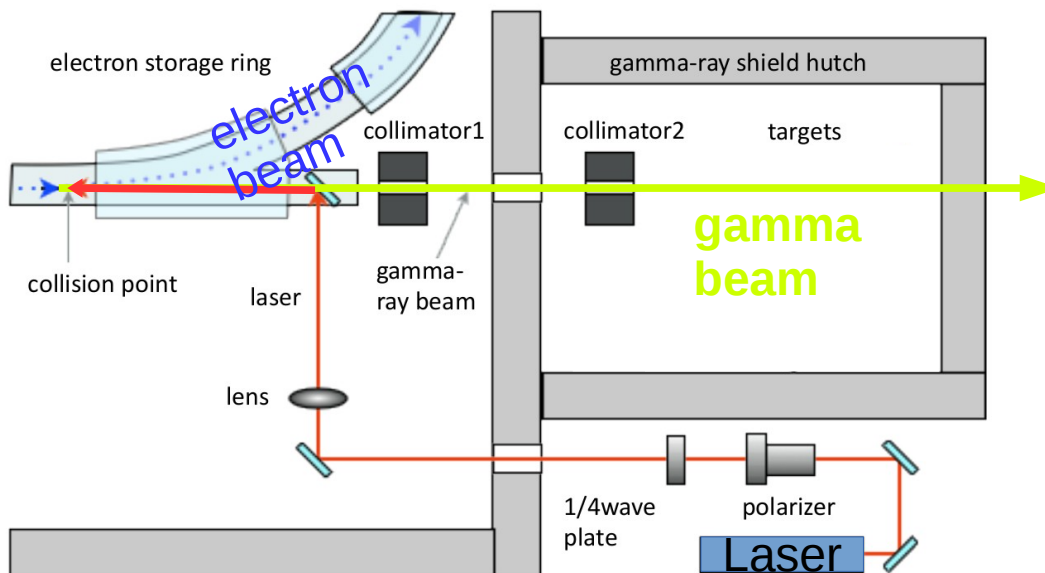


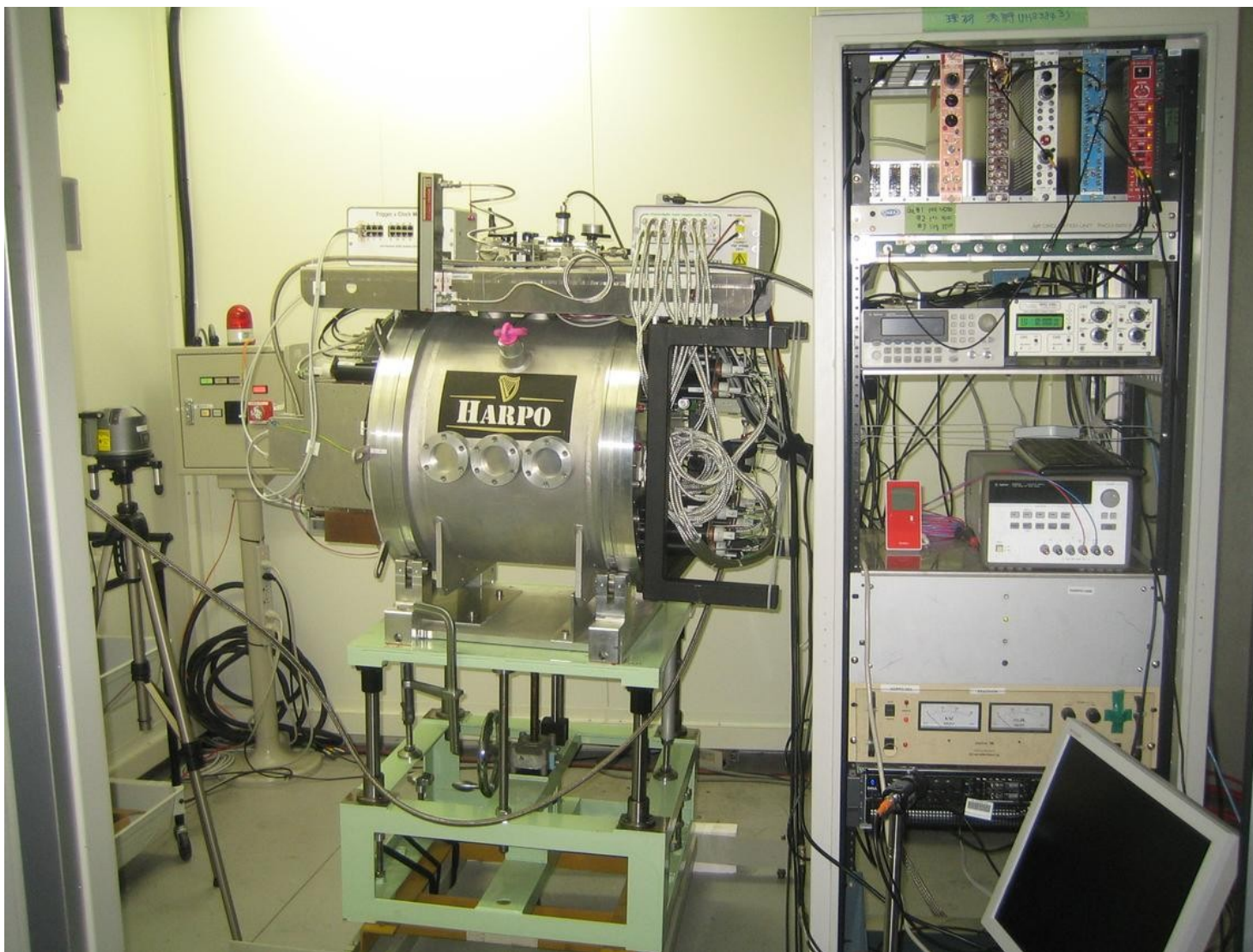
Expected performance



D. Bernard,
NIM A 701 (2013) 225

- Demonstrator built and tested in polarised photon beam in NewSUBARU, Japan
 - 13 Energy points, 1.74 to 74MeV, ~ 60 Mevents





Polarimetry in the pair regime with HARPO
Philippe Gros, LLR, CNRS/IN2P3, France
 TeVPA2016, CERN