

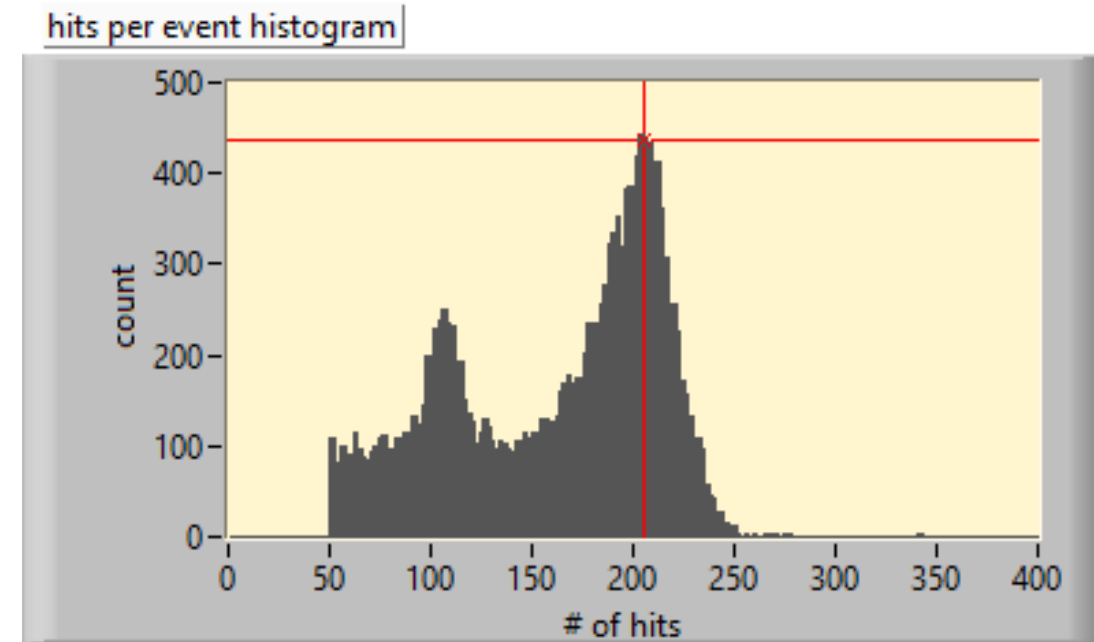


Double clusters in ^{55}Fe events

Fred Hartjes
NIKHEF

Motivation double cluster search

- Looking for the possible DAQ problems that have been observed with the laser beam ionization
 - Downstream chips transmit too less hits
- Trying to see the effect in double ^{55}Fe clusters
- Two types of events
 - Double clusters from **fluorescence photons**
 - Simultaneously created
 - Leading to the ‘escape peak’
 - **Accidental** double cluster events
 - Searching in a $100\ \mu\text{s}$ time window
- **Single chip** events investigated
- **Events with 2 chips** in various combination investigated



Using automatic cluster finding

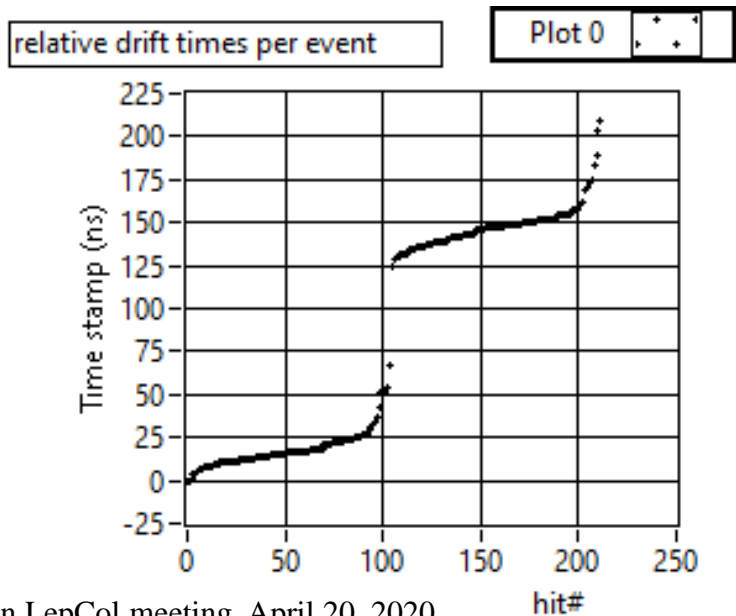
- Run 785, taken at 30-4-2019
- Irradiated by ^{55}Fe source
- Ar/iC₄H₁₀ 81.2/18.8
 - => no secondary emission
- Vgrid = - 400 V
- Field 360 V/cm
- Averaged ToT 1200 ns => $\varepsilon = 92\%$
- Data from chip 0

- Drift time range 1000 ns
 - => almost no chance on accidental double clusters
- Min hits per cluster: 50
- Data taking range: 170 s
- Events found: 17.0 k

The screenshot shows a software interface with two main sections: 'Data in' and 'Settings'. The 'Data in' section includes a 'run directory' field with a file explorer icon, containing the path 'C:\Data\LepCol\Module concept\Testboxes\8-fold QUAD\8-fold testbox data\ SPIDR data'. Below this are fields for 'delimiter' (set to '\s'), 'hits file', 'Run#' (785), and 'Chip#' (0). The 'Settings' section contains several adjustable parameters: 'Max hits limit' (3M), 'start time (ns)' (1), 'Td lower limit' (-100), 'End time (ns)' (170G), 'max # of hits' (500), 'minimum hits/track' (50), 'drift time range (ns)' (1000), 'to (ns)' (60), 'C1' (500m), 'Min. ToT (ns)' (150), 'Apply min. ToT' (checkbox), 'Use previous dat' (checkbox), and 'save results?' (checkbox).

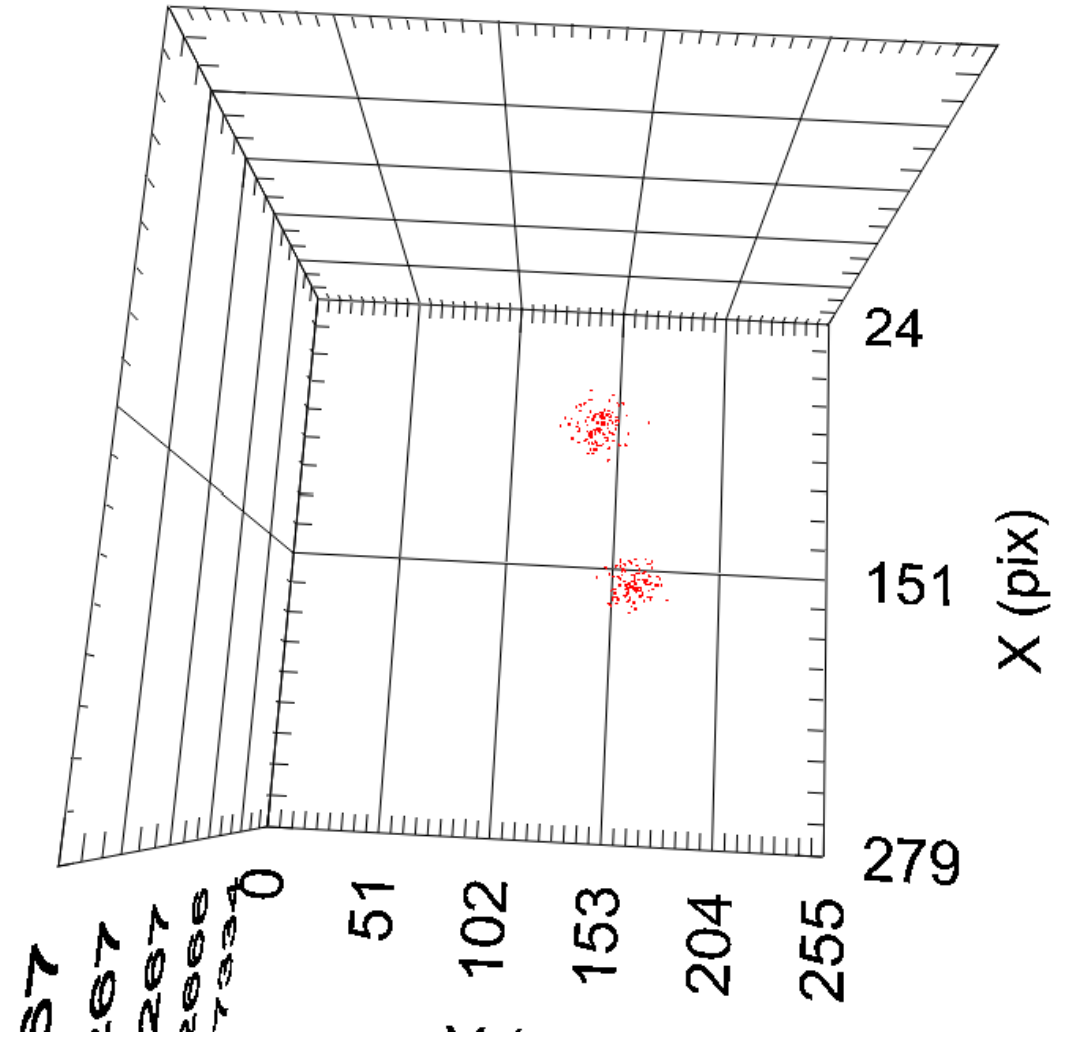
Fluorescence double clusters chip 0

- Typical event
- All fluorescence cluster events consist of two equal clusters of 100 – 110 hits each
 - In a few cases one of the clusters was lowered by the edge of the chip or pileup
- Time between two clusters is in the 0 – 200 ns range
- The plot below shows the relative drift times as they are collected



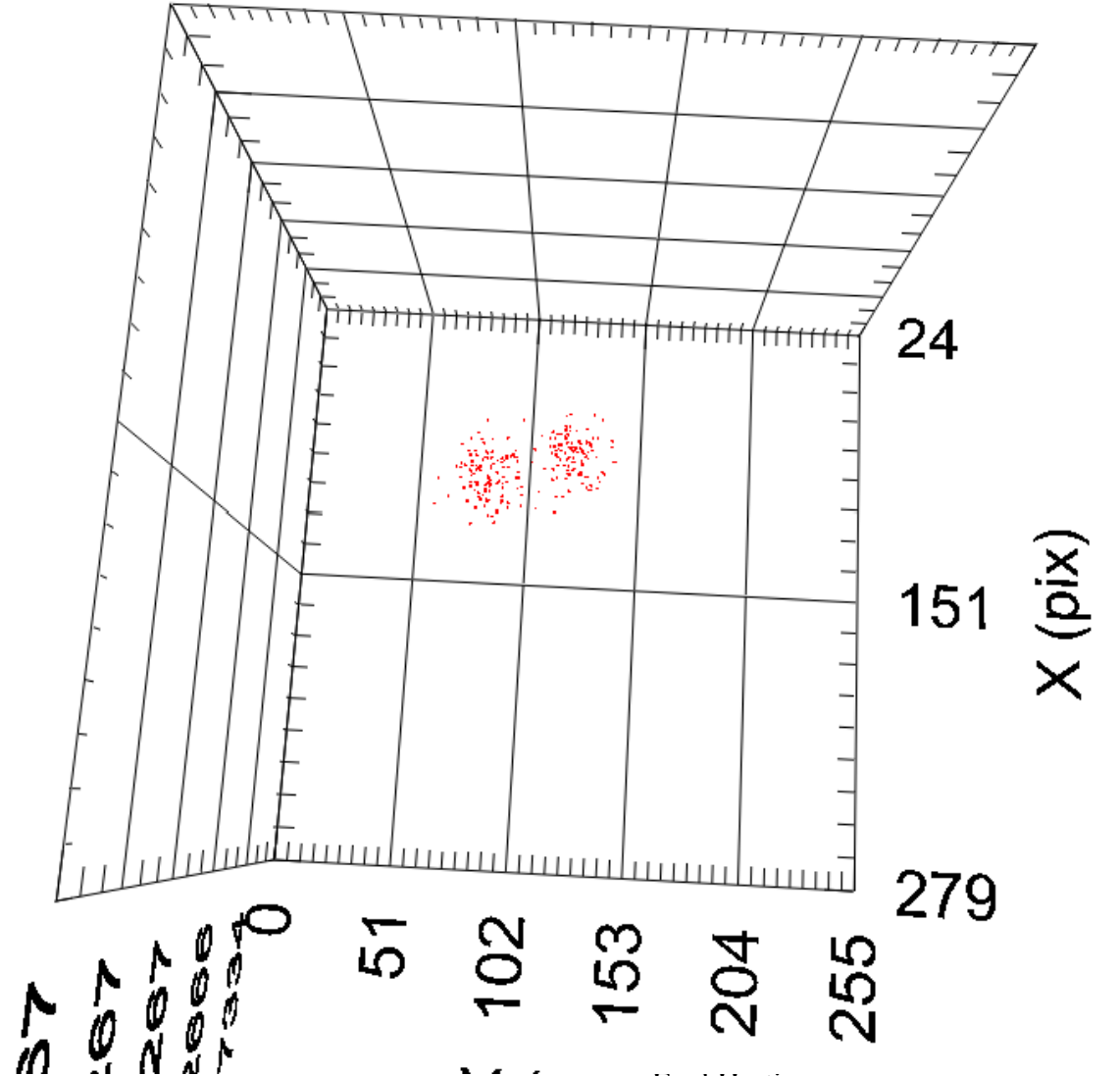
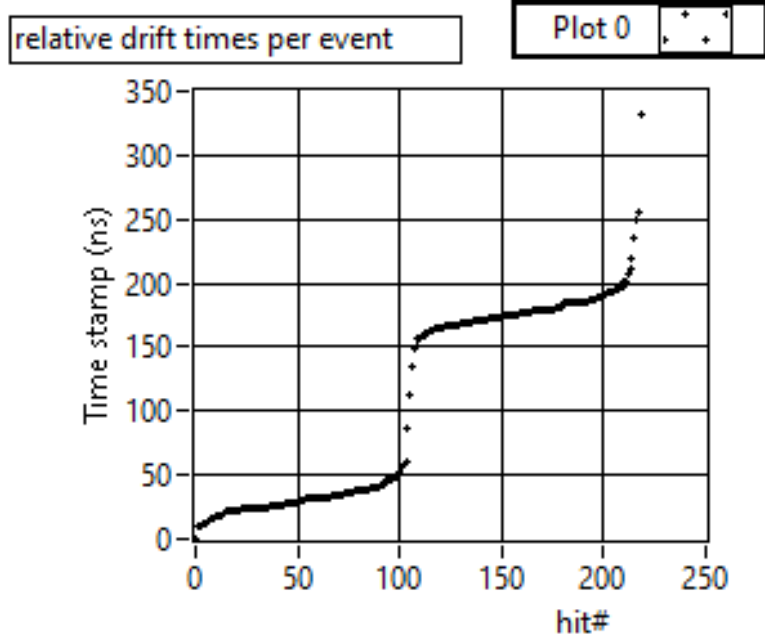
Event display

Typical event



Another fluorescence event chip 0

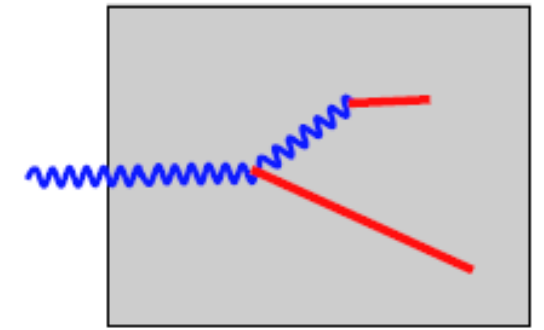
Event display



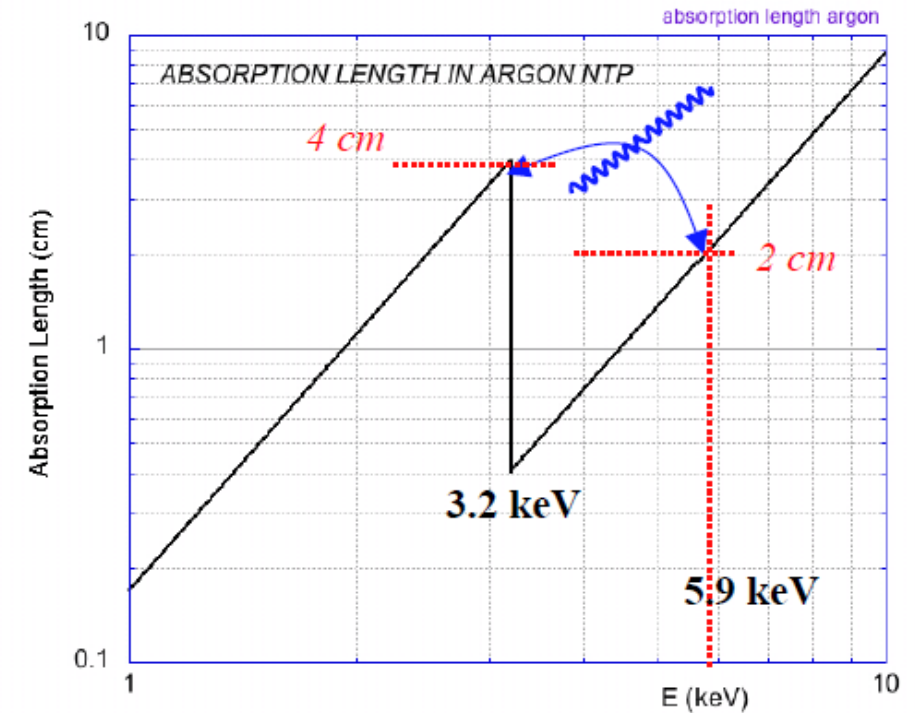
Explanation: 2.7 keV fluorescence photon

- **Occasionally** a fluorescence photon is emitted in the conversion process at the **argon** atom
- For most gaseous detectors double cluster events are not seen as such
 - **Both** ionization clusters are detected => added to the regular 5.9 keV peak
 - **One** cluster is formed **outside** the sensitive range leaving only the other to be detected => escape event

■ **At GridPix both clusters often are detected individually**



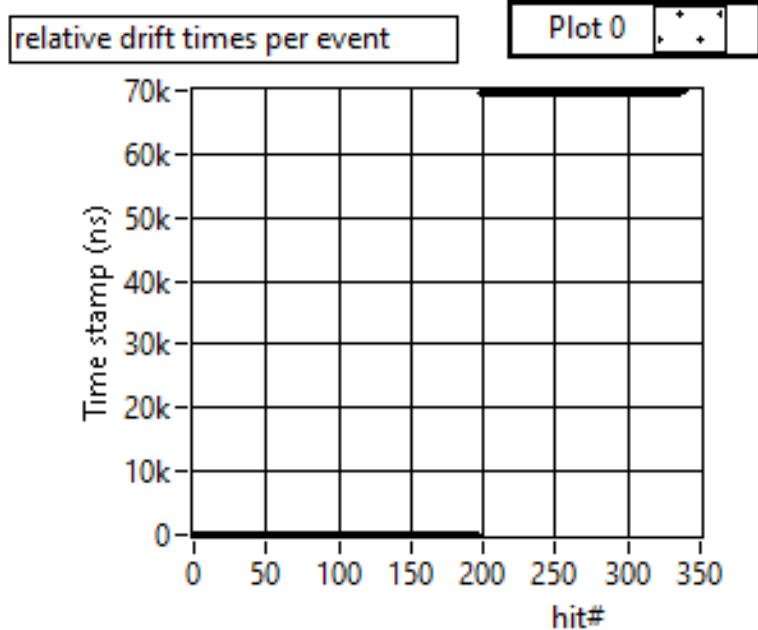
^{55}Fe 5.9 keV:



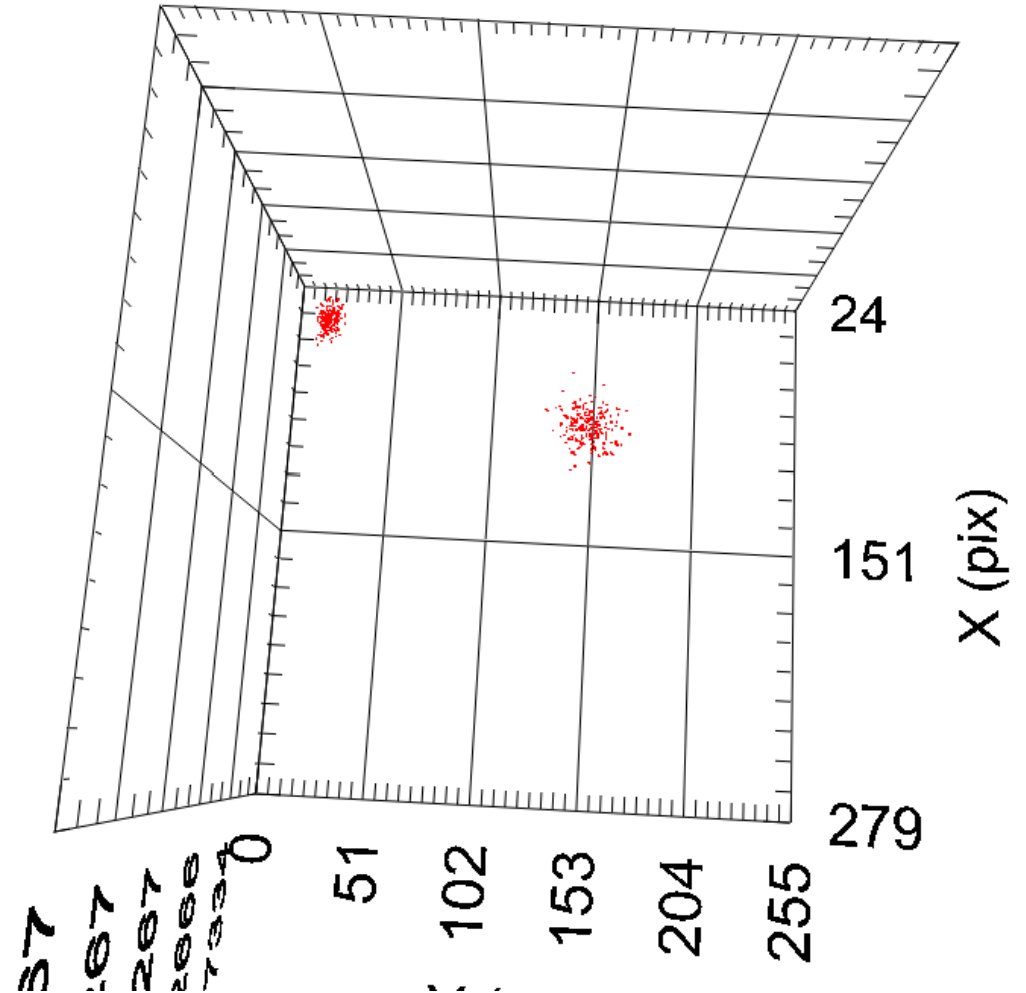
*Fabio Sauli: Gaseous detector fundamentals
Edit 2011*

Accidental double cluster events on chip 0

- Search in **100 μs** wide time window
- Example: two clusters **70 μs** apart
- First cluster 200 hits
- Second one \sim 130 hits
 - Pileup, close to edge



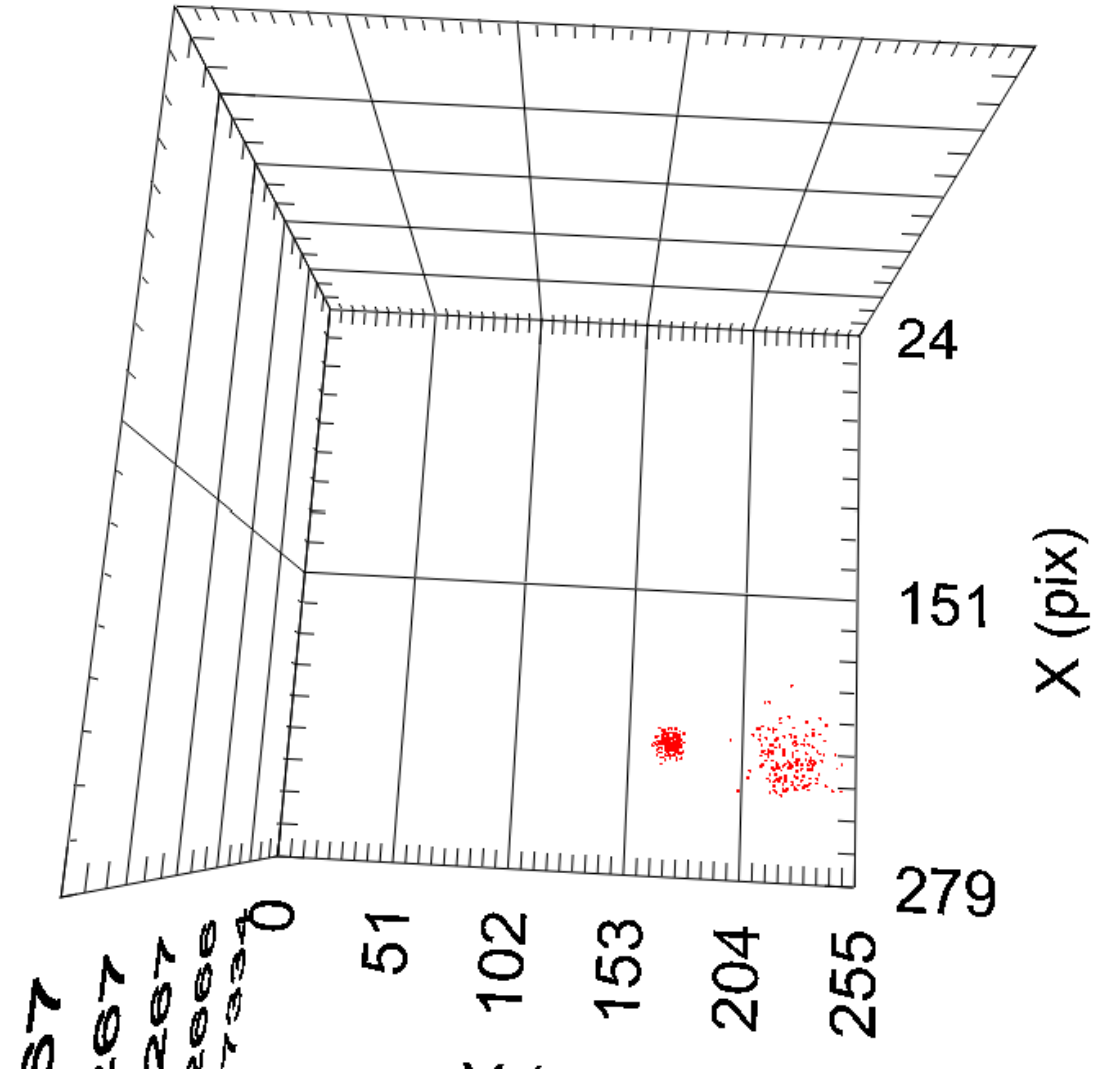
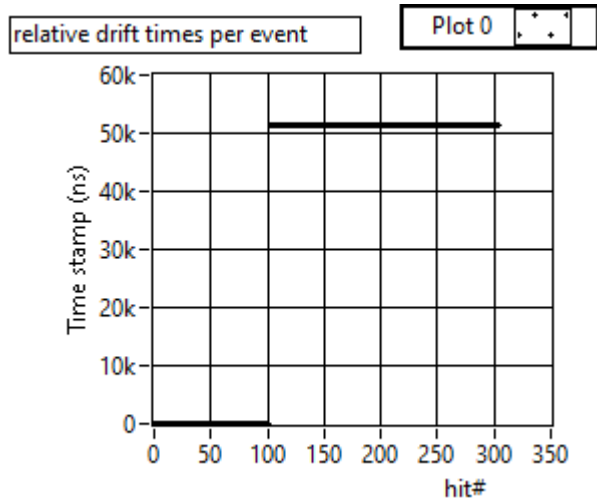
Event display



Another accidental double event on chip 0

Event display

- Clusters 52 μs apart
- First cluster ~100 hits
 - Reduced by pileup
- Second one ~210 hits



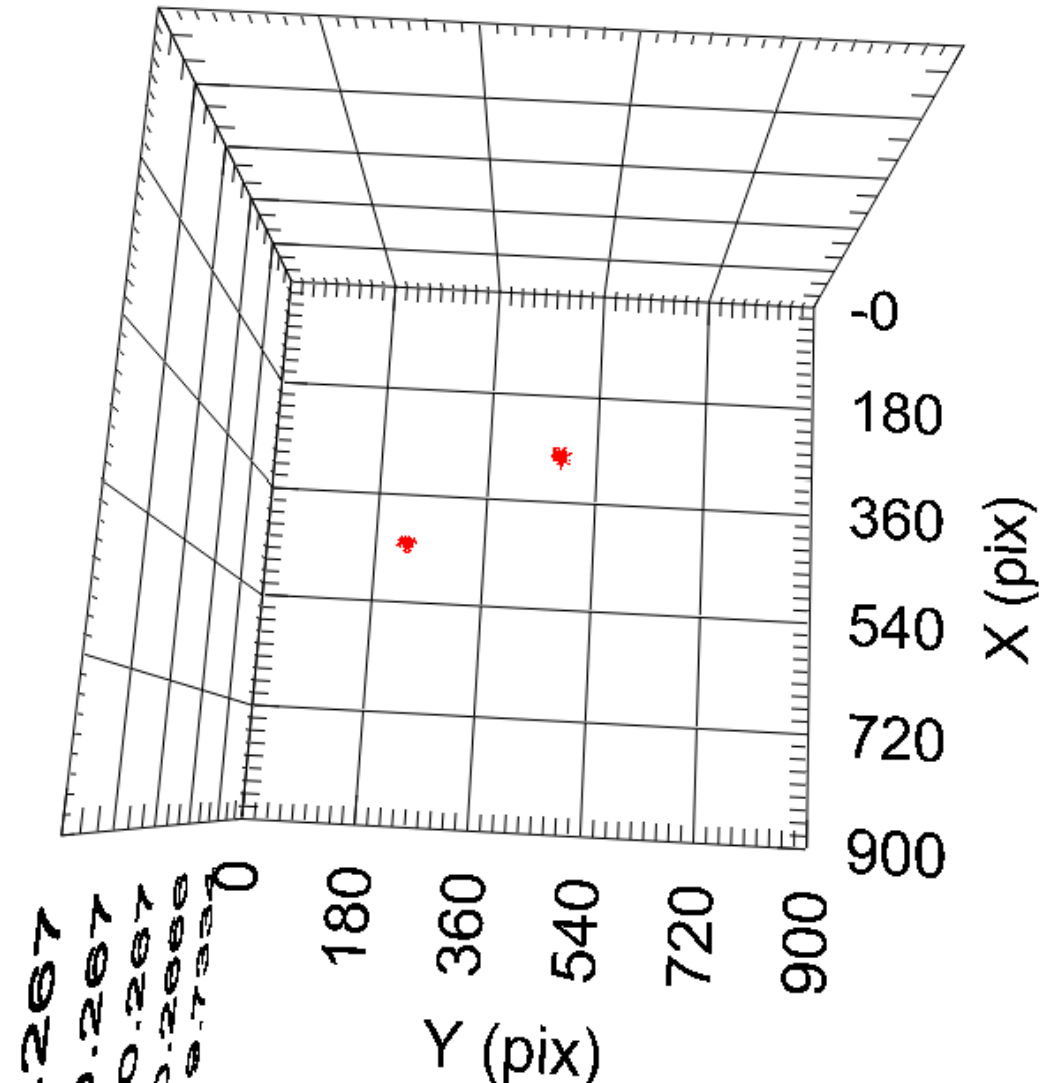
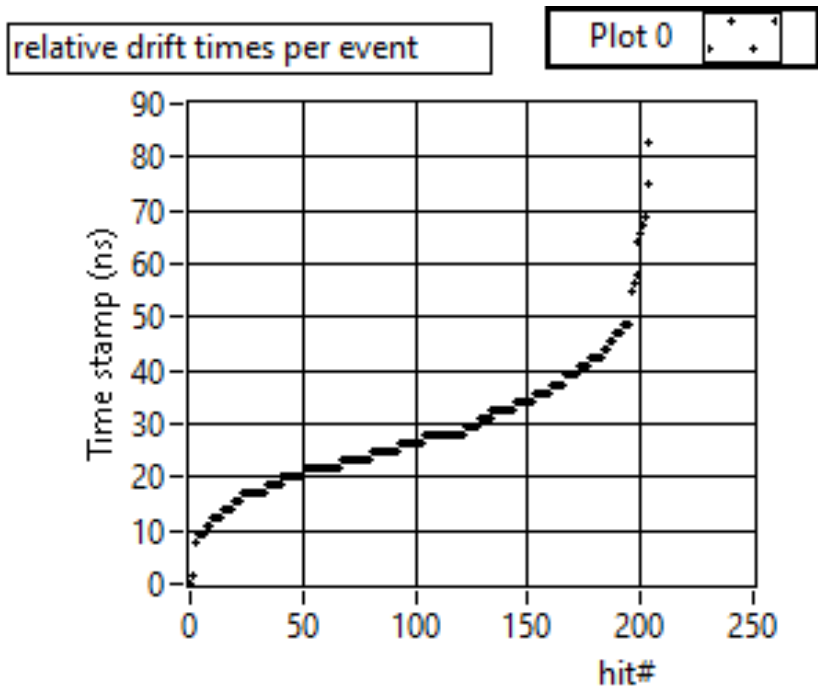
Double chip events

- Time window $100 \mu\text{s}$

Fluorescence photon events on different chips

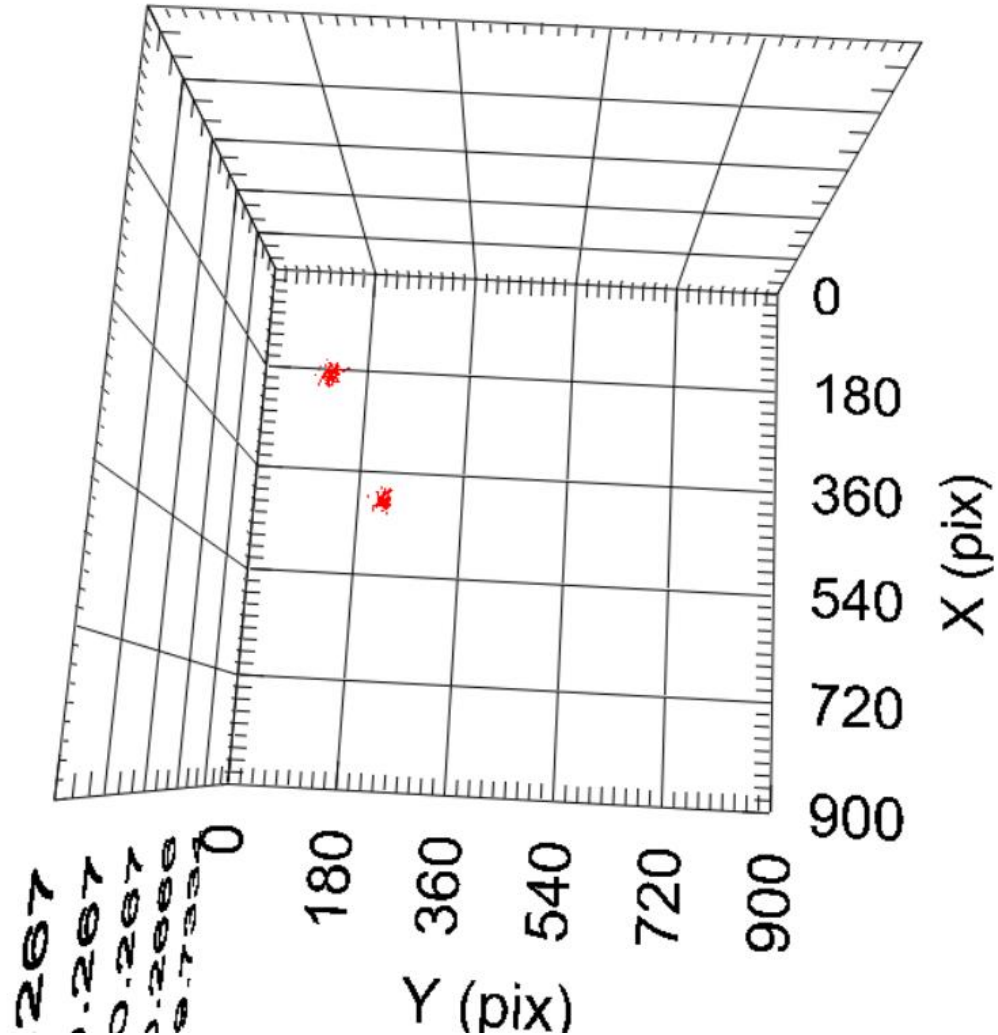
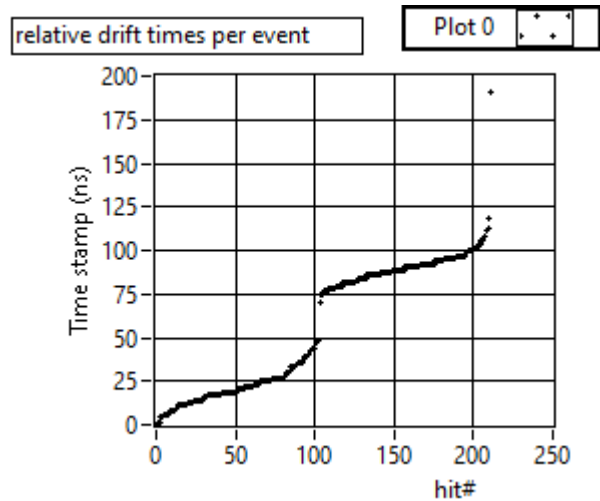
Event display

- Clusters almost simultaneously created
- Both ~ 100 hits
- On **chip 0 and 1**



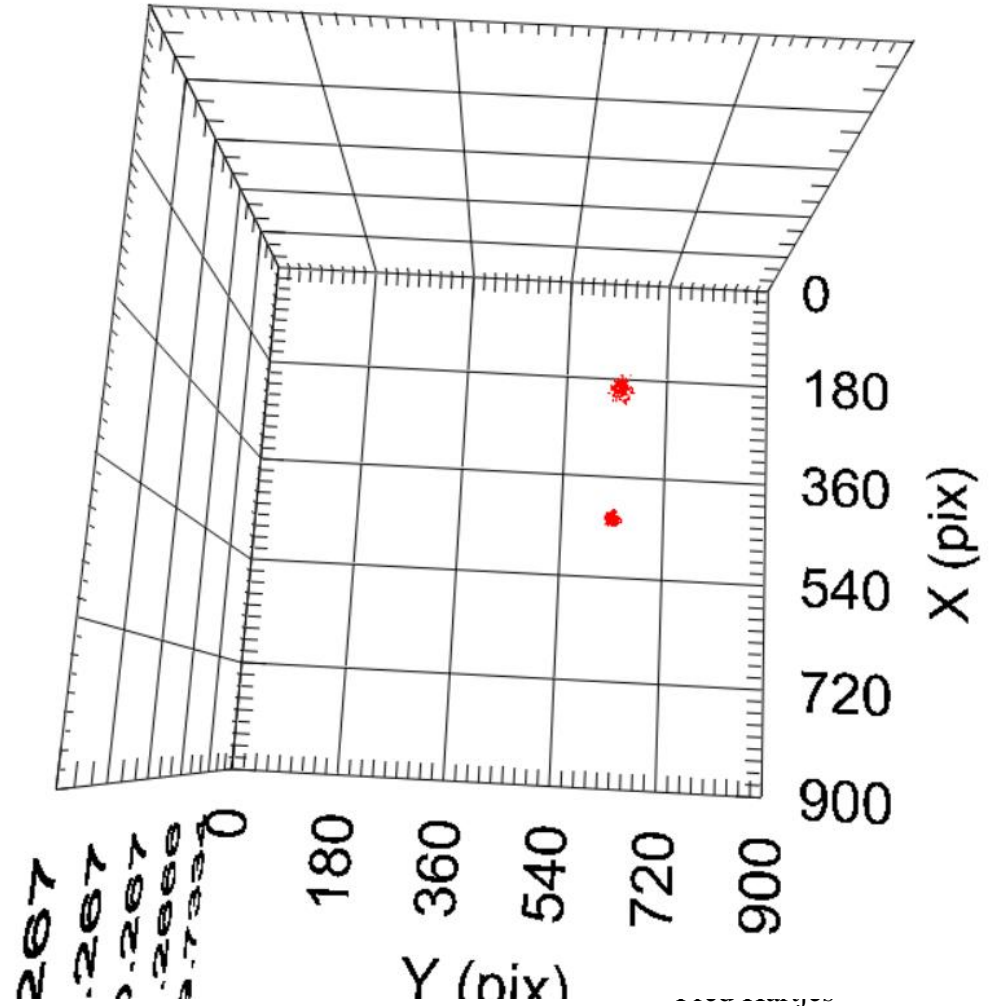
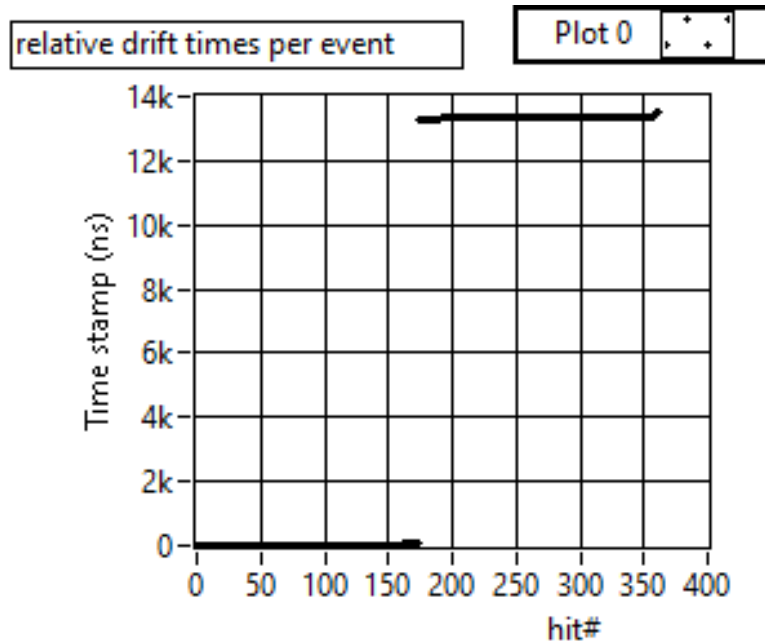
Fluorescence photon events on different chips

- Clusters created 70 ns apart
- Both ~ 100 hits
- On **chip 1 and 2**



Accidental double events on different chips

- Time difference $13.5 \mu\text{s}$
- Both ~ 180 hits
- On **chip 0 and 3**



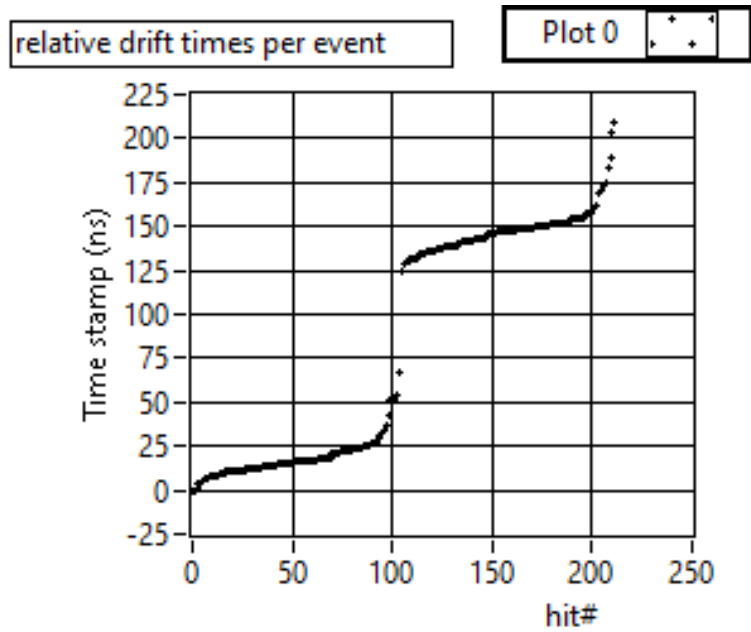
Conclusions

- The ^{55}Fe measurements were analyzed on double cluster events, either simultaneously generated by a fluorescence photon or accidental within a range of $100\ \mu\text{s}$
- The double cluster events show **no indication of systematic loss of hits** because of DAQ problems
 - Neither on the same chip or on two different chips

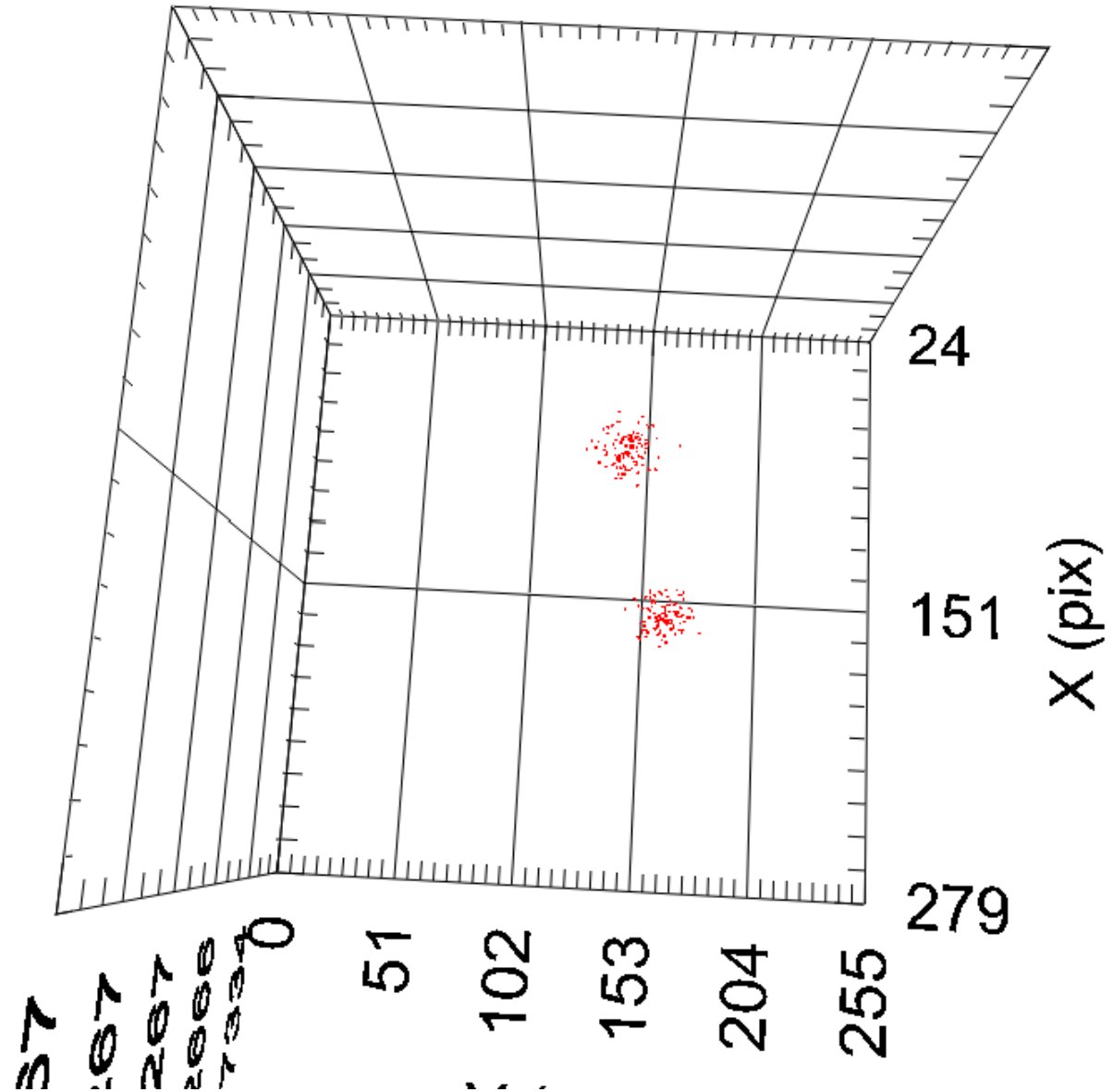
Spare

Another event

- Typical event of two clusters

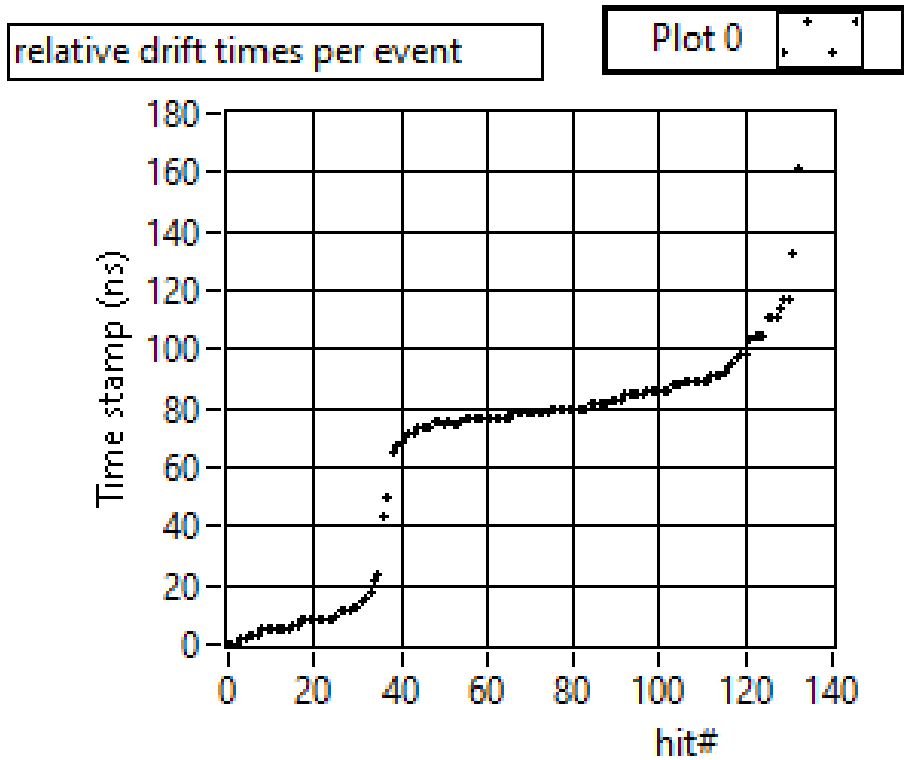


Event display

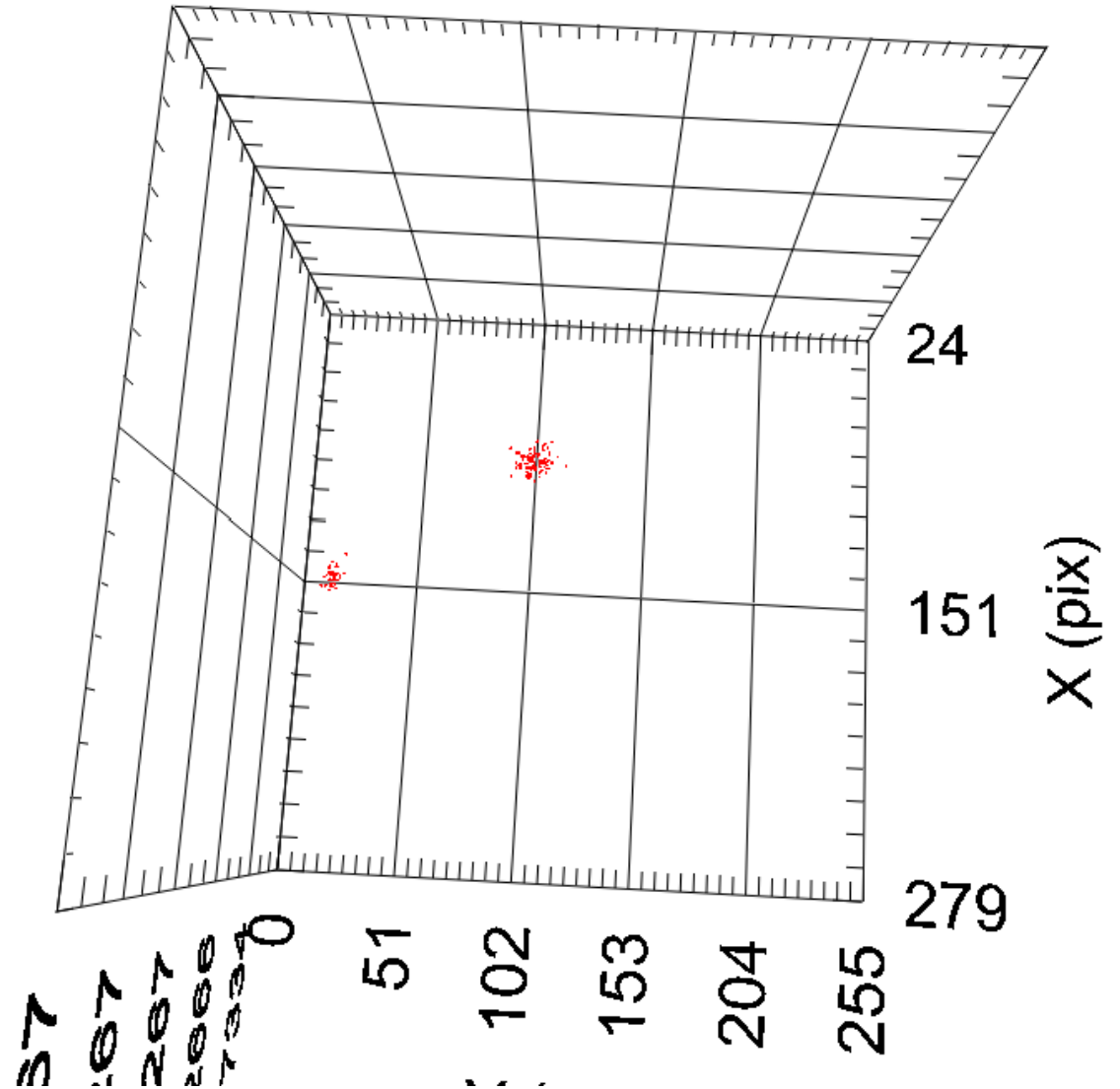


Another event

- Left cluster partly cut off by the chip edge
- The other cluster has less than 100 hits because pileup



Event display



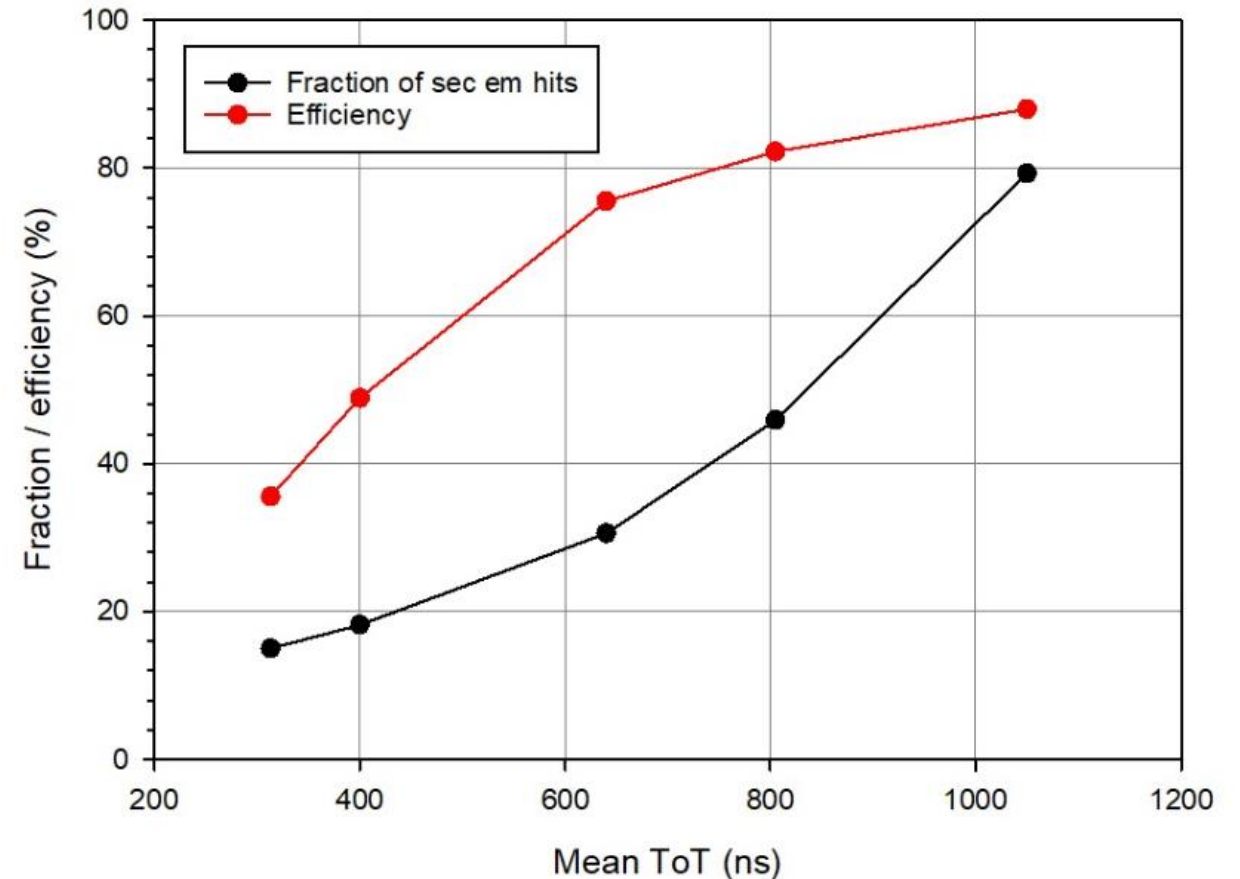
Run using T2K gas

- Run 775, 24 - 4 - 2019
- Vgrid = -330 V
- ToT = 800 ns

- => 82% SE efficiency
- => 44% of all hits originate from secondary emission

Secondary emission fraction vs mean ToT for T2K gas
From ^{55}Fe irradiation

Data 23-30 - 4 - 2019
From ^{55}Fe irradiation



Run using T2K gas

- Both clusters have 140 hits
- # of hits increased by secondary emission

