Verification of Hough method results and new approach in pattern recognition of simulated fake trigger events

E. Gajdos, P. Bobik, B. Pastircak

Hough method

- Previously used method for pattern recognition

- See ICRC 2013 article

  Simulations and the analysis of fake trigger events background in JEM-EUSO experiment, id-1283

- Method of matrix combination

  - for Hough method a so called matrix combination method was used

  - Shower pixel moving ground projection column was selected

  - Combined columns for different showers

  - All combination off possible incoming showers and their projection should be tested/used

M. Staron, Diploma work
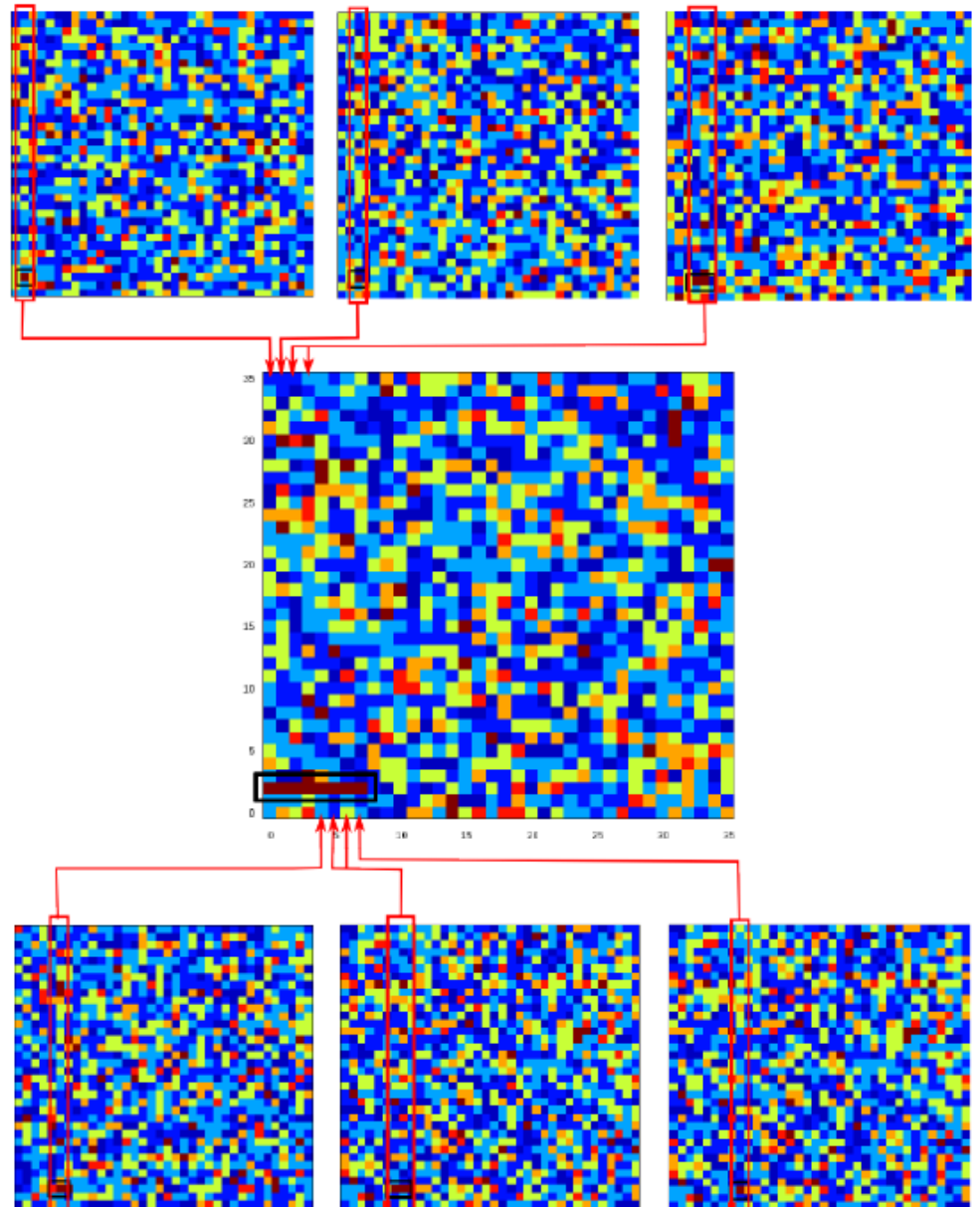
Clustering, verification of Hough method results

- Method description

  - Grouping data (points/pixels) with similarity to each other
  - Key is pattern definition

- Pattern definition

  - directly related continous line
  - Pixel values bigger than treshold T_{px}

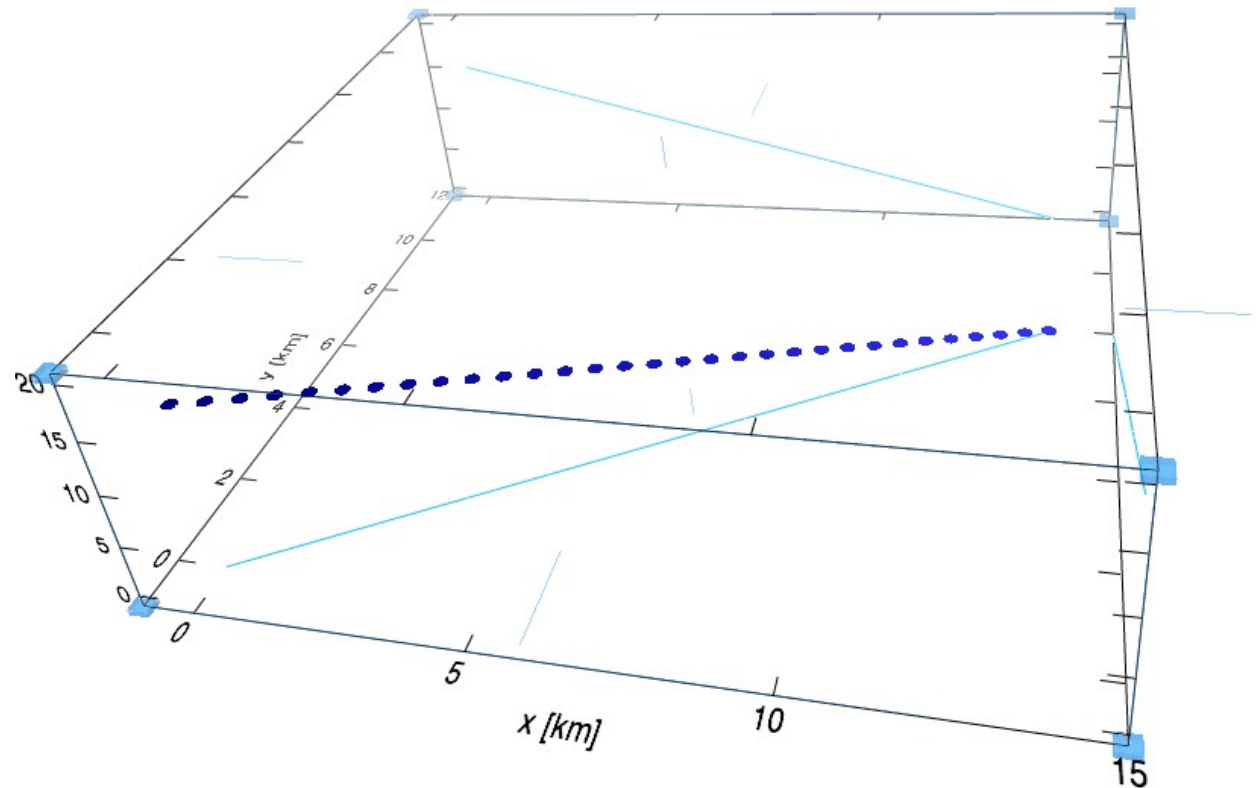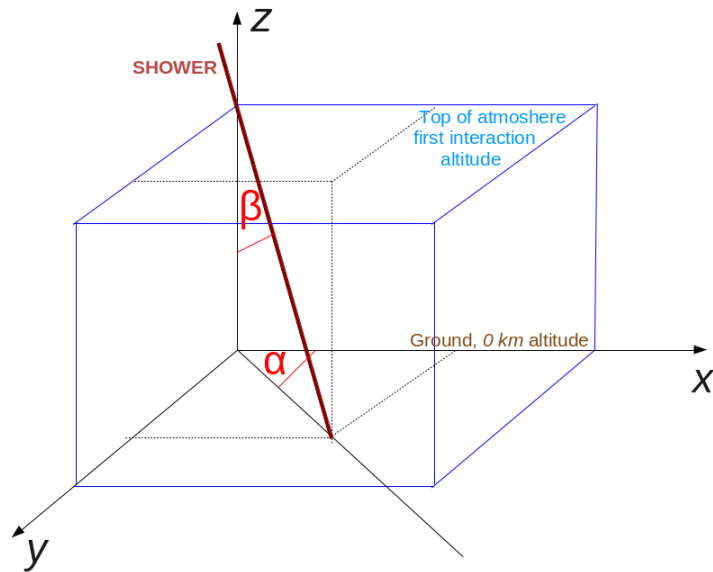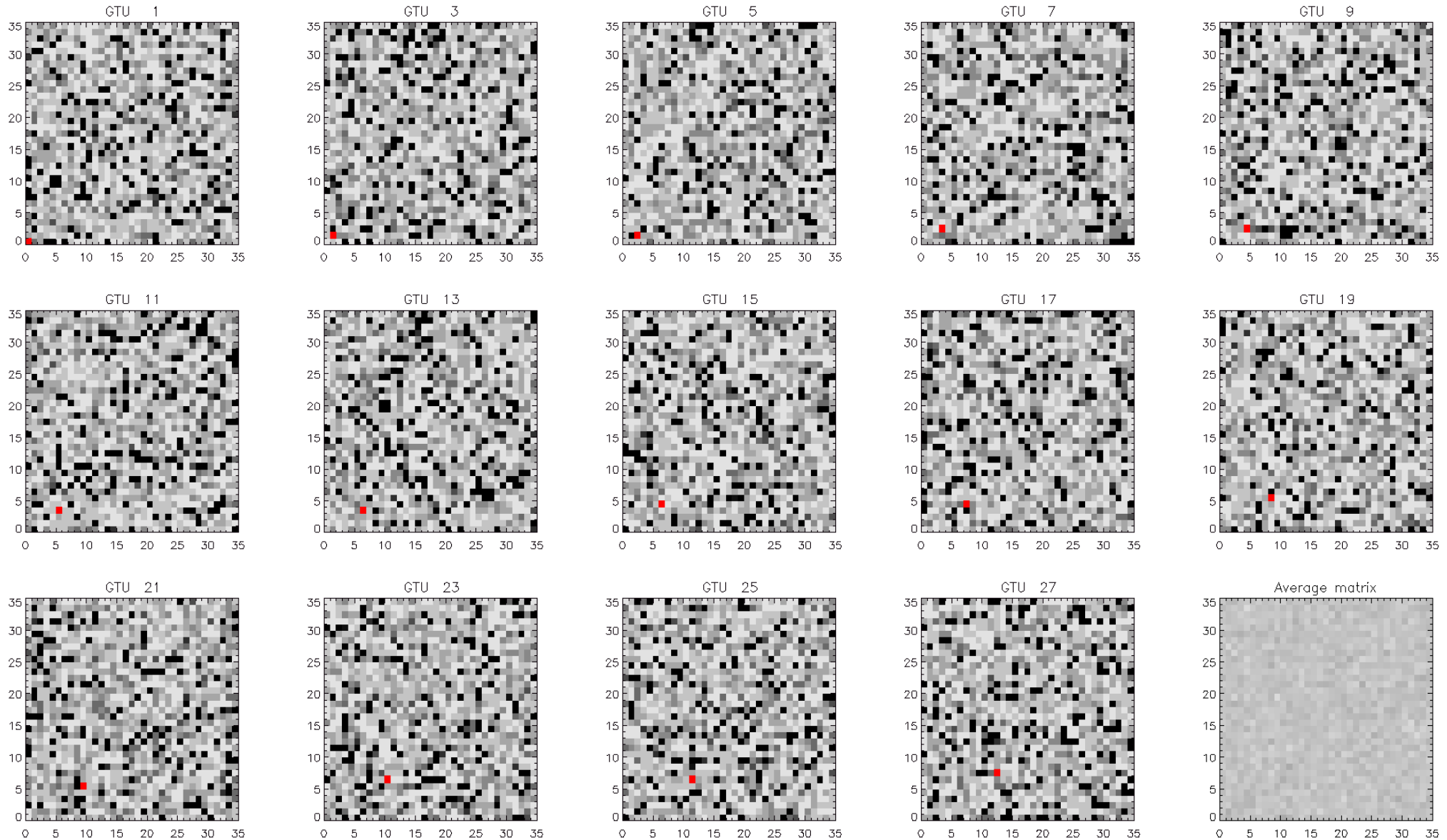# Fake shower "visualization/definition" for pattern recognition

Illustration of principle

Fake shower added to (Poisson) noise : zenith angle 45°, axial angle 30°
Signal → let be = noise + 5 pe /(px GTU)
First interaction / visible pixel at 15 km, $x_0 = 0$, $y_0 = 0$

Fake shower "visualization/definition" for pattern recognition

α = 45º β = 30º

Simple summation of pixels over time does not work. Signal is "drowned" in noise.

Red pixel is fake shower

Note: M36 structure, not triggered noise, not simulated shower : Illustration of principle

Fake shower "visualization/definition" for pattern recognition

- Summation method used for 2D pattern reco

Delete background condition

- If $\quad \boxed{pixel_{value} \leq 3 \quad then \quad pixel_{value} = 0}$

Delete/reduce background from signal condition

- If $\boxed{\begin{array}{c} pixel_{value} > 3 \ \ then \ \ pixel_{value} = pixel_{value} - 2 \\ \\ ++number_{reduced\ pixel} \end{array}}$

Pattern recognition matrix $\quad M36(i,j) = \dfrac{\displaystyle\sum_{k=1}^{31} pixel_{value}(i,j)}{number_{reduced_{pixels}}(i,j)}$

- Fake shower added to *M36(i,j) i.e. to appropriate pixel +5 pe/(px GTU)*

Fake shower "visualization/definition" for pattern recognition

α = 45° β = 30°

Fake shower visible for pattern recognition
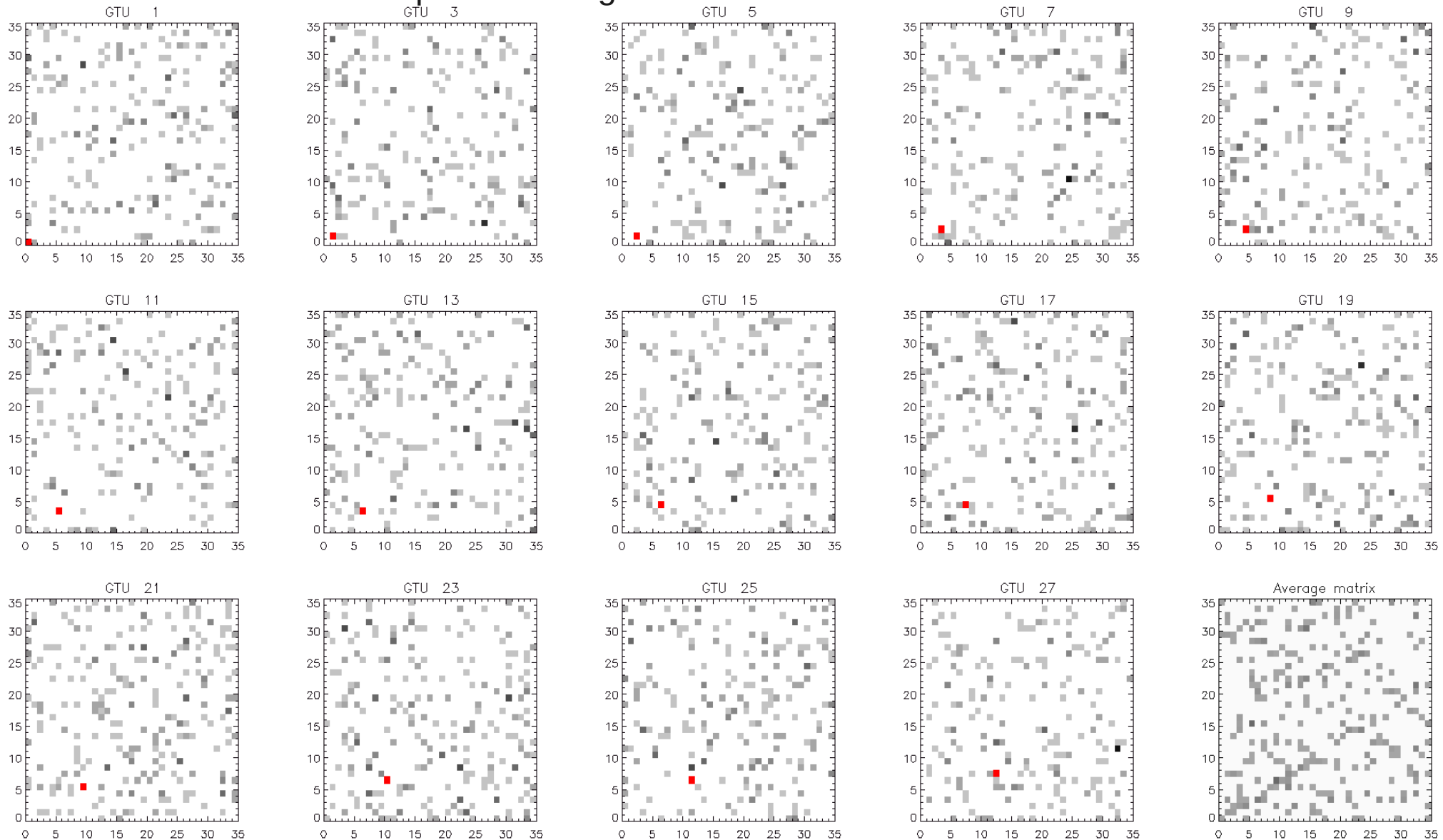
Red pixel is fake shower

Note: M36 structure, not triggered noise, not simulated shower : Illustration of principle

Fake shower "visualization/definition" for pattern recognition

$\alpha = 50^o$ $\beta = 60^o$
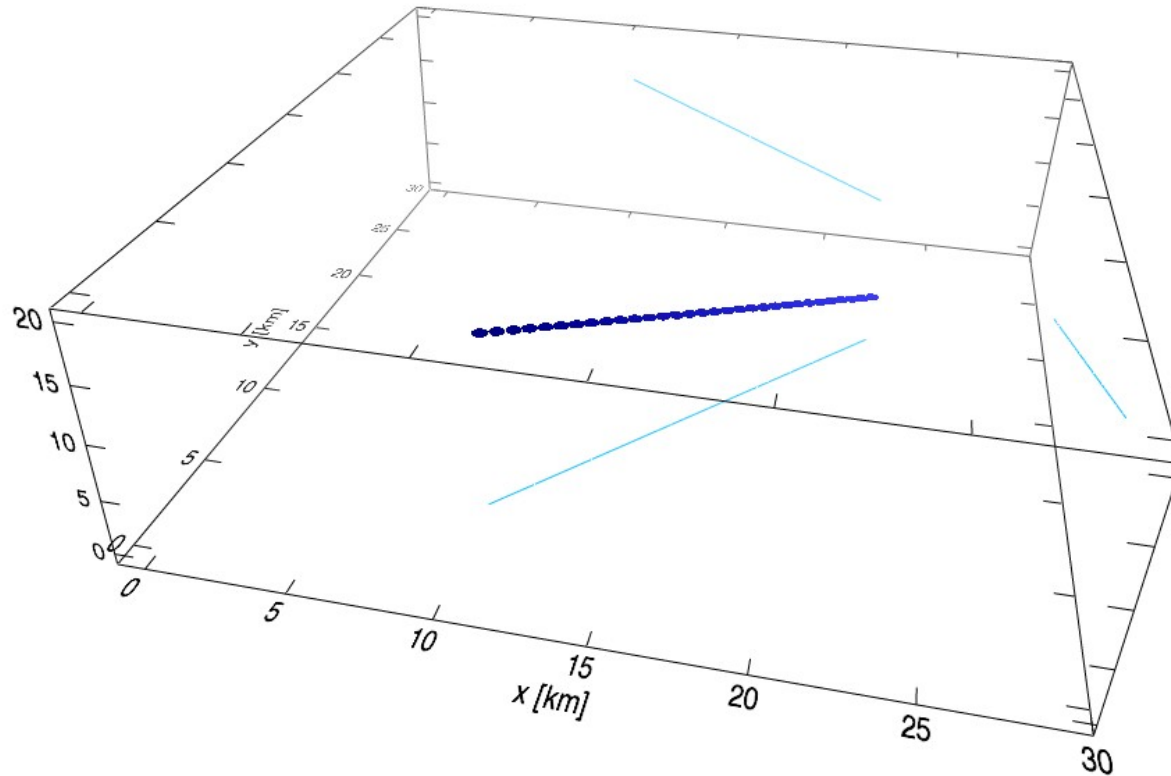

Illustration of principle

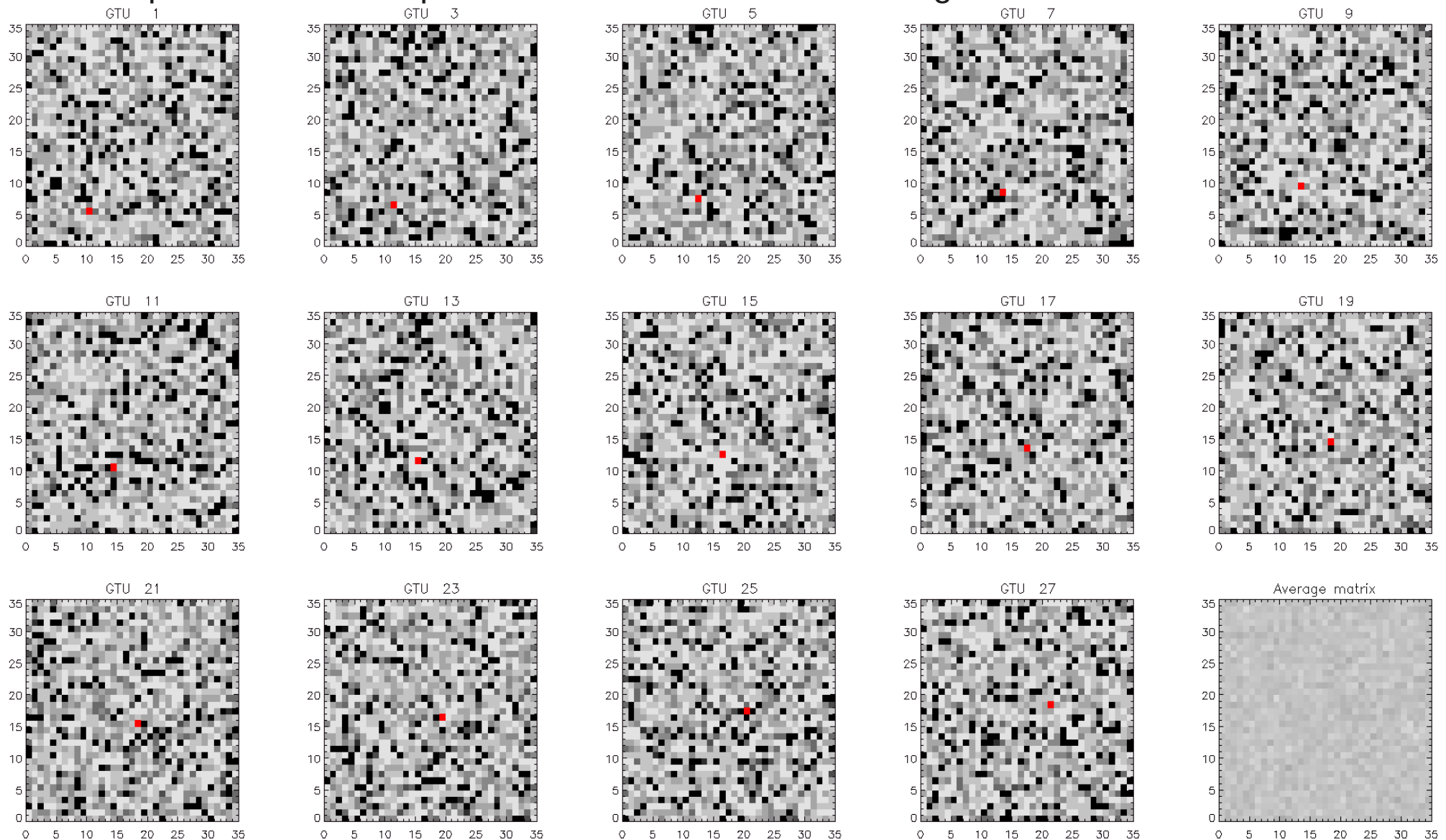Fake shower added to (Poisson) noise : zenith angle 60°, axial angle 50°

Signal → let be = noise + 5 pe /(px GTU)

First interaction / visible pixel at 15 km, $x_0 = 10$ km, $y_0 = 5$ km

Fake shower "visualization/definition" for pattern recognition

α = 50º β = 60º

Simple summation of pixels over time does not work. Signal is "drowned" in noise.
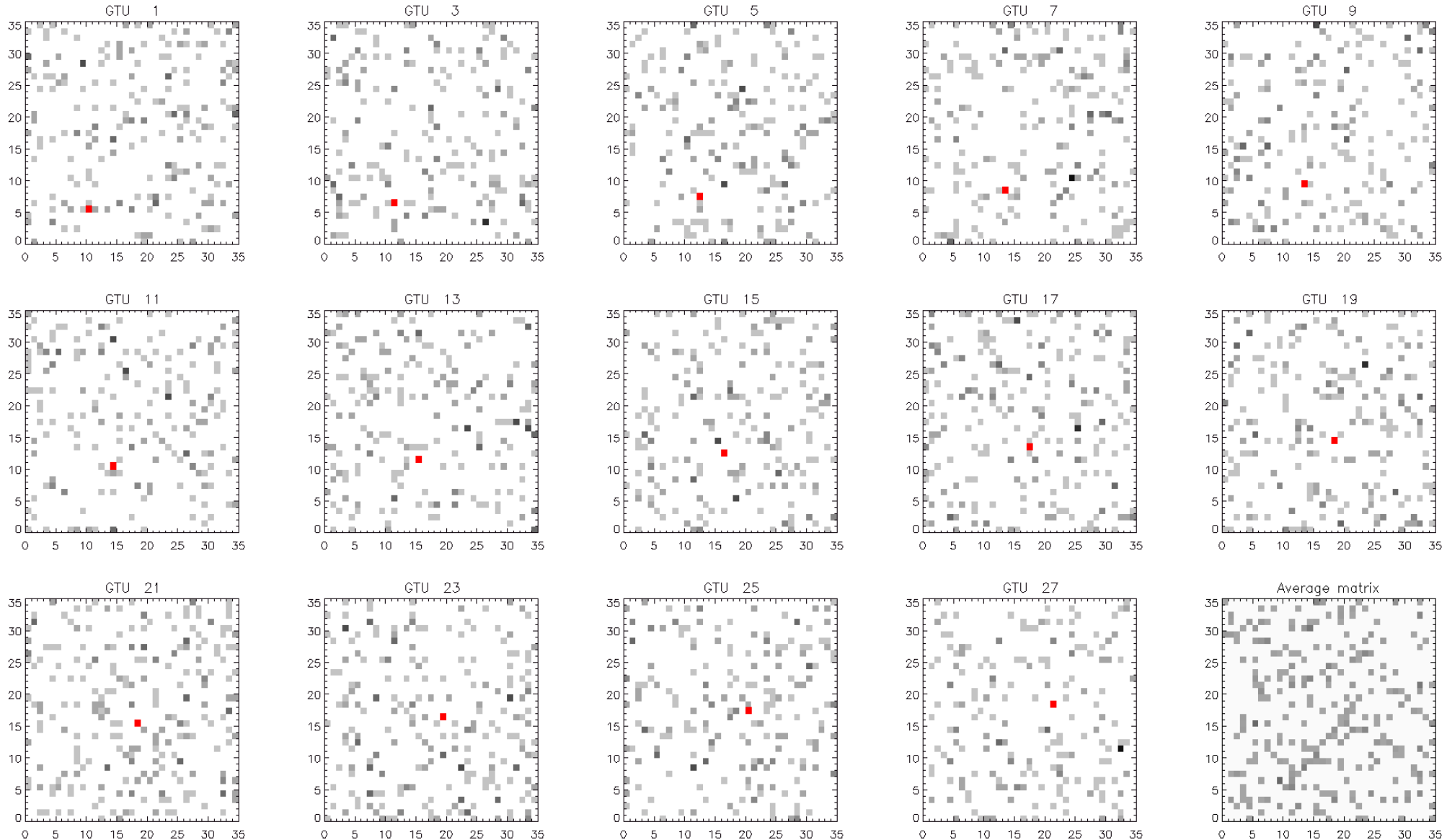

Red pixel is fake shower

Note: M36 structure, not triggered noise, not simulated shower : Illustration of principle

Fake shower "visualization/definition" for pattern recognition

α = 50° β = 60°

Fake shower visible for pattern recognition

Red pixel is fake shower

Note: M36 structure, not triggered noise, not simulated shower : Illustration of principle

Clustering, summation method

- Analysis on simulated data

- Pattern recogniton method

  Clustering - for crosschecking / verification reasons (to check Hough method results)

- Francesco Fenu code simulation for M36 (see B. Pastircak presentations over this topic at this and previous meetings)

25 000 seconds (10 runs) of simualted measurements on one PDM was used for analysis
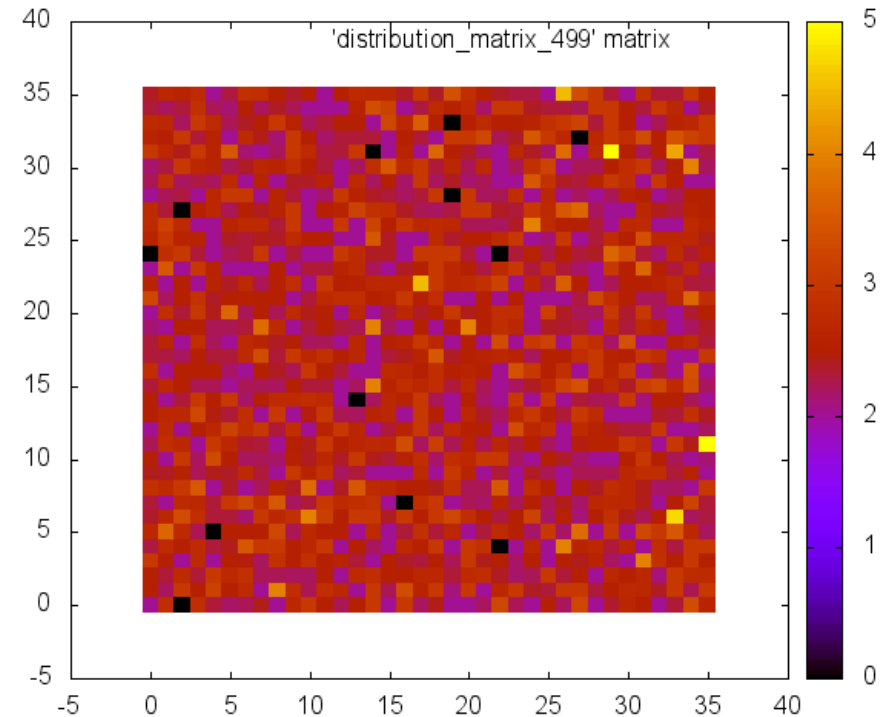
Example of matrix prepared by summation method from one triggered event

Clustering, verification of Hough method results

- Results from ~3000 events

- 25000 seconds on one PDM analysis

- Clustering with $T_{px} \geq 3$

  i.e. ≥ 3 for "shower" signal

  for ≥ 5 for noise + "shower" signal

- Number of patterns with particular length in all triggered events

- Results qualitatively simmilar to Hough/ICRC2013 analysis
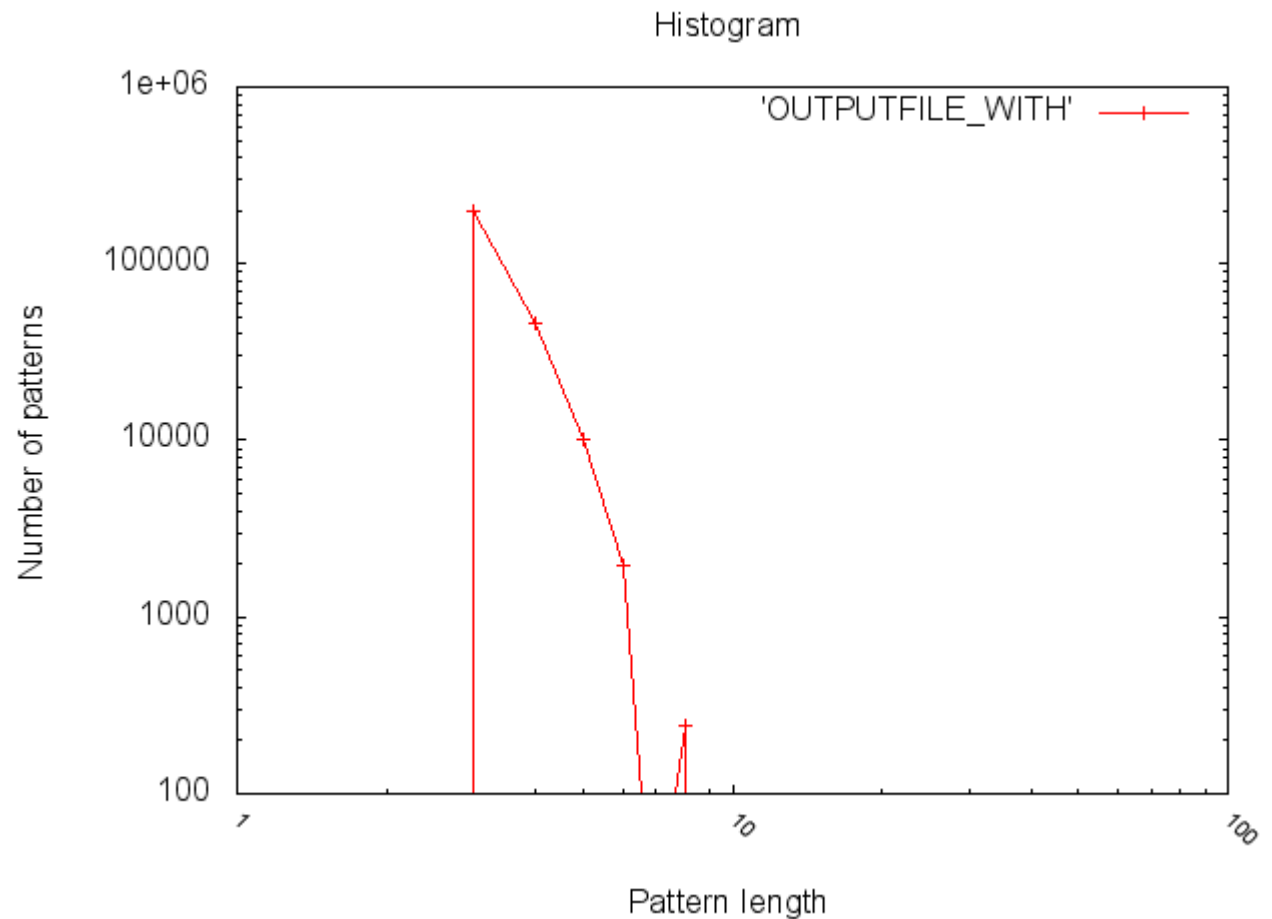
Conclusions / Outlook

- Clustering results depends on pattern definition (pixel value treshold)

- Solution : 3D method for pattern recognition, ongoing work