LIME Run-2 first look at golden dataset

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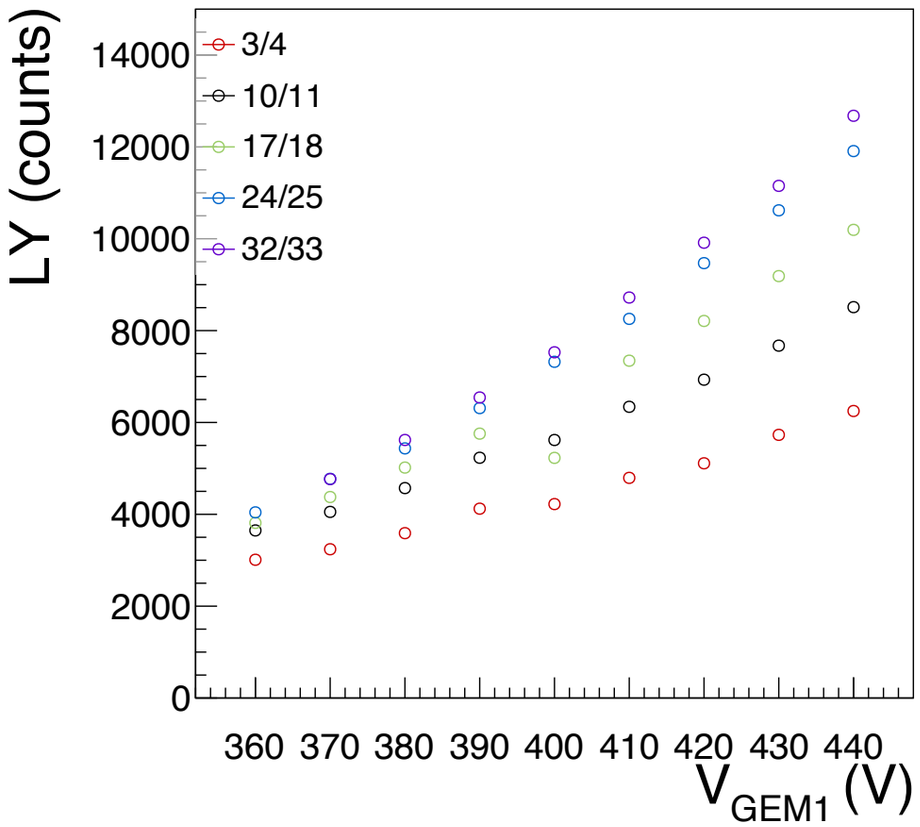
Reconstruction & analysis meeting, 16 March 2023

LIME Run 2 ended

- Run-2 golden dataset taken from March 6 -> March 9 2023.
  - $4 \times 10^5 \cdot 0.3\,s \approx 33\,\mathrm{hr}$ of exposure of LIME gas volume
  - Detector kept at the highest gain (HV=440 V and gas flux = 20 l/h) with few instabilities - few discharge detected

06-03 11:25 — to — 06-03 12:17	Calibration	Yes	20	440	11281-11287
06-03 12:21 — to — 07-03 11:29	**Golden**	No	20	440	11288-11582
07-03 11:36 — to — 07-03 12:10	Calibration	Yes	20	440	11583-11589
07-03 12:18 — to — 08-03 16:48	**Golden**	No	20	440	11590-11951
08-03 16:48 — to — 08-03 17:36	Calibration	Yes	20	440	11951-11958
08-03 17:36 — to — 09-03 09:55	**Golden**	No	20	440	11959-12165
09-03 09:55 — to — 09-03 10:30	Calibration	Yes	20	440	12168-12174
09-03 10:30 — to — 09-03 11:30	**Golden**	Yes	20	440	12175-xxxxx

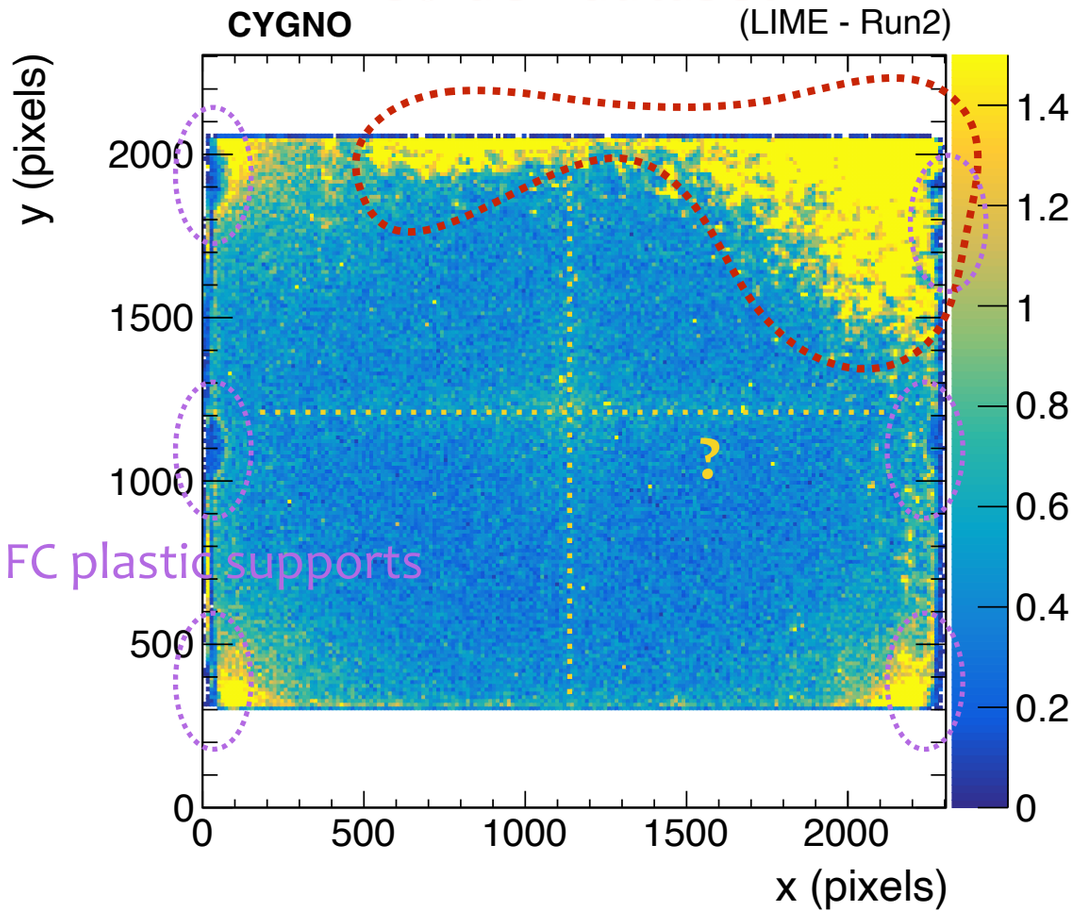
- From the ^{55}Fe calibration with z and HV scans, the LY is maximum, within the range $[1.0 - 2.4]\,\mathrm{ph/eV}$ for Z in the range $[5 - 48]\,\mathrm{cm}$
  - See this presentation for details



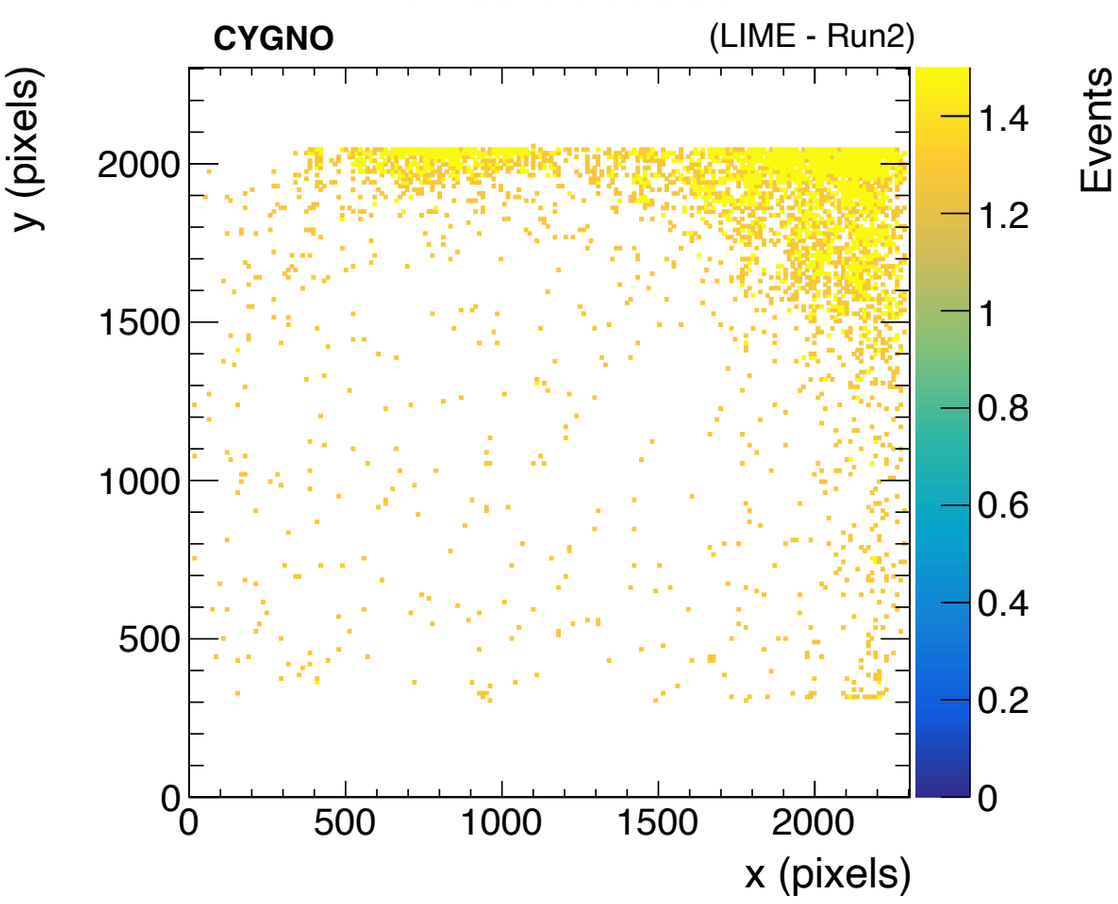
Clusters selection and calibration

- Loose cluster selection: all lengths, all detector acceptance:
  - Cluster RMS > 6 photons to suppress a bit fake clusters and sparks
- Fake clusters estimated from clusters reconstructed in pedestal runs, normalised to the same livetime
- Compare Golden data (No source) with data with ^{55}Fe, just to have an idea of the energy scale
  - Absolute energy scale calibration done with ^{55}Fe with Z=25 cm

Golden dataset



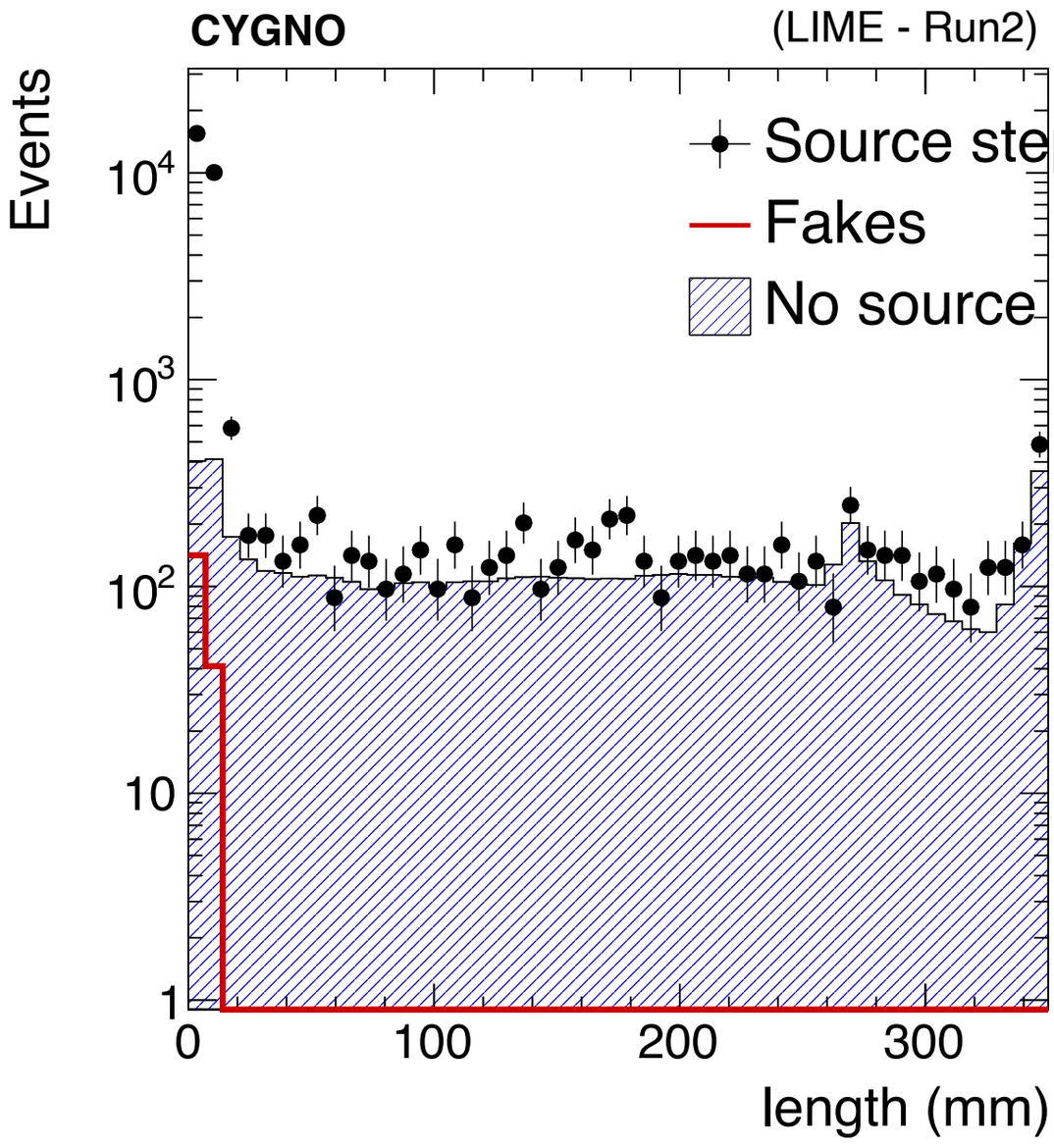
Fakes dataset

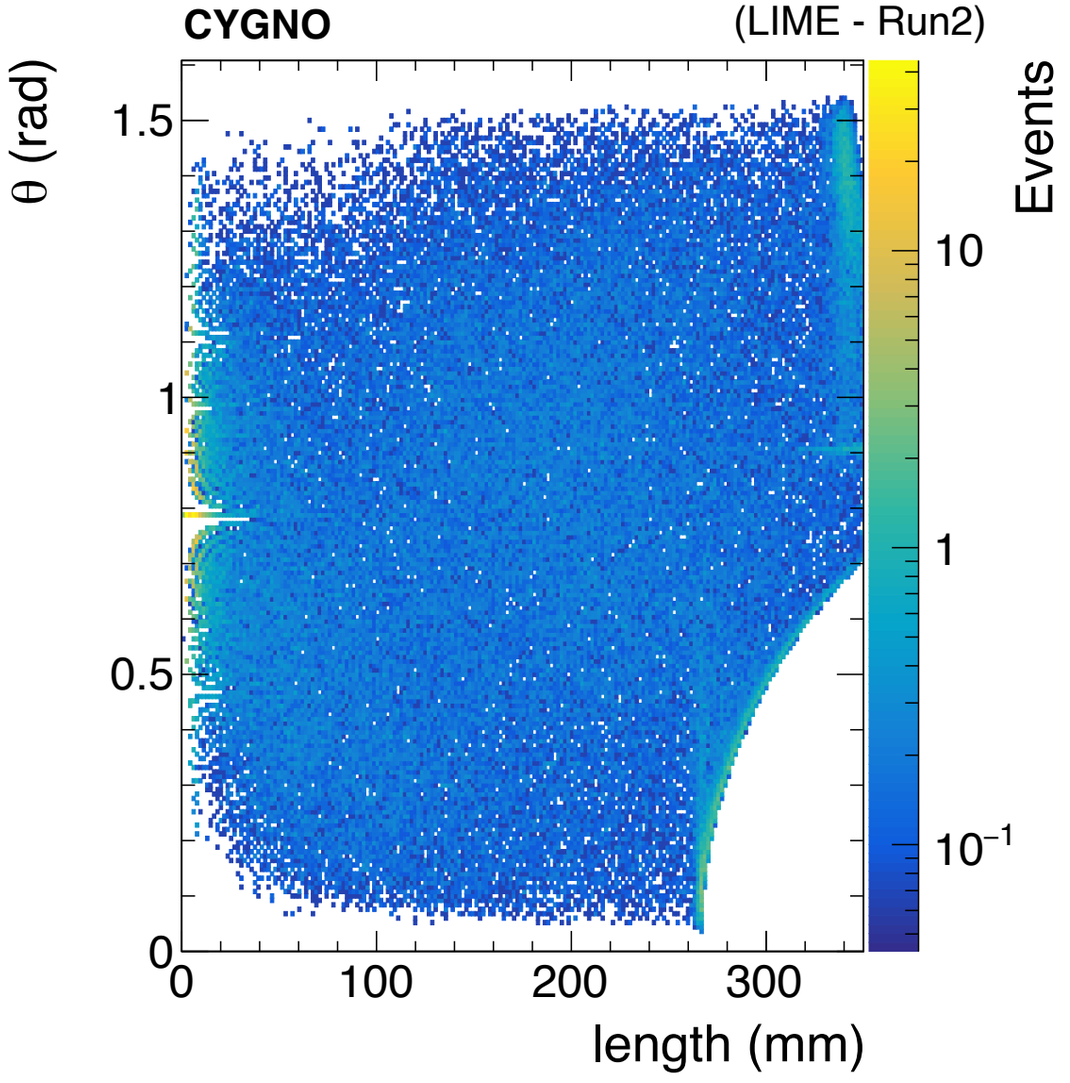


- Some features to be understood: e.g. the middle-sensor cross. In the following concentrate on the central circle

Cluster shapes: length

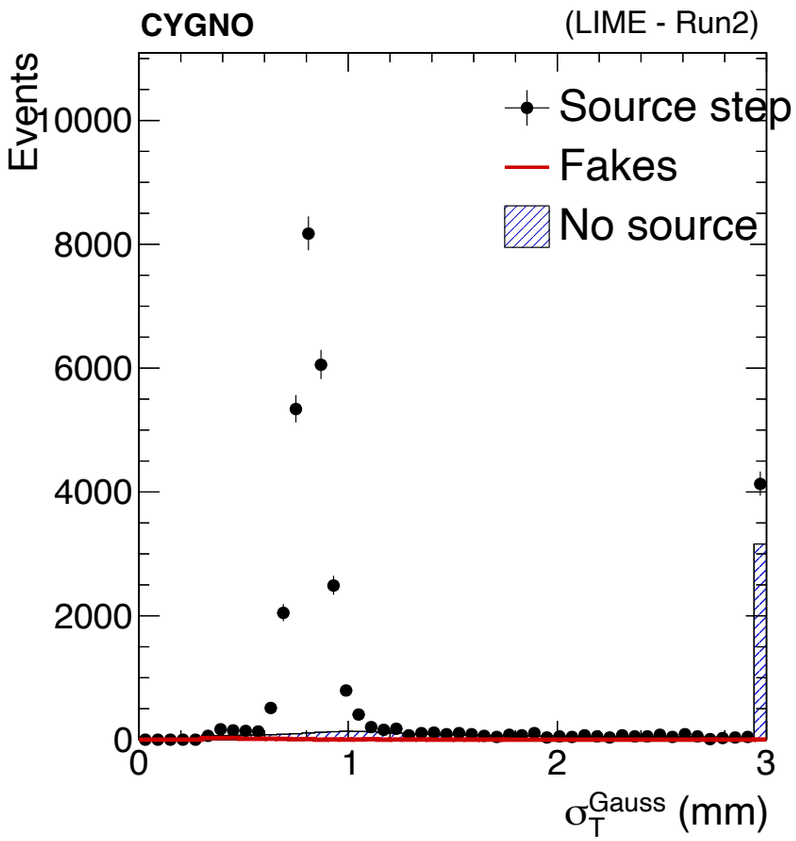
- Clusters as long as the full sensor can be seen
- Again, effect of "length saturation" due to global exposure visible, despite reduced for 300 ms wrt LNF 50 ms exposure time (peak at ~26 cm)



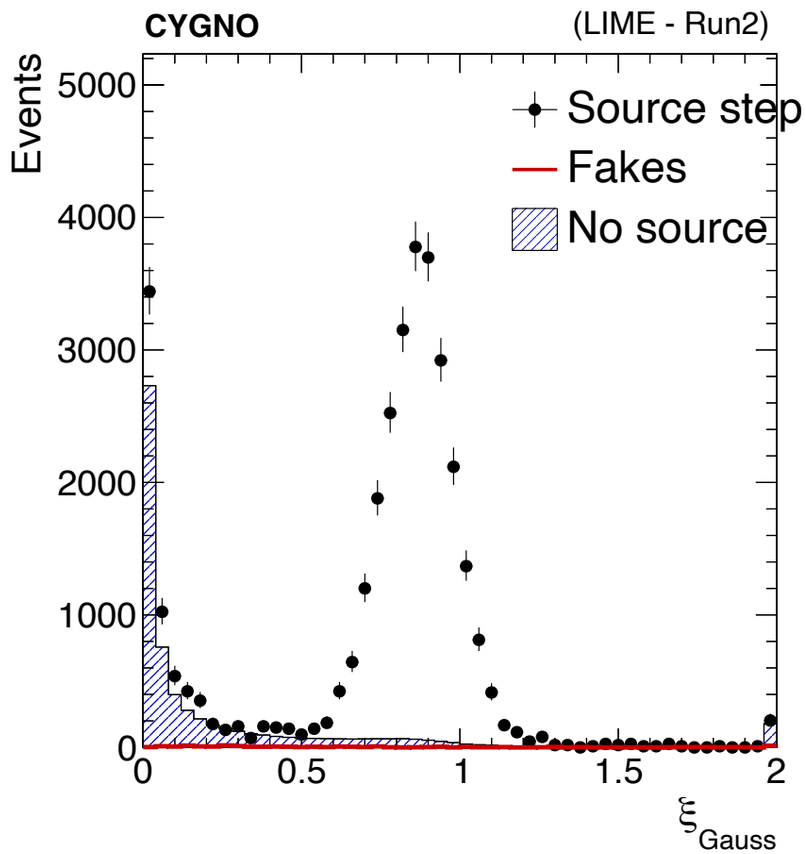


Cluster shapes: width

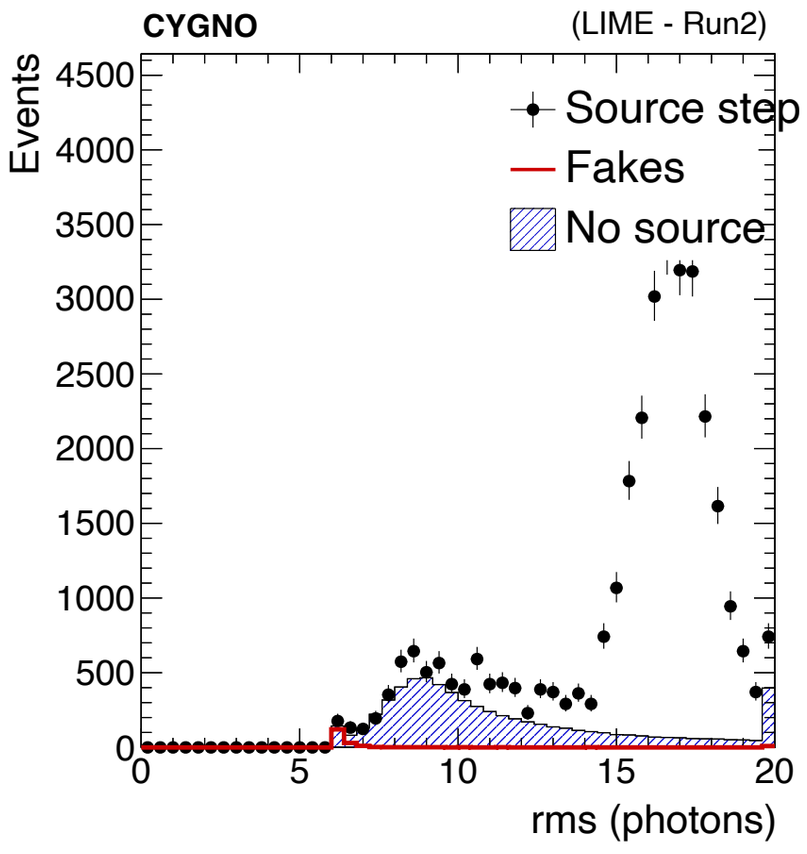
- $^{55}\mathrm{Fe}$ spots have transverse resolution $\sigma_T^{\mathrm{Gauss}} \approx 800\,\mu\mathrm{m}$
- Slimness is a good candidate to cleanly select spots from other clusters (eg. To select a pure X-rays sample for energy calibration)
- Cluster rms > 6 (applied for this sample) only kills a subset of fake clusters



Transverse resolution



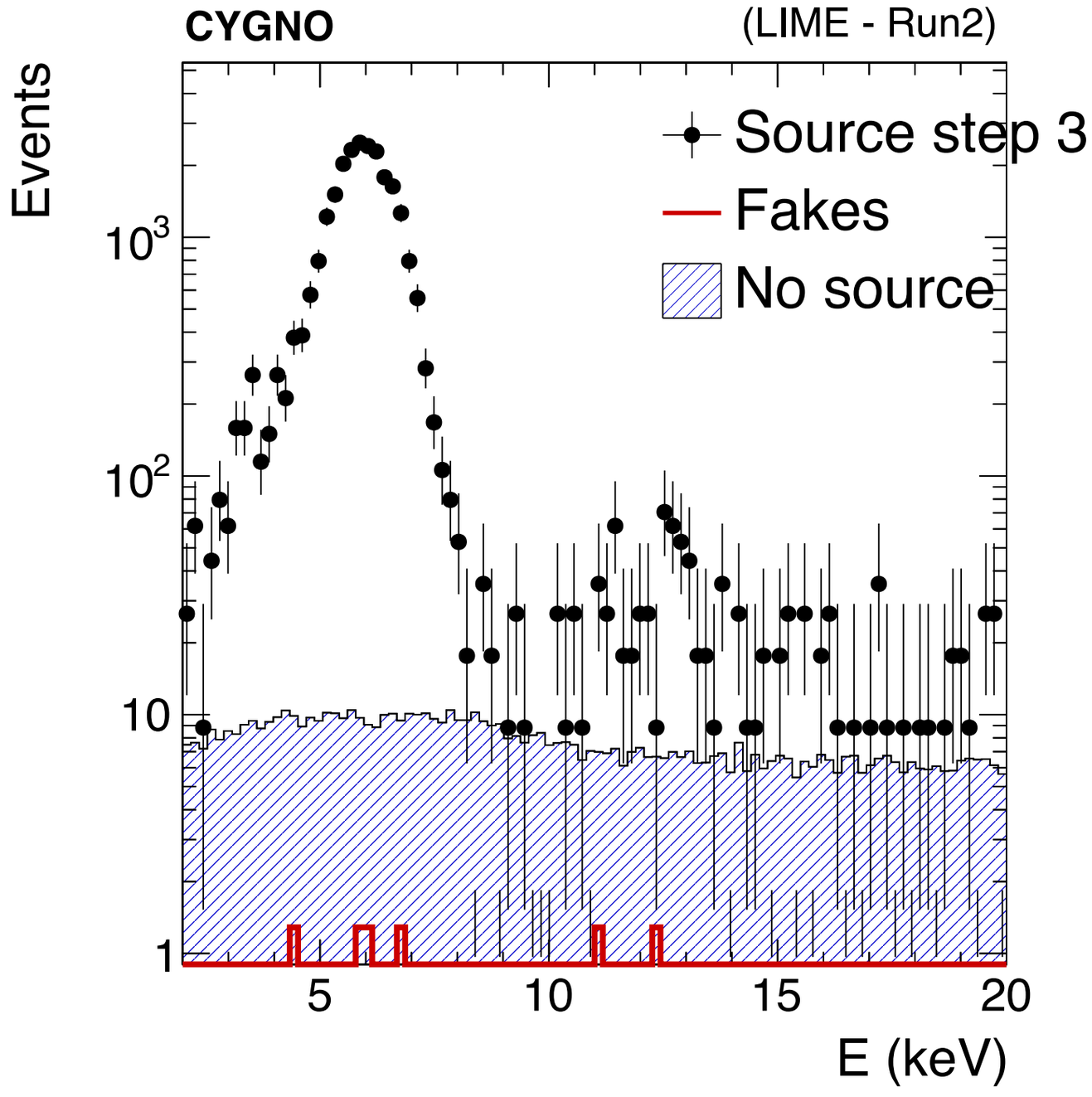
Slimness



Cluster RMS

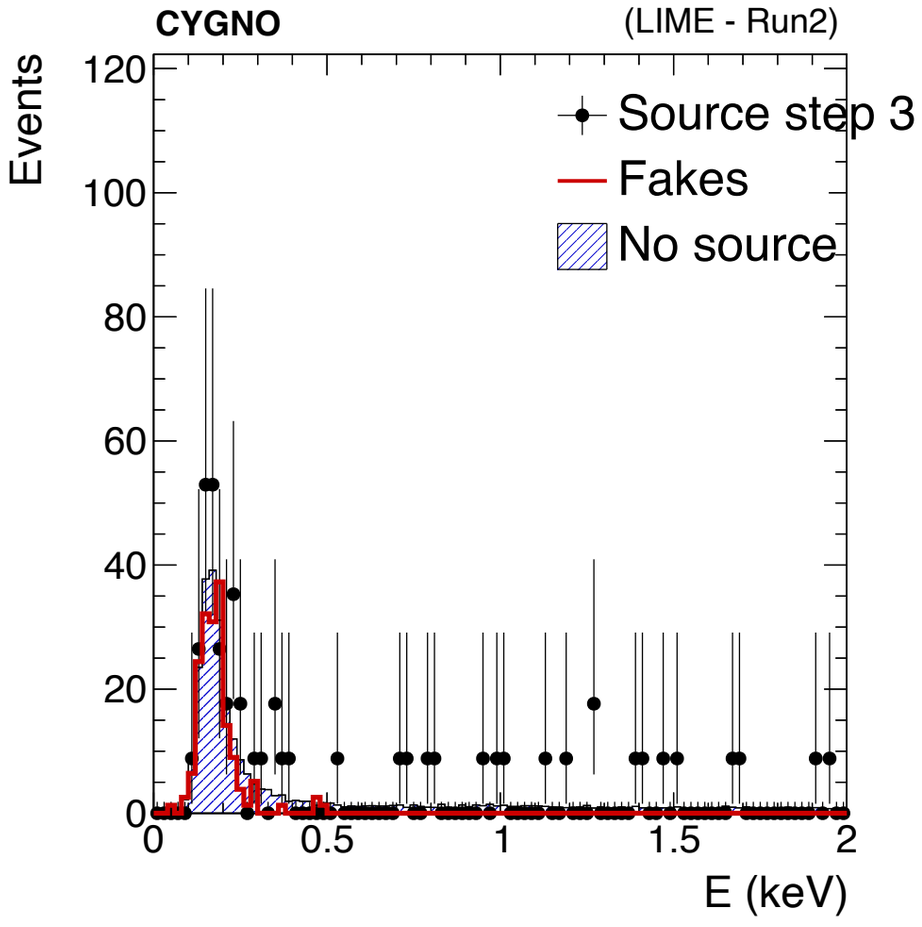
Energy spectra: calibration

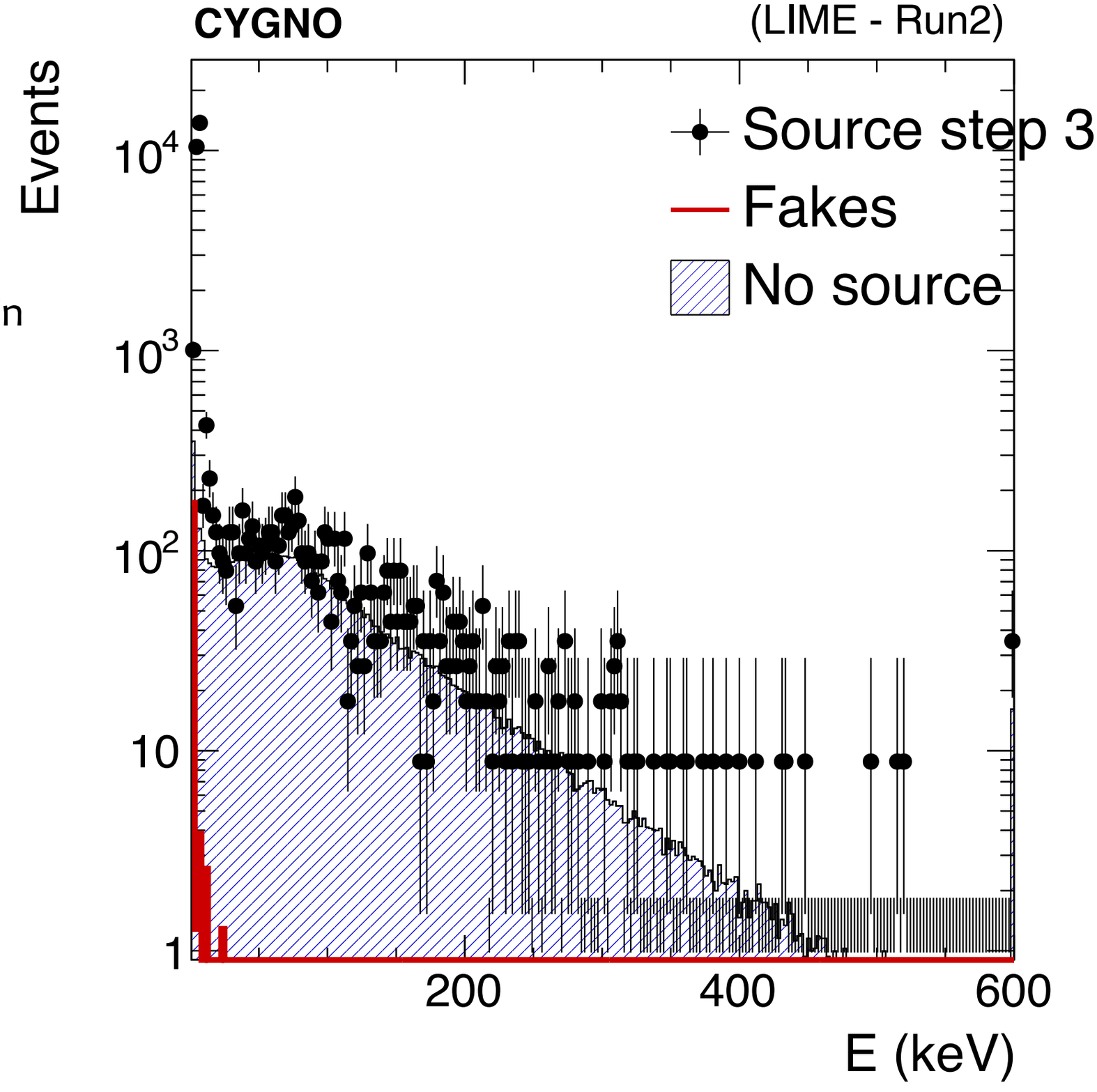
- *Source step 3* means ^{55}Fe, Z=25 cm. This is used for energy calibration.
  - Raw photon yield $\approx 10^3$



Energy spectra

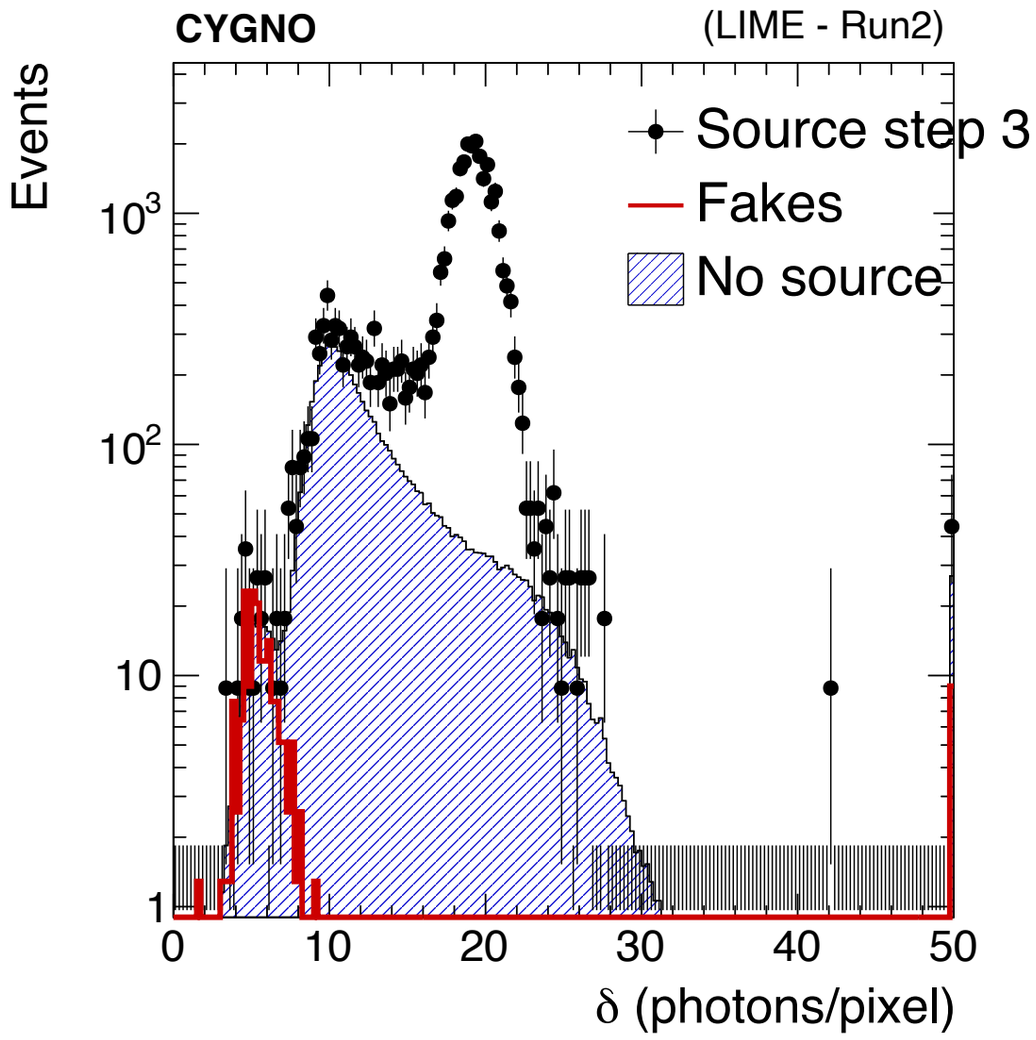
- Spectrum for fakes dies for $E \gtrsim 300\,\mathrm{eV}$
- Data spectrum exponentially decreases for E>100 keV
  - E > 600 keV in the overflow bin

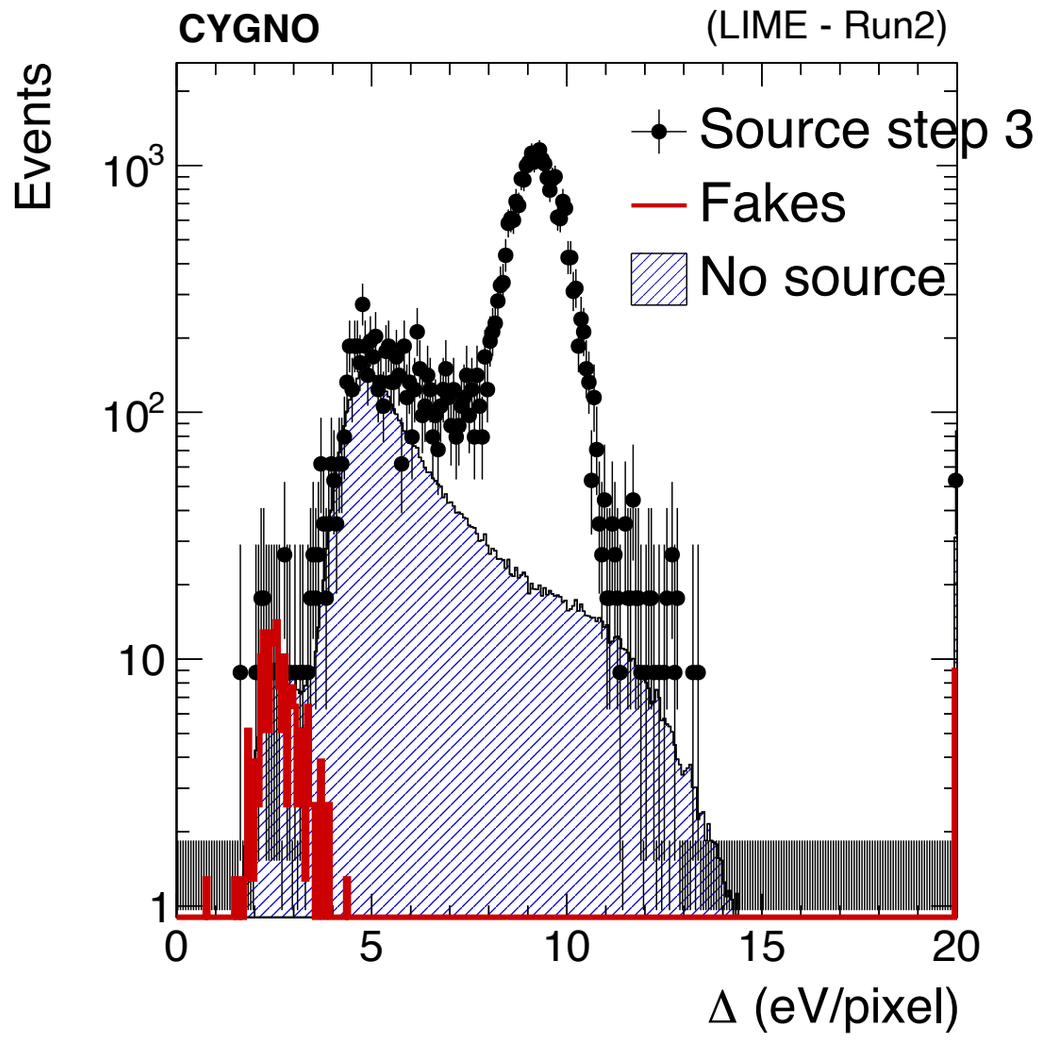




Energy density

- Our usual workhorse variable for NR search is energy density $\delta \equiv N_{pho}/N_{pix}$, or, after calibration, $\Delta \equiv E/N_{pix}$

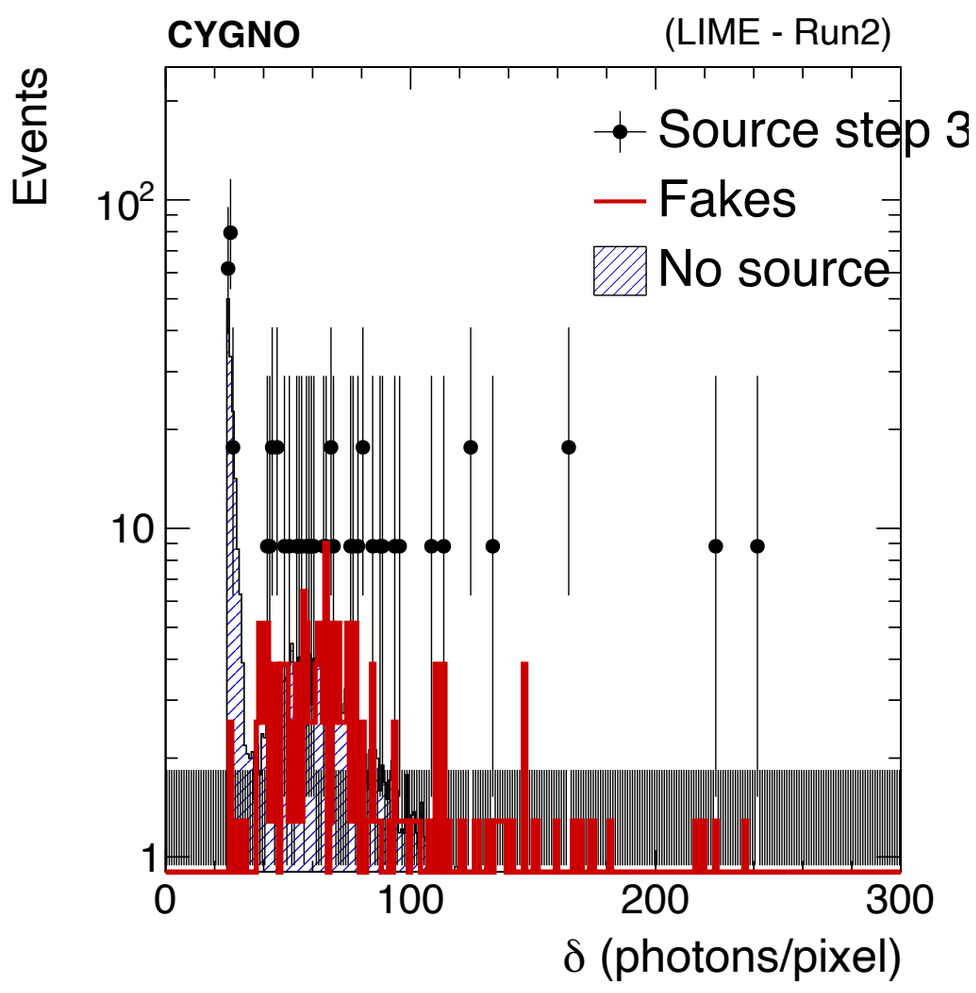


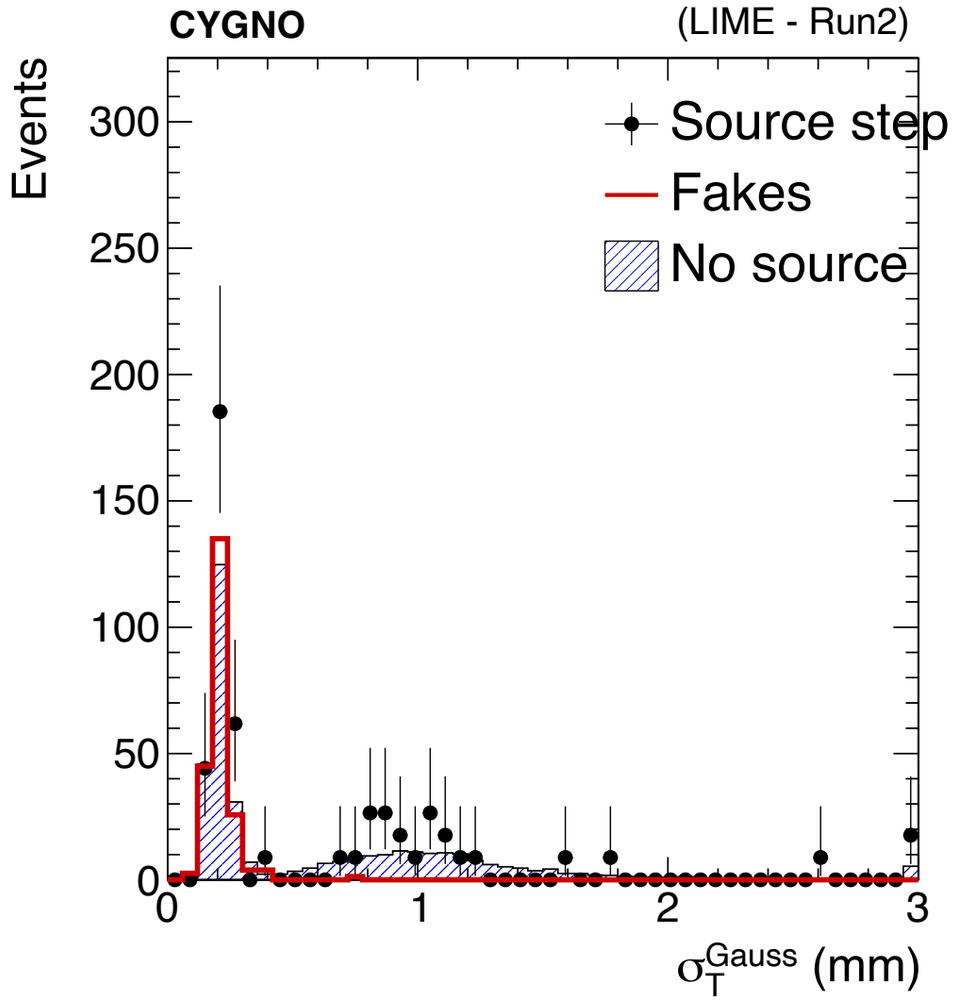


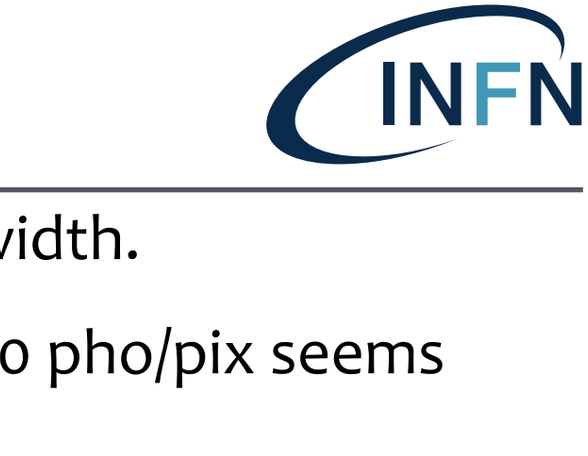
- As expected, fakes are low density
- As NOT expected, the high-density (corresponding to the high-energy overflow bin) are also present for fakes
  - Hypothesis: interactions of particles directly in the CMOS sensor

CMOS interactions

- If they are interactions in the CMOS, they should be very narrow in width.
- Selecting a sample with $\delta > 25$ pho/pix, the rate of events around 50 pho/pix seems the same for fakes and golden data
  - Indeed that component is extremely narrow (1-2 pixels wide) => consistent with CMOS interactions



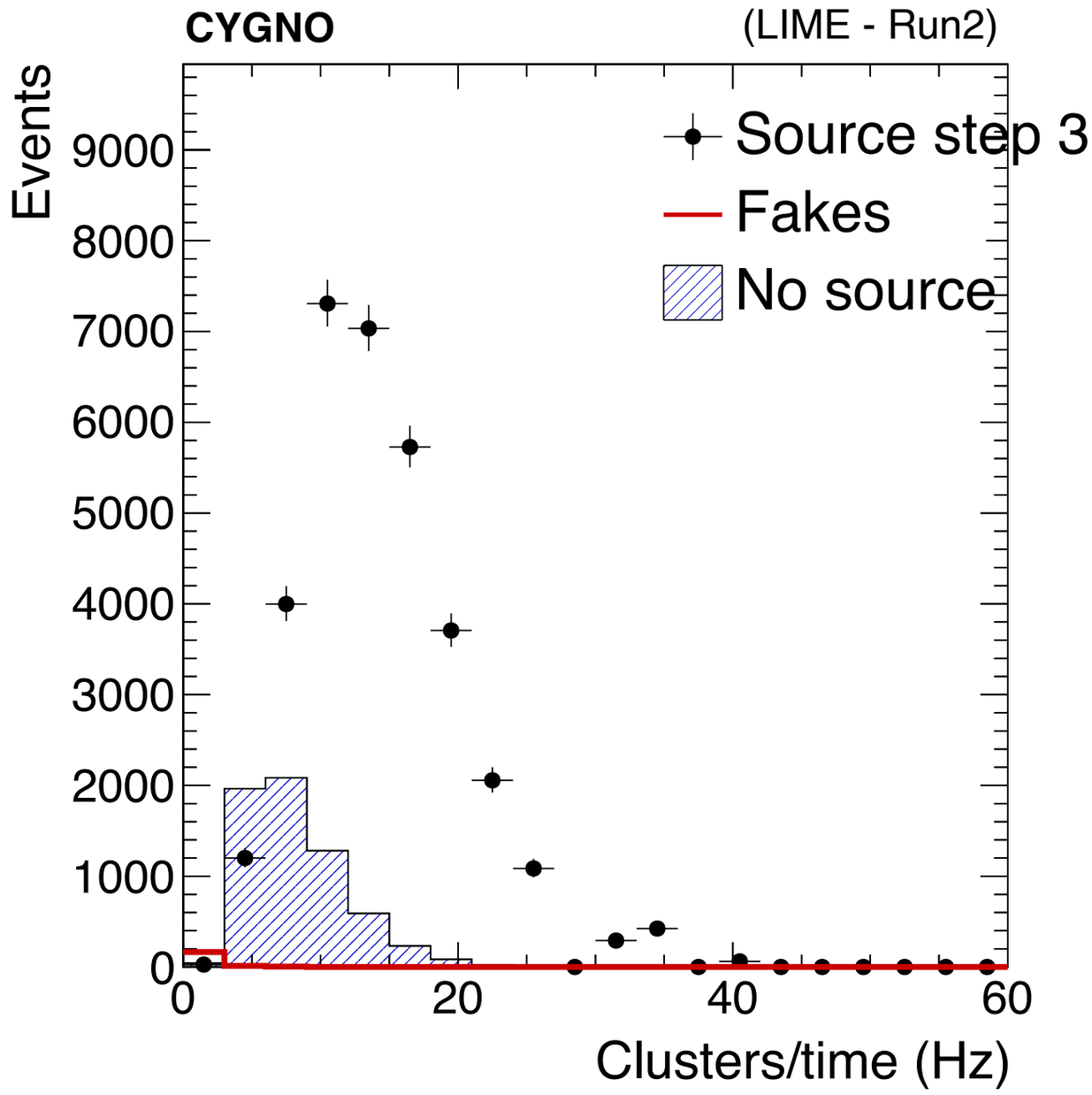




D. Pinci, 2015: Narrow, very bright tracks

Interaction rate

- Estimate from number of clusters, normalised on the exposure, and only within R<800 fiducial volume V_{fid} (i.e. $V_{fid}/V_{tot} = \pi R^2/L^2 \approx 38\,\%$ of the total sensitive volume)



All clusters in golden dataset
$\approx 7\,\mathrm{Hz}$

The End