# Detecting neutrinos from the next galactic supernova in the NOvA detector


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# Neutrino signal from the core-collapse supernova


Type II SN radiates ~**99%** of the collapse energy in neutrinos:

**~$10^{58}$** neutrinos: **$E_\nu$~10-60 MeV** within **T ~10s**

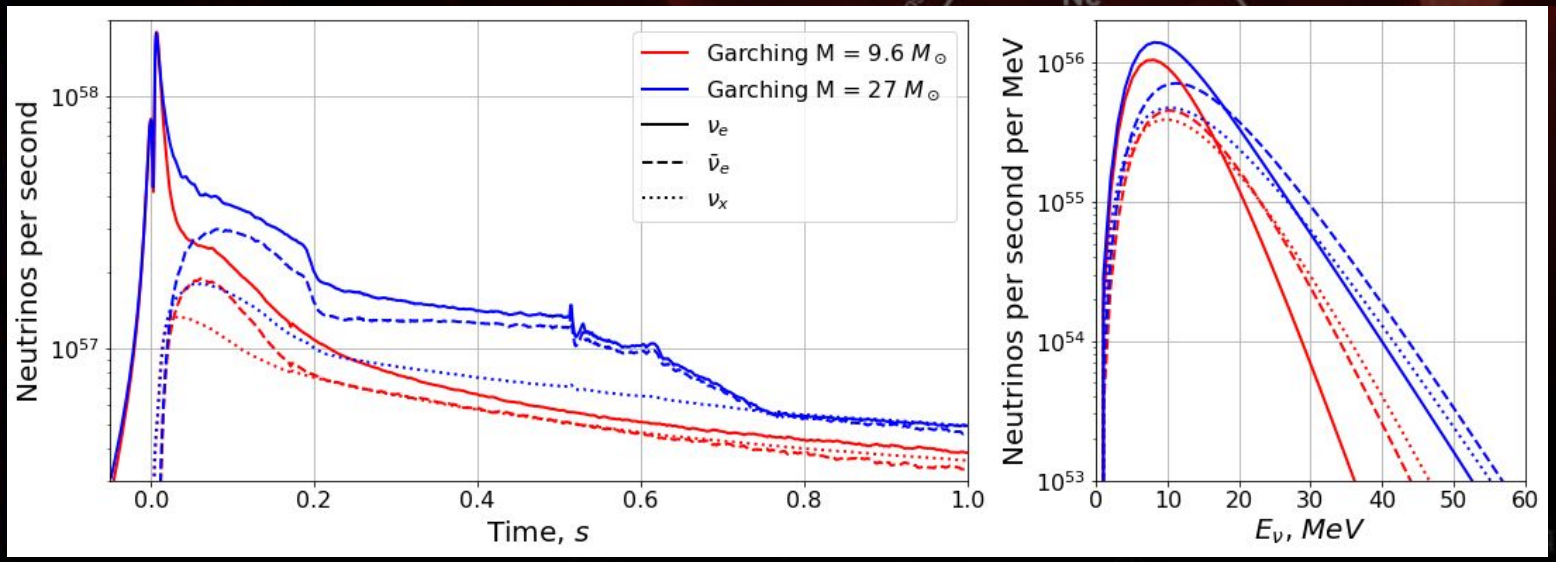
**Neutrino signal: probe of**

- Neutrino properties
- Supernova properties

*arXiv:1508.00785 [astro-ph.HE]*

Galactic SN are very rare: **~1-3** per century!

(and have never been observed in the neutrinos in our galaxy)



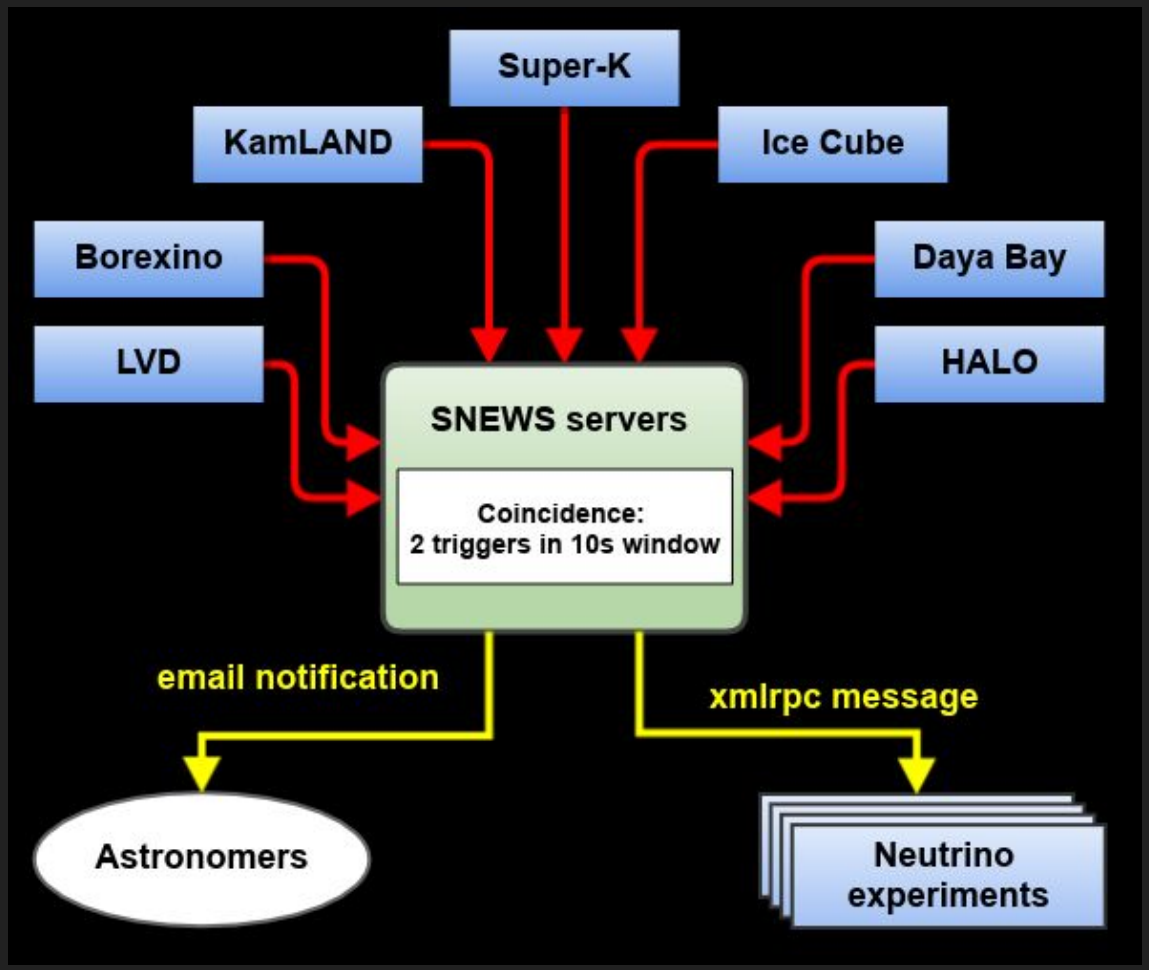
# SuperNova Early Warning System

snews.bnl.gov

A global network to make sure we don't miss a galactic event.

Neutrinos arrive several minutes to hours prior to optical signal

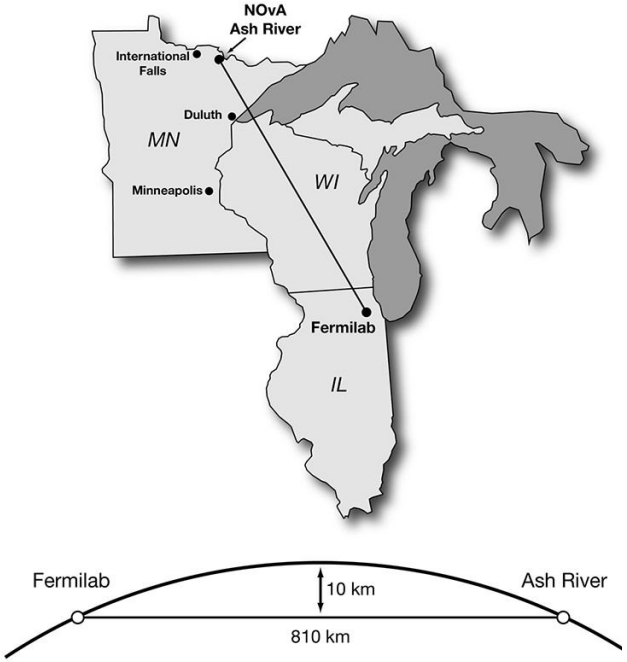
NOvA currently listens to a trigger from SNEWS, to save data in case of supernova.

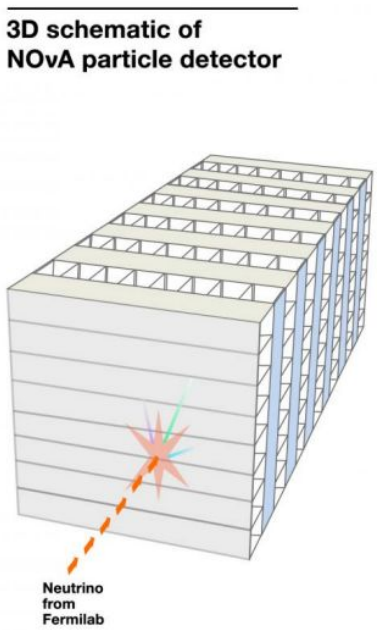


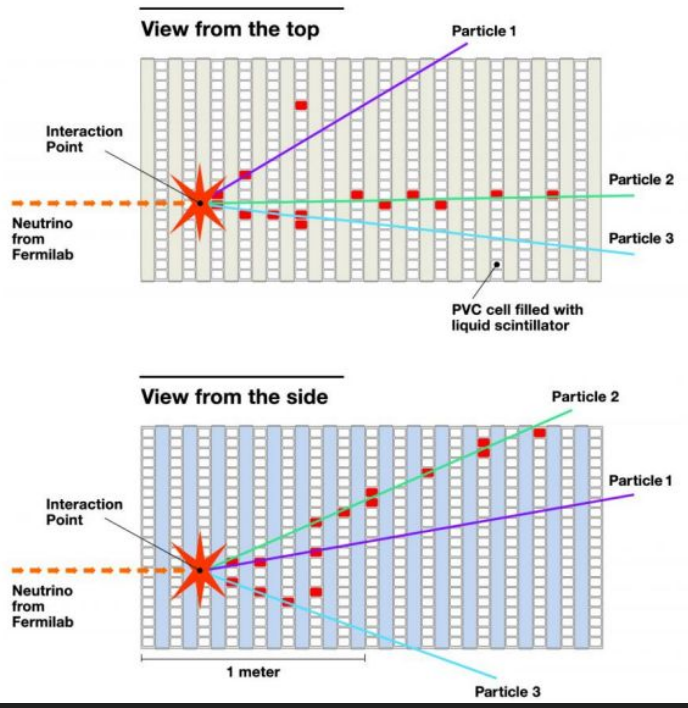
# The NOvA experiment

**Main goal:** study of neutrino oscillations in a muon neutrino beam with **<E>=2 GeV**.
NOvA uses two detectors with similar structure.

Detectors are composed of extruded PVC cells filled with liquid scintillator.
The scintillation light is transported by the wavelength shifting fibers, then read by APD



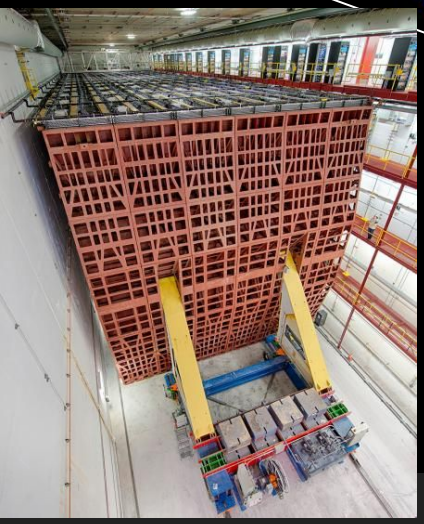



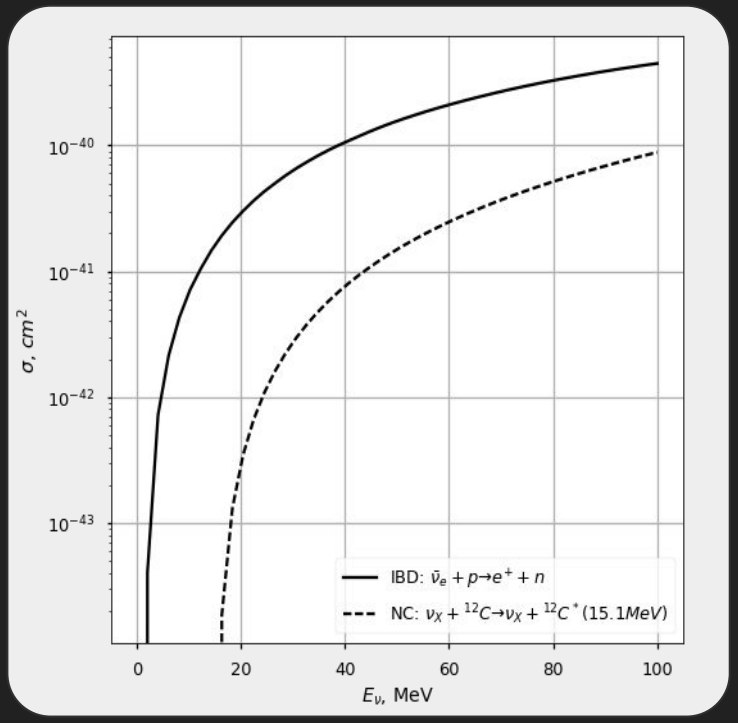

Large and segmented NOvA detectors can be used for additional physics goals.

# NOvA Far Detector: 5ms time slice

- M = **14 kton**
- Nchannels = **344064**
- Location: Ash river on surface



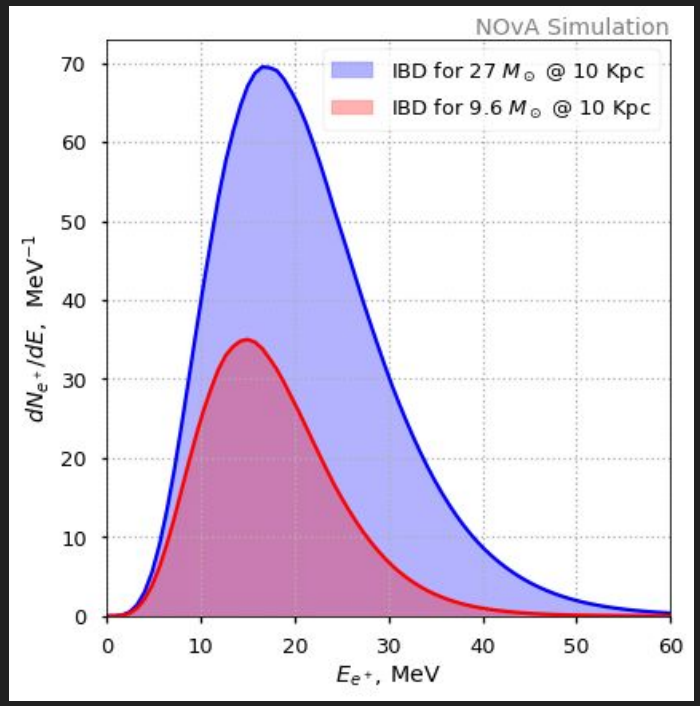
# SN neutrinos interactions in the Far Detector



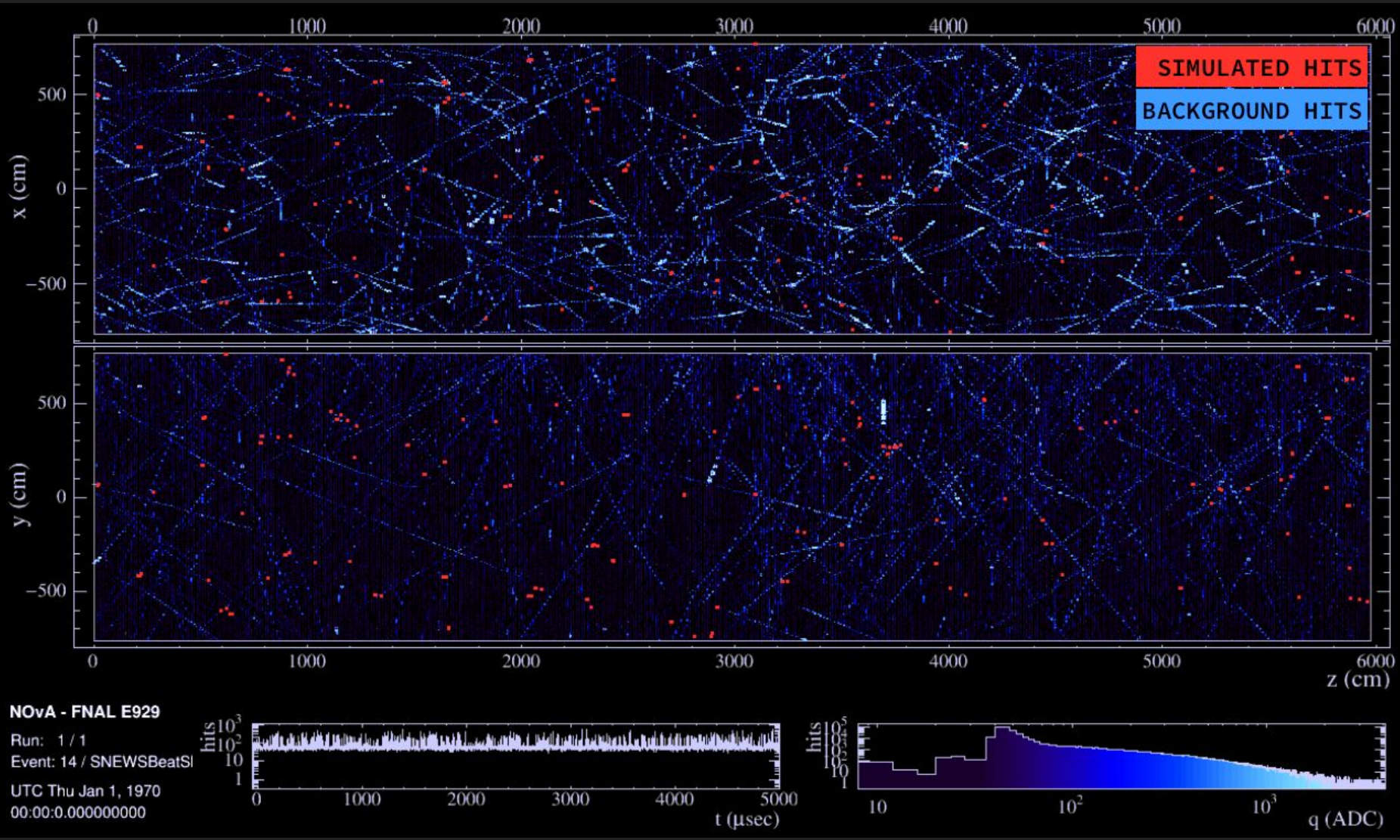

Other channels give negligible contribution: energy too low or small interaction rate.

Main detection channels:

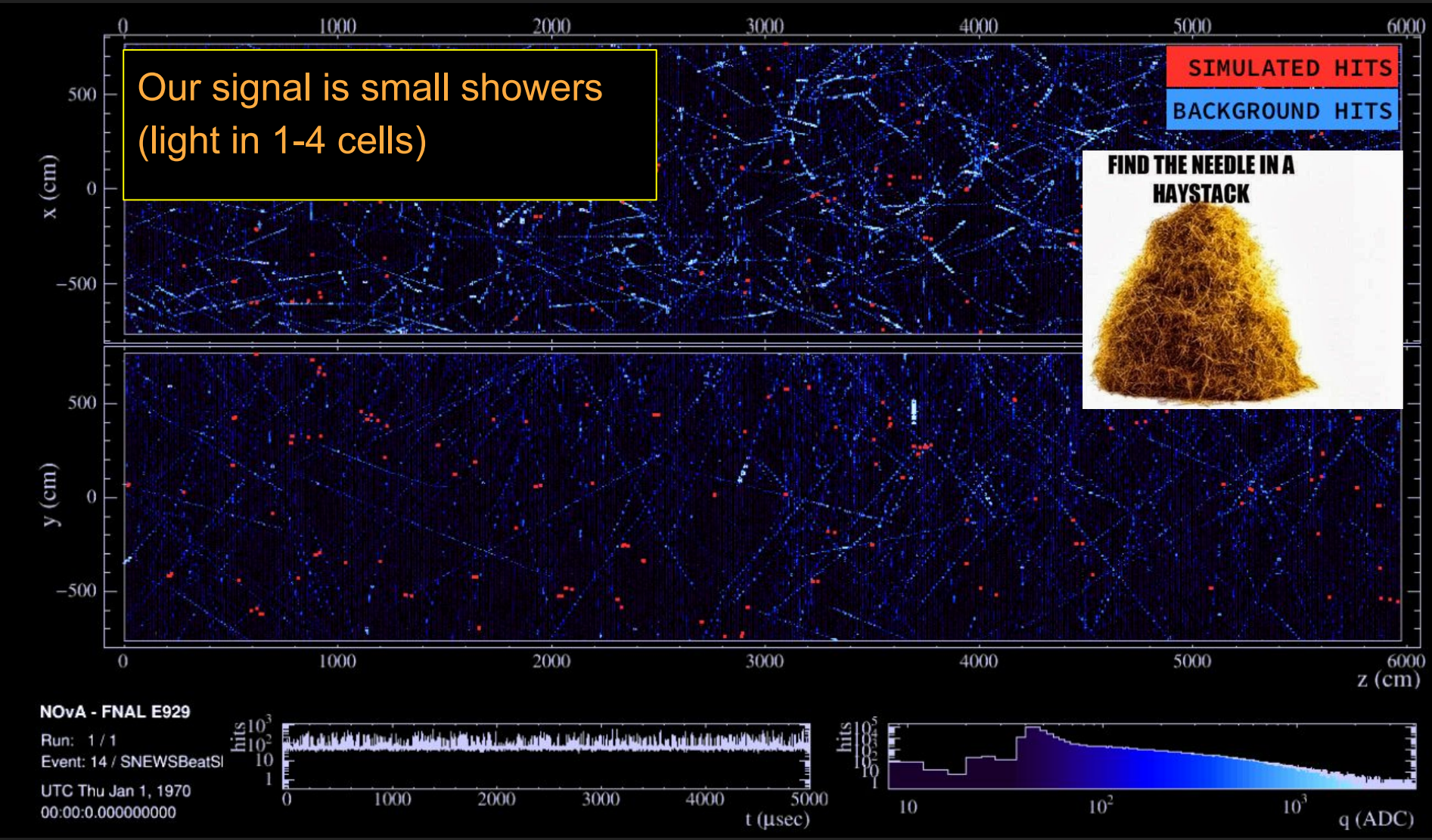
- **Inverse Beta Decay**
  - signature:
    positron shower (10-60 MeV)
- **Neutral Current**
  - signature:
    deexcitation gamma (15.1 MeV)



# Far Detector: 5ms of cosmic data + SN simulation



# Signal selection



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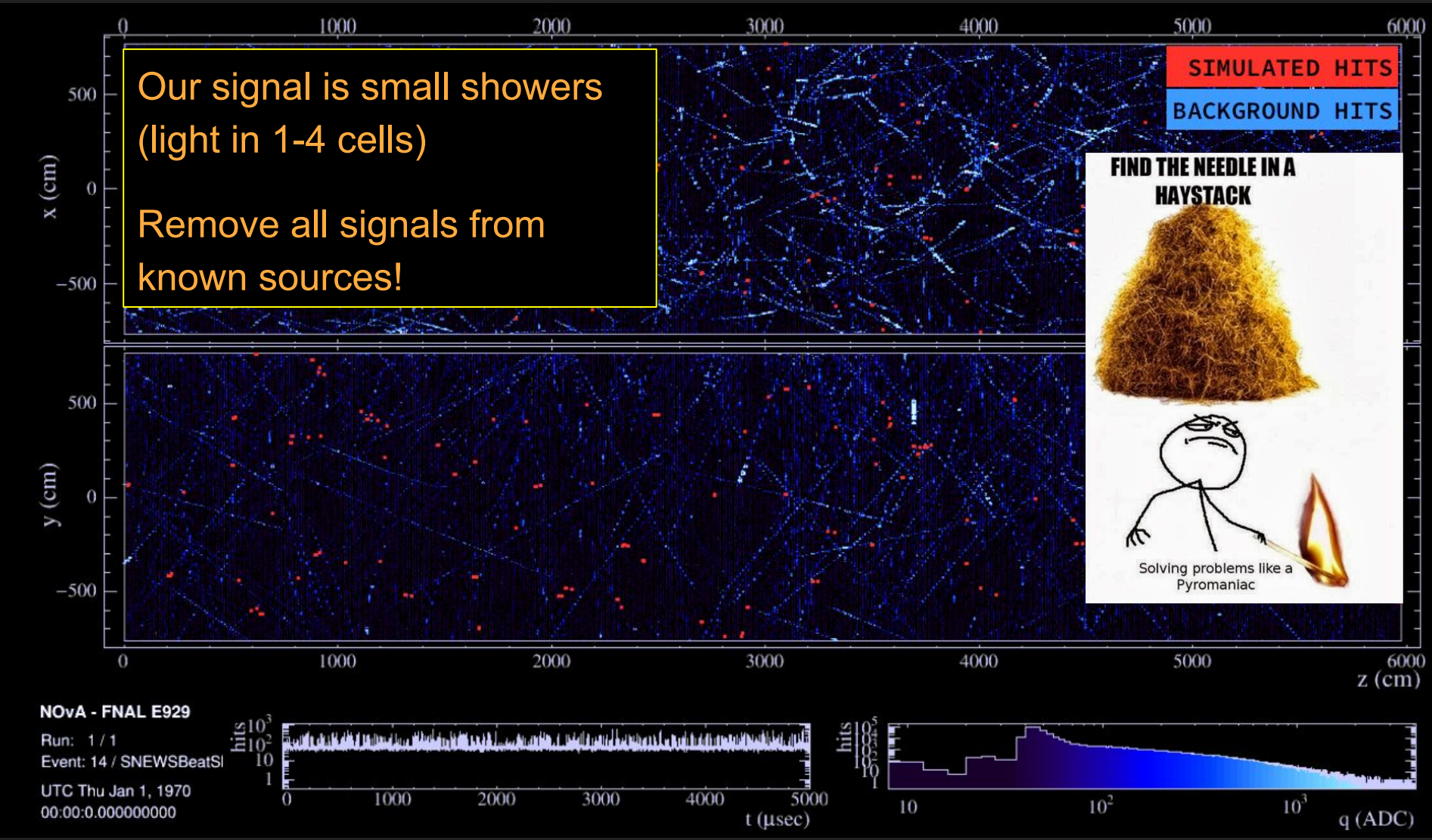

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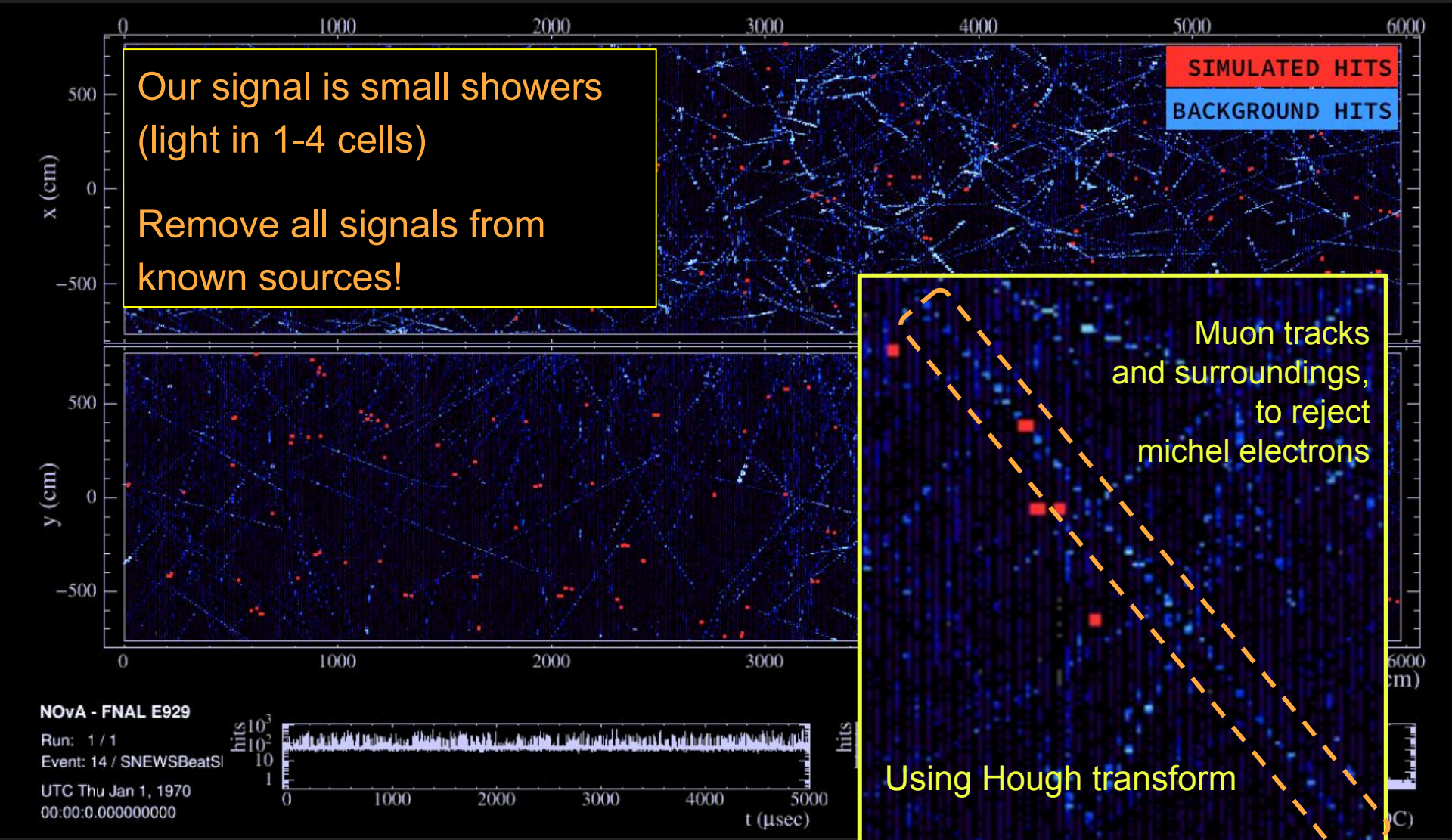

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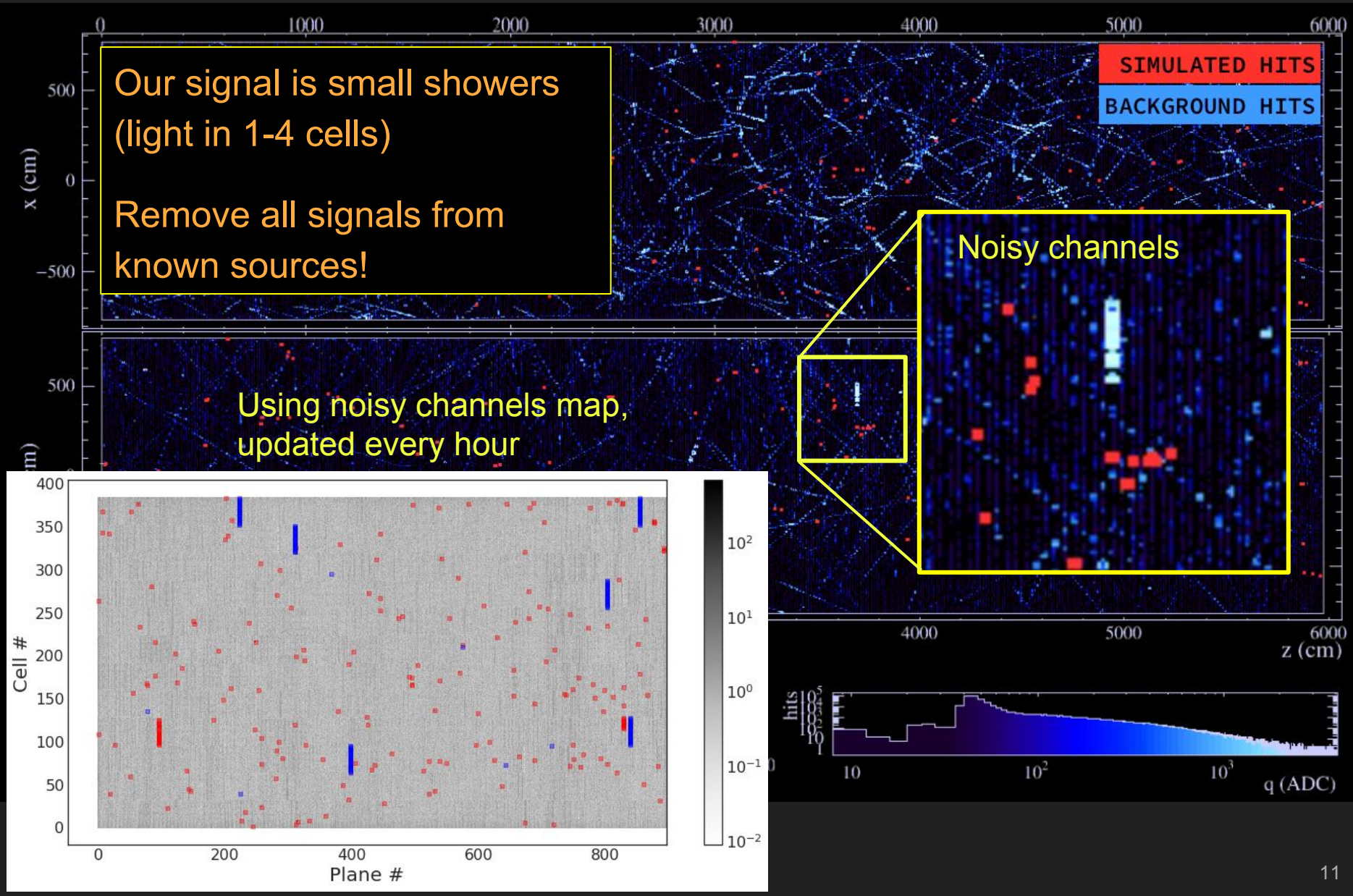

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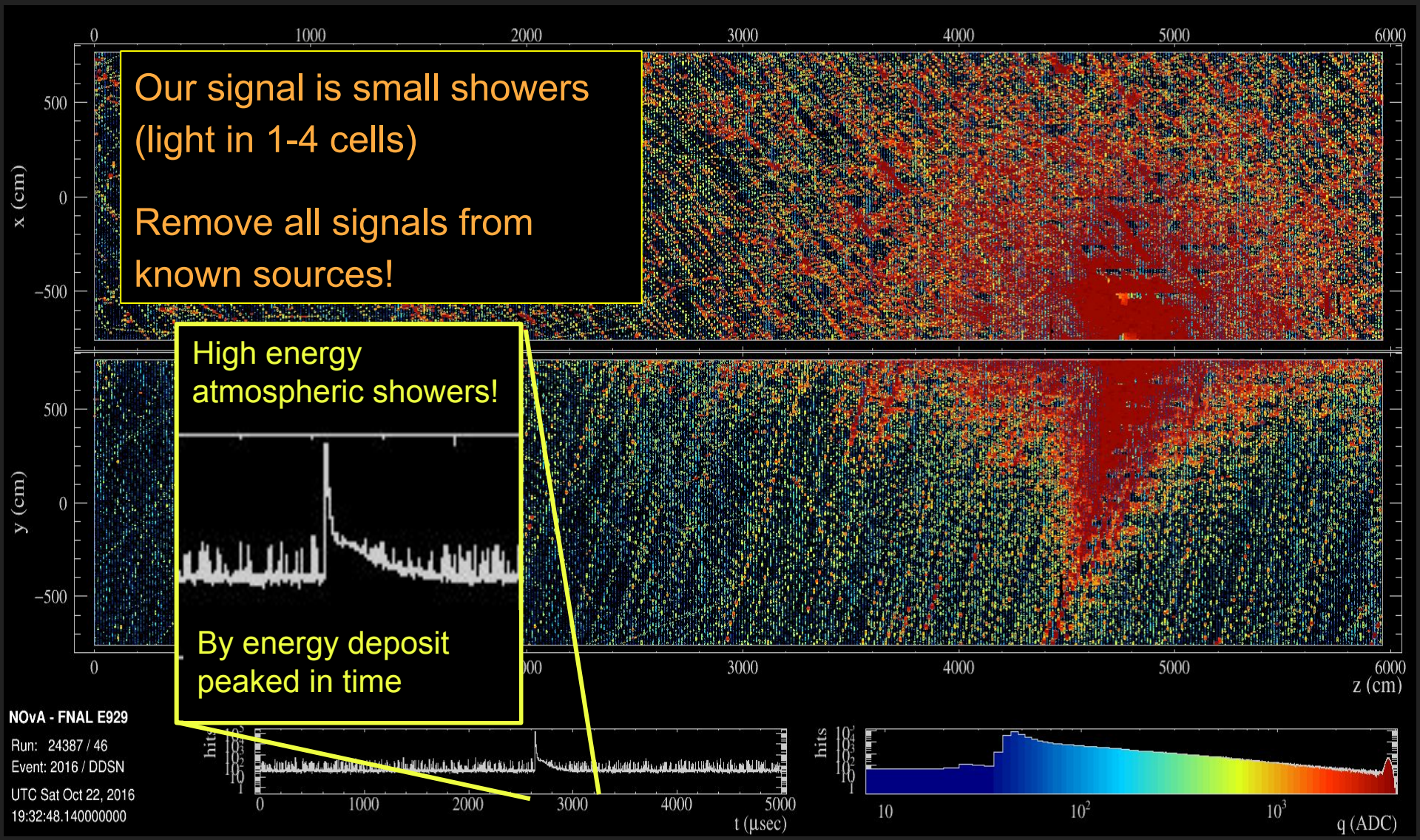


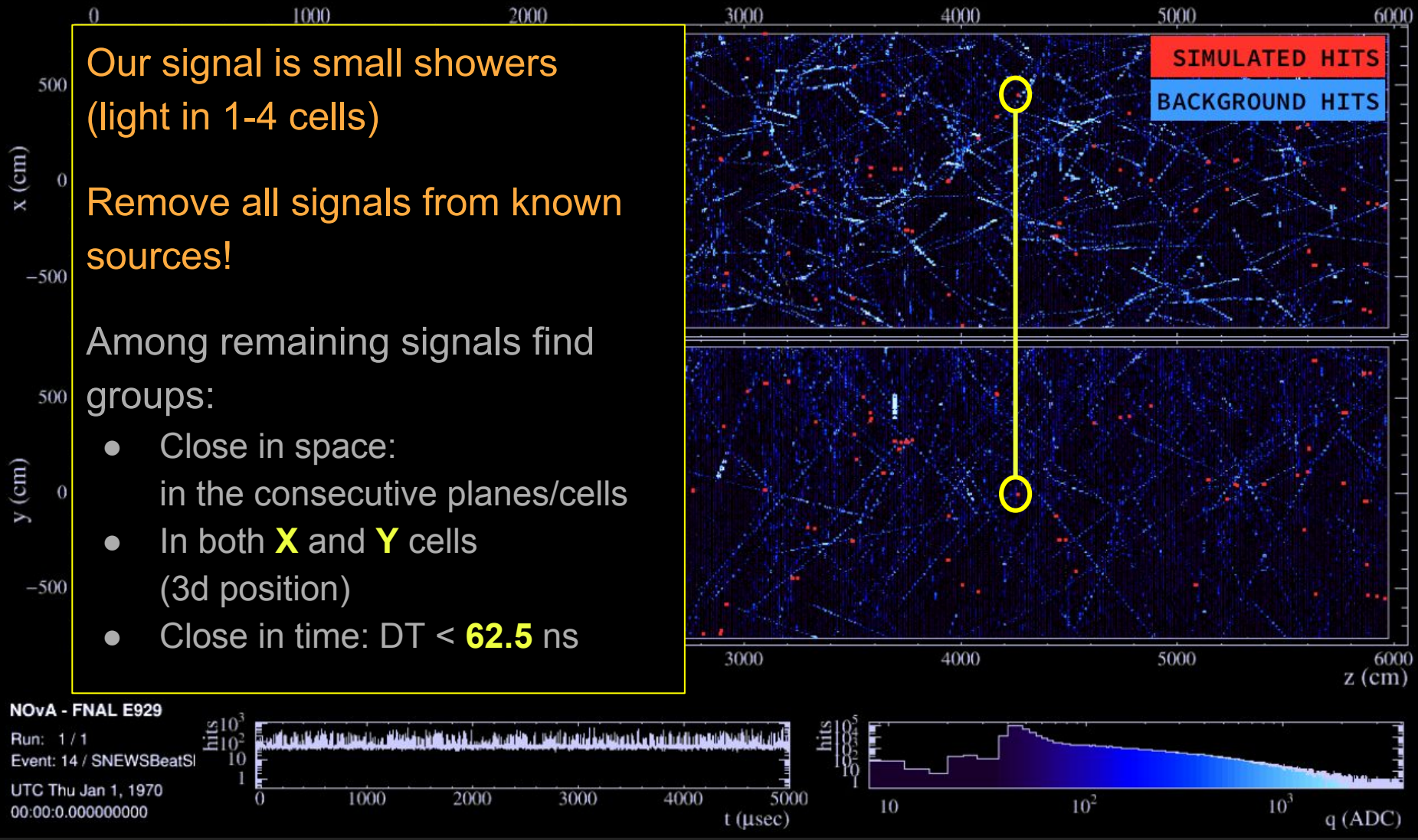
# Signal selection

Our signal is small showers (light in 1-4 cells)

Remove all signals from known sources!

Among remaining signals find groups:

- Close in space:
  in the consecutive planes/cells
- In both **X** and **Y** cells
  (3d position)
- Close in time: DT < **62.5** ns



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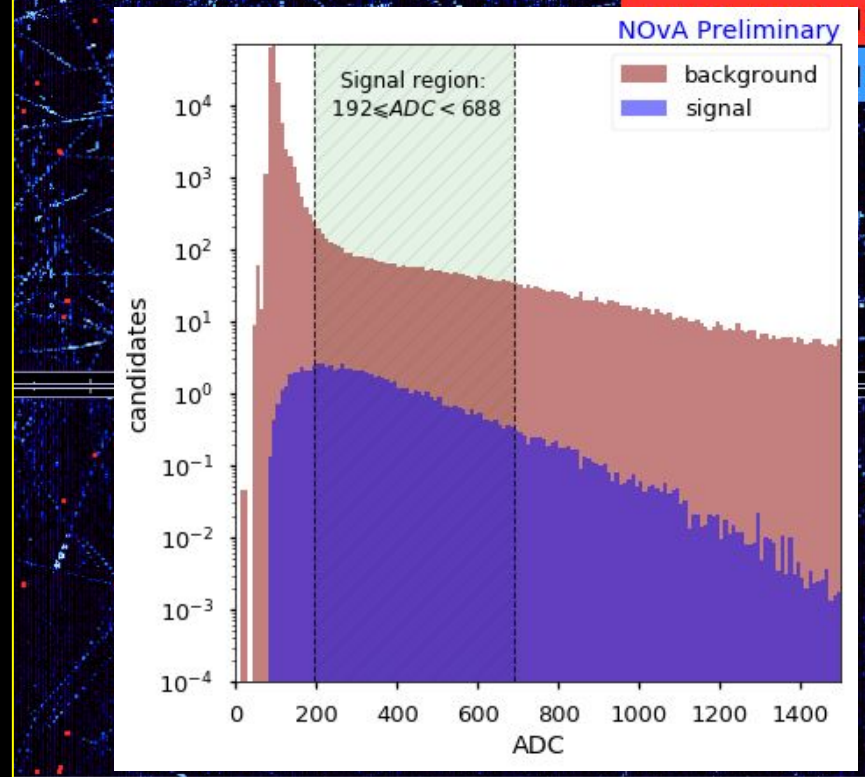
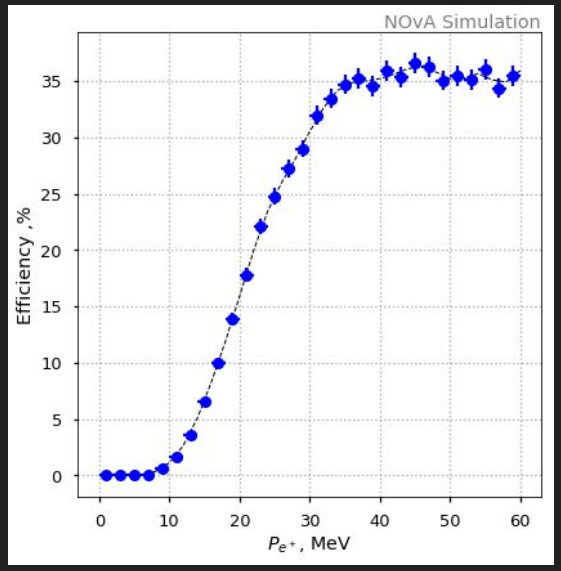
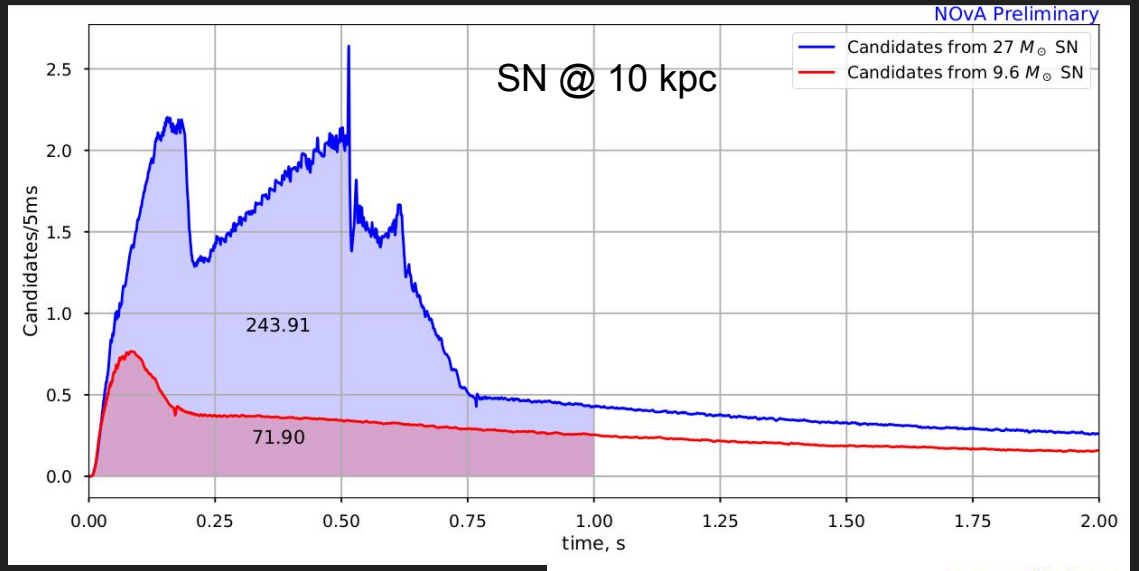
Select the signal region in the light amplitude: ADC counts



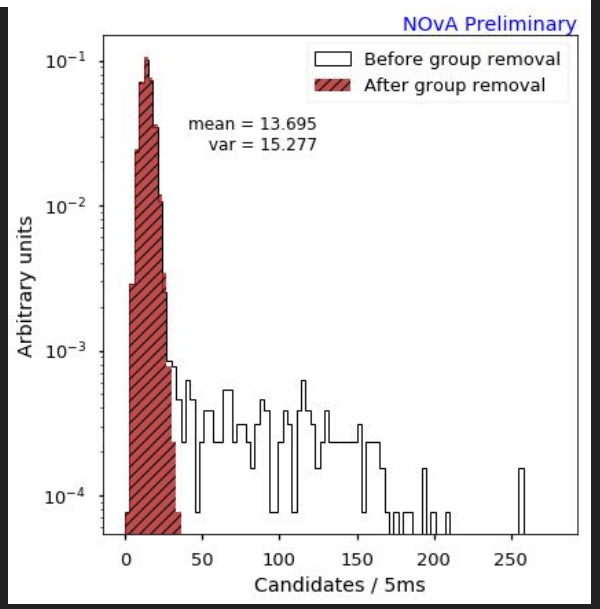
# Results of the neutrino candidates selection



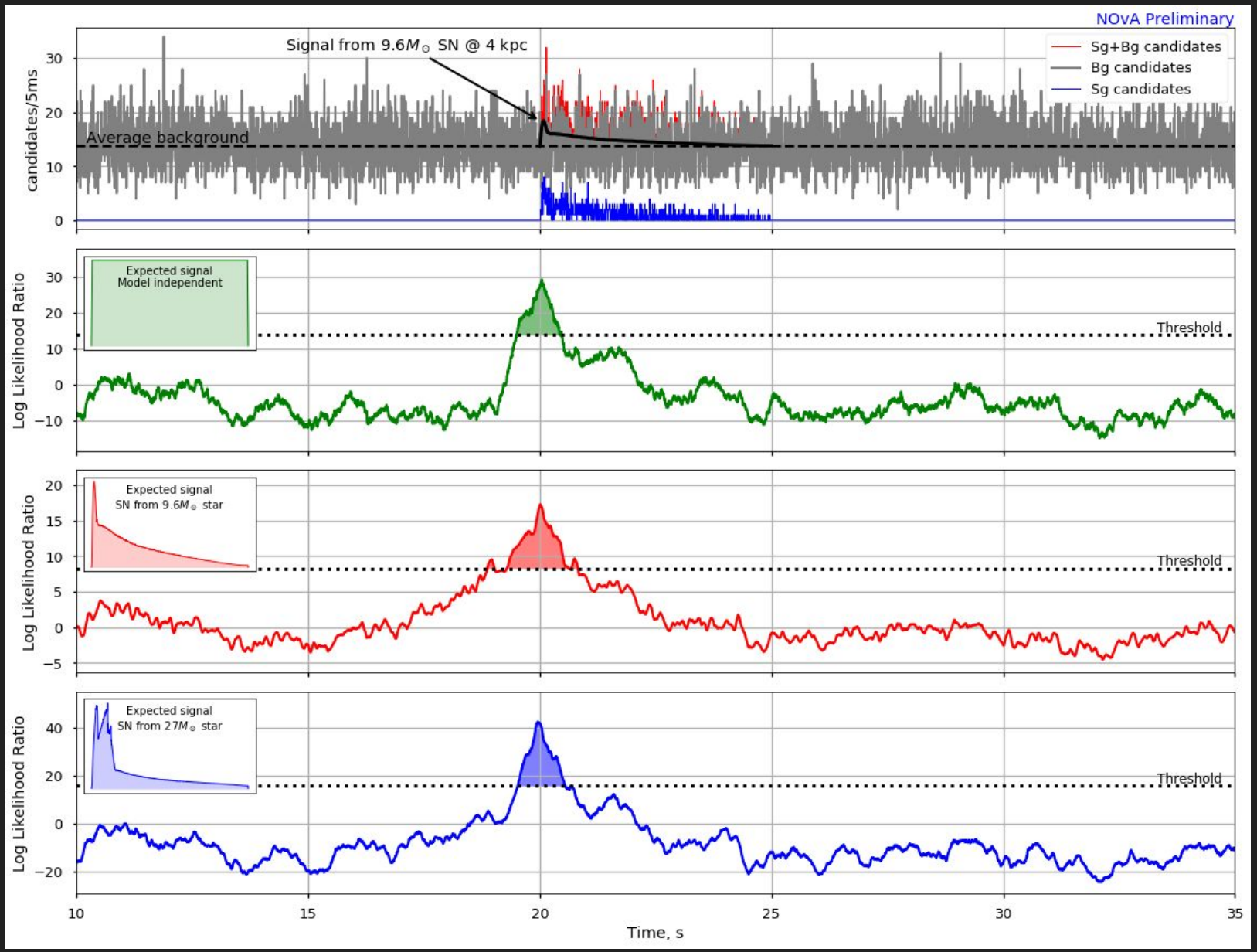




In order to trigger on the galactic supernova neutrino signal, we need to observe the singal excess above the background fluctuations.

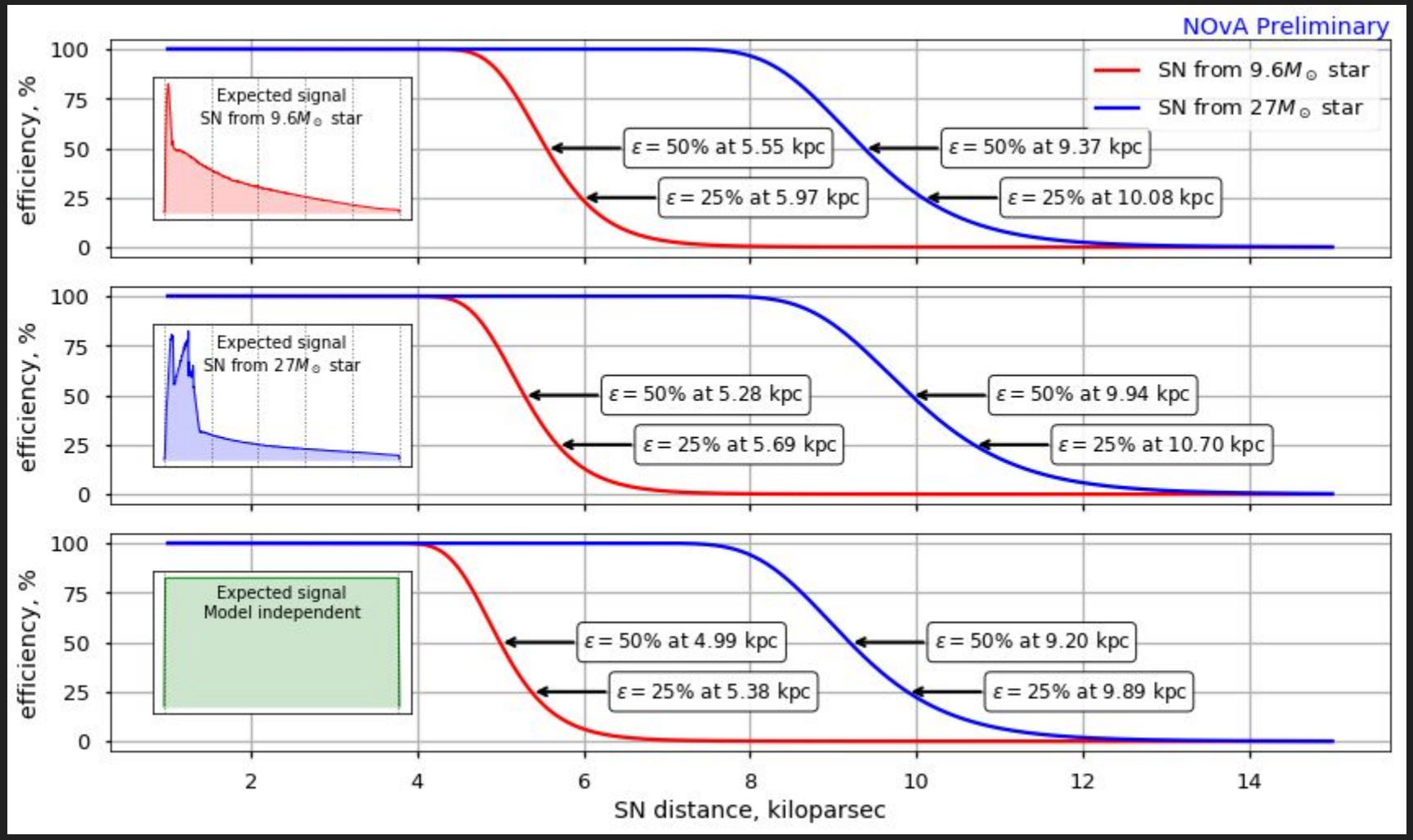
If the significance exceeds threshold, the trigger saves the SN data for offline analysis.



# Signal processing and triggering: example



# NOvA supernova trigger sensitivity



# Conclusions

The dedicated triggering system  extends the NOvA physical program.

Supernova triggering system is performing signal selection and reconstruction in real time.

Operating since Nov 2017, tuned to false triggering rate ~1/week.

We present new corrected sensitivity analysis

- Detection efficiency reevaluated.
- More conservative with respect to previous presented results.

Perspectives and plans:

- We’re getting ready to contribute to SNEWS.
- Use also Near Detector (200 tons, 100m overburden)
- Tune the candidate selection procedure, to achieve better efficiency.