

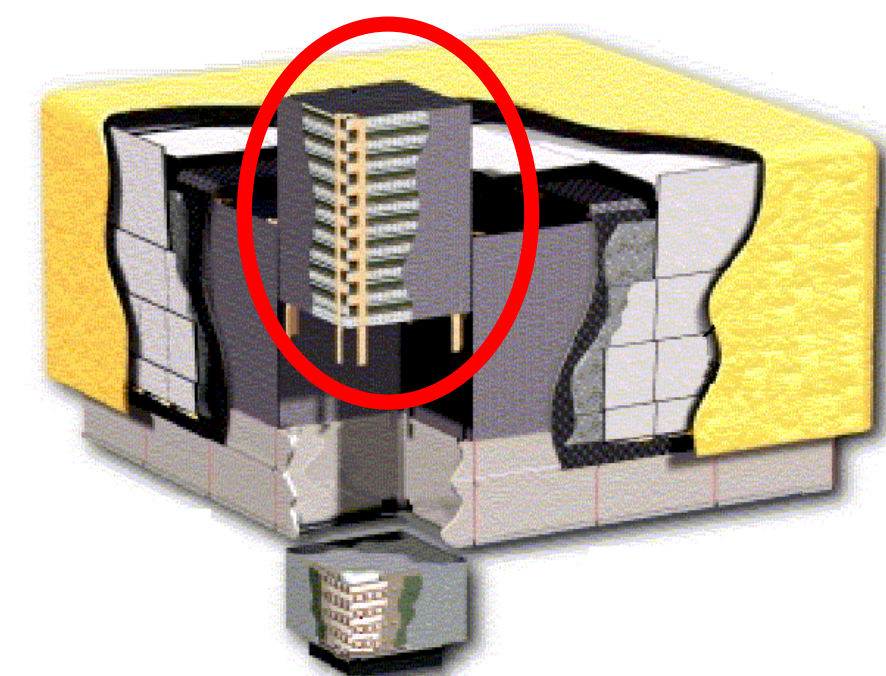
Performances of the Fermi-LAT silicon strip tracker after 14 years of operation

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The Fermi-LAT Tracker

The **Large Area Telescope (LAT)** on-board the NASA Fermi Gamma-ray space telescope is a pair-conversion γ -ray detector able to measure γ -ray photons from 30 MeV to more than 300 GeV.



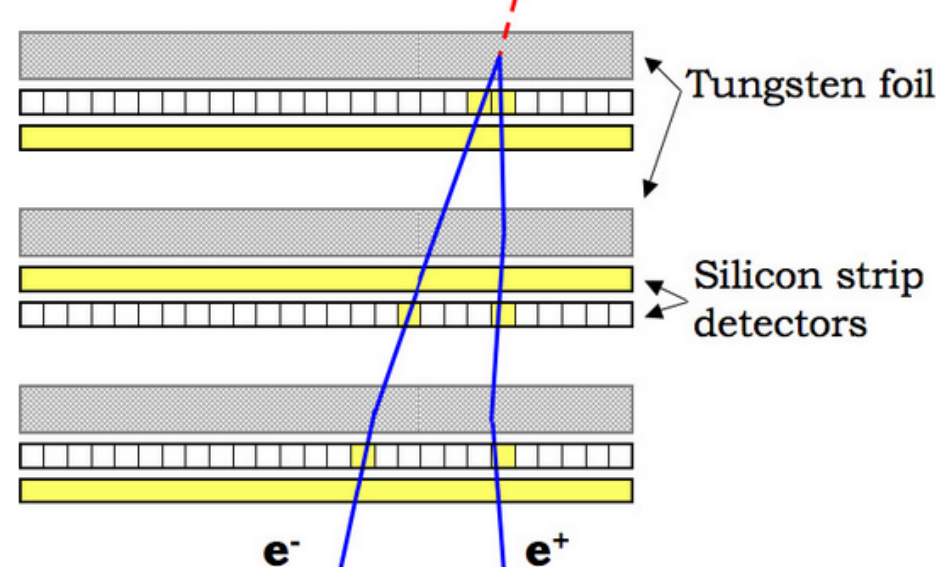
Modular design:

4x4 array of towers with a tracker and calorimeter module, surrounded by an anticoincidence detector

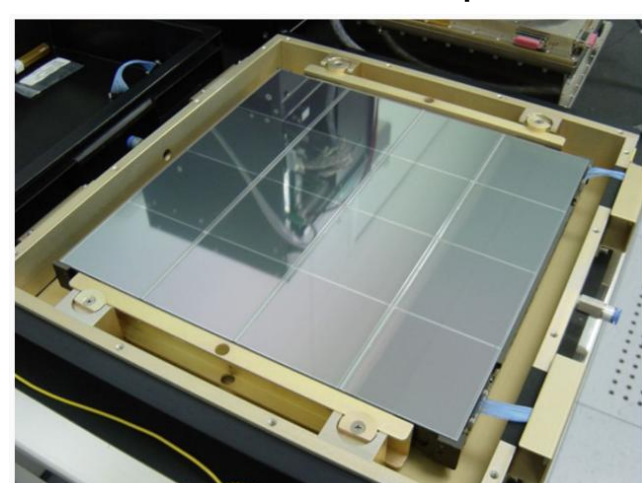
LAT Tracker

- 18 x-y detection planes of single sided silicon strip detector (SDD)
- Interleaved with tungsten foils to increase conversion probability (12 foils $0.03 X_0$ thick, 4 foils $0.18 X_0$ thick)
- 4 parallel ladders, each ladder built by connecting the strips of 4 SSD
- 400 μm thickness
- pitch of 228 μm
- 15536 strips per layer
- $\approx 200 \mu\text{W/channel}$
- data stream: hit strips coordinates (digital readout) + layer OR Time over threshold (ToT)
- Self triggering (3 bi-layers hit in the same tower)

Incoming gamma ray



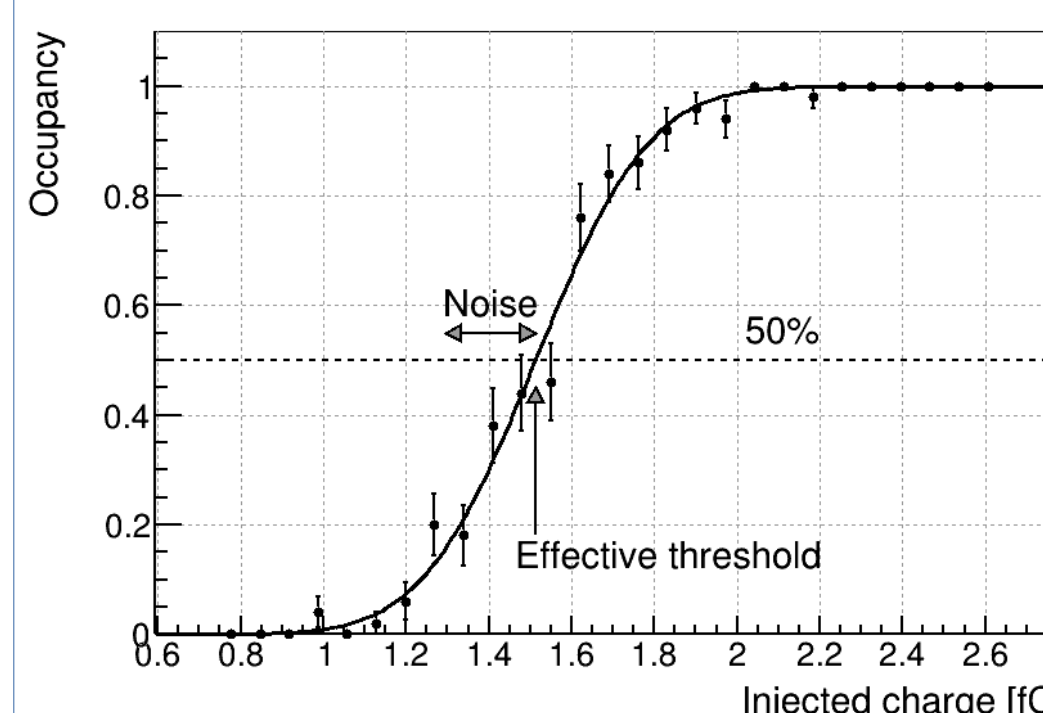
Picture of a tracker plane:



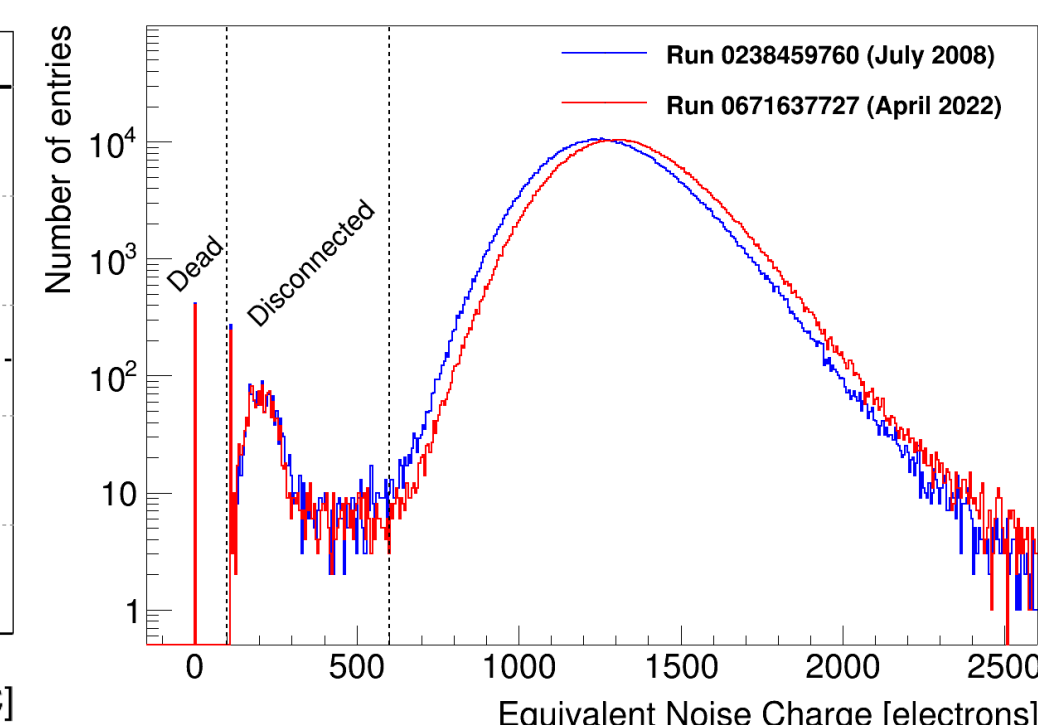
Noise performances

- Noise is monitored by means of charge injection runs.
- for each Si strip the average occupancy as a function of the injected charge is fitted with an error function. The slope gives an estimation of the width of the underlying noise distribution.

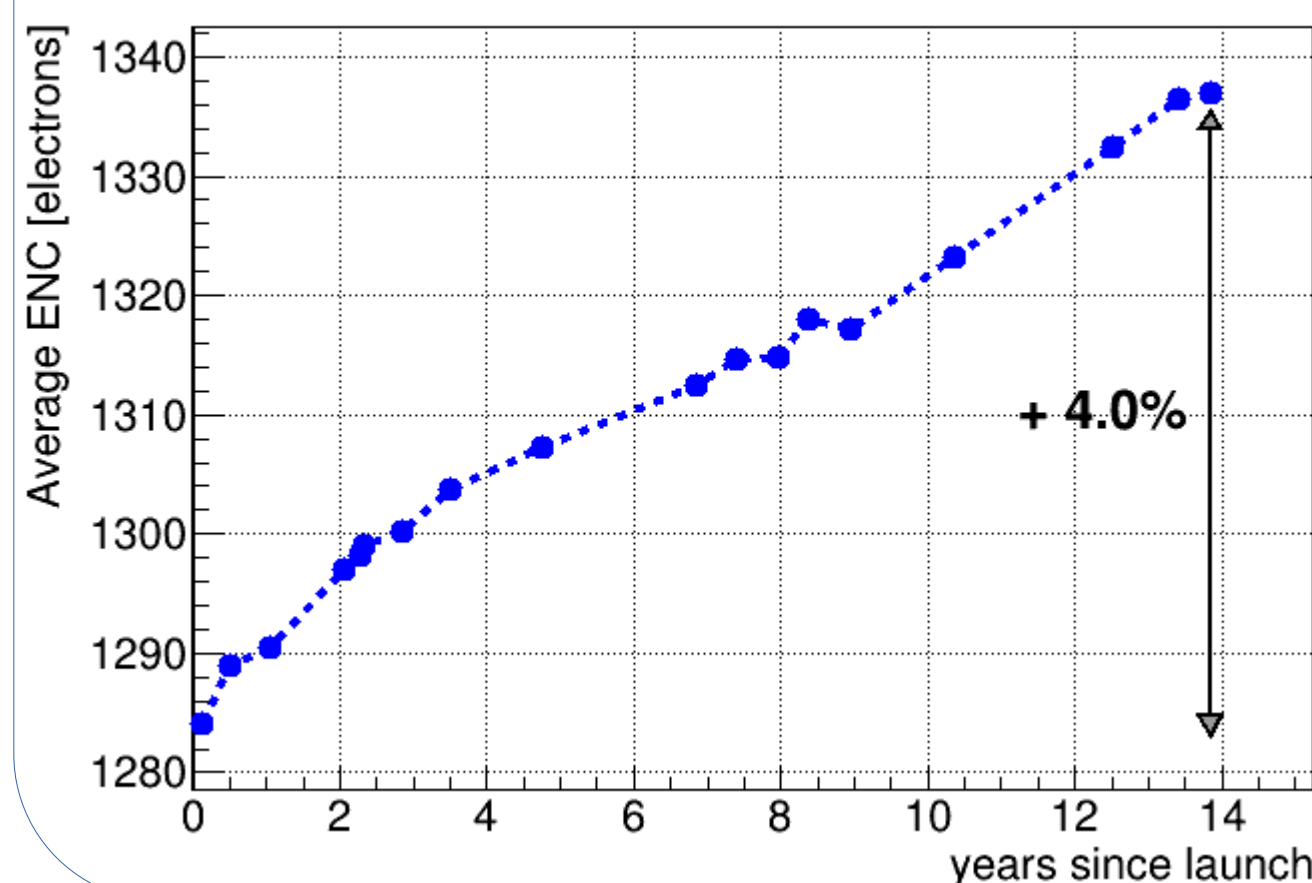
Charge injection scan example



Noise distribution



Time evolution of equivalent noise charge

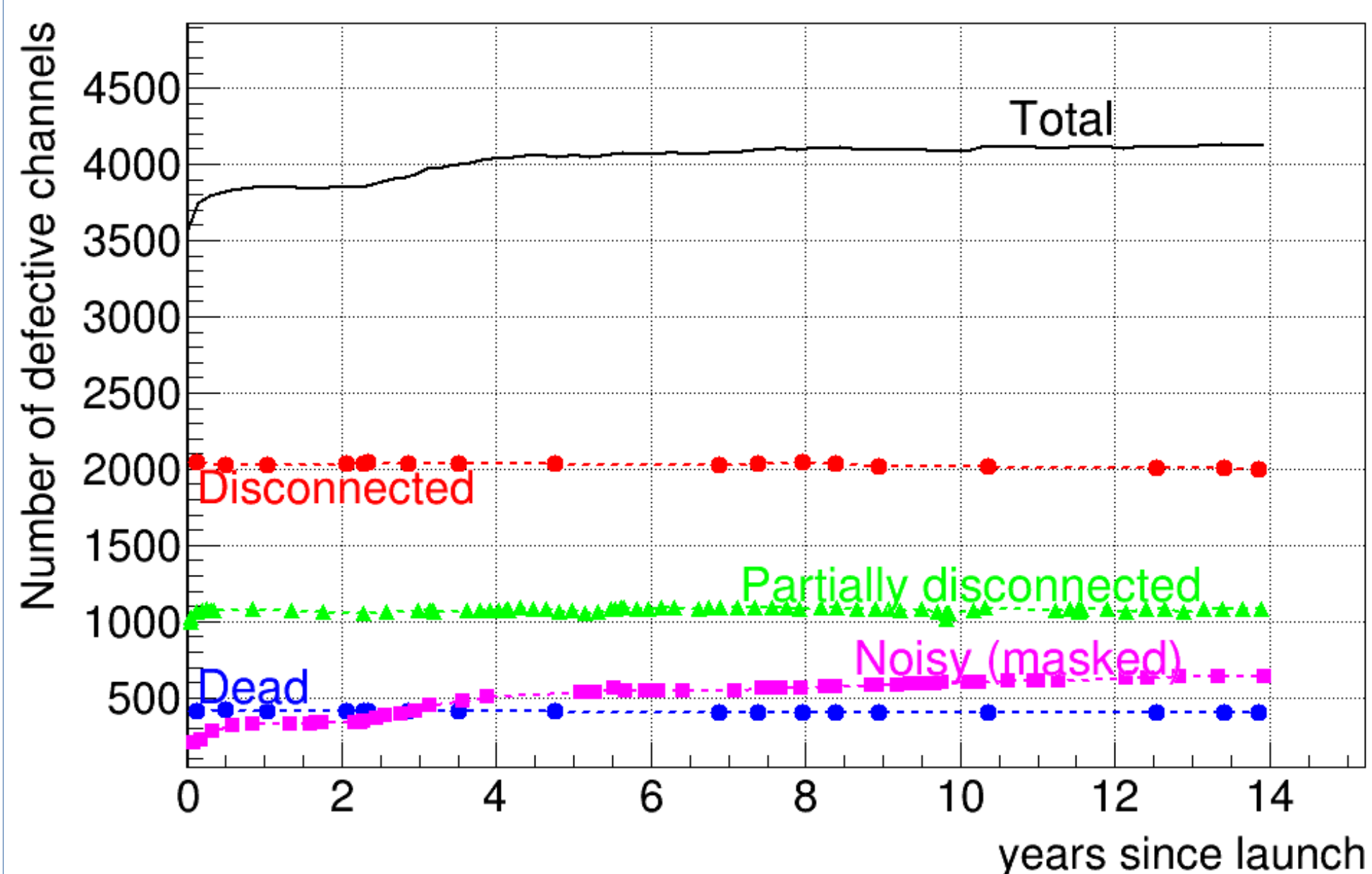


~4% increase of equivalent noise charge (ENC)

related to increased leakage current due to radiation damage

Defective channels

Time evolution of bad strips



Different types of bad channels:

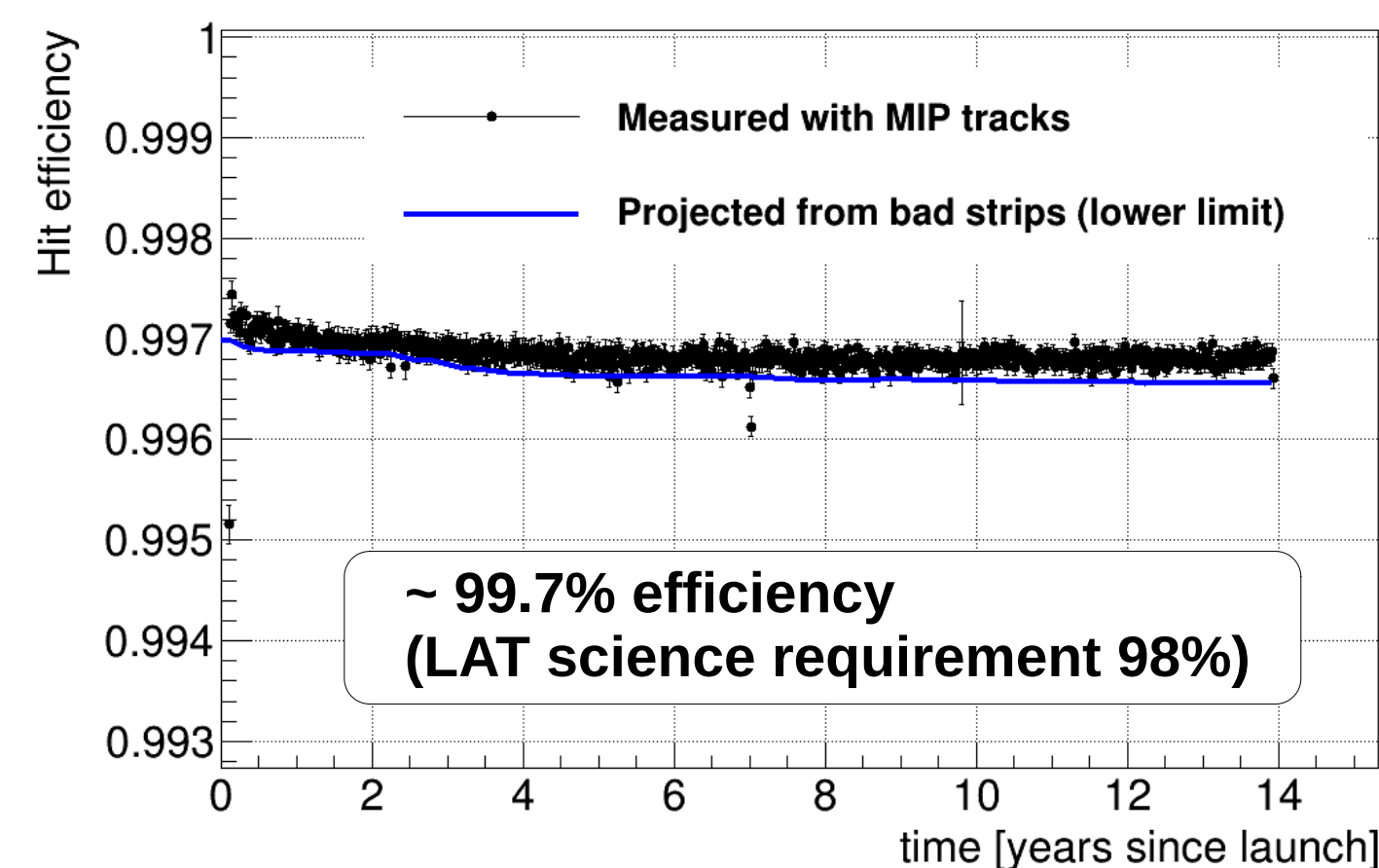
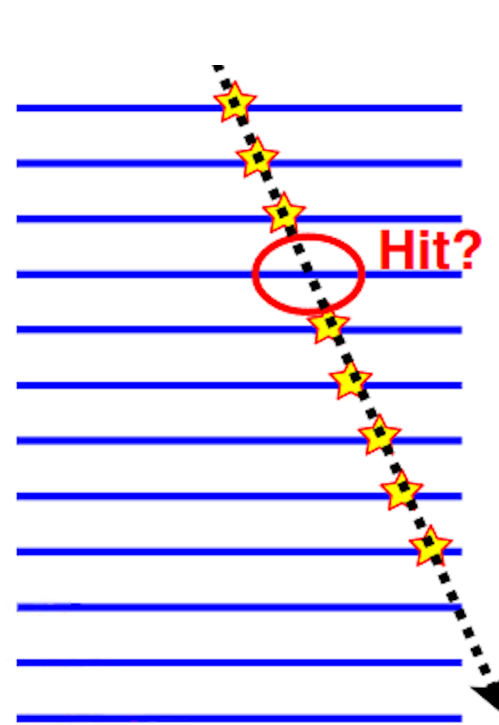
- Dead preamplifier.
- Disconnected: silicon strip is not physically connected to the preamplifier input. Low (~ 250 electrons) ENC.
- Noisy: noise occupancy $> 1\%$, masked to both trigger and data.
- Partially disconnected: one or more of the wire bonds along the ladder is defective. Intermediate noise levels.

• 3661 defective strips at launch time (0.31% of the total)

• 4120 defective strips at present (0.46 % of the total)

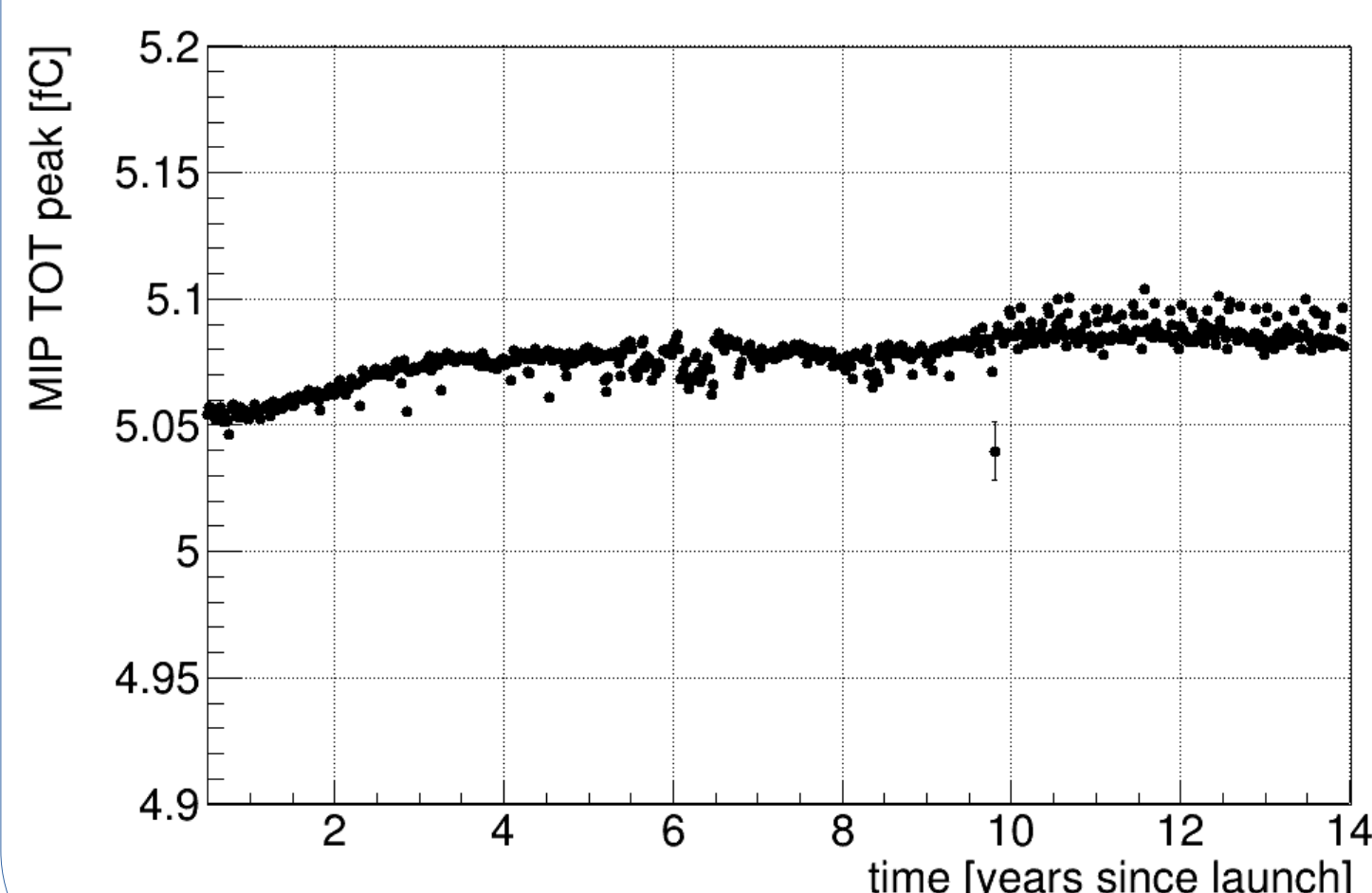
Strip hit efficiency

Hit efficiency estimated by selecting MIP tracks and searching for missing hits in the active volumes



~ 99.7% efficiency (LAT science requirement 98%)

MIP charge monitoring



- MIP charge deposit estimated by time over threshold signal of each layer

• Stable within 1%