Low energy response calibration and long term gain monitoring of the NuSTAR detectors

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Caltech

Low energy response calibration

- Bright source low energy discrepancies
    - ,between FPMA & FPMB, between other observatory
- Expand the lower energy limits
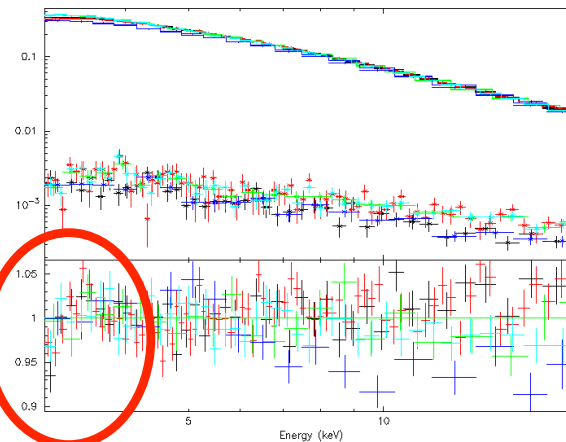
Crab Stray-light (IACHEC 2016 Pune)

20 ksec
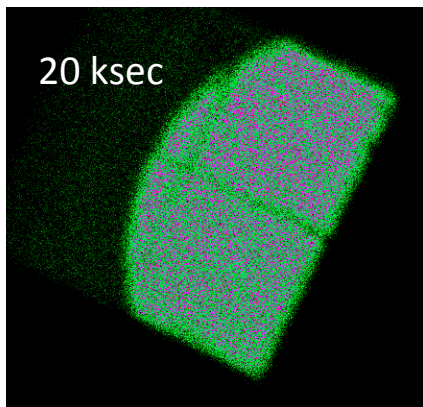
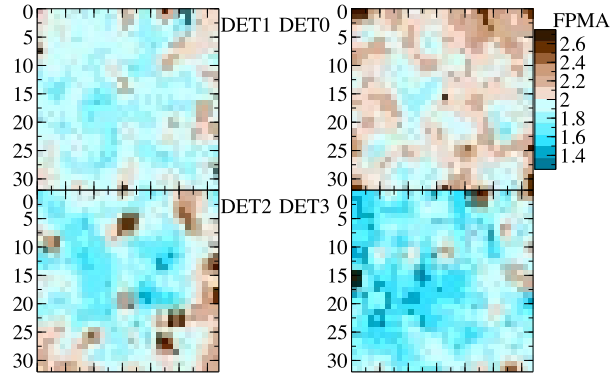OLD values:

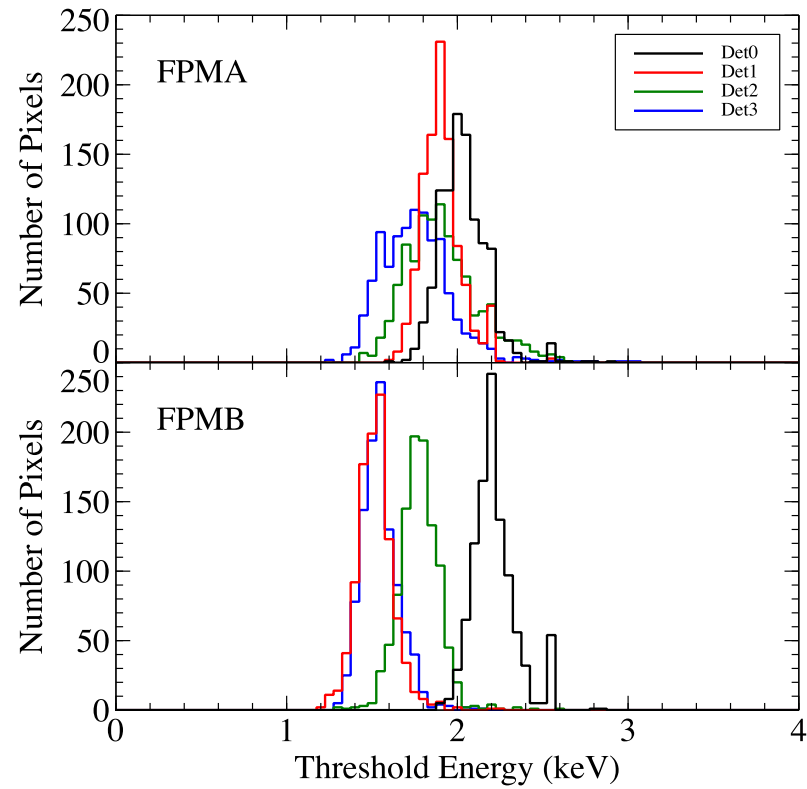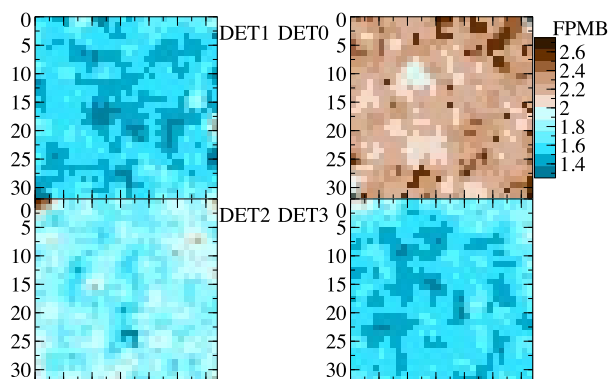CZT = 0.187

Pt = 0.138

i.e. not ARF related

CHEC 2016 Pune

11

Low energy response calibration
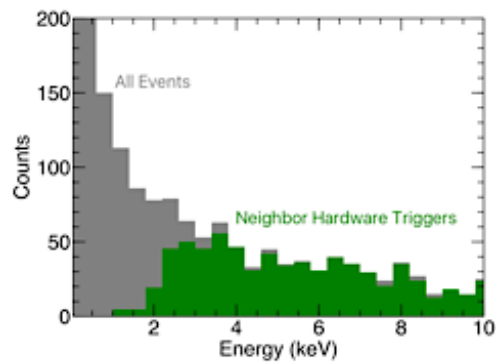
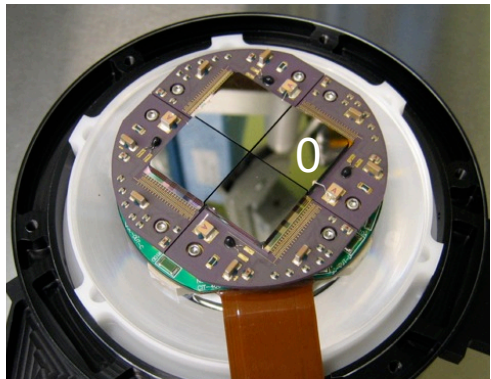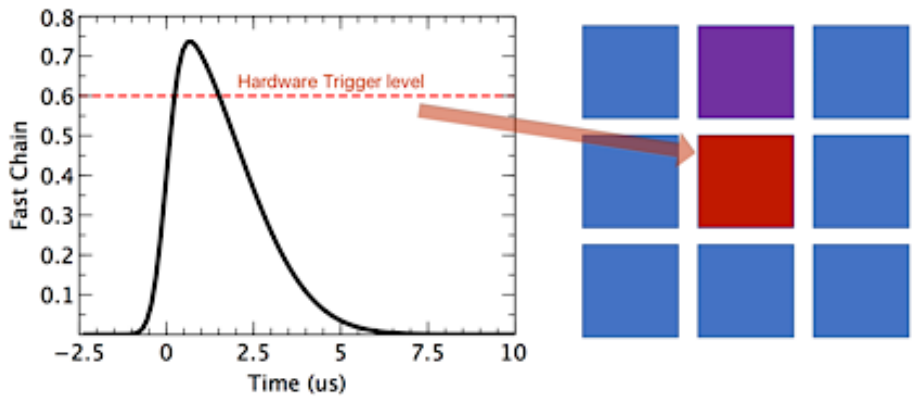- **Threshold refinement**

FPMA

FPMB

Grefenstette, SPIE 2018

Low energy response calibration

- How the threshold adjustment affect to the RMF

→ multi-pixel events

Grefenstette, SPIE 2018

Low energy response calibration
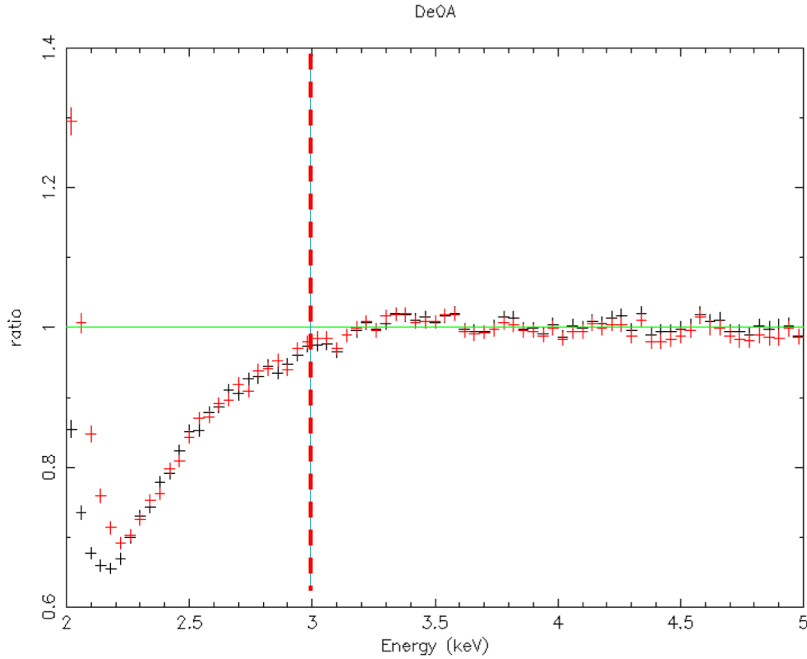
- ■ **New RMF**

Geant4 + chare transport (WP)
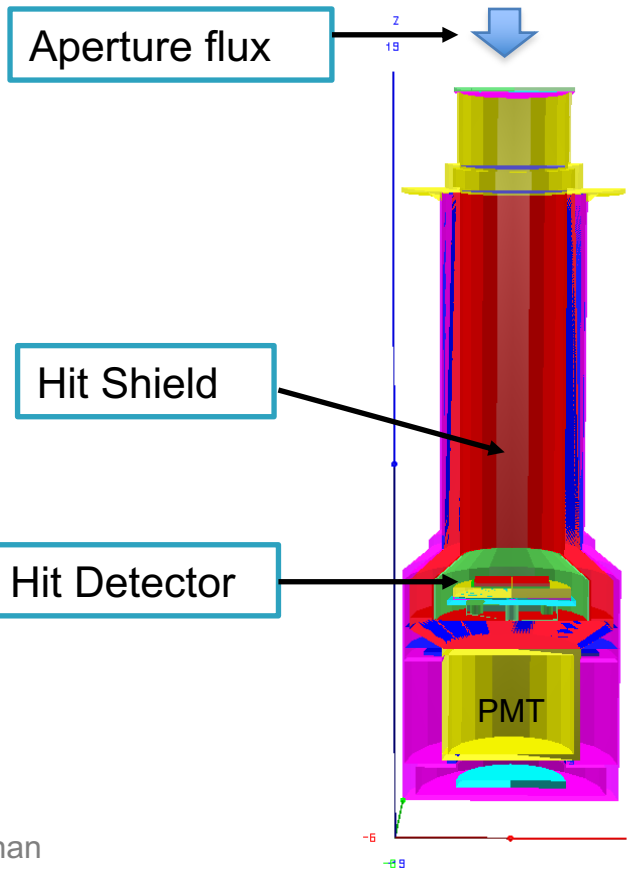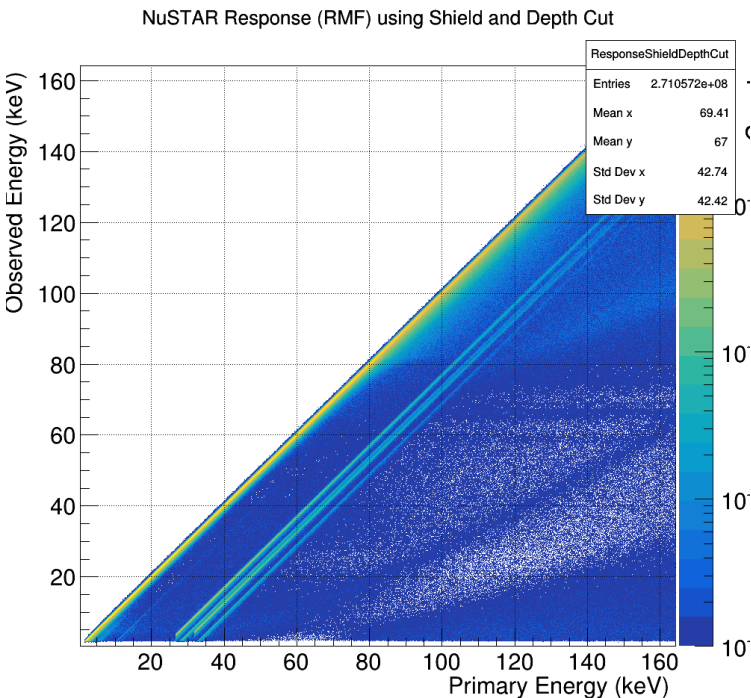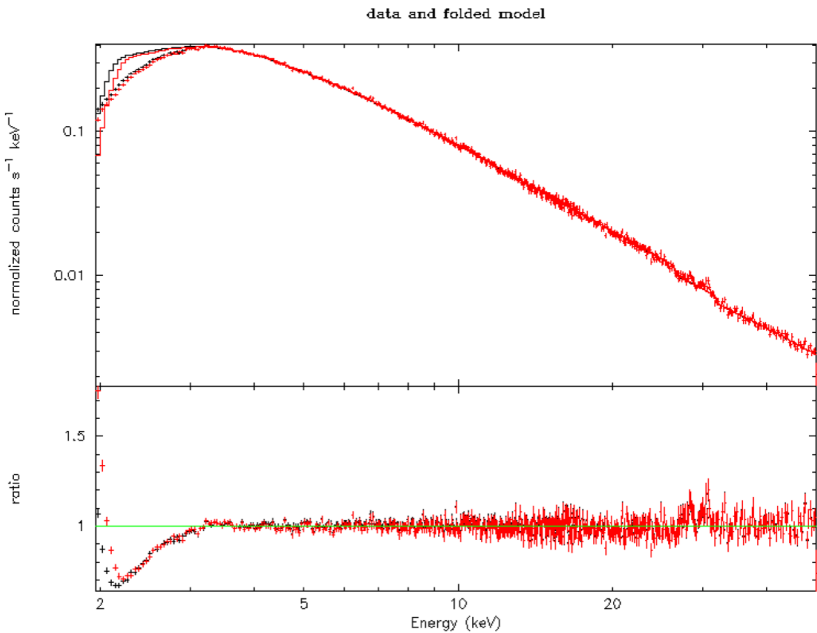
NuSTAR Response (RMF) using Shield and Depth Cut

Low energy response calibration

- Validation
  - nuabs parameter has been adjusted

Low energy response calibration

- ■ Validation ▪ nuabs parameter has been adjusted

Long-Term Gain monitoring

NuSTAR
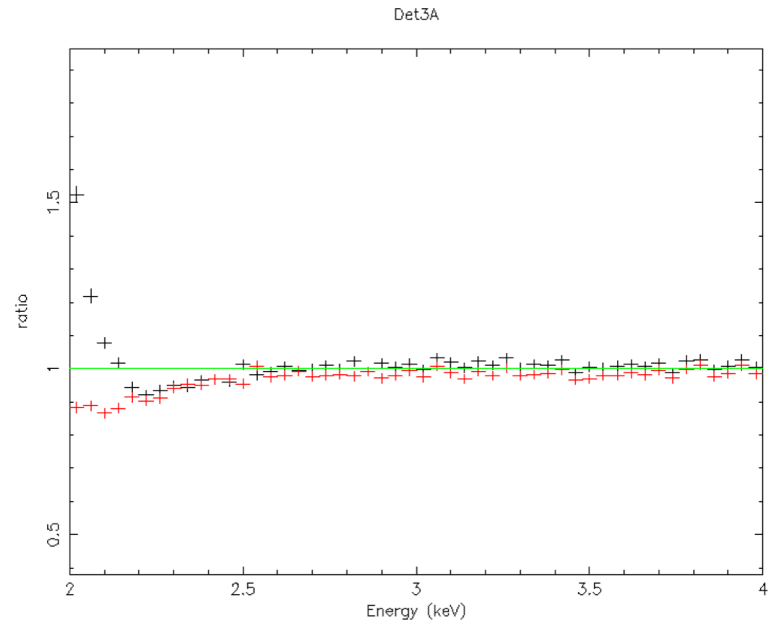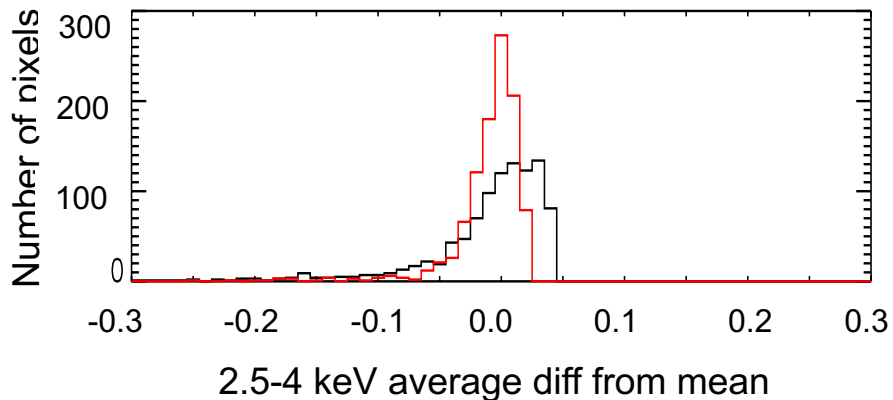
- ## Transfer function
  - PI = PI0 * Slope(Temp, time) + Offset(Temp)

In-flight calibration source ^{155}Eu
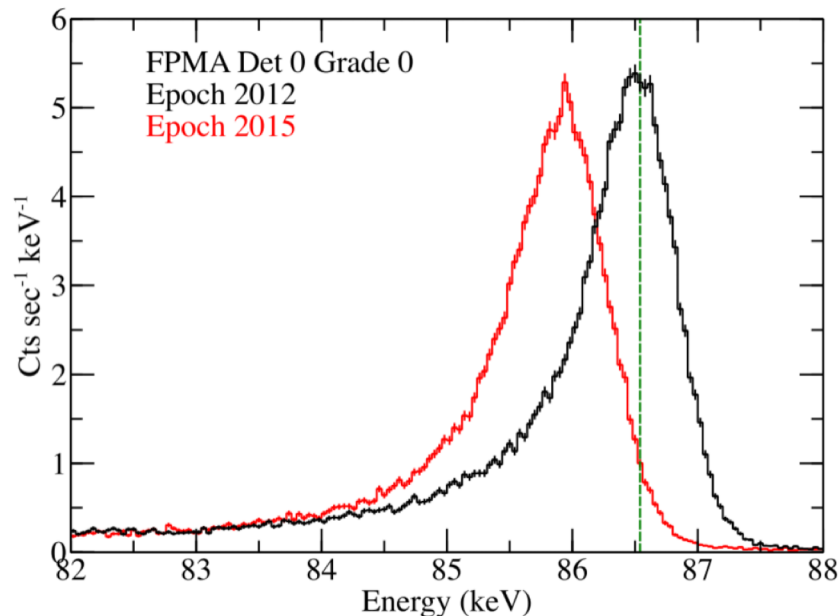- Deploy on 2012 (IOC)
→ confirmed ground calibration

- Deployed on 2015
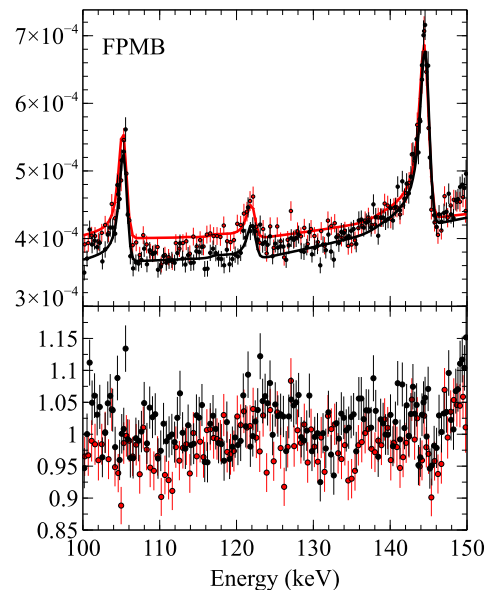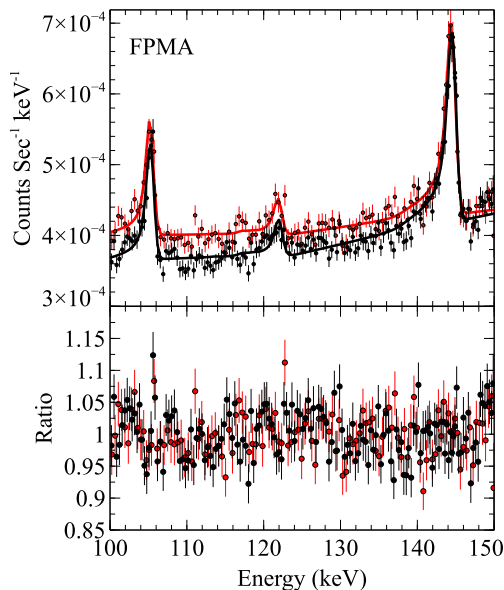→ gain dropped
→ CALDB incorporates linear
  0.2%/year gain drop

FPMA Det 0 Grade 0
Epoch 2012
Epoch 2015

Long-Term Gain monitoring

- # Background lines
  - Use year-long integrations of background lines at 105, 122 and 144keV

Long-Term Gain monitoring
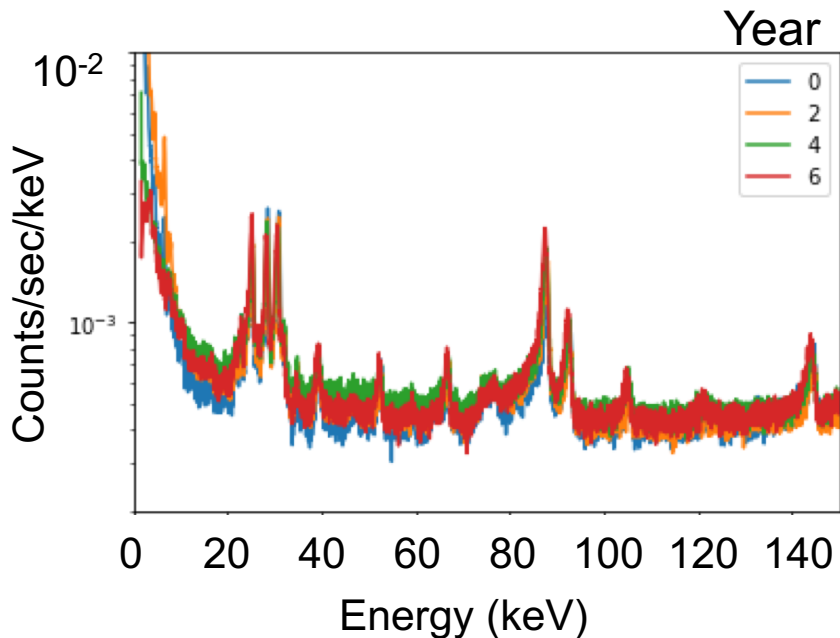
- Background lines
  - Linear 0.2% per year gain drop

Start to deviate from 0.2% per year linear correction

Long-Term Gain monitoring
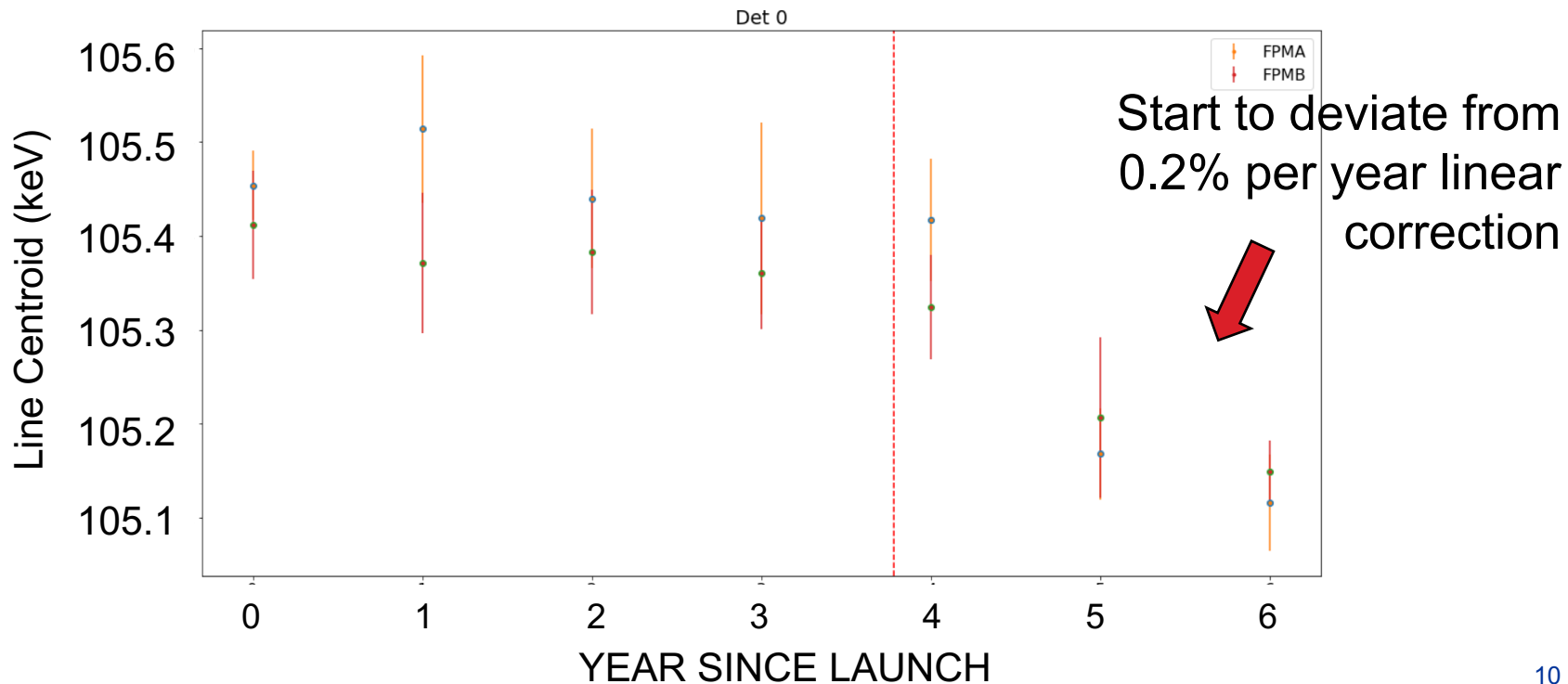
- **Background lines**
  - Turn off time-dependence and reprocess the archive.

Long-Term Gain monitoring
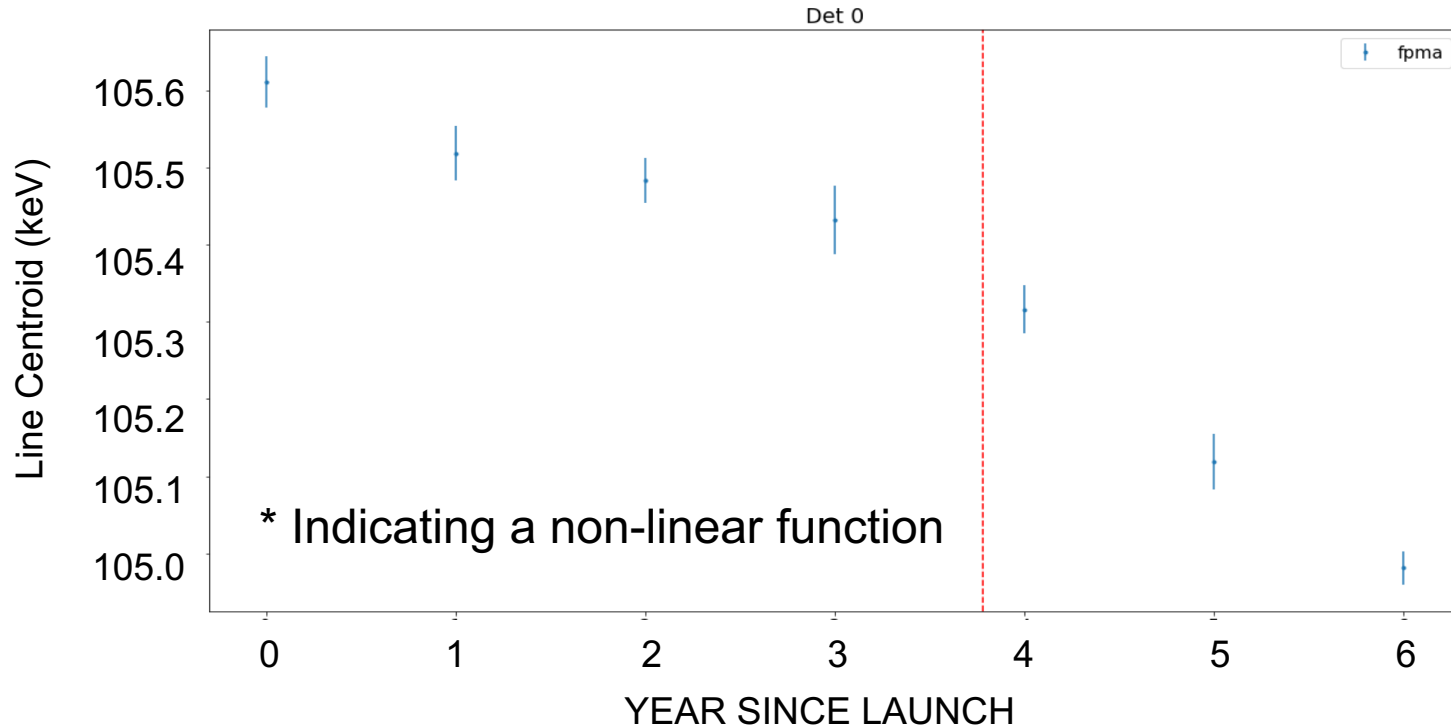
- ## Offset

  - Most Fe-K sources time variable

  - Cas A extended and dynamically broadened

  - → Use Kepler

Long-Term Gain monitoring
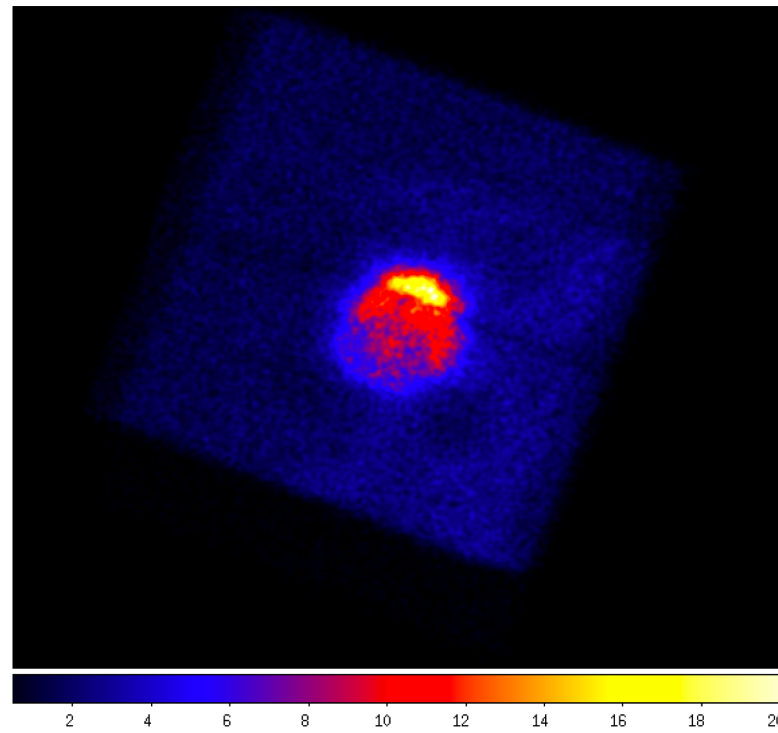
- **Offset - Kepler**

    Use baseline model (continuum + lines)

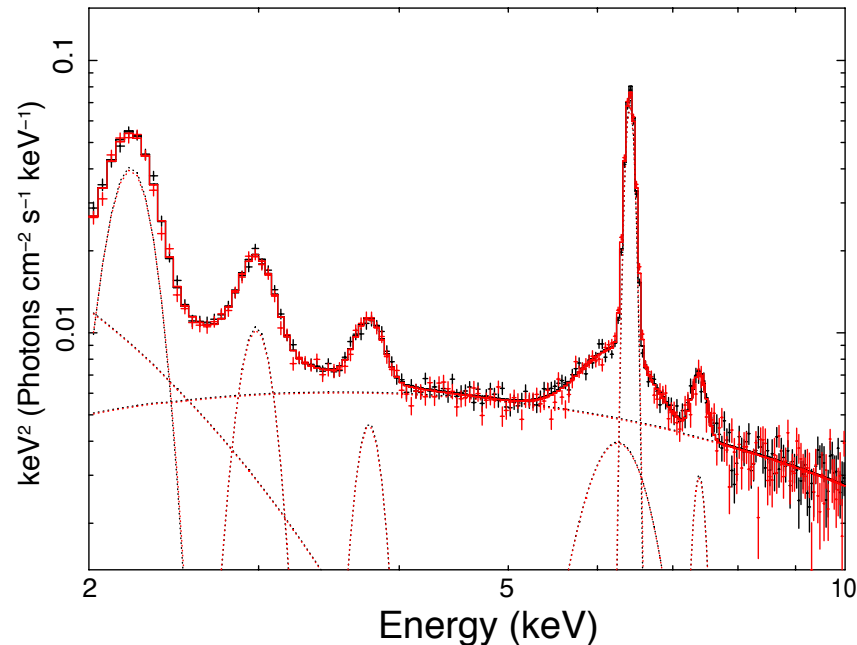   Use XSPEC "gain" fit formalism with SLOPE=1

Results: Offset between 2014

2017/04	12 ± 10 eV
2017/10	-25 ± 11 eV
2018/06	6 ± 10 eV
2019/03	-26 ± 7 eV

* No offset shift measured

Summary

- Low energy discrepancy is still under investigation
  - New RMF is generated based on threshold measurements. It is now under validation.
  - Need more study

- Long term gain monitoring

  $$PI = PI0 * Slope(Temp, time) + Offset(Temp)$$

  - Slope (gain) indicate a deviation from the current 0.2% per year linear correction. → Require CALDB update
  - Offset still show no time dependence

  → We will Continue monitor