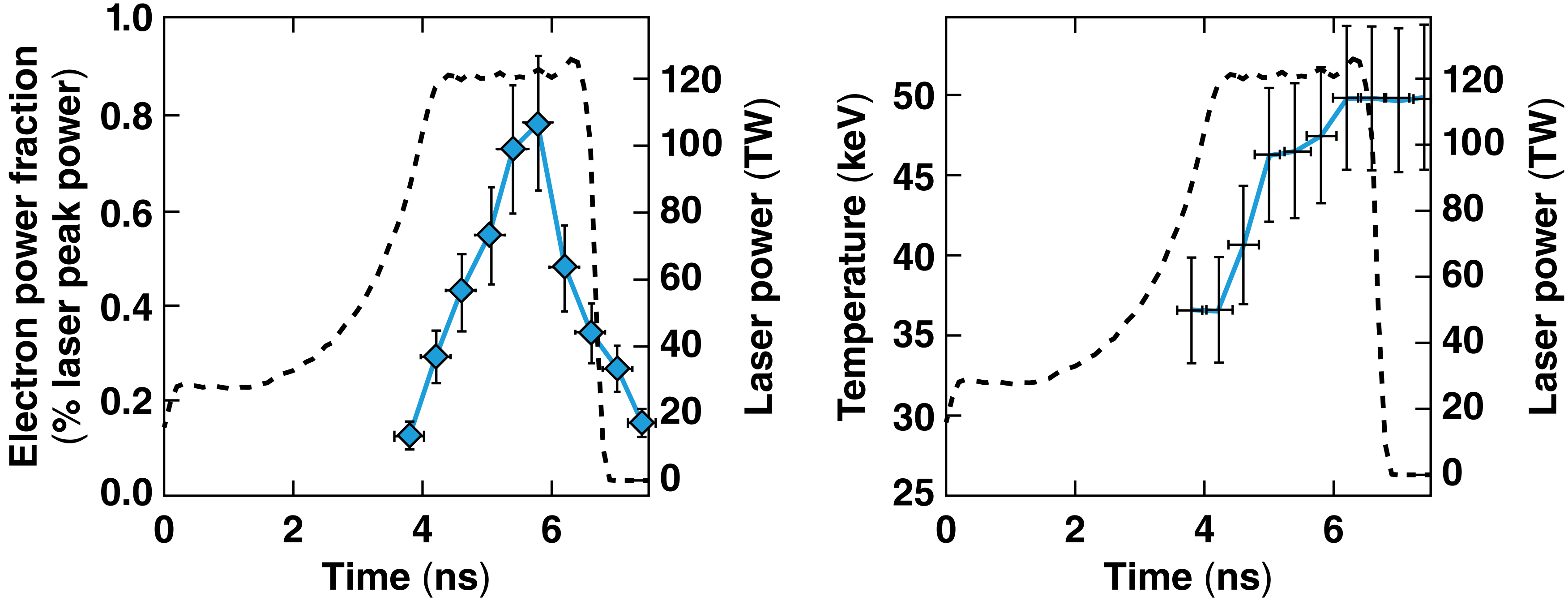
Initial Polar-Drive Implosions on the NIF

N130731 $I \sim 8 \times 10^{14}$ W/cm^2



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Summary

Initial laser–plasma interactions (LPI's) from the National Ignition Facility (NIF) polar-drive (PD) implosions are encouraging

UR LLE

- LLE has performed its first NIF PD implosion at ignition-relevant intensities (8×10^{14} W/cm^2)*
- The temporal evolution of the scattered laser light spectrum is similar to that from a 2-D simulation
- About 0.3% of the laser energy is converted to hot electrons by the two-plasmon–decay (TPD) instability
- Less than ~0.4% conversion efficiency is required for ignition designs

The study of LPI in NIF PD implosions is just beginning.

*See also P. B. Radha *et al.*, UO4.00001; R. S. Craxton *et al.*, UO4.00003; A. K. Davis *et al.*, UO4.00004, this conference.

Collaborators

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NIF implosion experiments are necessary to study LPI and its effects

Laser–plasma interactions at the NIF scale

- **Coronal density scale length**

$$L_{\rho}^{\Omega} = 150\ \mu\text{m}$$

$$L_{\rho}^{\text{NIF}} = 600\ \mu\text{m}$$

- **Linear gain calculations are inadequate to predict LPI on NIF scales**
- **Additional physics (collisions, weak ion-wave damping) are required to extrapolate OMEGA data to NIF scales***

*J. F. Myatt, FR1.00001, this conference (invited);
J. F. Myatt *et al.*, Phys. Plasmas 20, 052705 (2013).

The extrapolation of OMEGA/OMEGA EP TPD results to the NIF is not straightforward—experiments are necessary

- **Linear theory predicts a linear dependence of the absolute TPD threshold (or convective gain) with density scale length (all else fixed)**
- **Gains for convective shared modes are large on the NIF because of the increased density scale length but temporal growth rates are similar to OMEGA**
- **The linear scaling comes from linear theory but TPD is always nonlinear because of absolute instability***
- **Experimentally, there are significant differences that could lead to differing nonlinear behavior (and hot-electron production)**
  - **NIF has 2× higher electron temperature (λ_D larger by ~$\sqrt{2}$)**
  - **PD on the NIF has a lower beam symmetry than OMEGA**
  - **Langmuir wave (LW) and ion-acoustic wave (IAW) collisional effects differ between OMEGA and the NIF**
- **LLE is investigating a model that accounts for these effects (*ZAK3D*)**

*R. W. Short *et al*., BO4.00009, this conference; W. Seka *et al*., BO4.00004, this conference; J. F. Myatt, FR1.00001, this conference (invited).

Polar-drive implosions on the NIF are being carried out with ignition-relevant intensities

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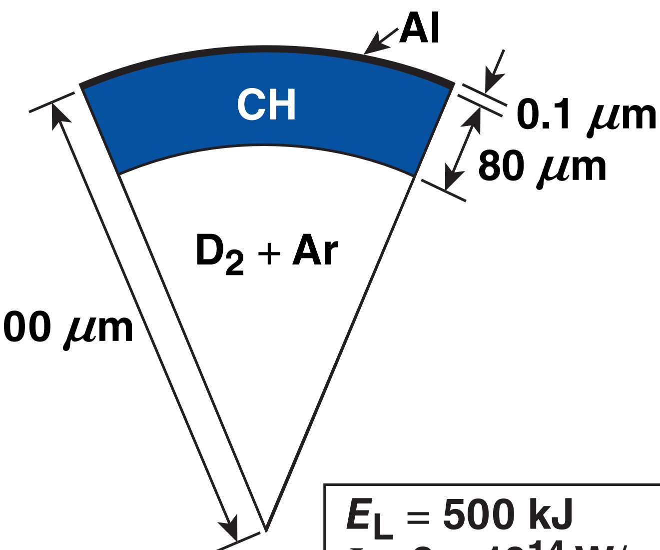
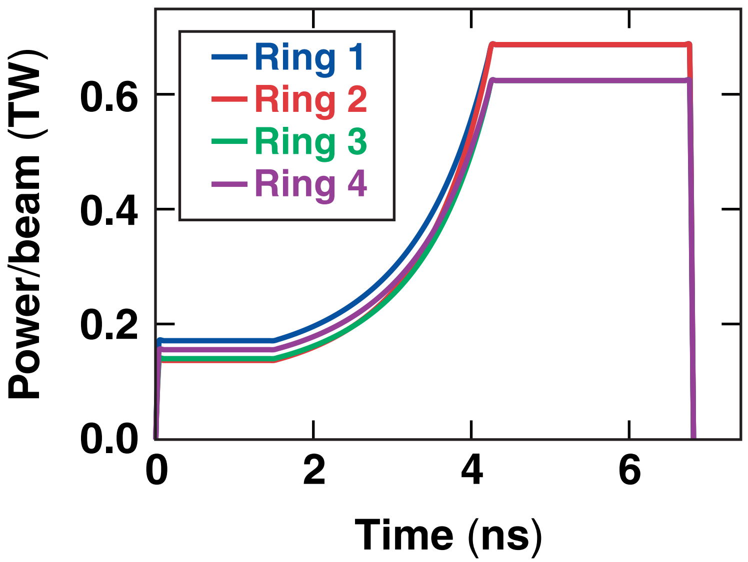


E_L = 500 kJ
$I = 8 \times 10^{14}$ W/cm^2
V_{imp} = 240 km/s
$\alpha \sim 3$

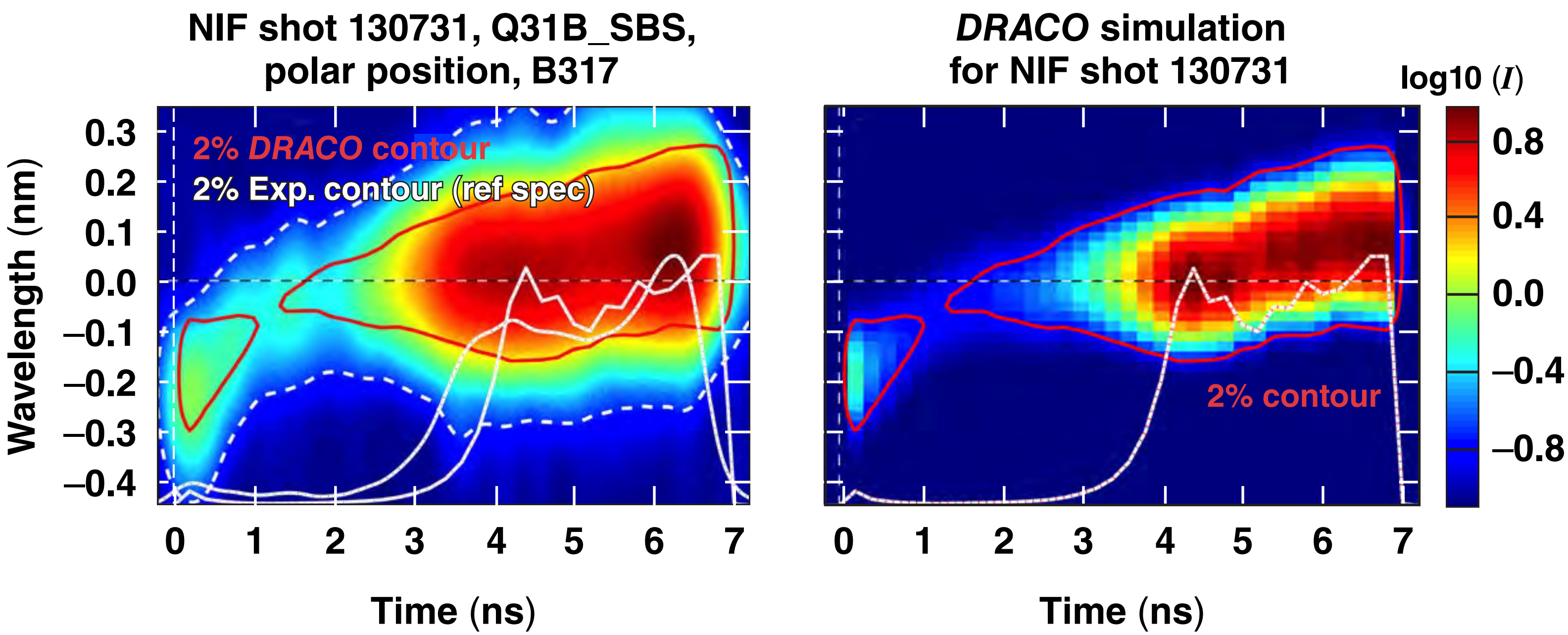


- Current single-beam nonuniformity precludes high-performance compression experiments

E22290d

One-dimensional predictions of the spectral evolution of scattered light shows similar shapes to those measured

UR LLE



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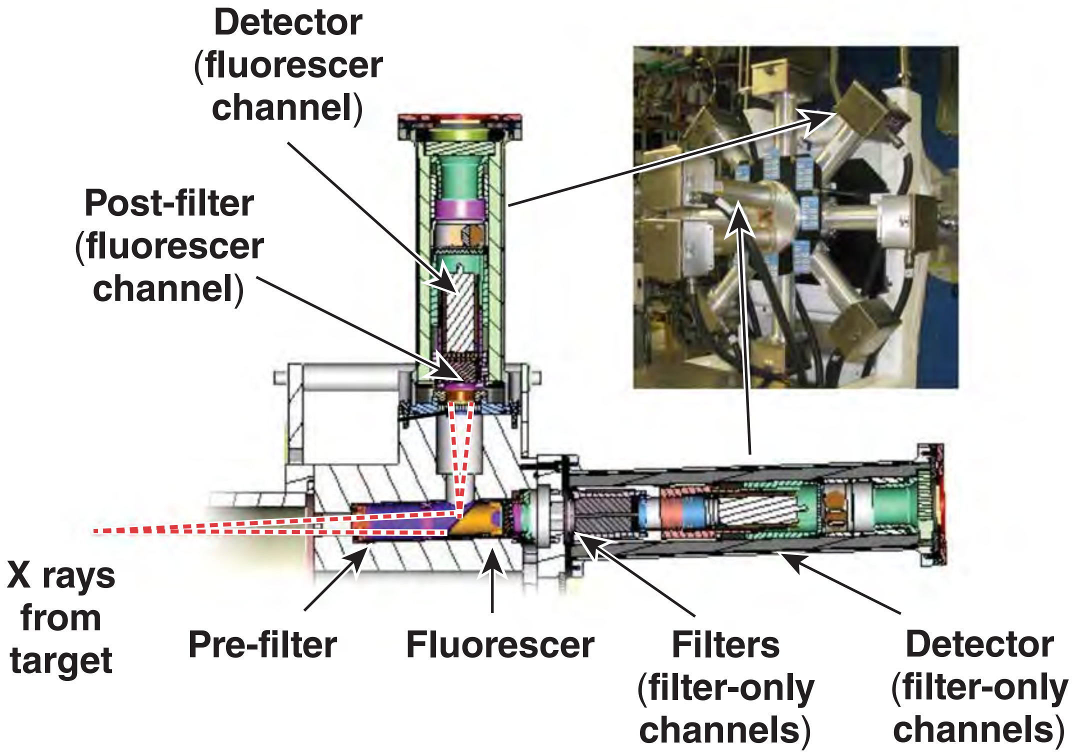
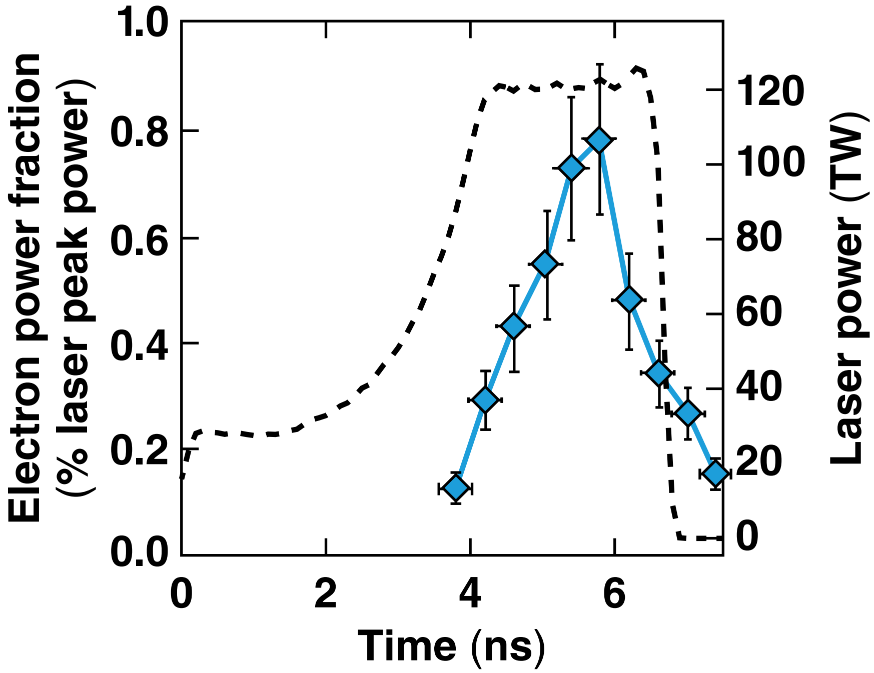
The filter-fluorescer x-ray diagnostic (FFLEX) measures the time-resolved hard x-ray signal generated by hot electrons

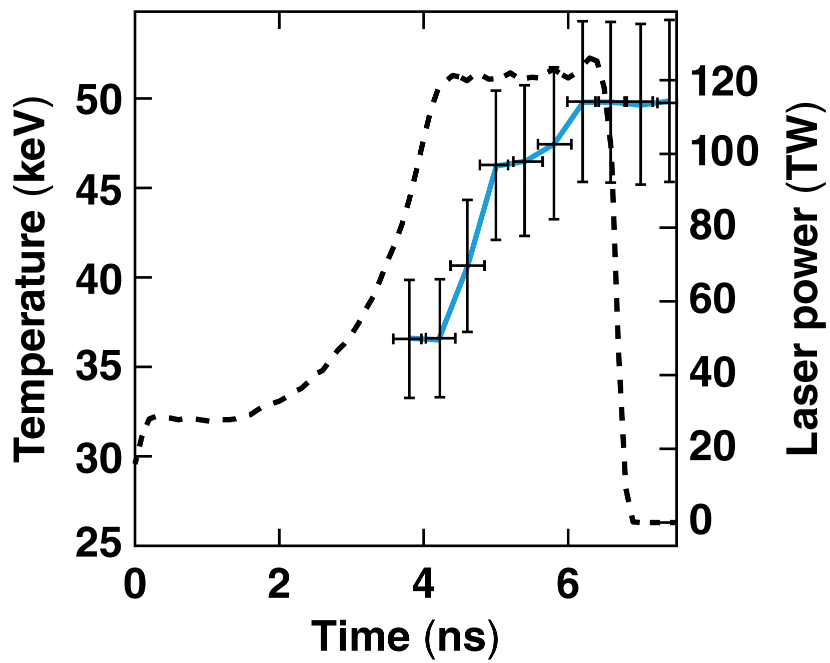


- Eight filter/fluorescer channels (~20 to 200 keV)
- Two filter-only channels (>100 keV)
- Time-integrated FFLEX has been in operation since 2004
- New FFLEX with faster photomultiplier tubes (PMT's) and scintillators provide fully time-resolved data

Measurements of energy in >50-keV electrons indicate tolerable preheat

N130731 $I \sim 8 \times 10^{14}$ W/cm^2





- The energy of electrons above 50 keV is 1600 J or ~0.3% of the laser energy
- Ignition designs can tolerate up to ~0.1% of the laser energy deposited in the high-density shell, corresponding to ~0.4% of the laser energy converted into hot electrons

E22373d

Summary/Conclusions

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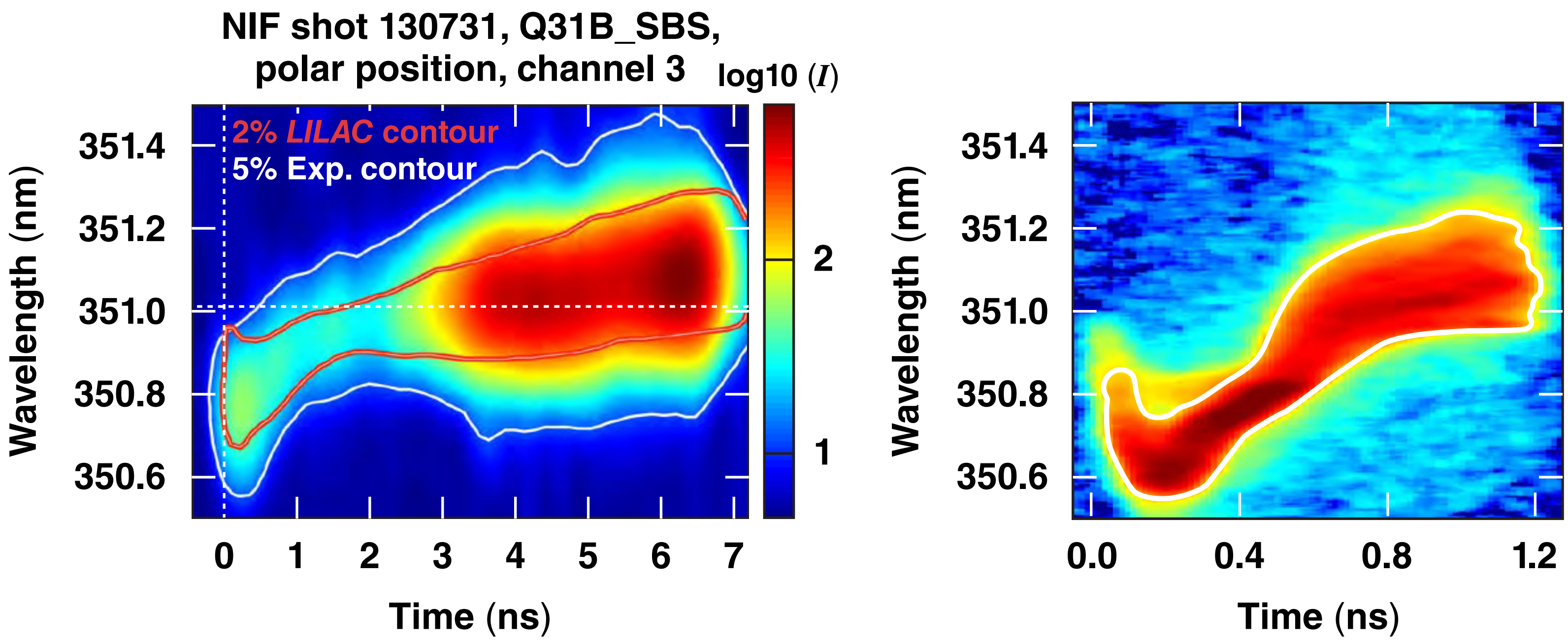
The scattered laser light shows spectral shifts similar to OMEGA



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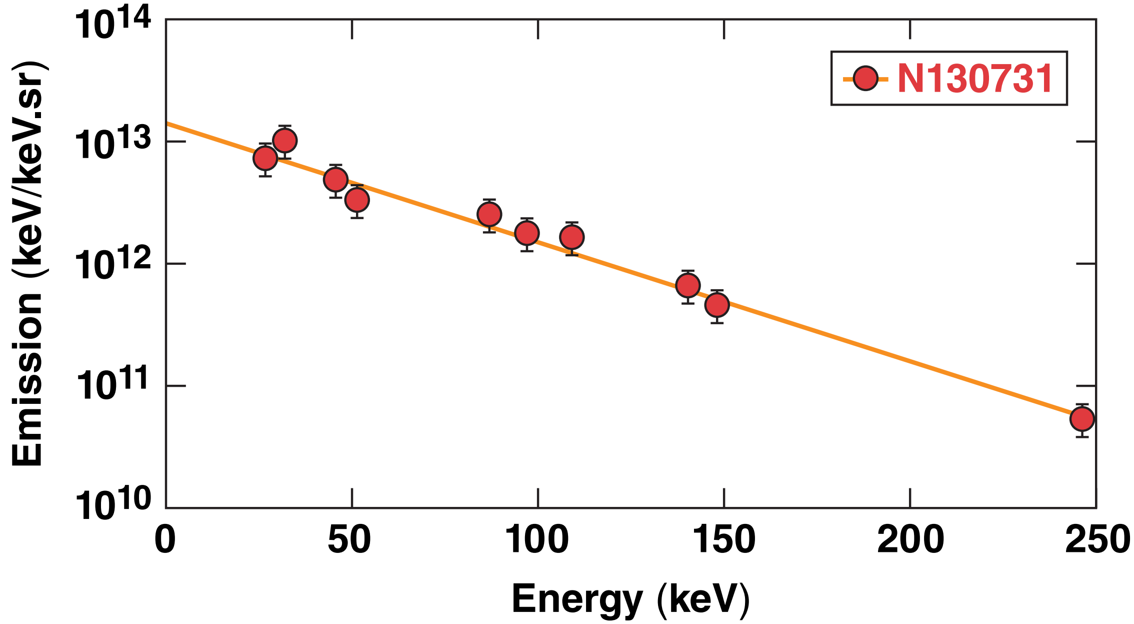
The time-integrated analysis shows a hot-electron temperature of 45 keV



	E (kJ)	*T* (keV)	*E* > 100 keV (J)
N130731	2.0±0.4	45±4	963±190