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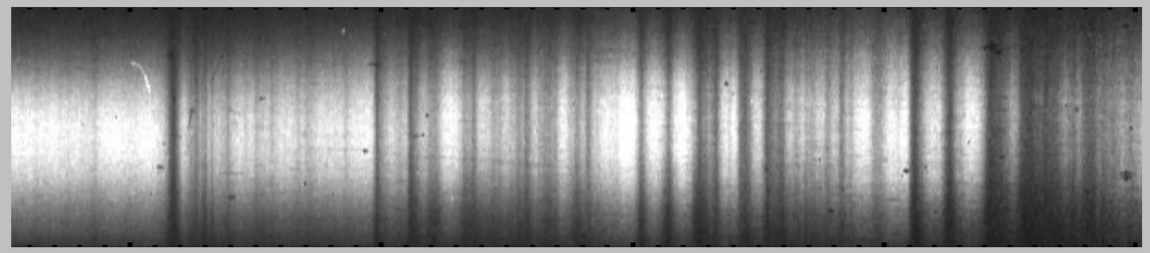

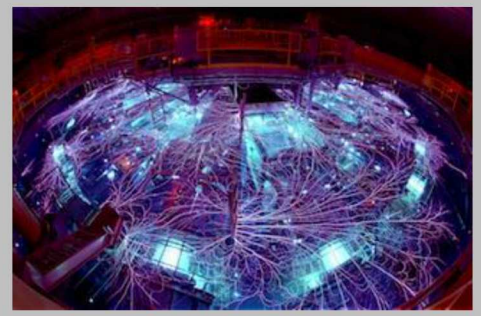

Current topics and future strategies for stellar interior opacities

Jim Bailey

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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Current active research topics for stellar interior opacity

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- **Test hypotheses for the discrepancy between stellar interior opacity models and Z measurements.**

1. **Revisit iron – re-analyze existing data with new methods; new experiments at Anchor 2 & 3 [replace CH w/ Be]**
2. **What is the best path to evaluate 2-photon absorption?**
3. **What impact does higher BB feature width have on stars?**

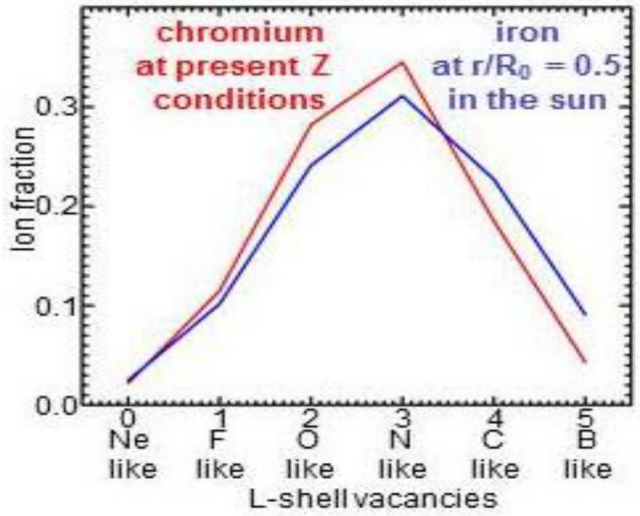
- **Develop chromium and/or titanium as surrogates for iron in order to test opacity models for the deep solar interior.**

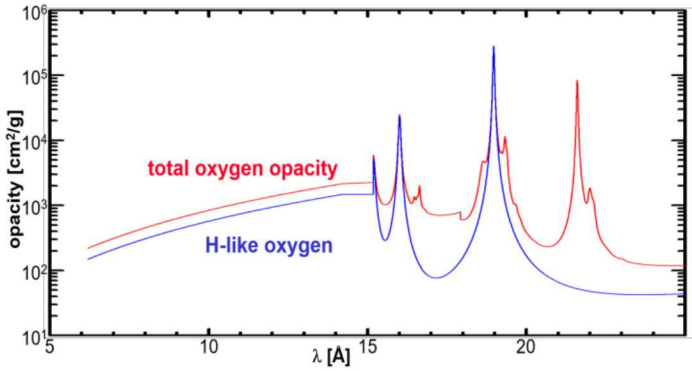
1. **Charge states are very similar**
2. **The question is how well the low Z elements emulate density effects and excited population physics**

- **Develop methods to measure oxygen opacity at solar interior conditions.**

1. **Main questions are continuum lowering affect on ionization; line profiles**
2. **Measuring out to He γ (possibly β) seems within reach**
3. **Eliminating oxygen contaminants from experiments is a likely requirement**

- **Can we measure opacity at higher T_e and n_e on the existing Z?**





Bailey *et al.*, *Nature* 2015

New capability development for stellar interior opacity

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- **Time resolved measurements.**

1. Measure Te and ne vs time
2. How well do we understand the evolution?
3. Can we use improved understanding to design better experiments?
4. Can we measure opacity at multiple Te, ne values in a single experiment?

- **Target fabrication innovation.**

1. WE measure differences between elements that are puzzling
2. Can we measure opacity from two elements in a single experiment?

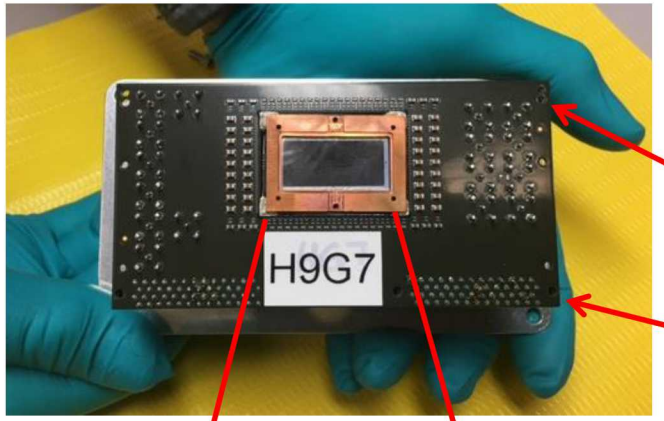
The recently commissioned hCMOS UXI cameras can meet these objectives

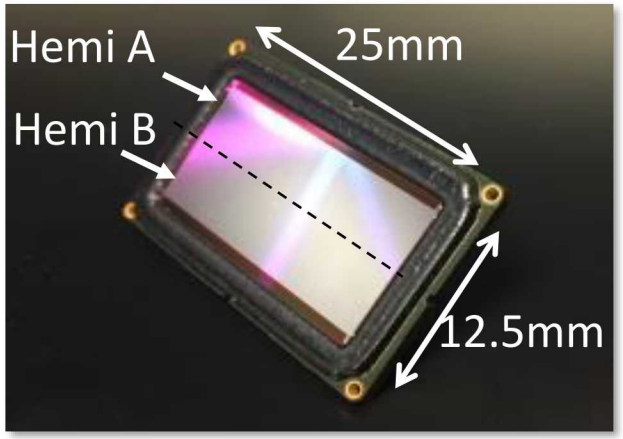
State-of-the-art characteristics:

- Single line of sight! → small detector, single sensing (≠ MCPs)
- Surface defect minimal compared to micro channel plates (gated cameras)
- Absolutely calibrated response → absolute source brightness
- Potentially high signal-to-noise, better than 20 on single acquisition
- Dynamic range from single to 1500 counts
- Highly uniform sensor response
- Flexible triggering scheme
- Tunable time integration duration from 2 to 18ns

→ More details in the next presentation by the hCMOS group

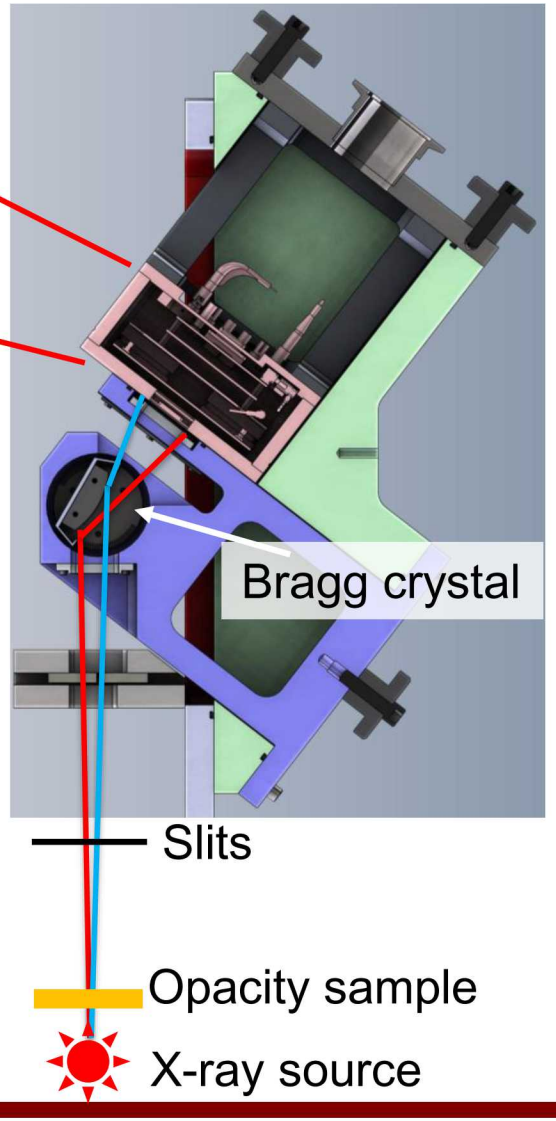
Sensor with packaging





hCMOS Sensor

Opacity spectrometer



First time-resolved x-ray spectra were recorded on UXI camera

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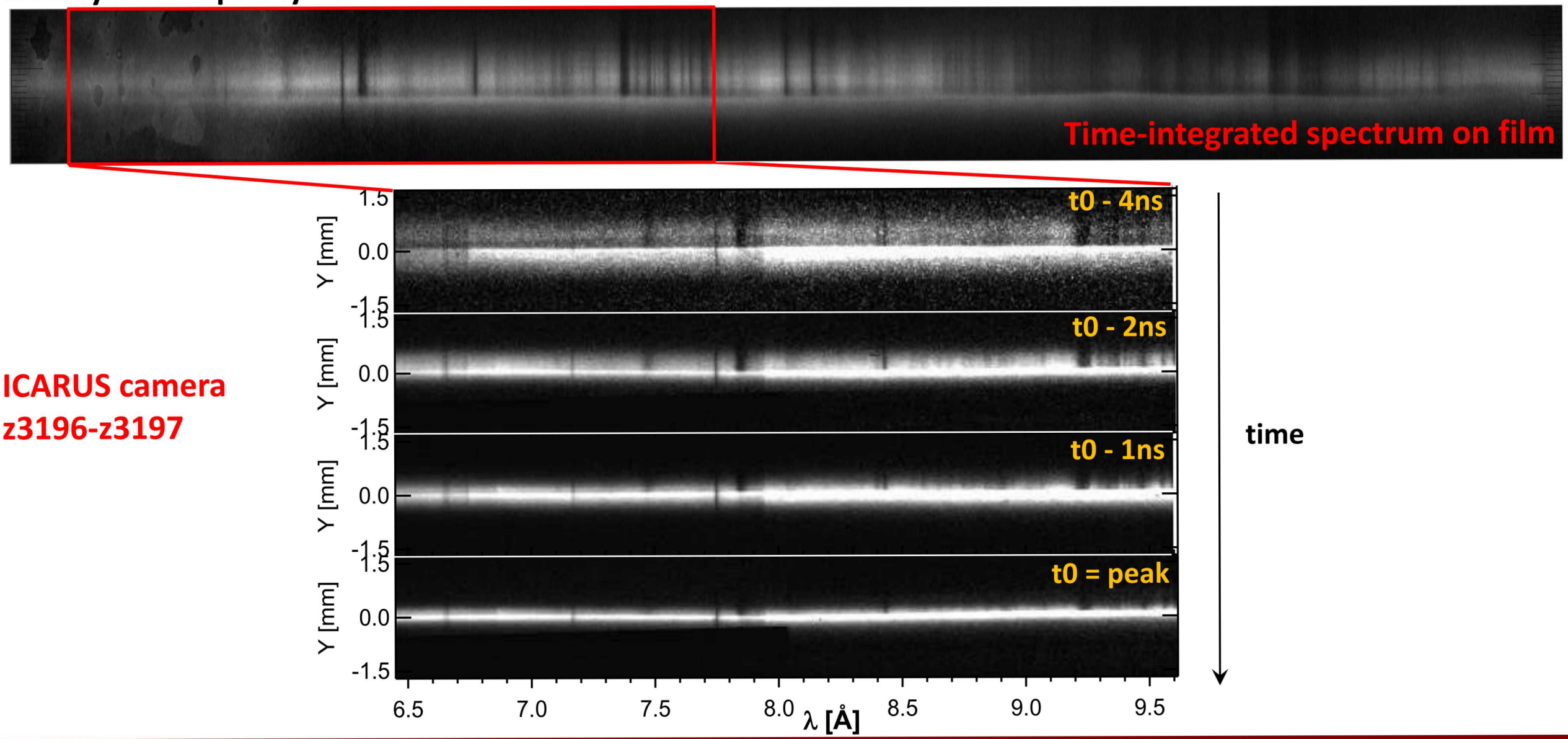
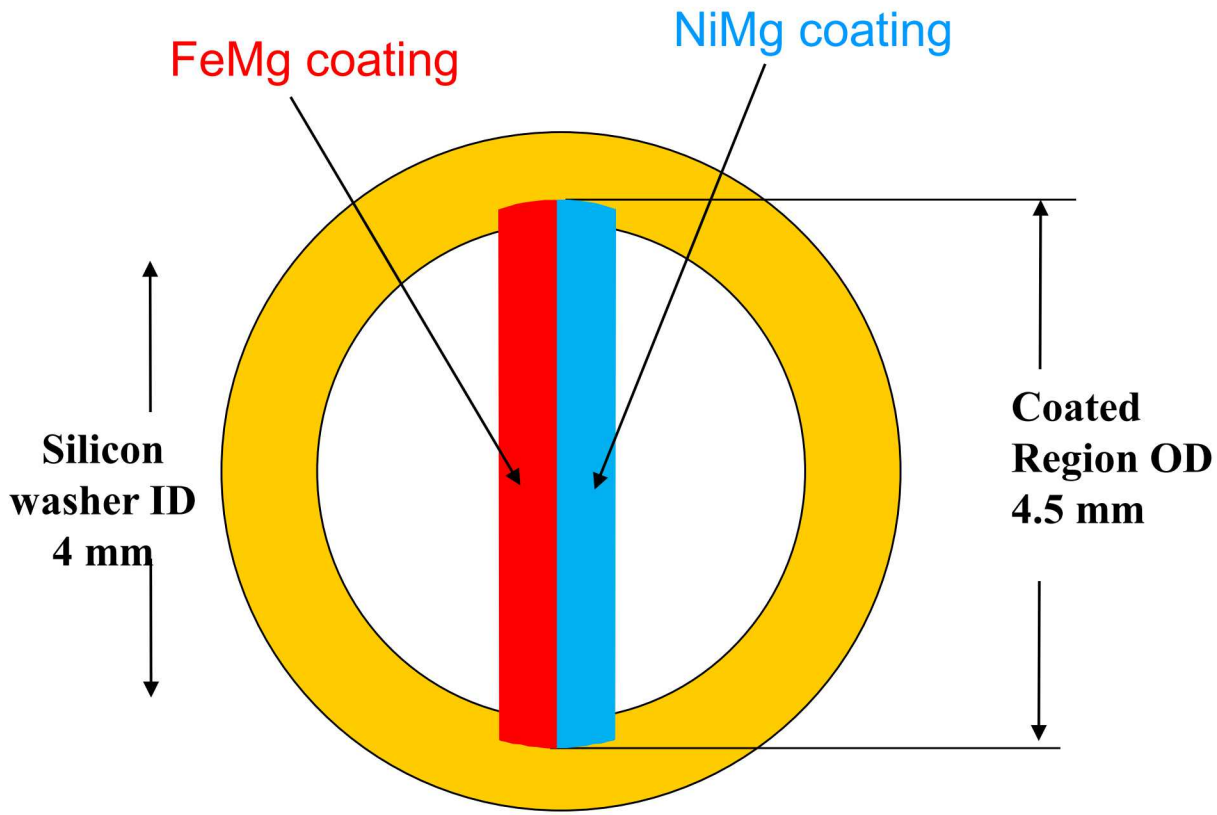
January 2018 Opacity 18a shots



ICARUS camera
z3196-z3197

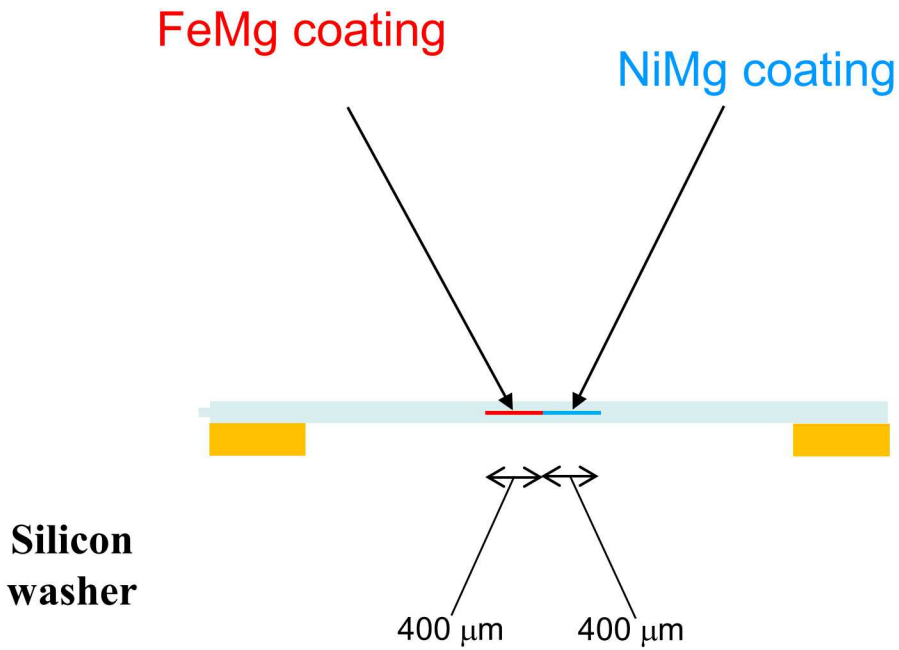
Dual element Opacity Experiment: Foil Details



Sandia target fab will attach foils to target holder

*Note: coated part of foil is encapsulated in CH

Dual element Opacity Experiment: Foil Details
Diagram is not to scale



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