Temperature determination using EUV imaging of a nanoflare heated loop

Aveek Sarkar & Robert Walsh

University of Central Lancashire
UK

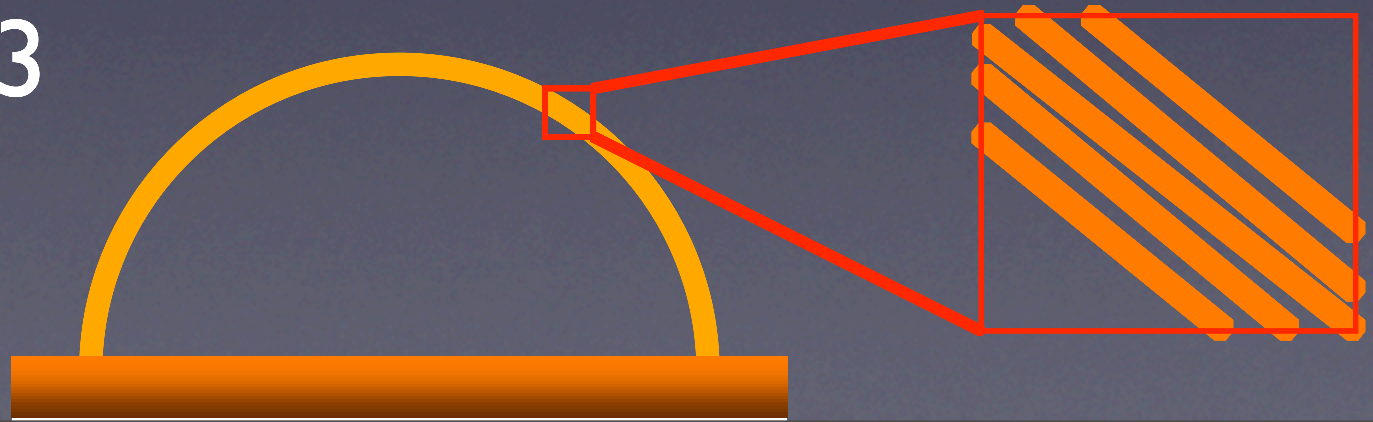
Hydrodynamic simulation

- The global loop consists of 125 strands

Each strand develops hydrodynamically independently from others

Strands are heated by multiple nanoflares

The overall heat input into the loop maintains a power-law slope ~ 2.3

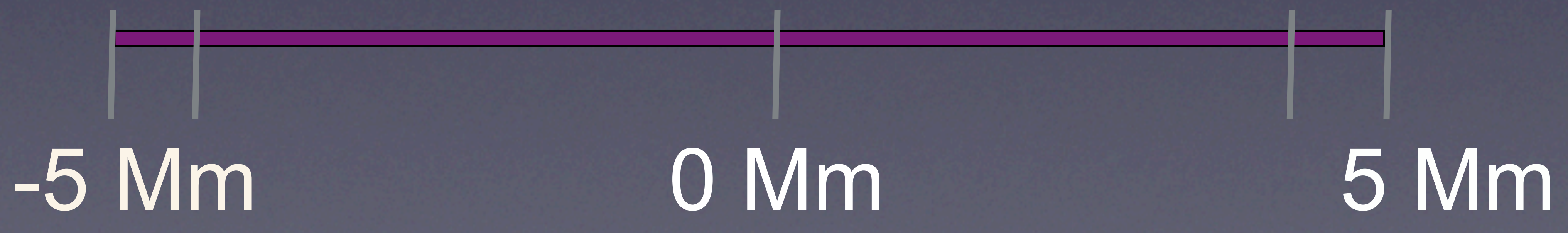


Simulation set up

10 Mm long loop

Chromosphere 0.5 Mm on both side of the loop

Strands are randomly heated by nanoflares



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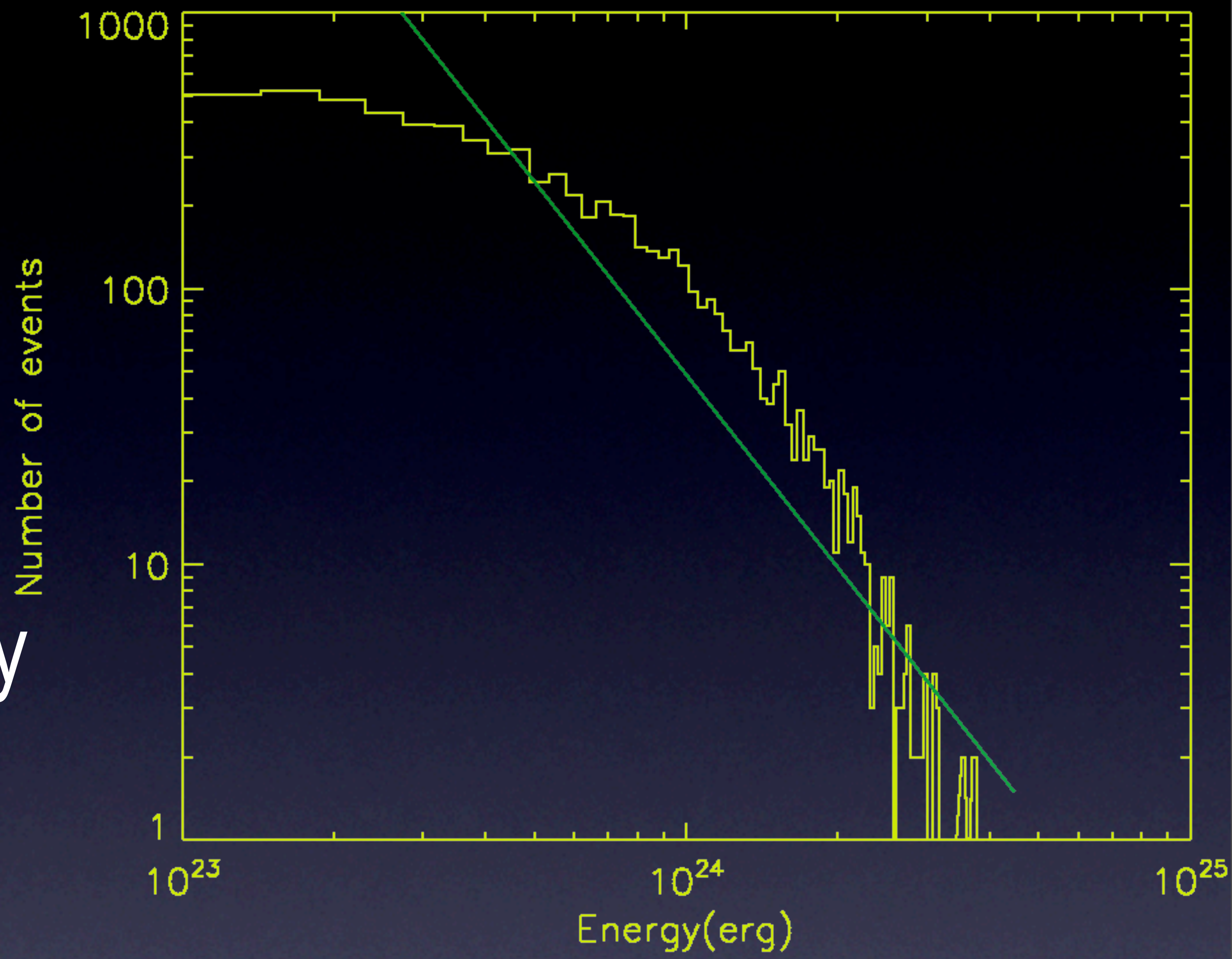

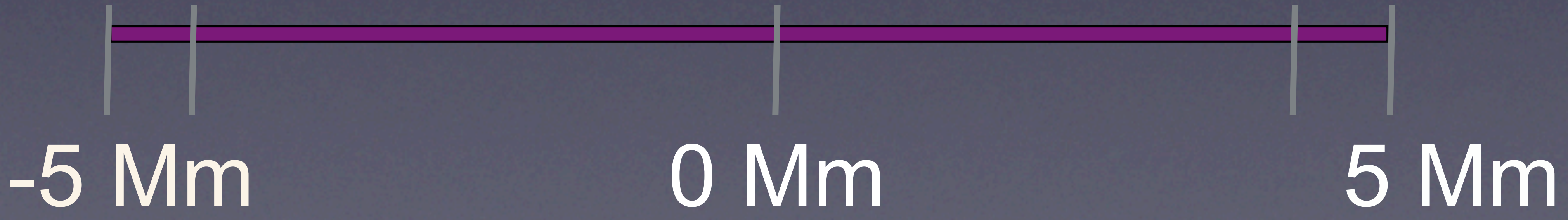

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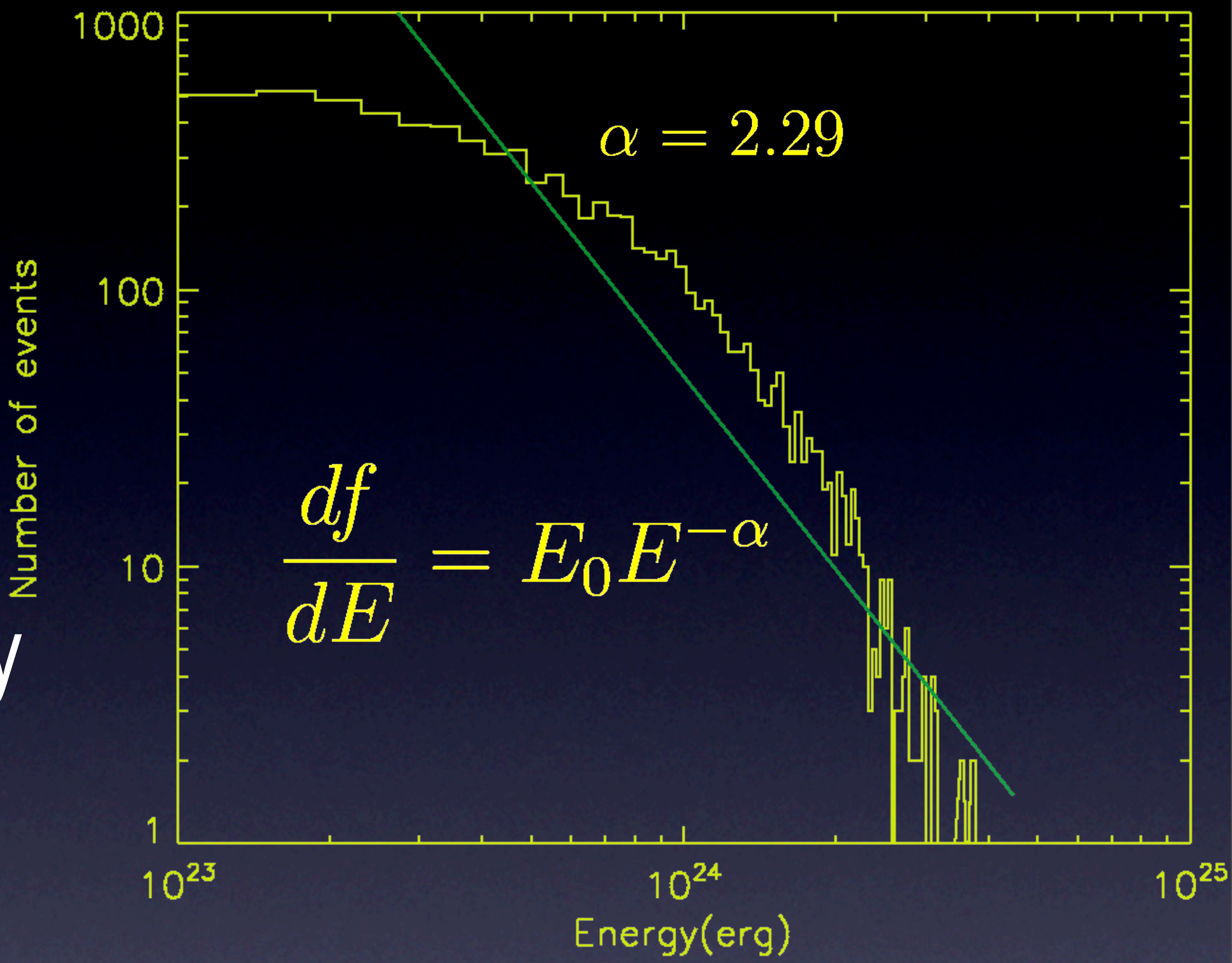

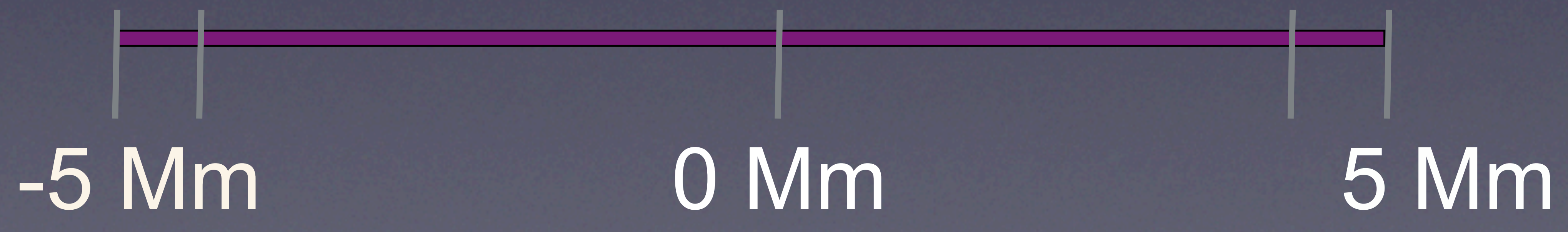

Output from every single strand

Temperature
Density
Velocity

→ Function of space(s) and time(t)

Output from every single strand

Temperature
Density
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⇒

Function of space(s) and time(t)

$$\overline{T}_{EM} = \frac{\sum_{i=1}^{125} n_i^2(s,t)\,dl(s)\,T_i(s,t)}{\quad}$$

Output from every single strand

Temperature
Density
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Function of space(s) and time(t)

$$\overline{T}_{EM} = \frac{\sum_{i=1}^{125} n_i^2(s,t)dl(s)T_i(s,t)}{\displaystyle\sum_{i=1}^{125} n_i^2(s,t)dl(s)}$$

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Emission measure weighted average temperature

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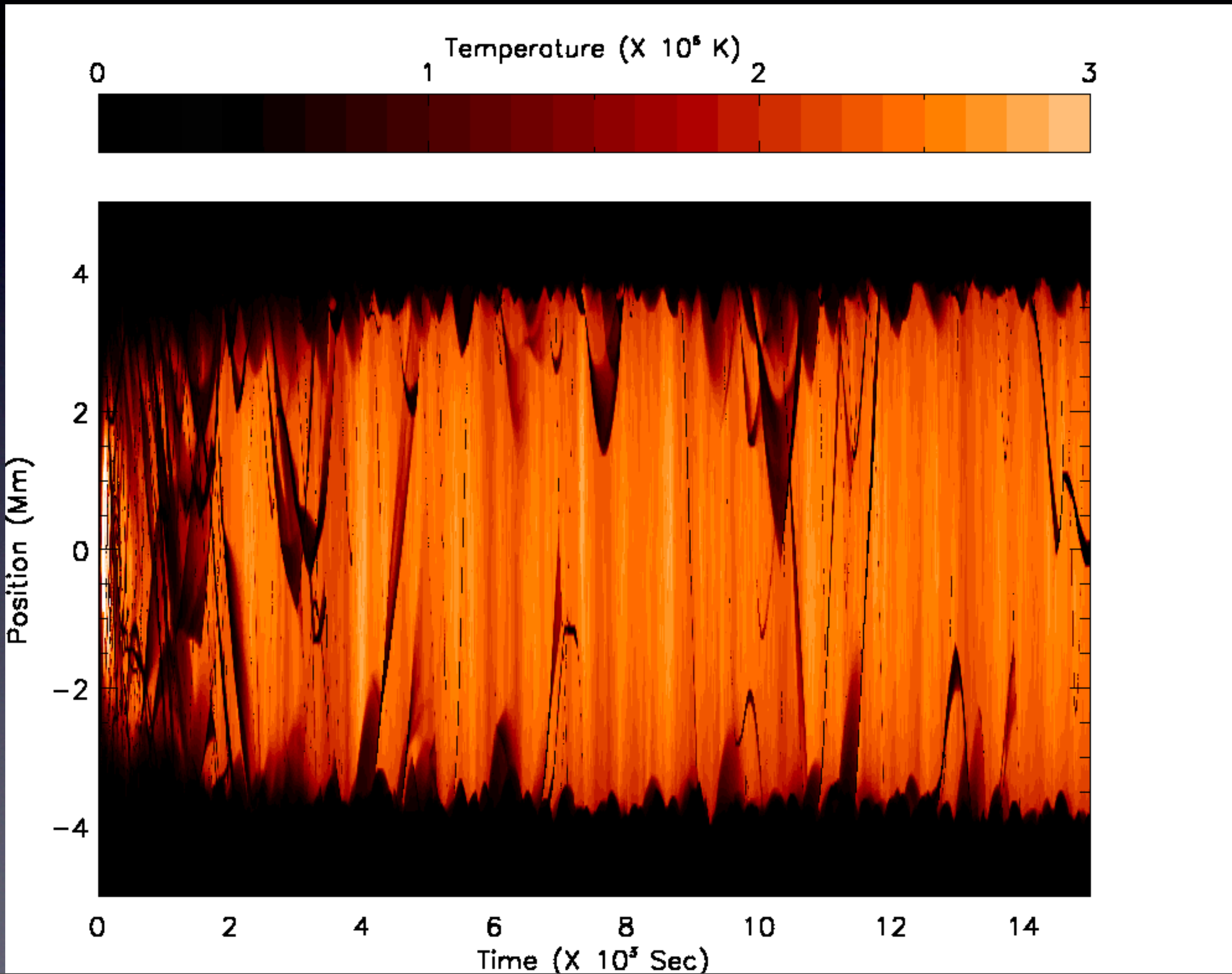
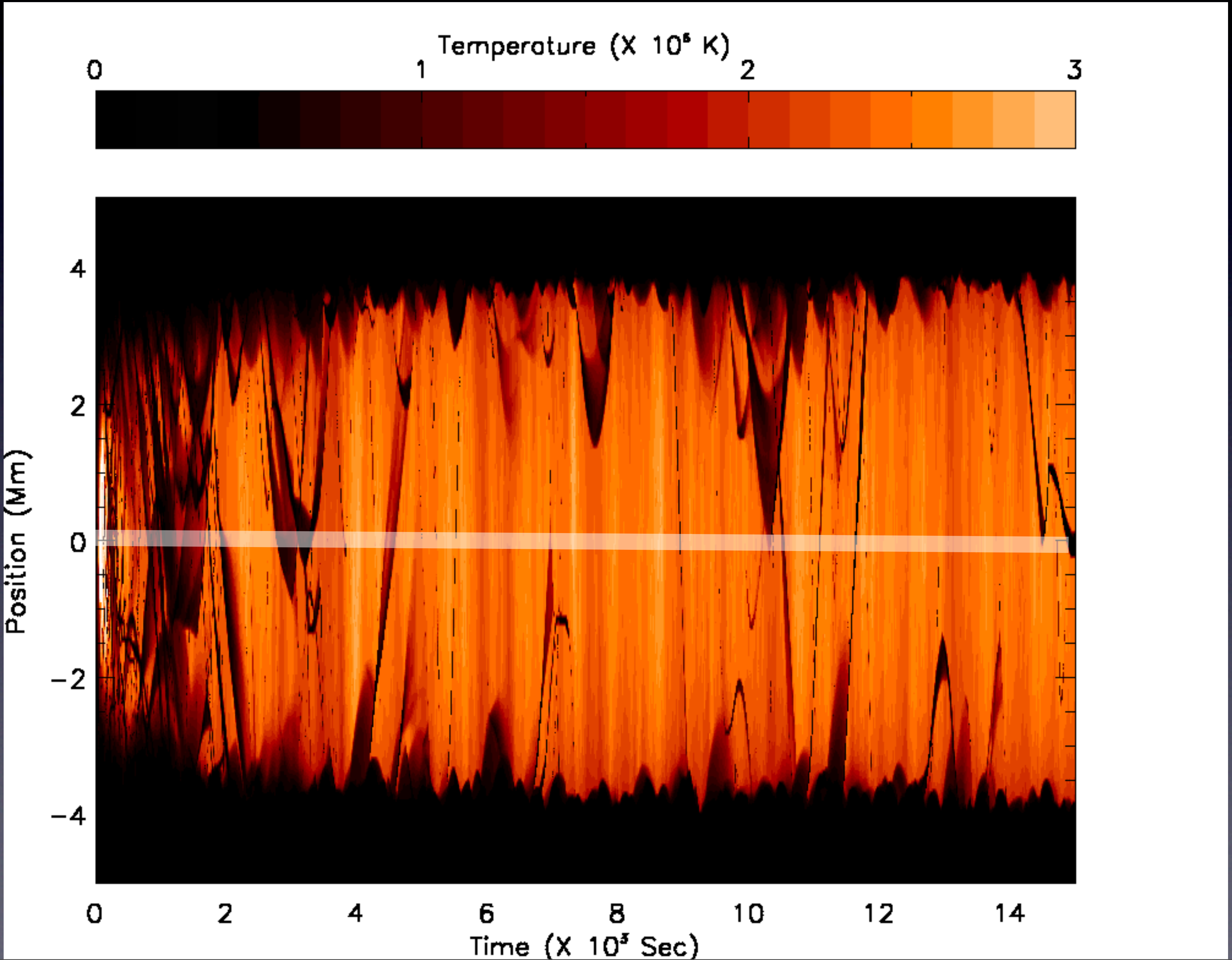


Emission measure weighted average temperature



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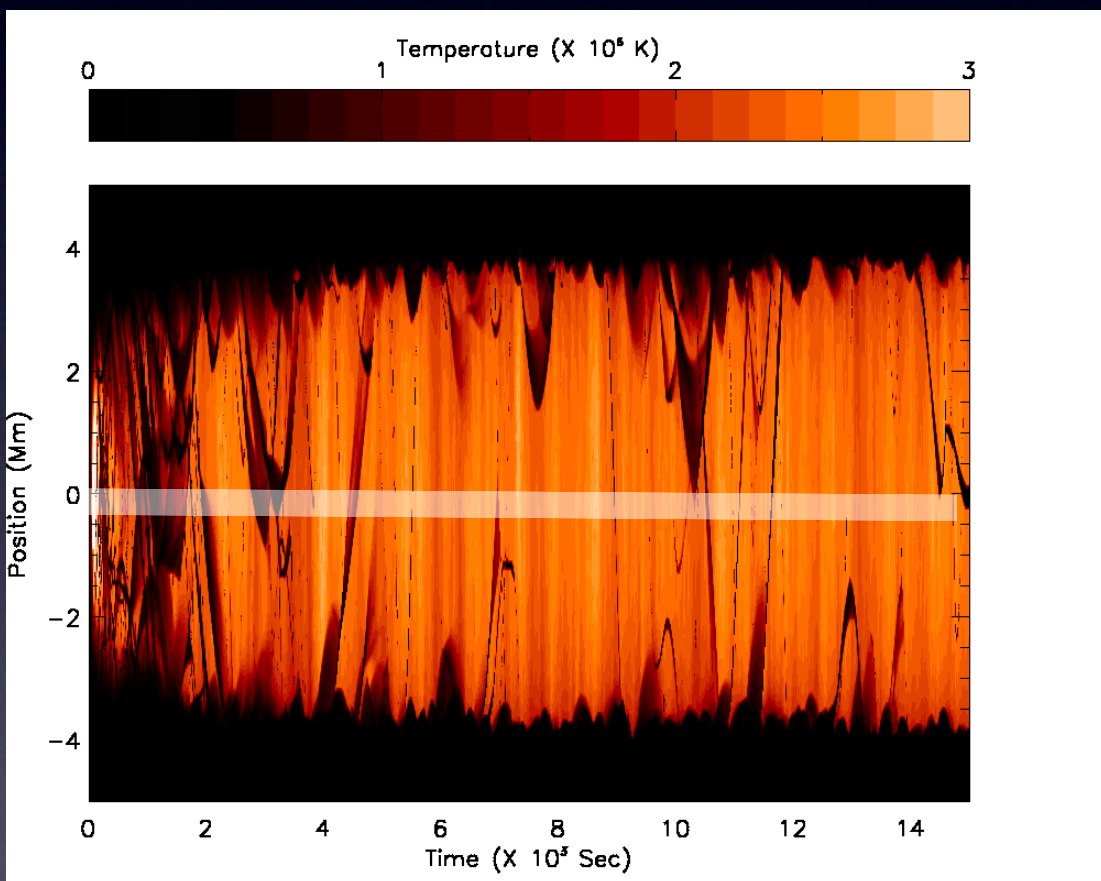
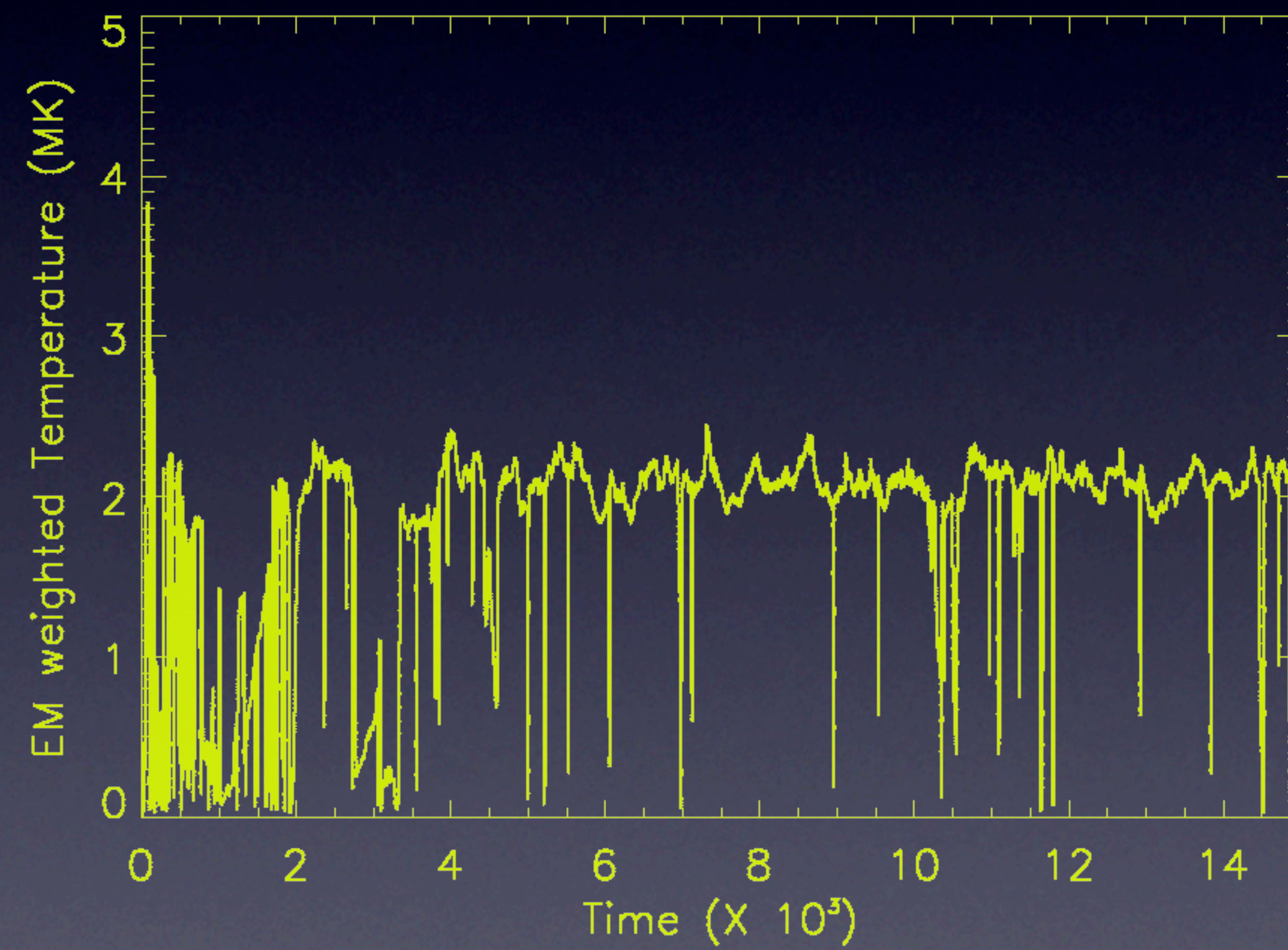
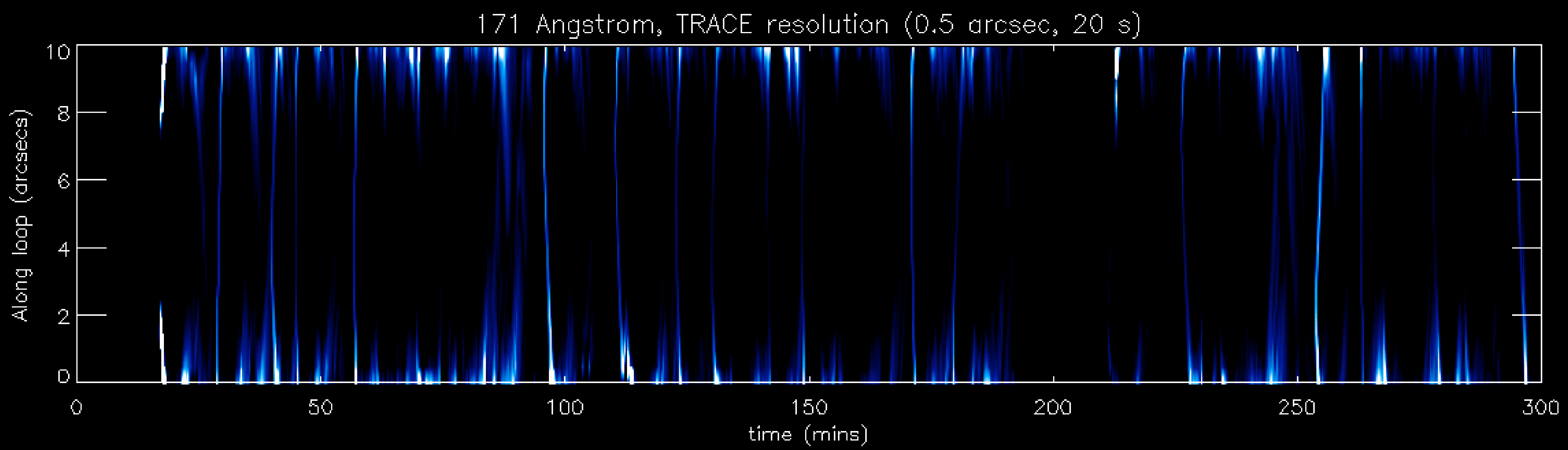




TRACE intensity in three passbands



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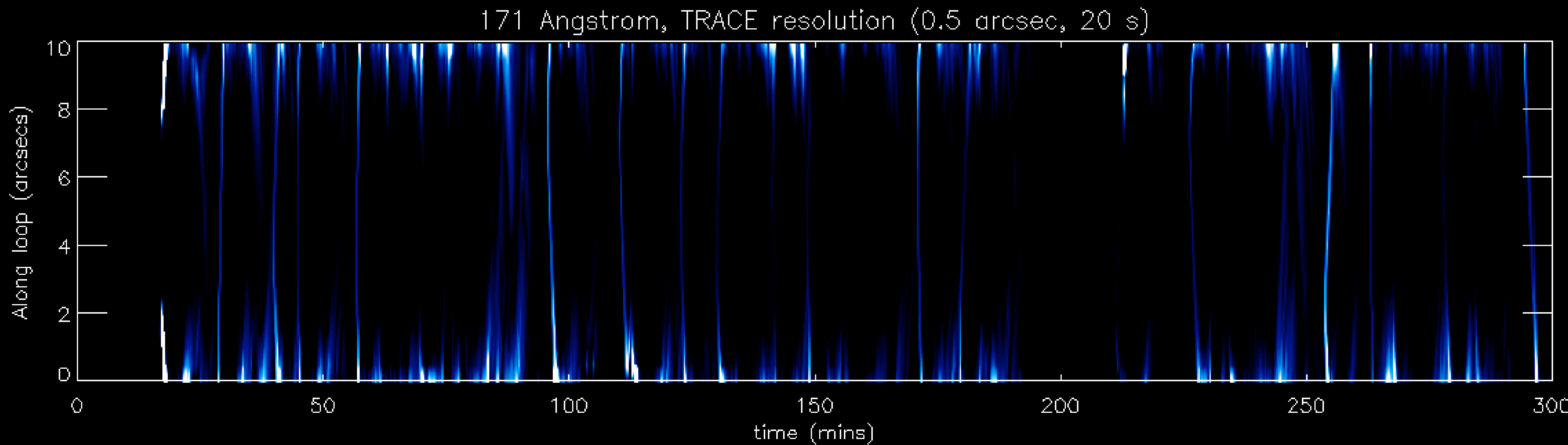
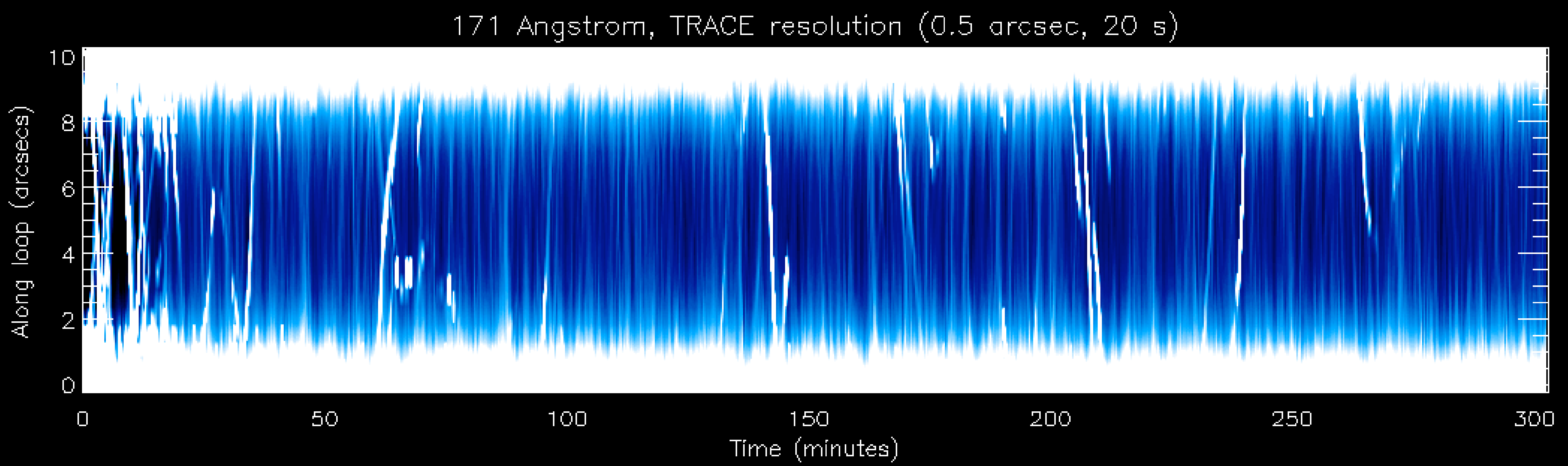
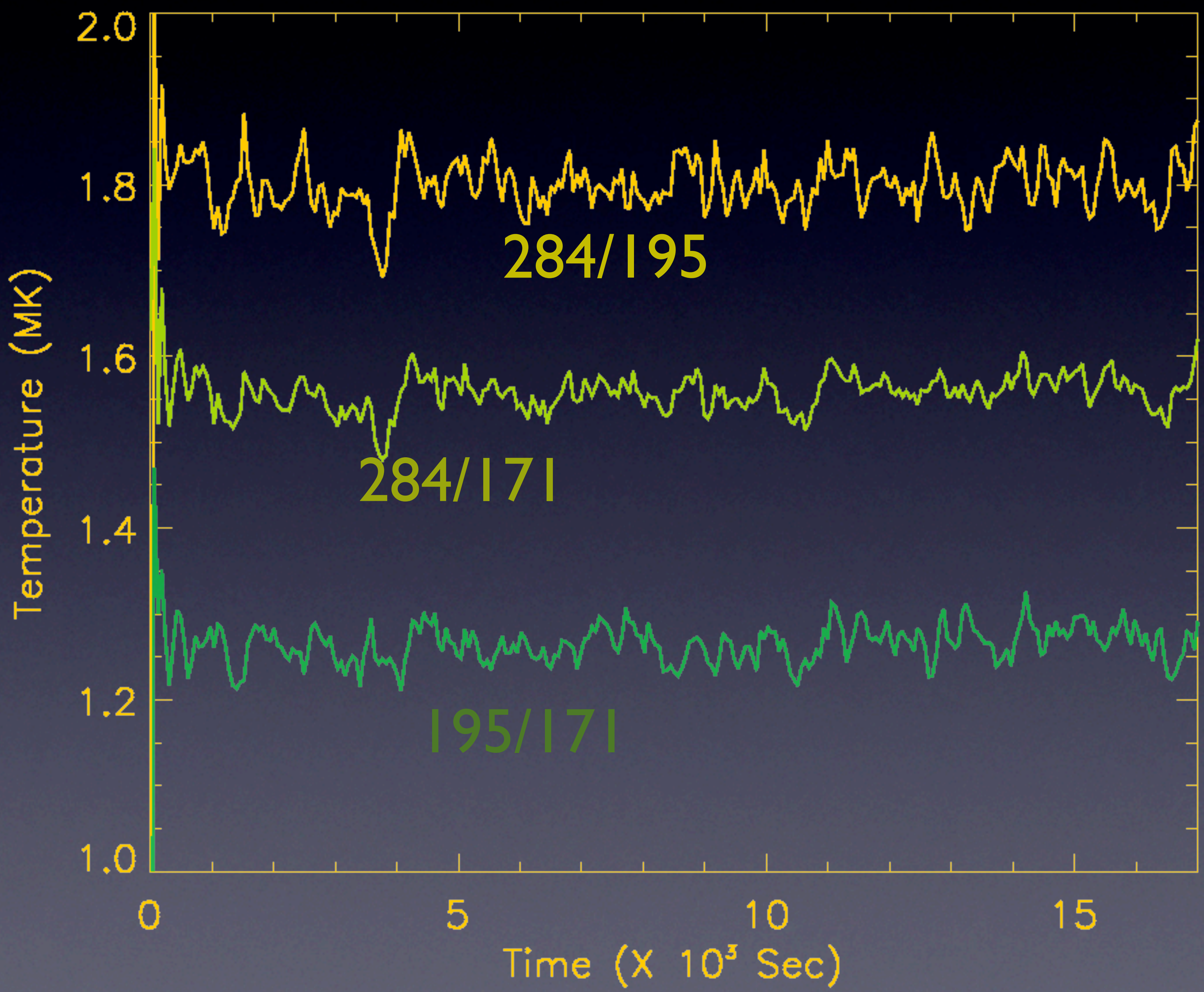




Temperature at the looptop location



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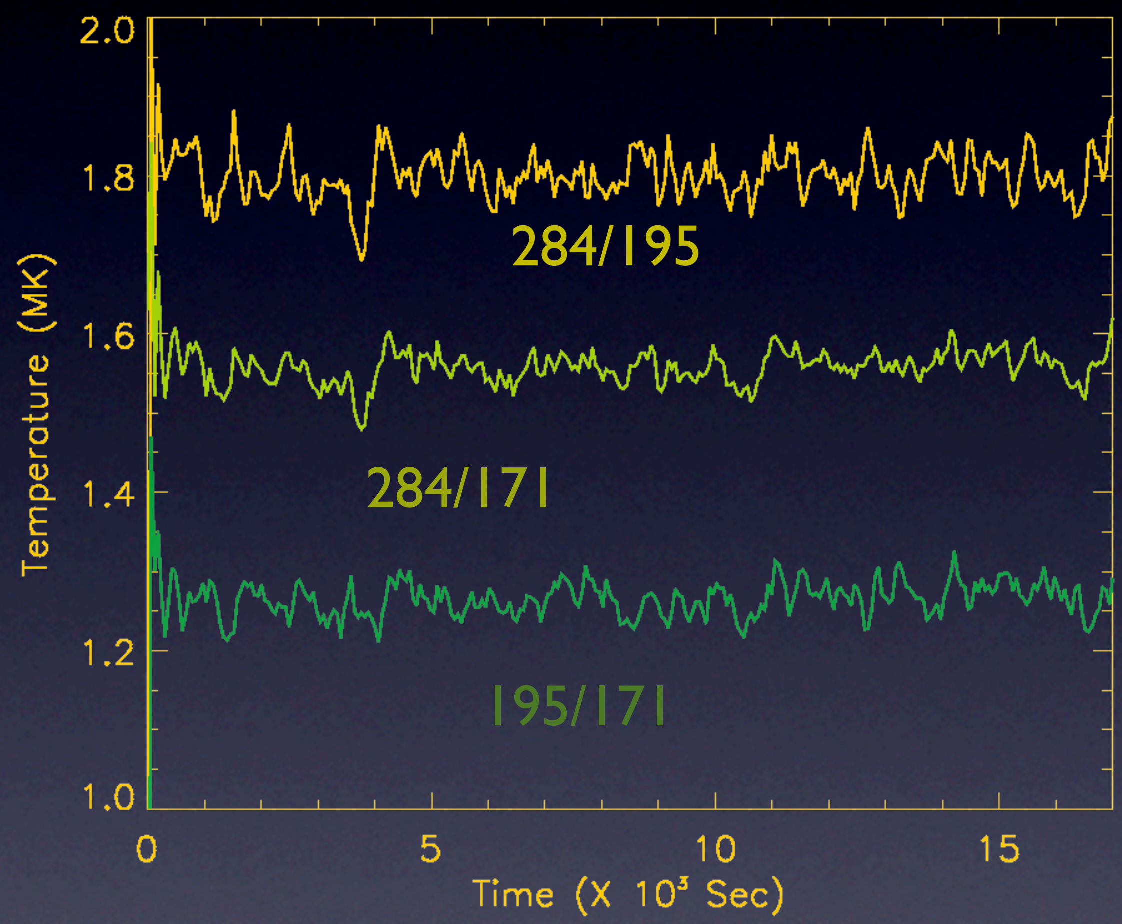

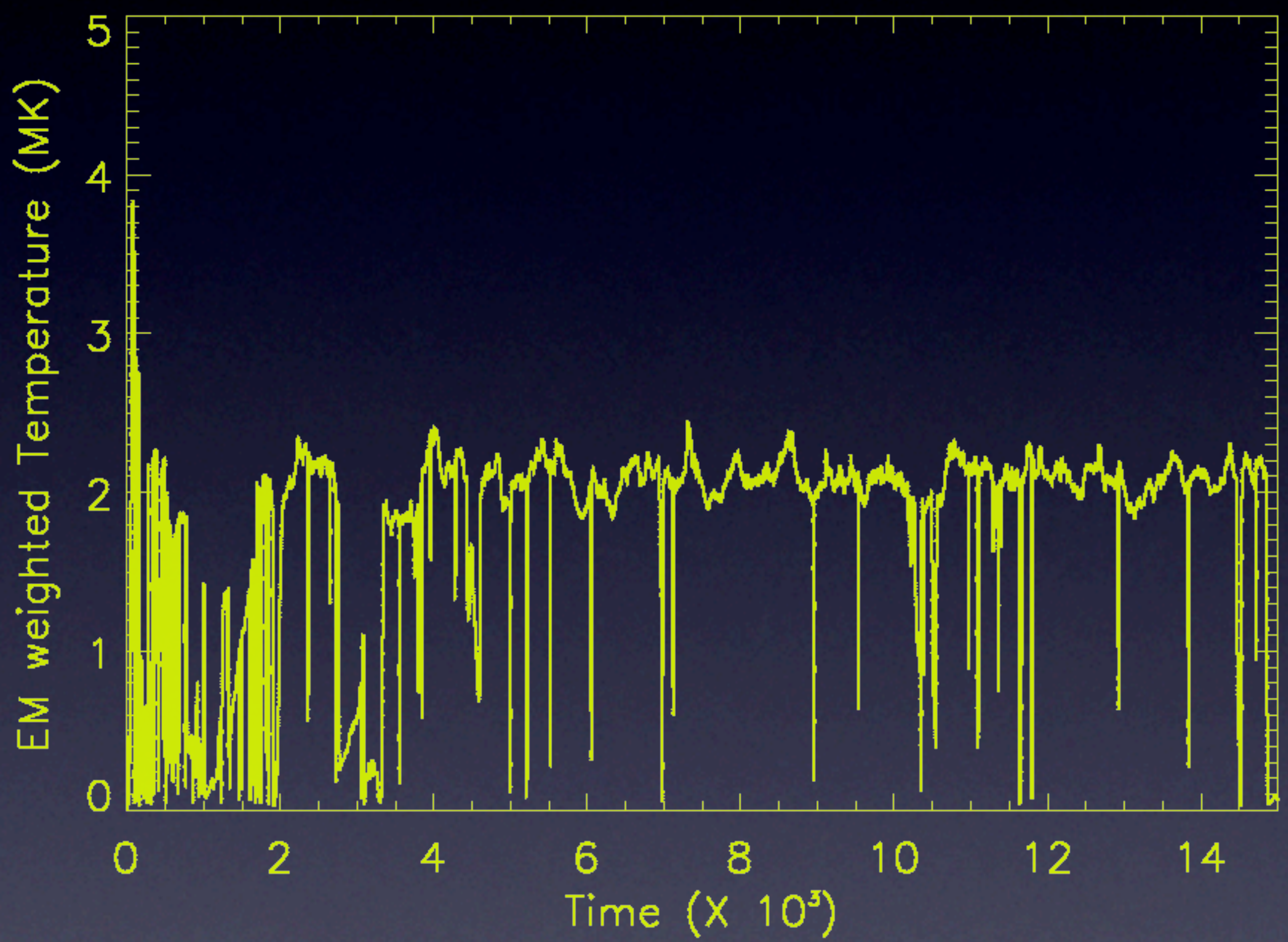

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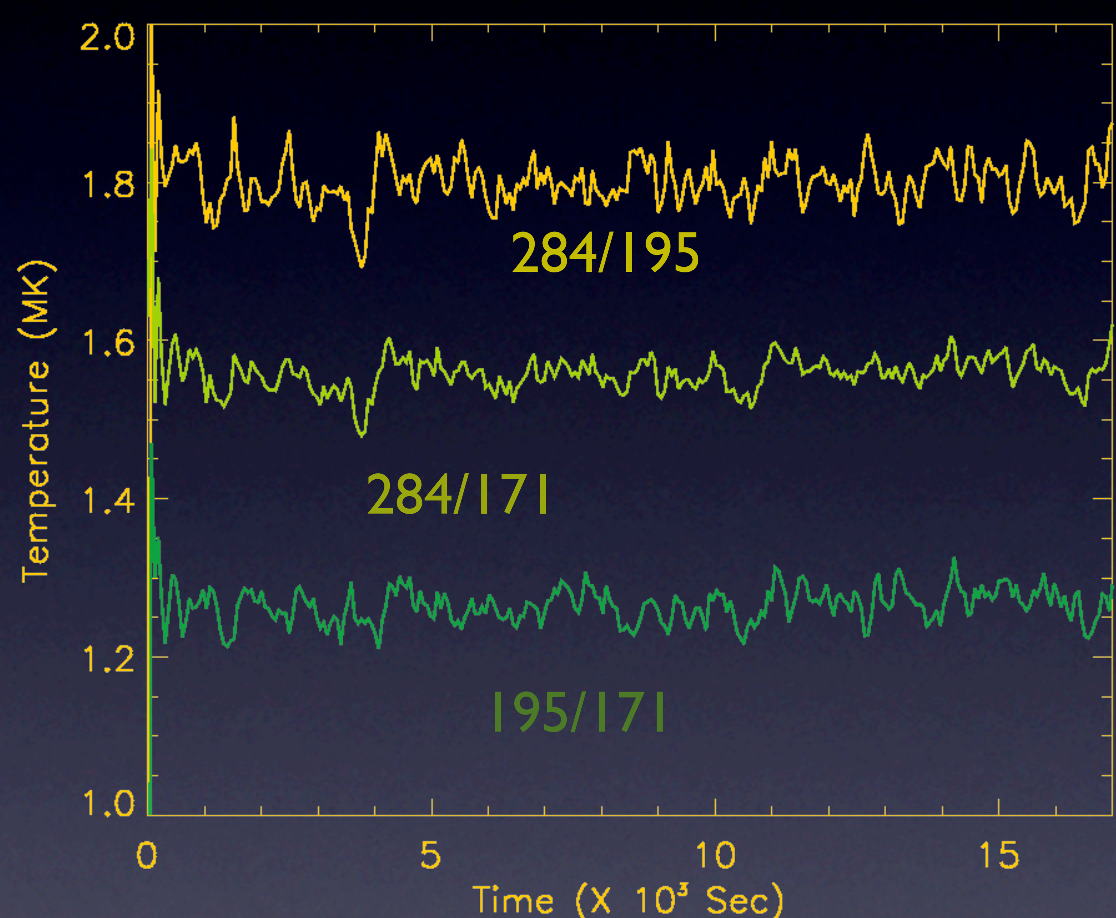
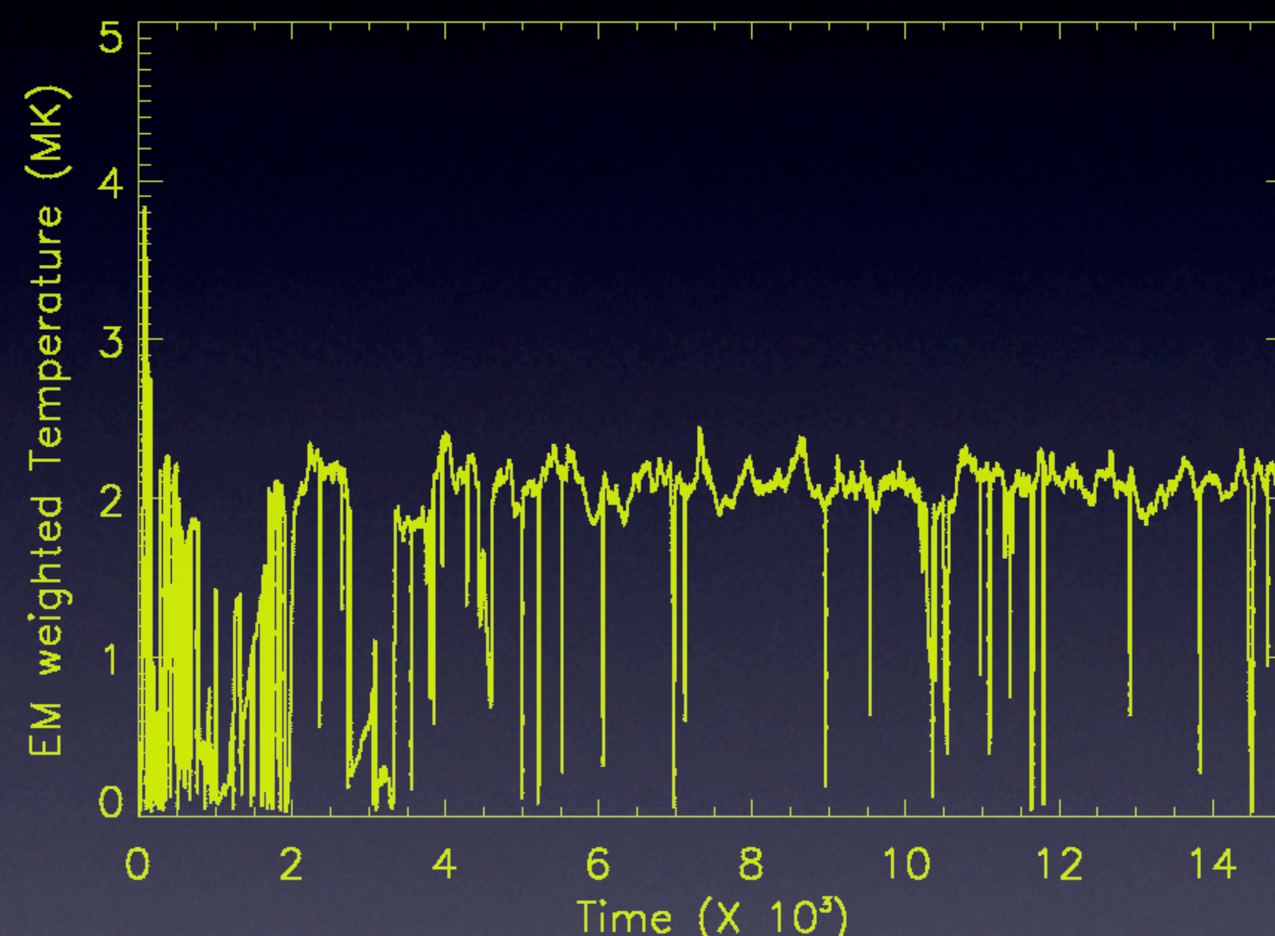
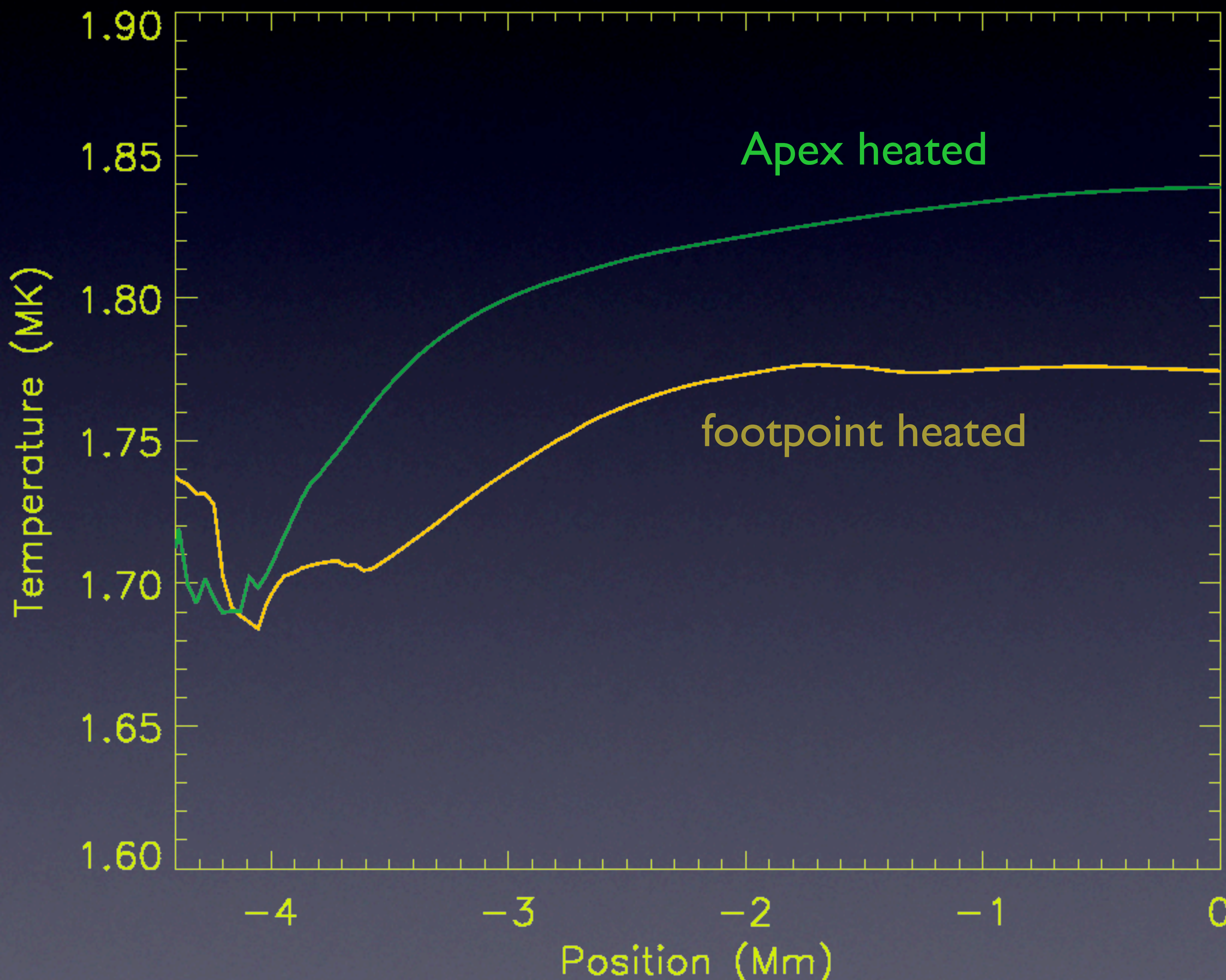




Discrepancy between T as would be measured from filter ratio method and actual temperature

Temperature along the length



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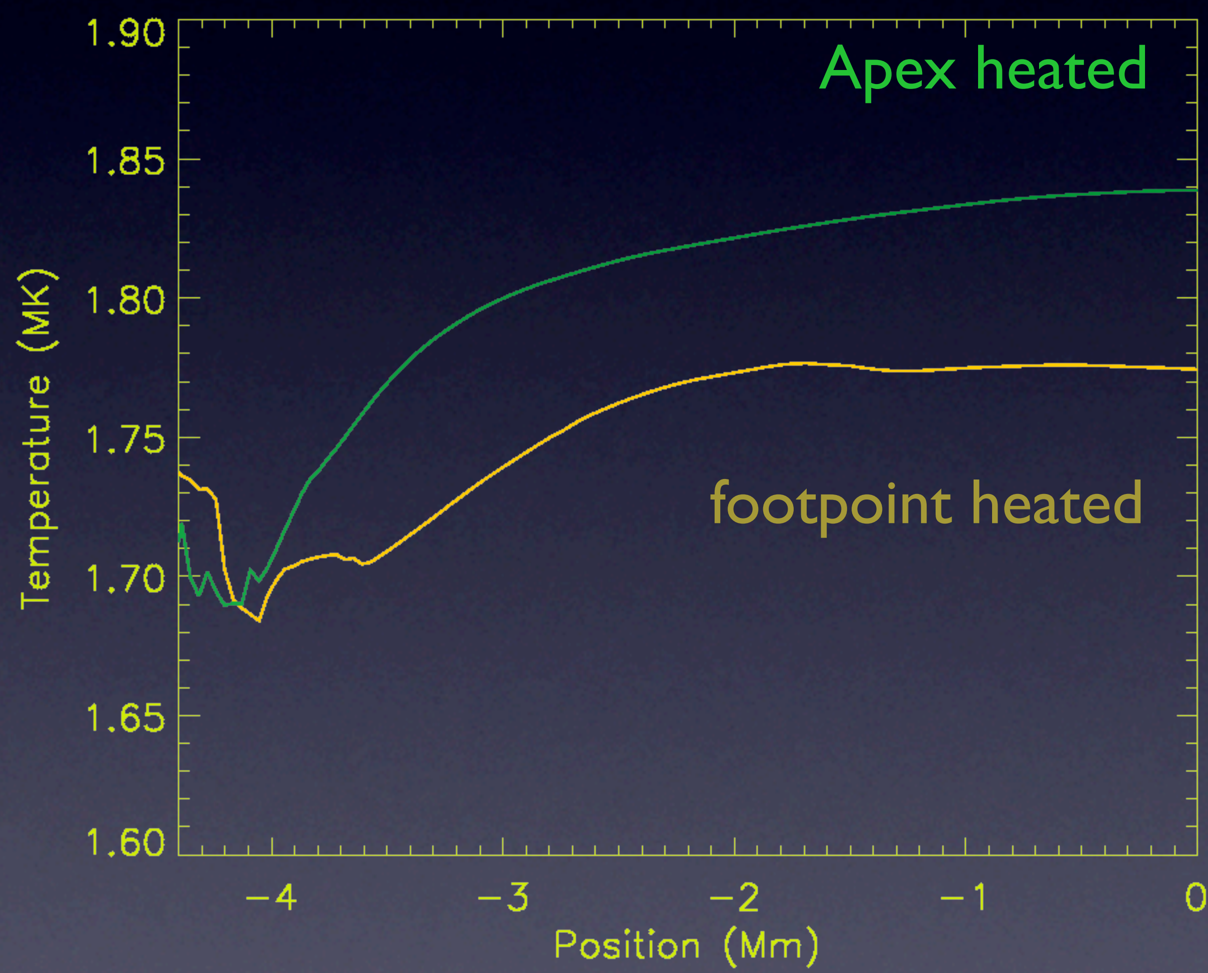

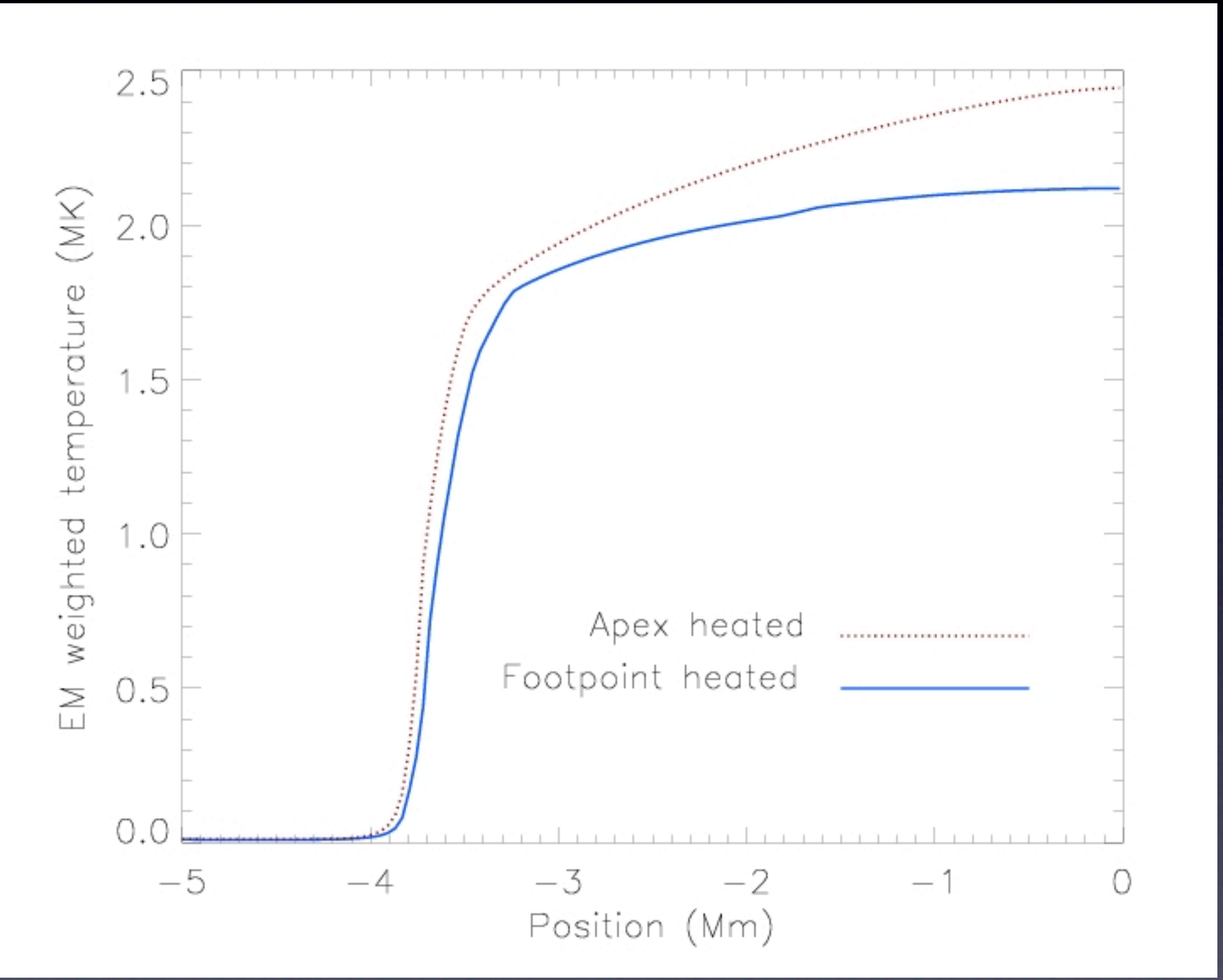

Combined Filter Ratio (CFR)

$$CFR_\lambda(T)$$

Reale et al. 07

Combined Filter Ratio (CFR)

$$CFR_\lambda(T) = \frac{(\prod_{\lambda=1}^{n} I_\lambda)^{1/n}}{I_\lambda}$$

Reale et al. 07

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Reale et al. 07

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Combined Improved Filter Ratio (CIFR)

Reale et al. 07

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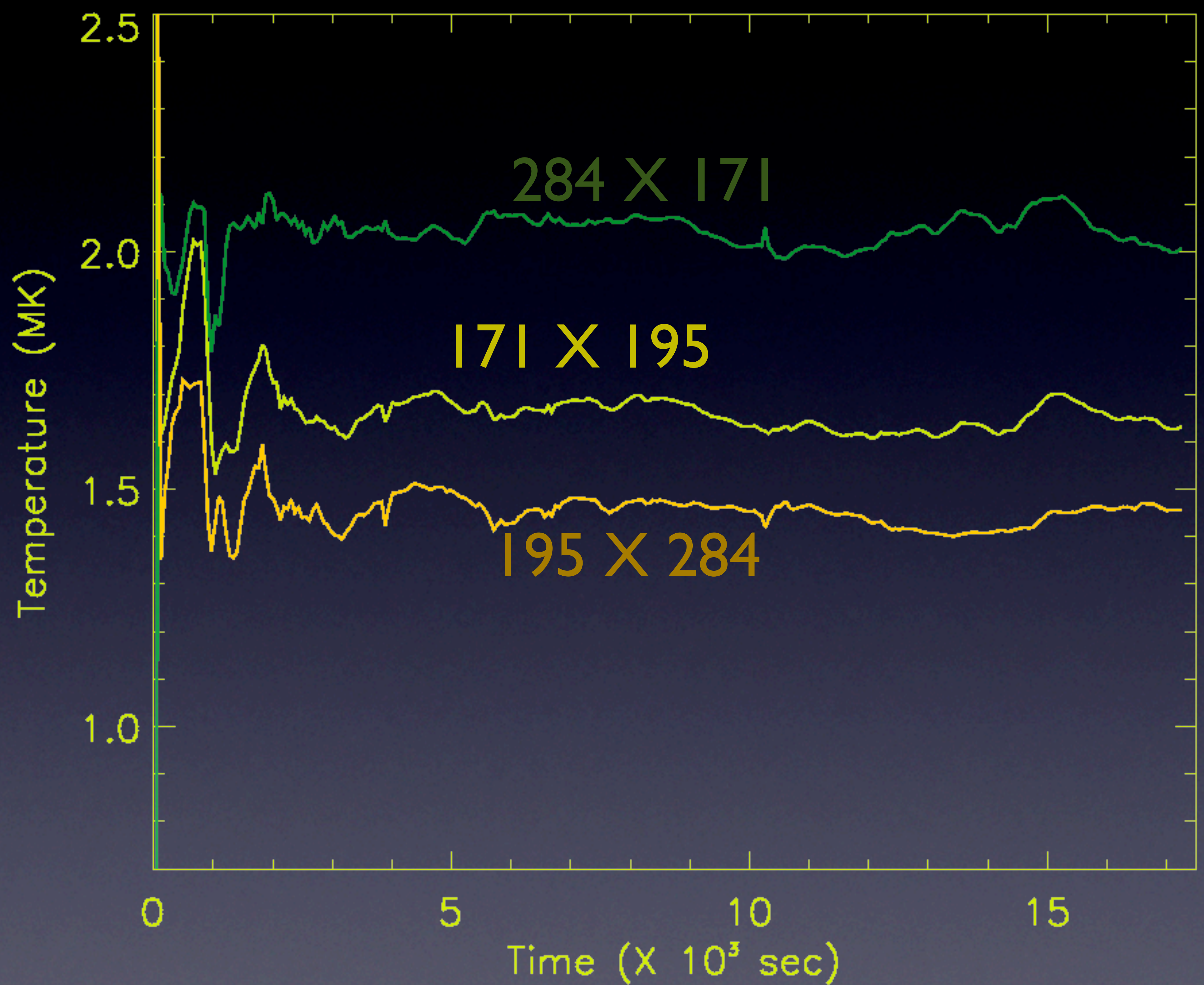
Combined Improved Filter Ratio (CIFR)

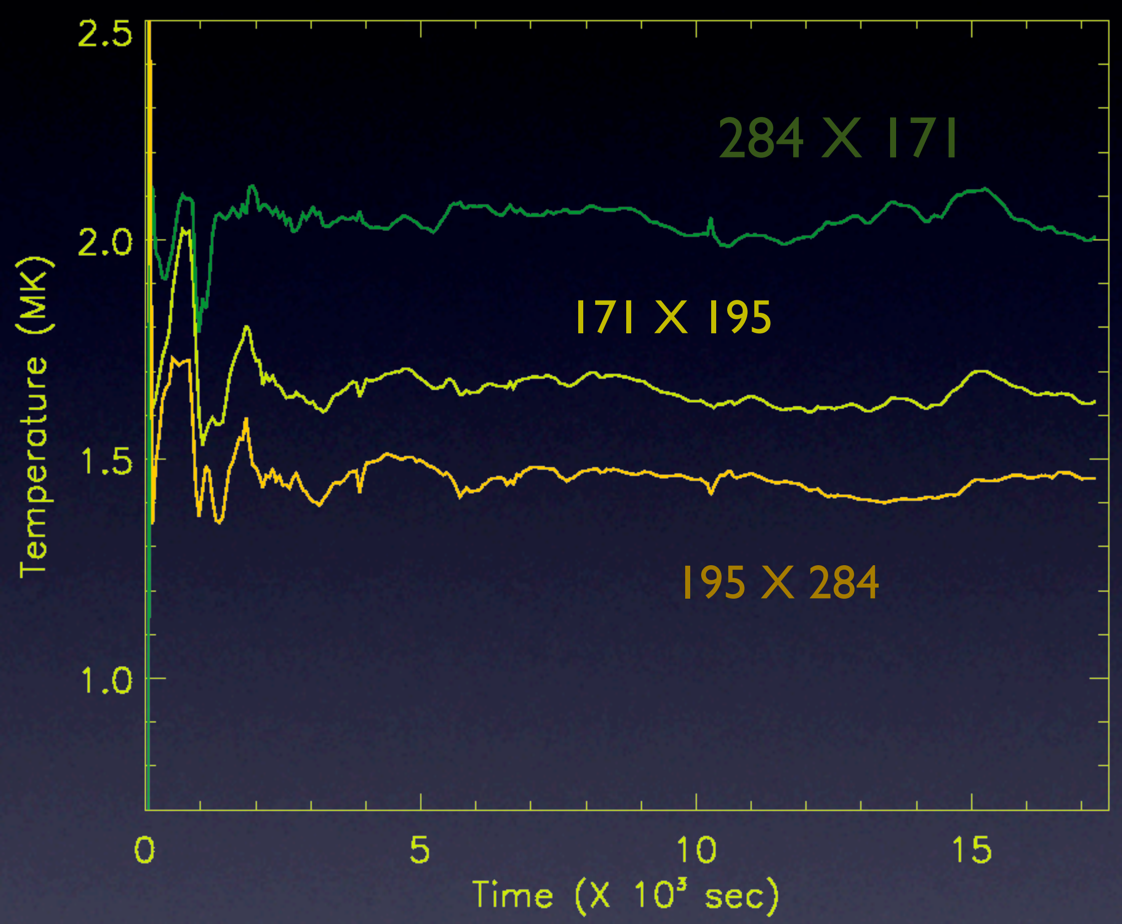
$$CIFR_{\lambda_1,\lambda_2} = CFR_{\lambda_1} \times CFR_{\lambda_2}$$

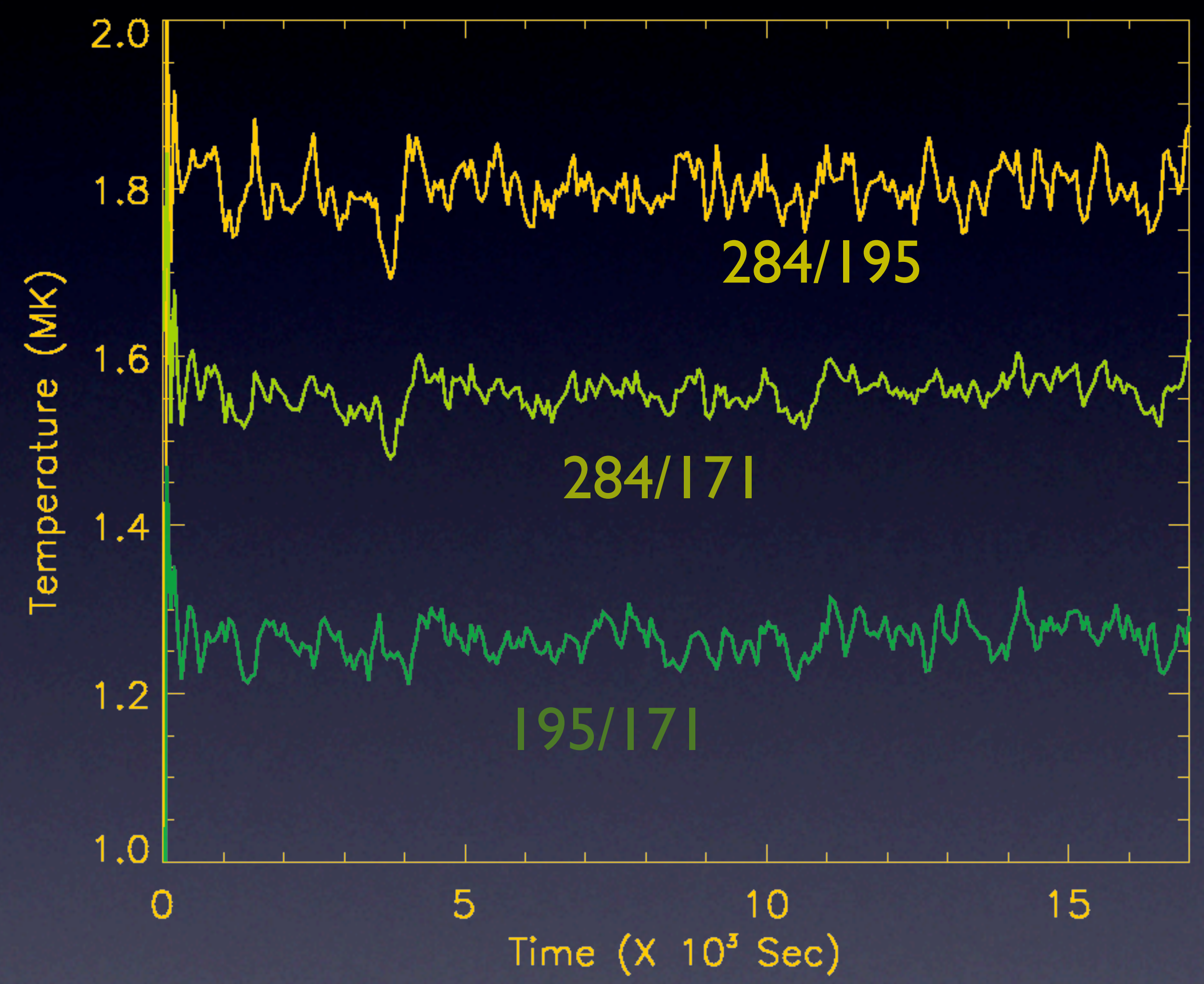
Reale et al. 07

CIFR at the apex location



CIFR at the apex location





Combined Improved Filter Ratio (CIFR)

$$I_\lambda \sim \int G_\lambda(T) DEM(T) dT$$

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$$DEM(T) = DEM_{flat}$$

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$$I_\lambda \sim \int G_\lambda(T)\,DEM(T)\,dT = DEM_{flat}\int G_\lambda(T)\,dT$$

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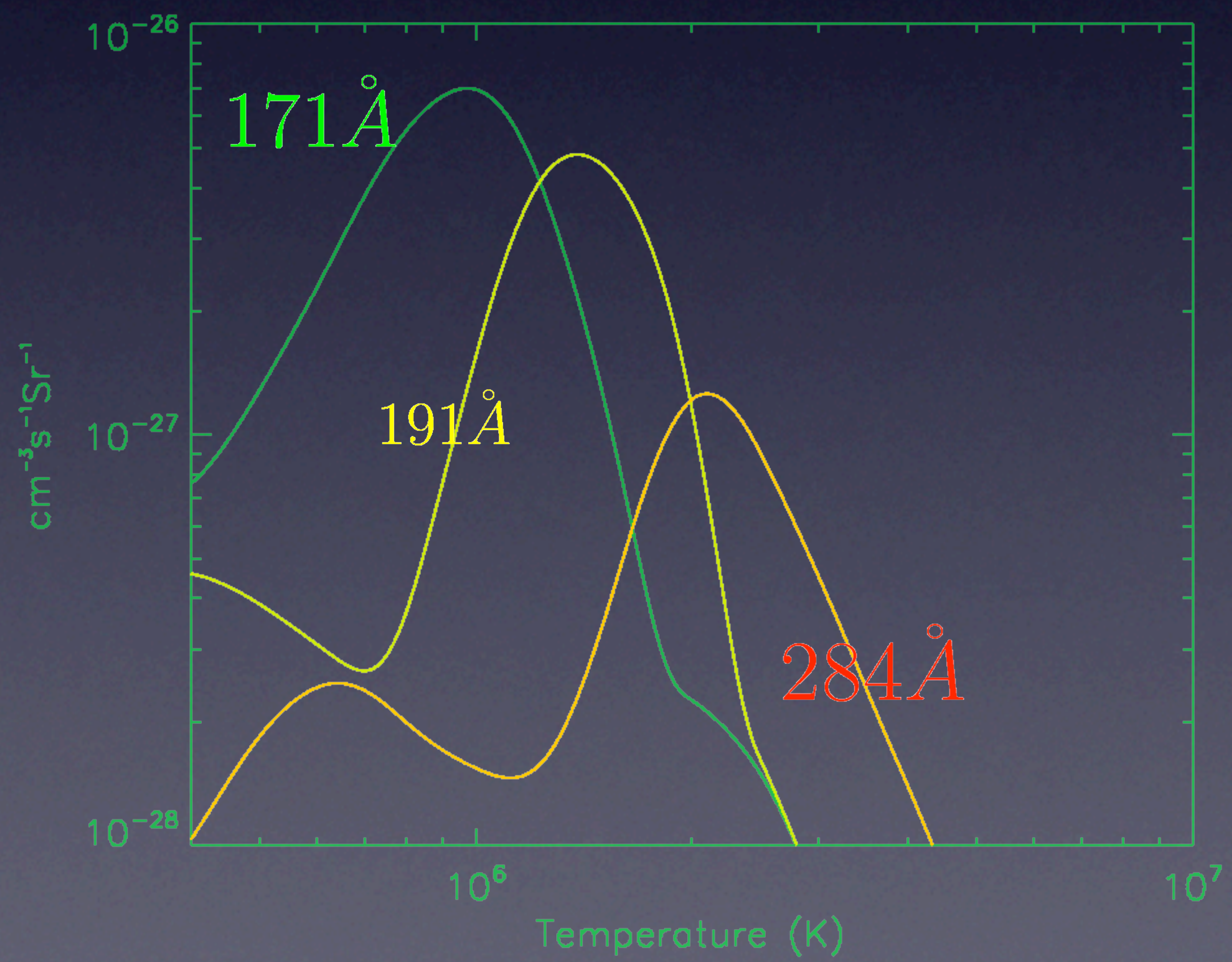

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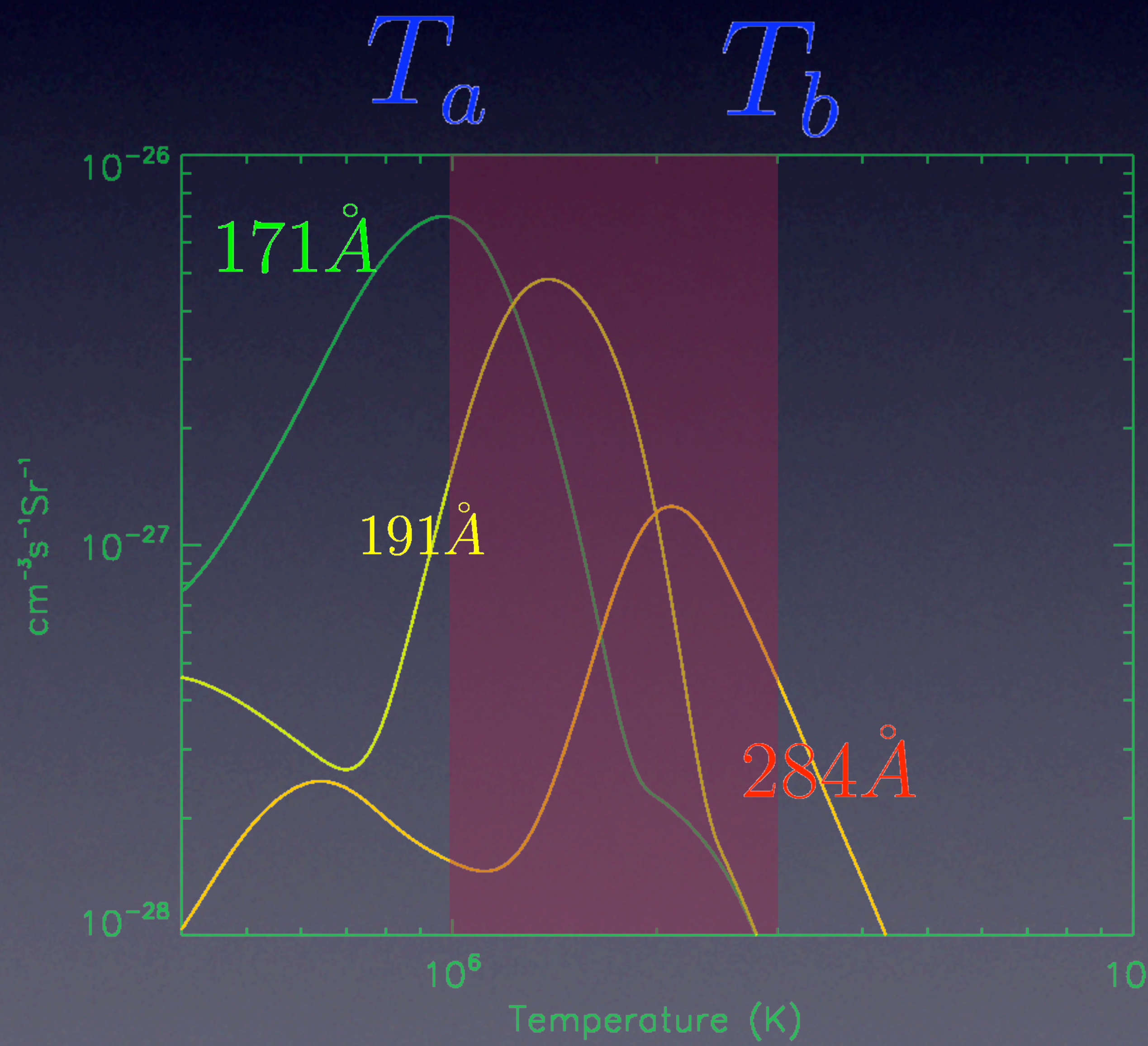

$$CIFR_{\lambda_1,\lambda_2} = \frac{(I_{\lambda_1} \times I_{\lambda_2} \times I_{\lambda_3})^{1/3}}{I_{\lambda_1}} \times \frac{(I_{\lambda_1} \times I_{\lambda_2} \times I_{\lambda_3})^{1/3}}{I_{\lambda_2}}$$

CIFR is also biased towards isothermality

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CIFR is also biased towards isothermality

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$$= \frac{(\int_{T_a}^{T_b} G_{\lambda_1} dT \times \int_{T_a}^{T_b} G_{\lambda_2} dT \times \int_{T_a}^{T_b} G_{\lambda_3} dT)^{2/3}}{\int_{T_a}^{T_b} G_{\lambda_1} dT \times \int_{T_a}^{T_b} G_{\lambda_2} dT}$$

CIFR is also biased towards isothermality

Summary

- Imaging instruments are unable to give the proper temperature (conclusion derived from the single and combined filter ratio techniques)
- Temperatures derived from the imaging instruments are isothermally biased
- Regardless of actual temperature single and combined filter ratio techniques return a constant instrumental value depending on the passbands used