Imaging the Solar Corona during the 2015 March 20 Eclipse using LOFAR

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[2]Astrotec Holding B.V., The Netherlands.
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[8]Observatoire de Paris, France.
[9]University of Glasgow, UK.

Cover Image: PROBA2/SWAP 174 Å

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Coláiste na Tríonóide, Baile Átha Cliath
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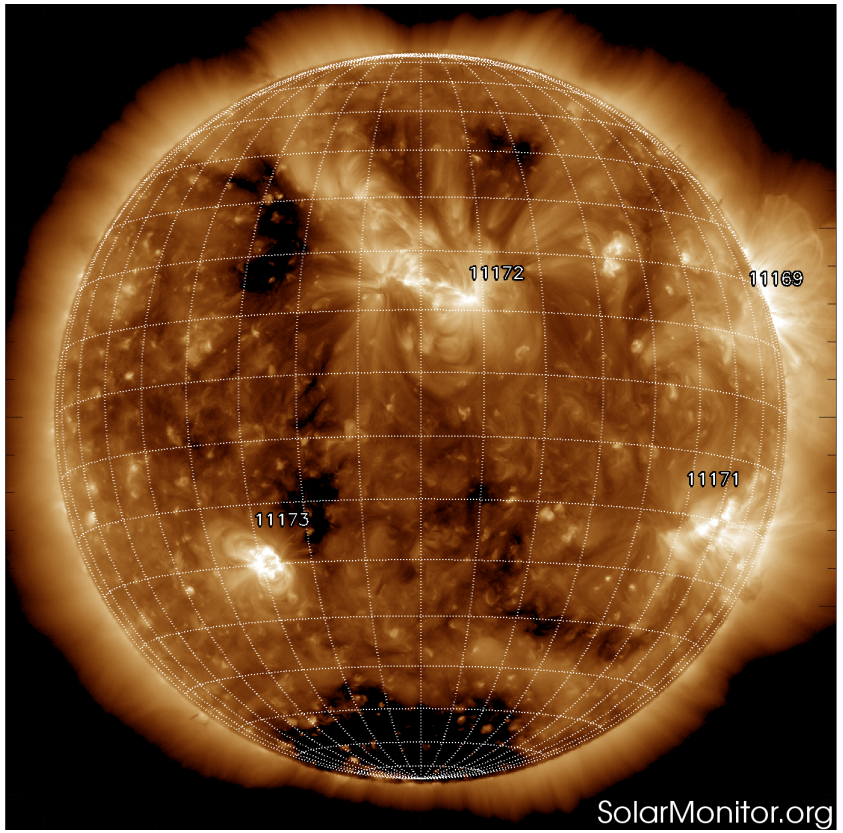
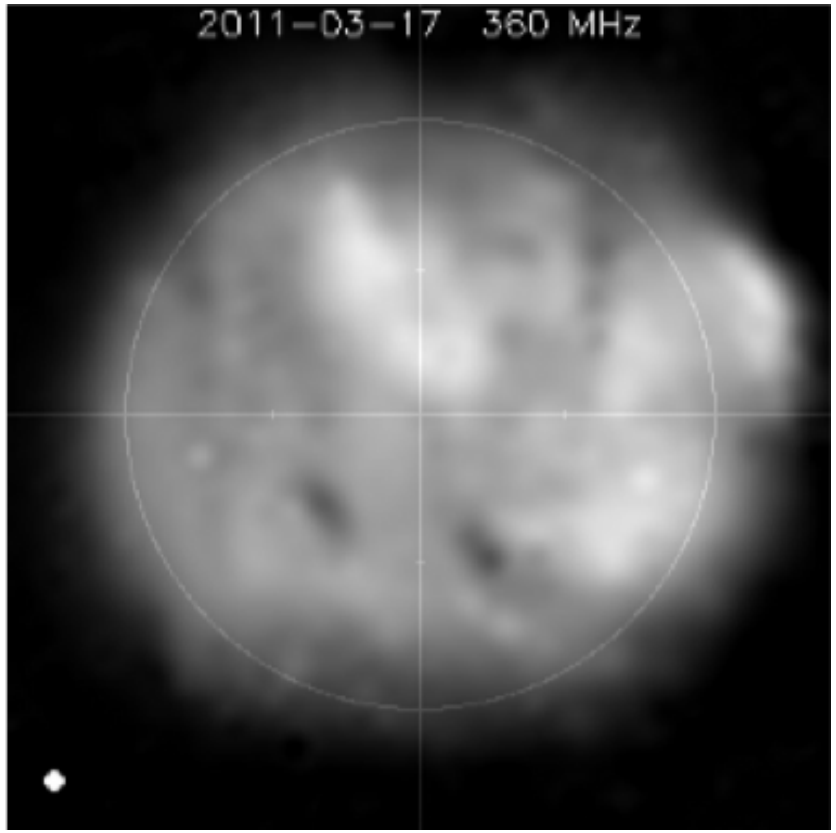
ASTROTEC HOLDING

Imaging Sun at Radio Frequencies

193 Å



360 MHz



150 MHz

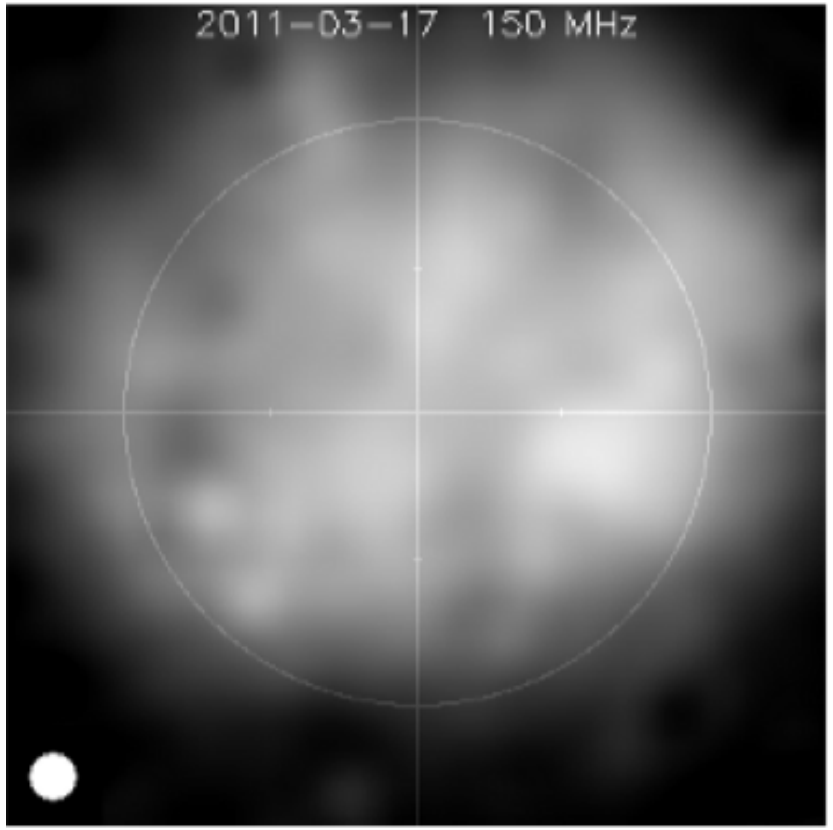


Image Credit: Mercier & Chambe, 2009

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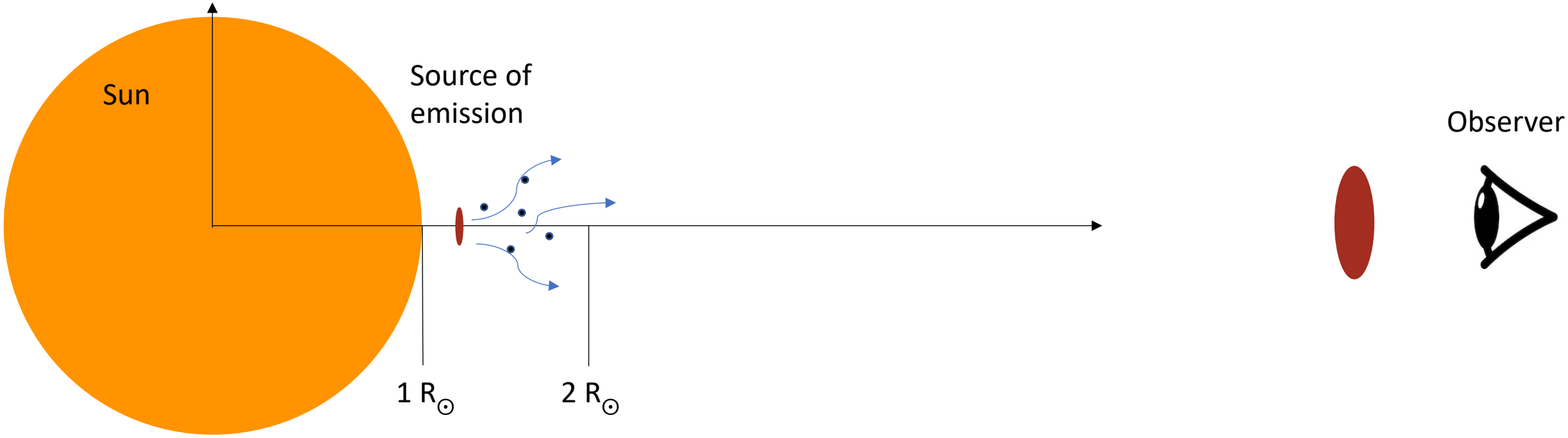
Science Question

How does turbulence in the corona affect observed source size?



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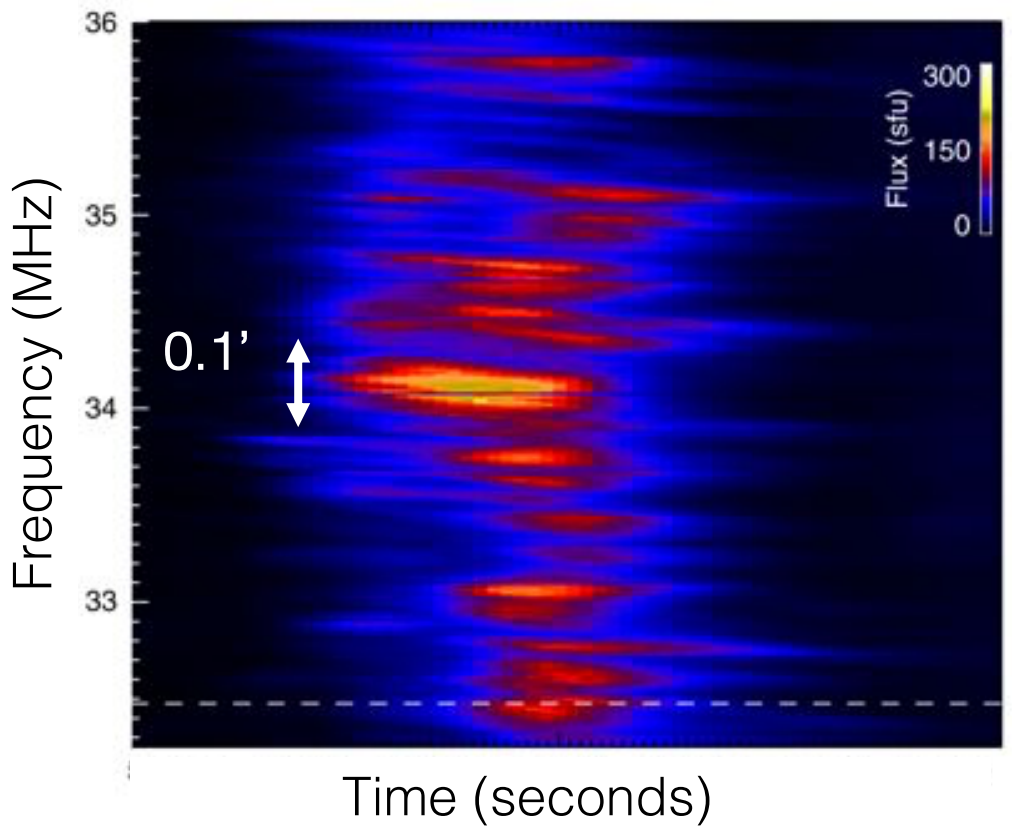
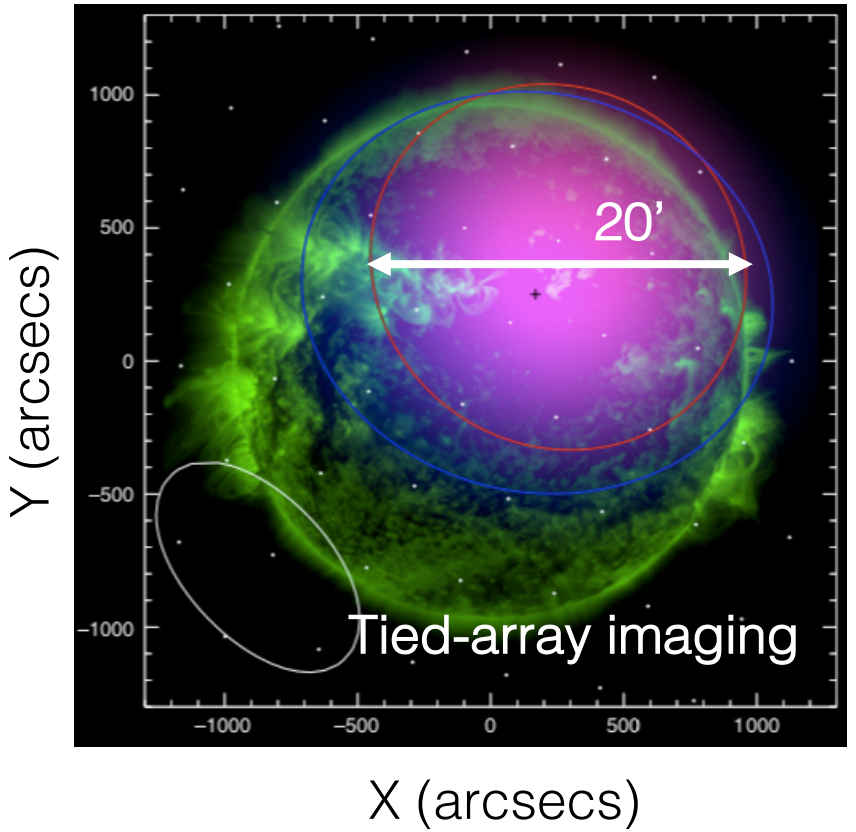
Theory

Limitation on observed source size due to scattering





Kontar et al., 2017

Aim

Novel technique to probe coronal source sizes

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Aim

Novel technique to probe coronal source size.

Partial solar eclipse observed by LOFAR

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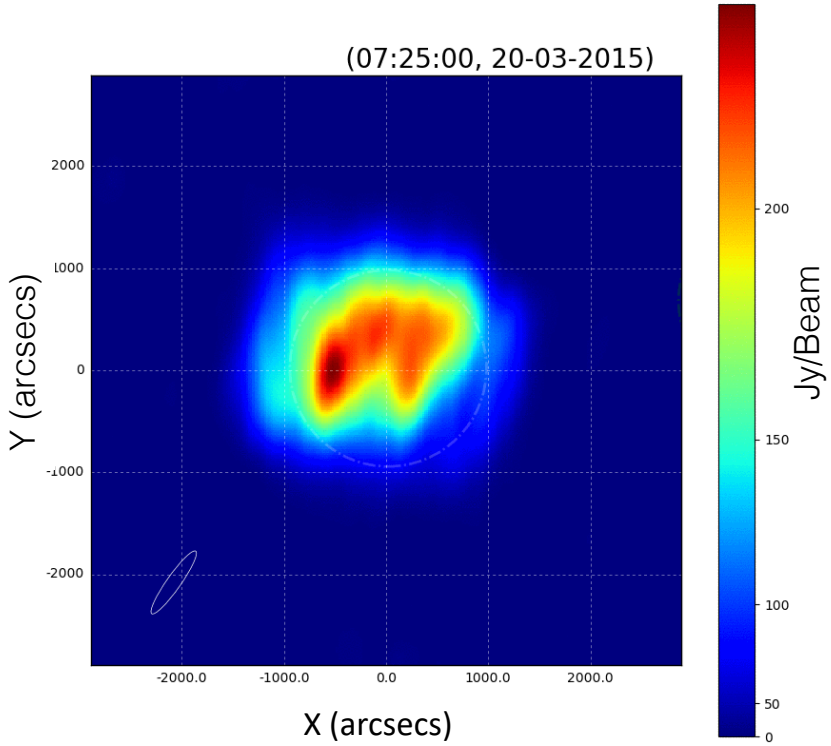
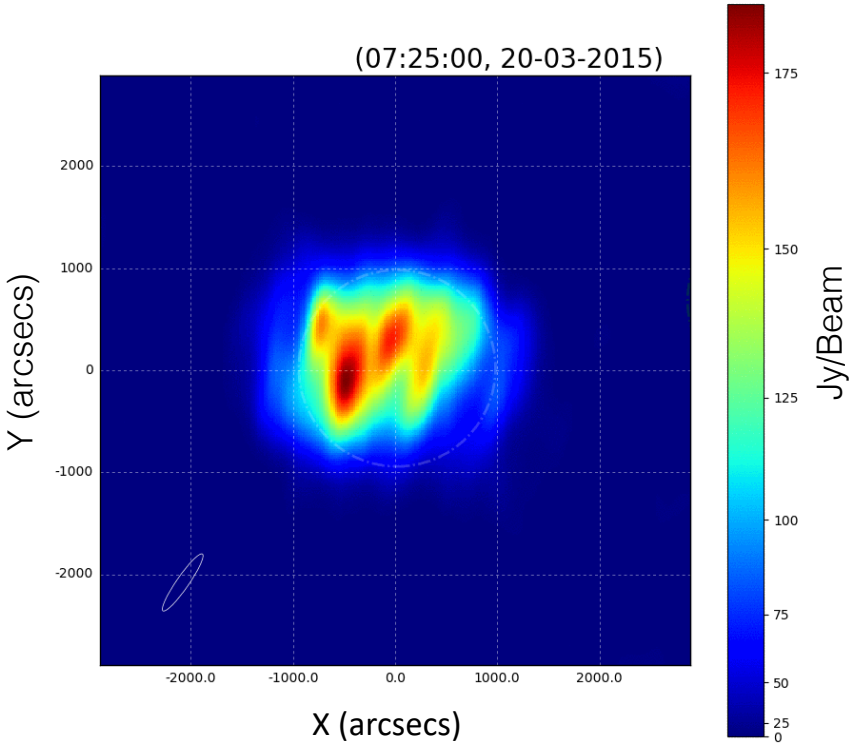
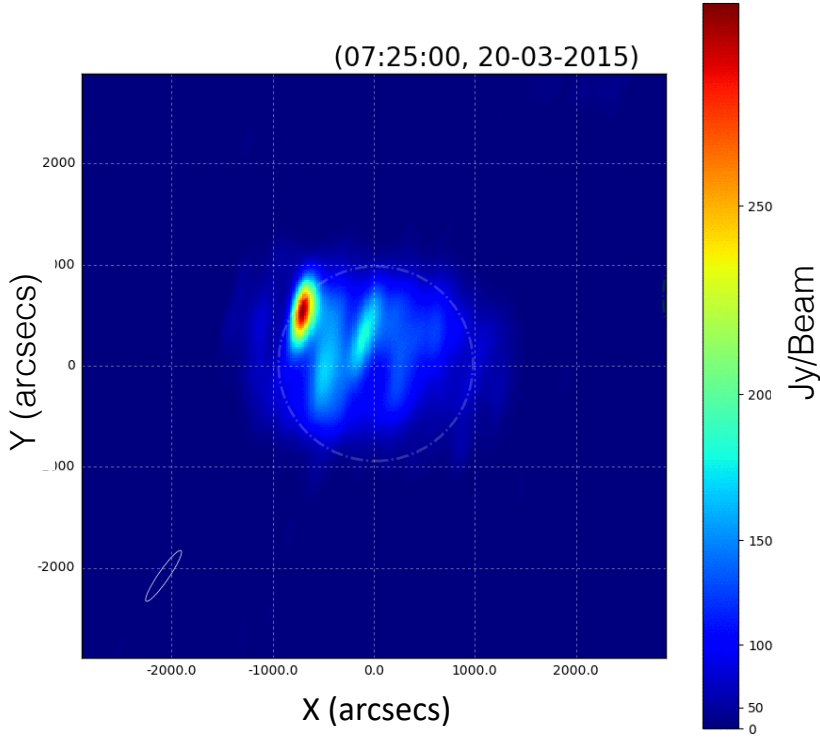


120 – 140 MHz



140 – 160 MHz



160 – 180 MHz

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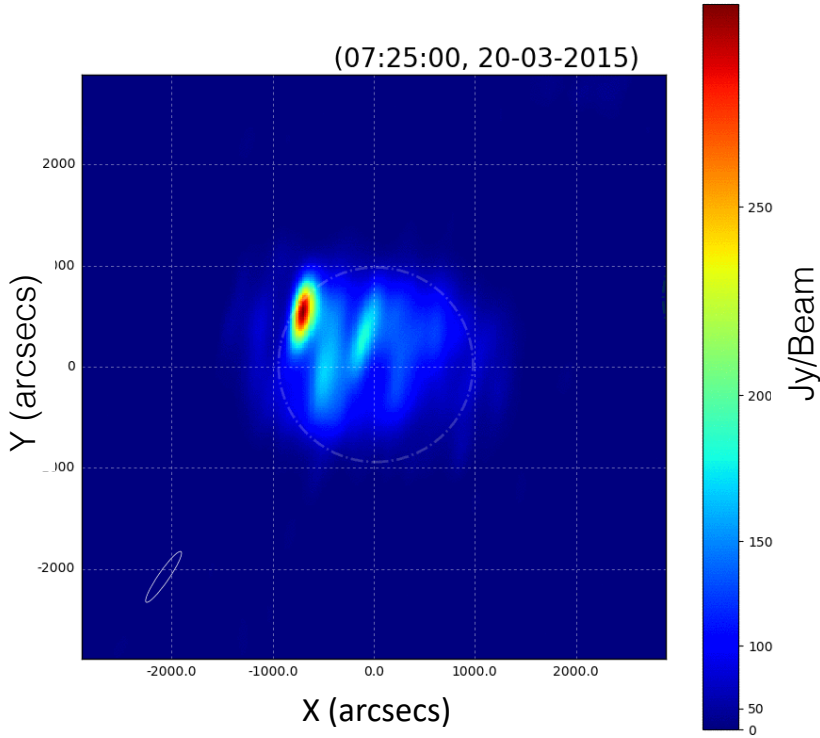
Partial solar eclipse observed by LOFAR

- 20-03-2015, 07:20 – 12: 00 UT
- Interferometric Imaging
- Max baseline ~3.5 km (beam size ~ arcminutes)
- HBA observation (120 MHz – 180 MHz)
- Source sizes ~5 – 10’



160 – 180 MHz

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Partial solar eclipse observed by LOFAR

Lunar De-occultation Technique

- Not limited by PSF
- Better spatial resolution

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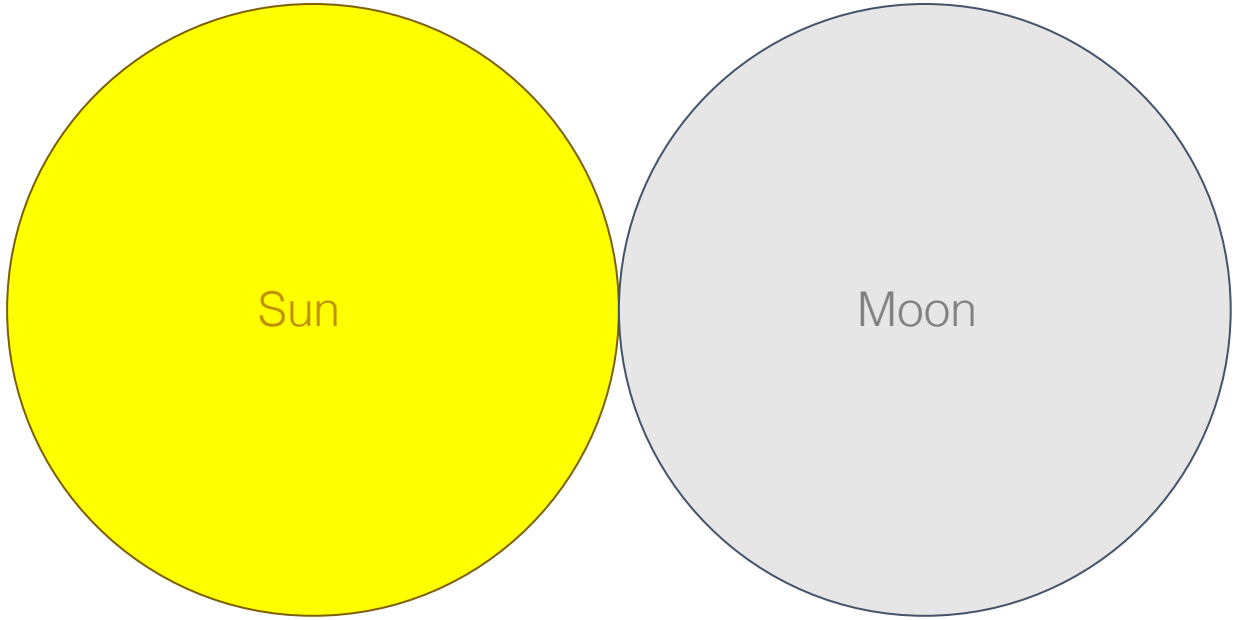
Lunar De-occultation Technique



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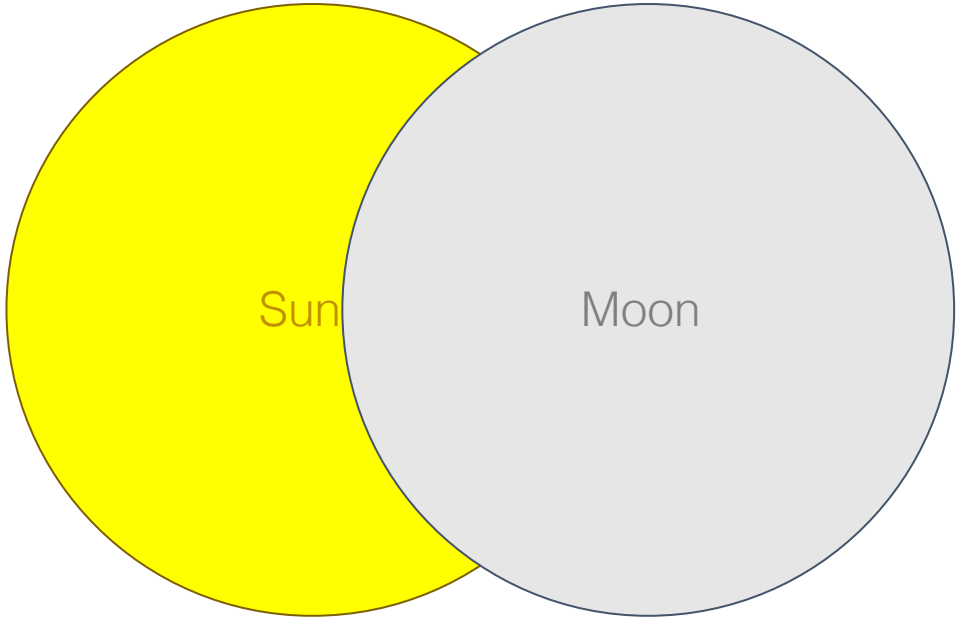

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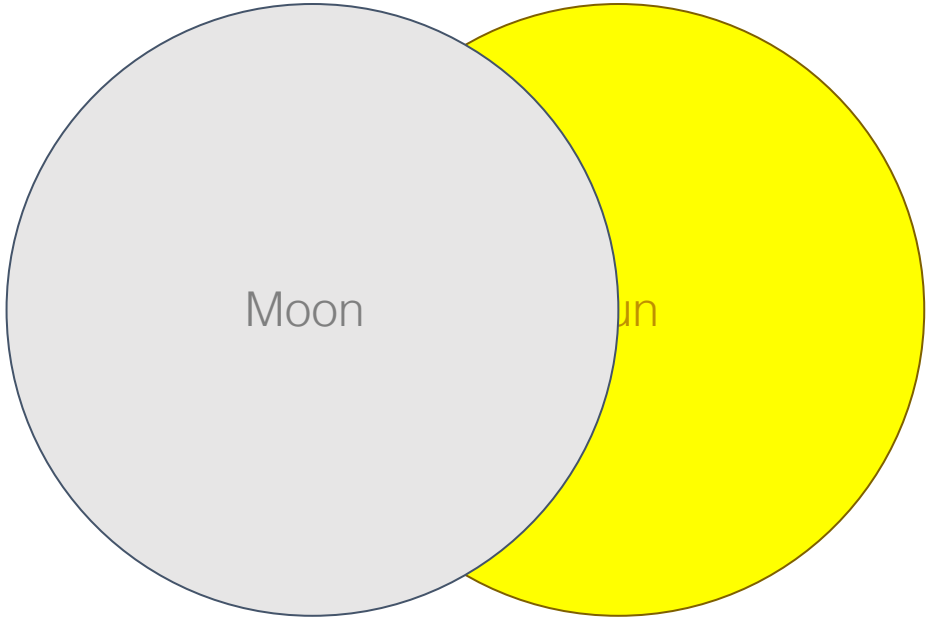

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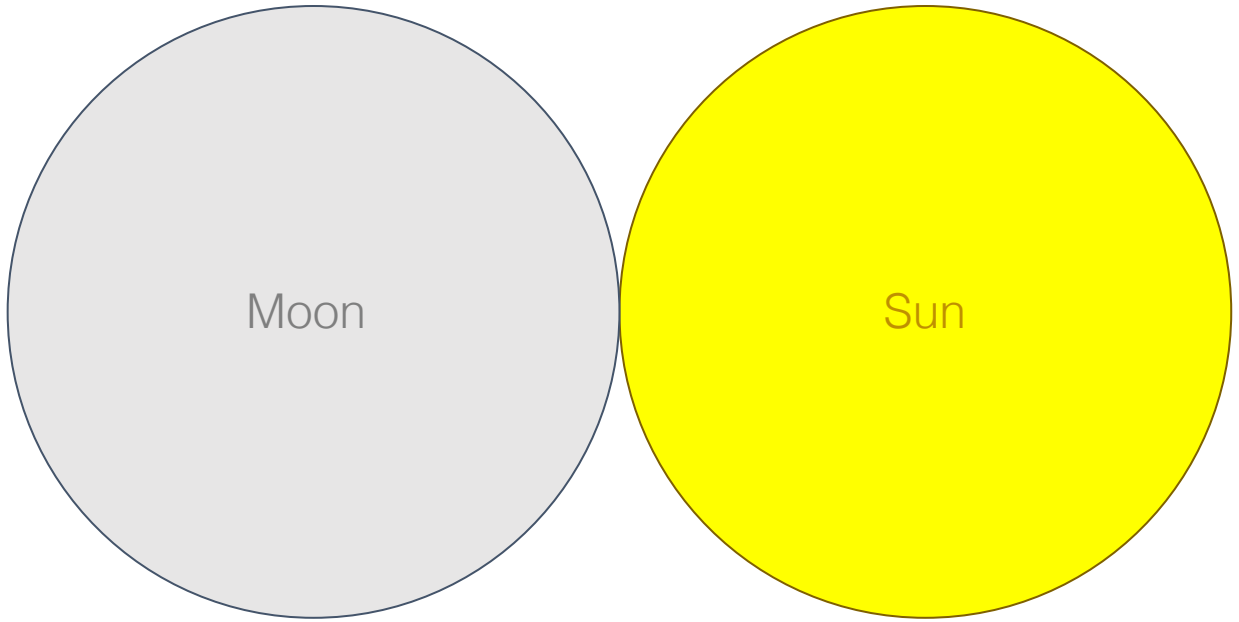

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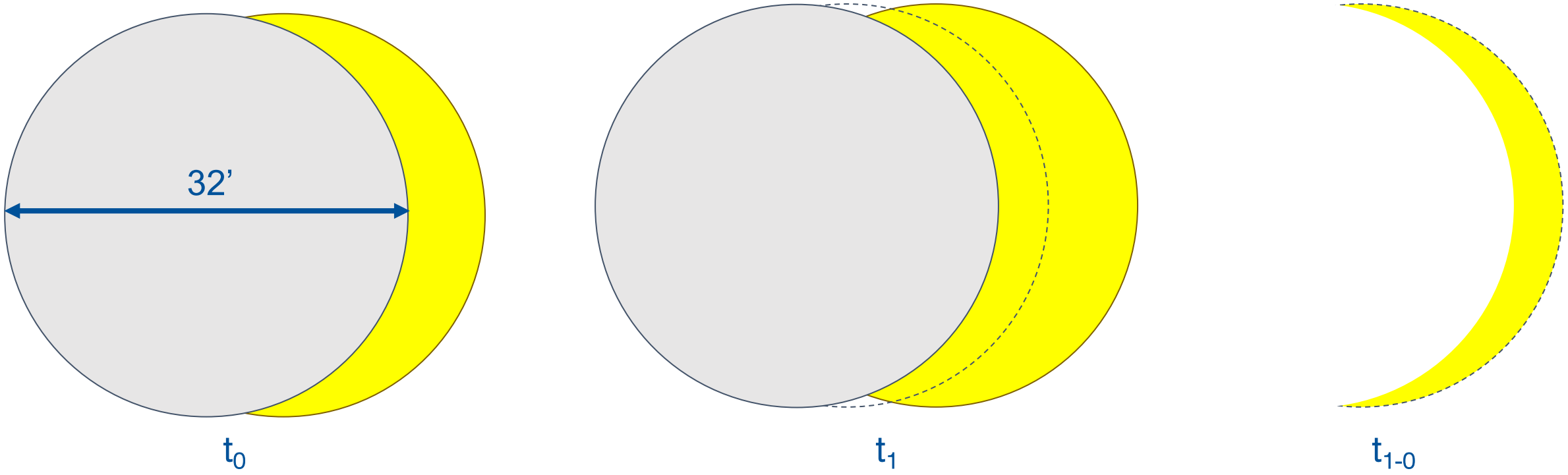

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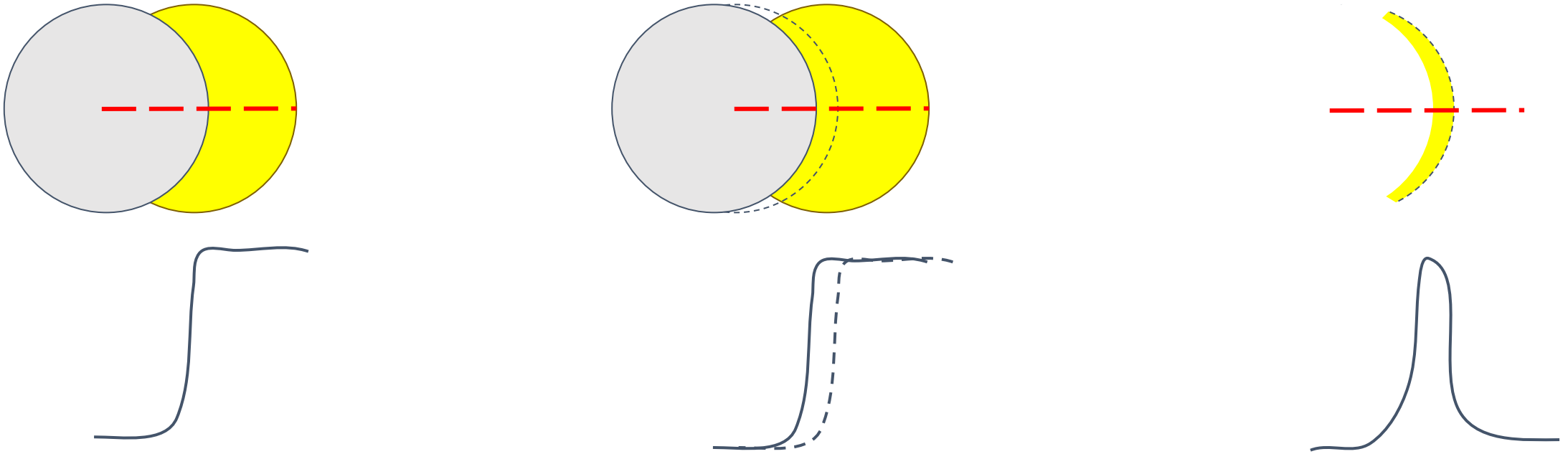

t_0 t_1 t_{1-0}

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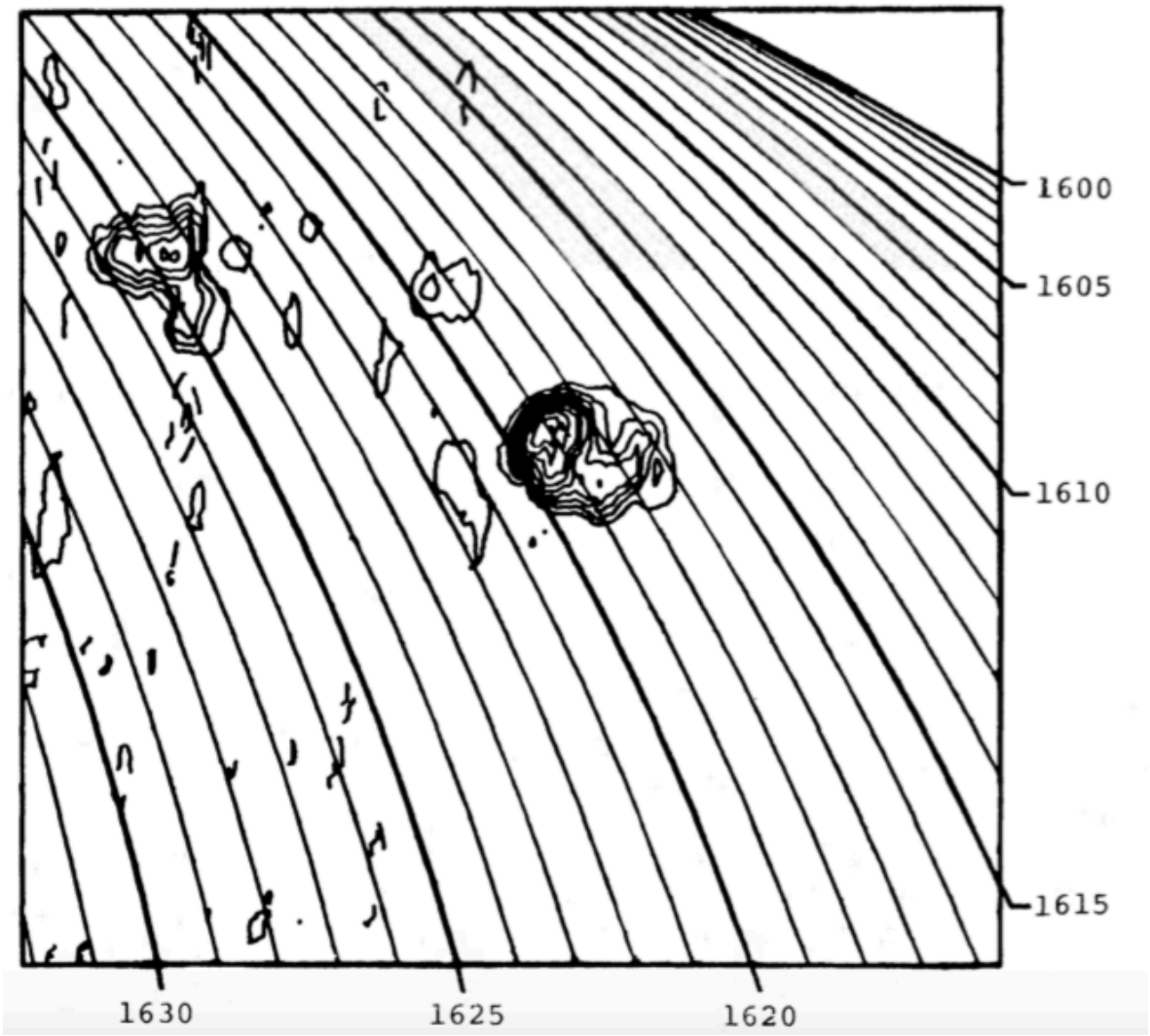
Previous Work

- Marsh, Hurford & Zirin, 1980.
- Gary & Hurford, 1986.



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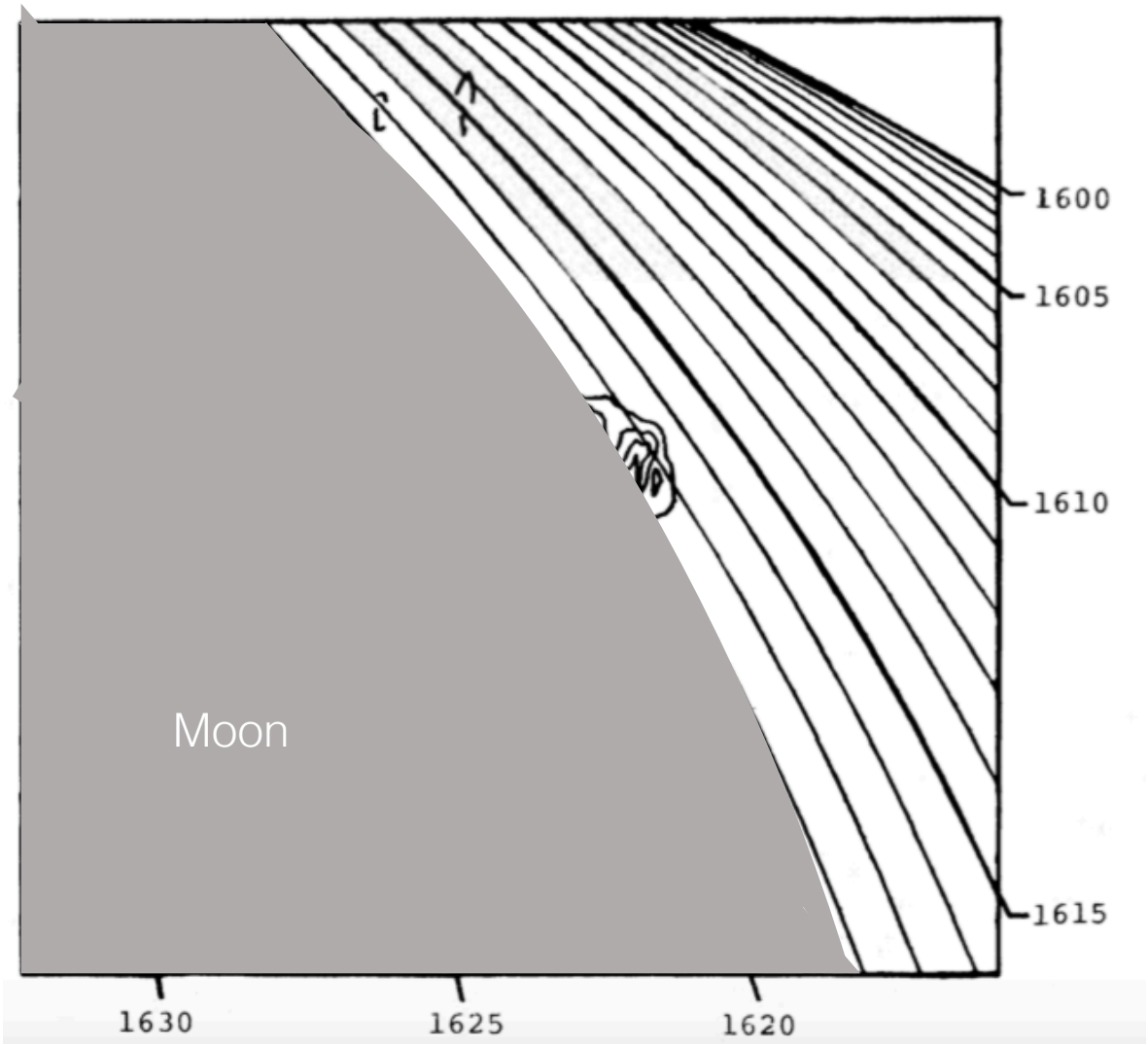

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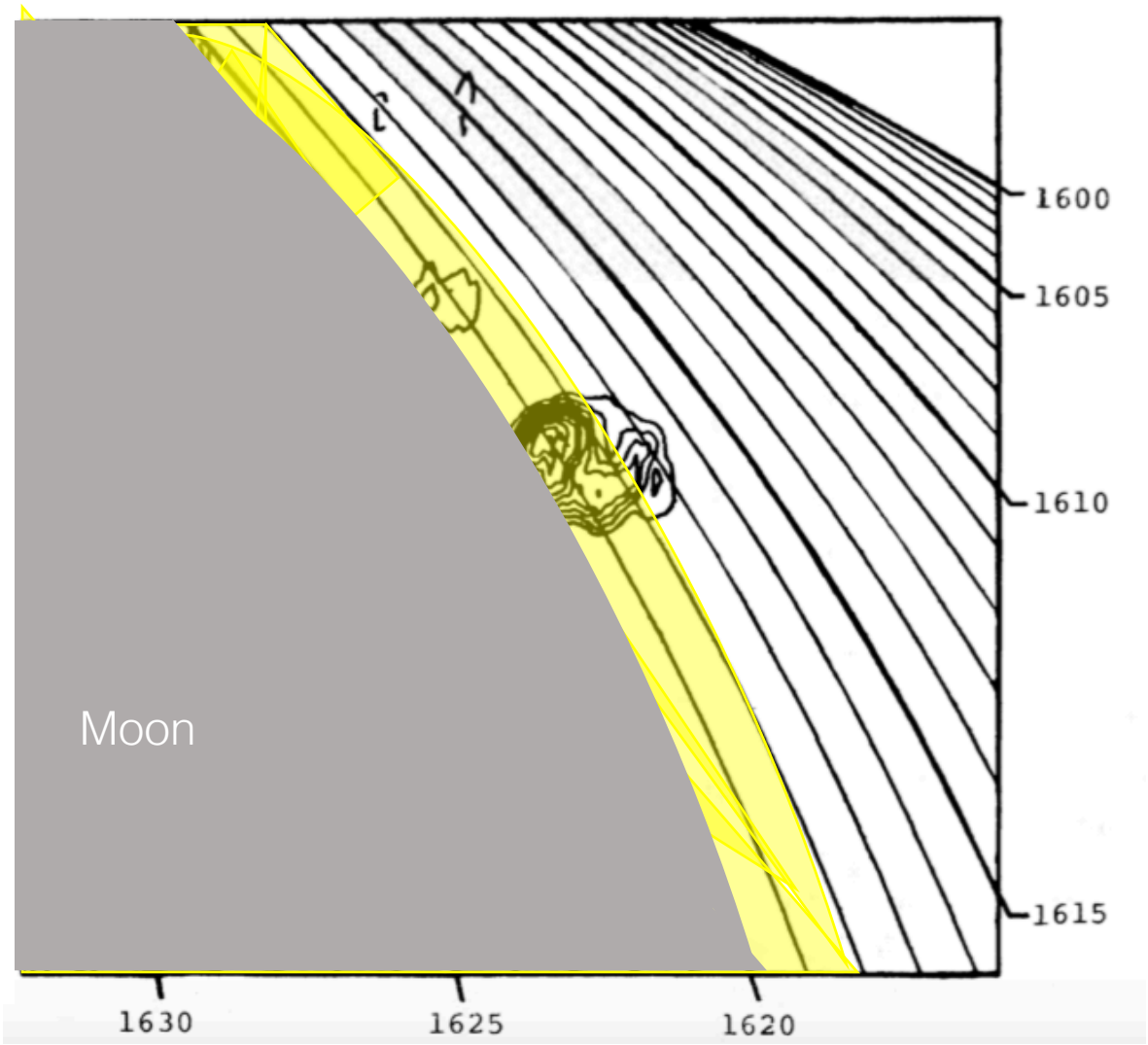

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Analysis on Simulated Data

Step 1: Simulate solar data

Step 2: Simulate moving lunar limb

Step 3: Difference consecutive intensity slices

Step 4: Find the max intensity in each interval

Step 5: Reconstruct original source sizes

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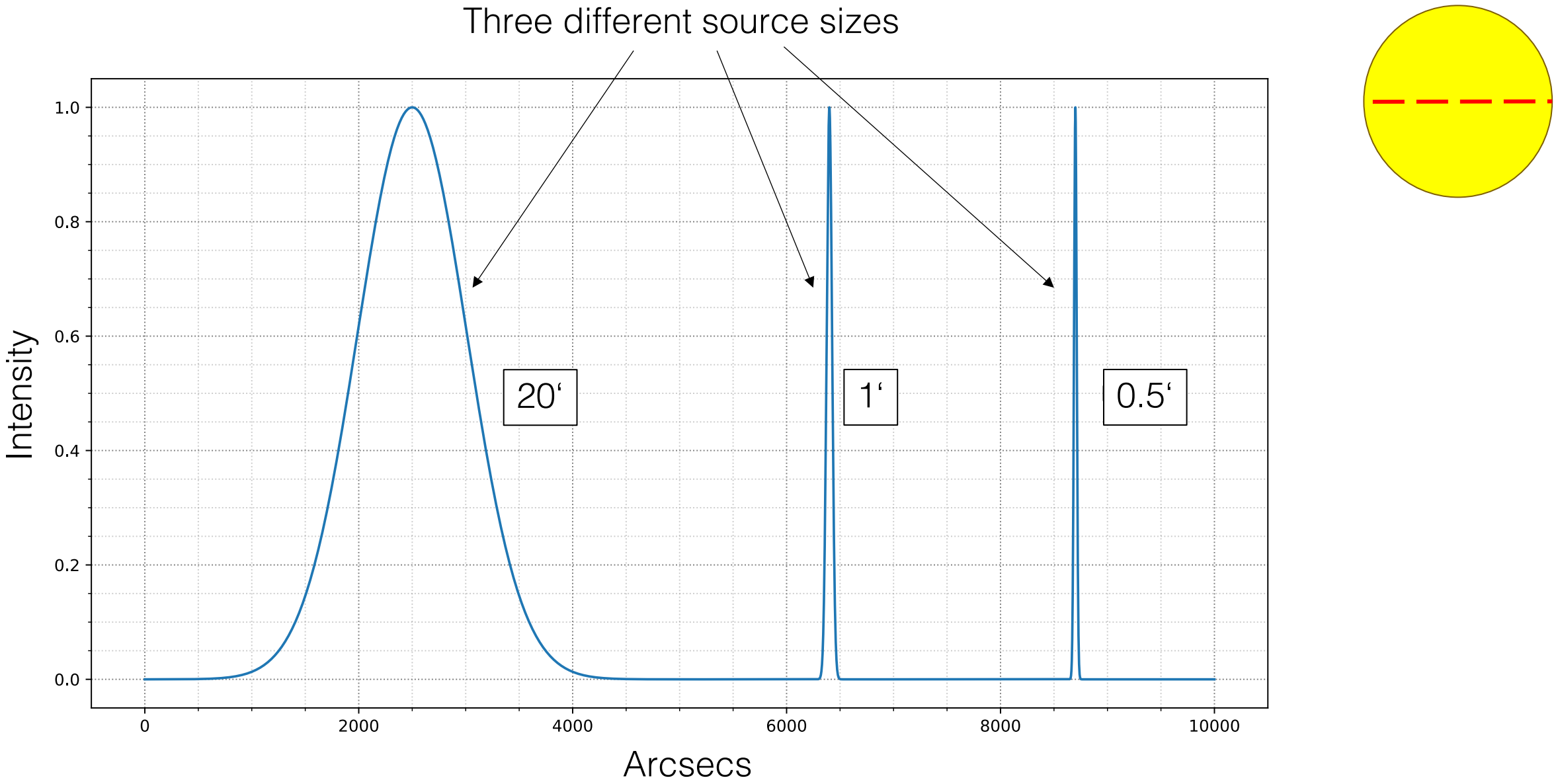

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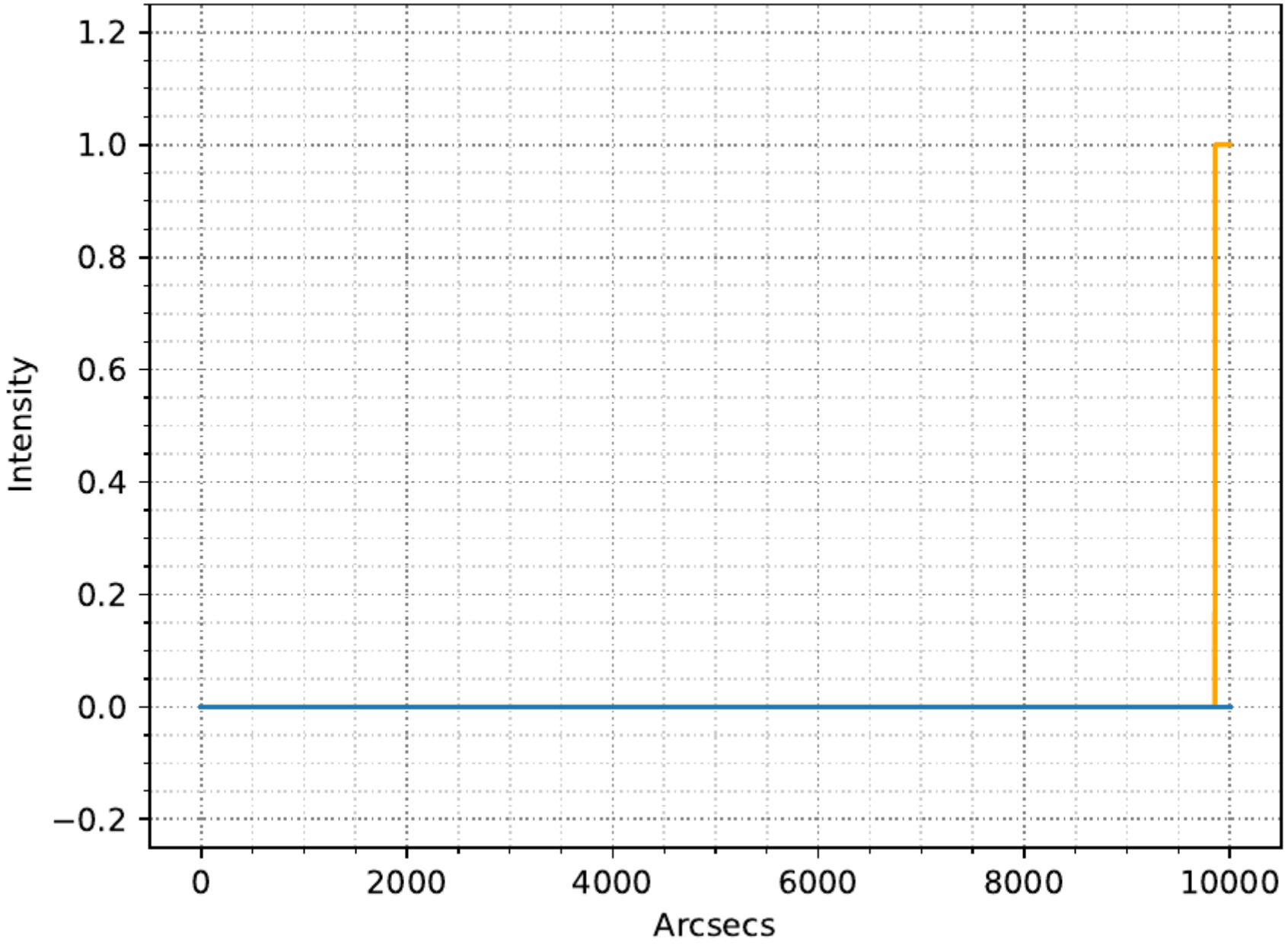

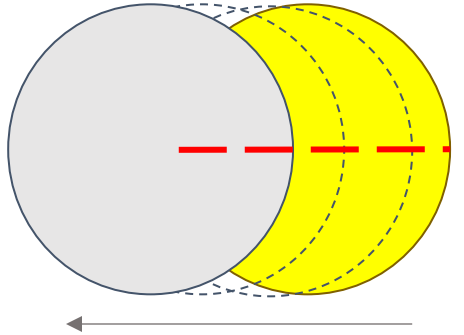

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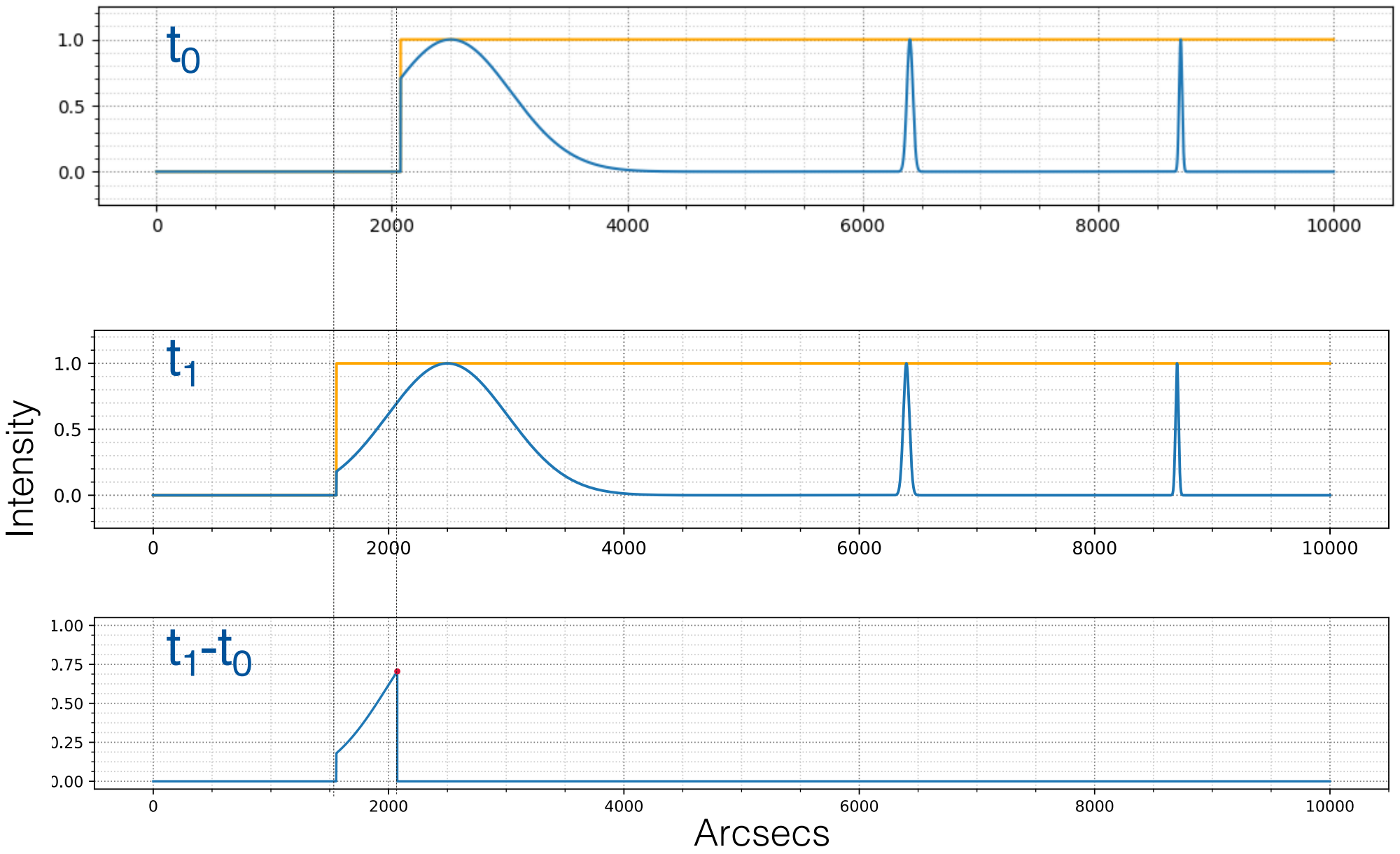

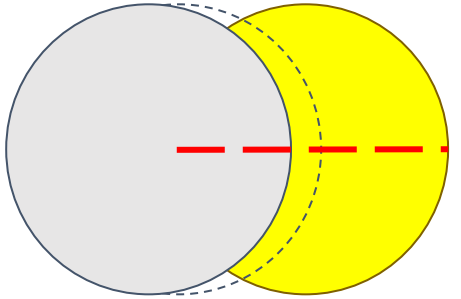

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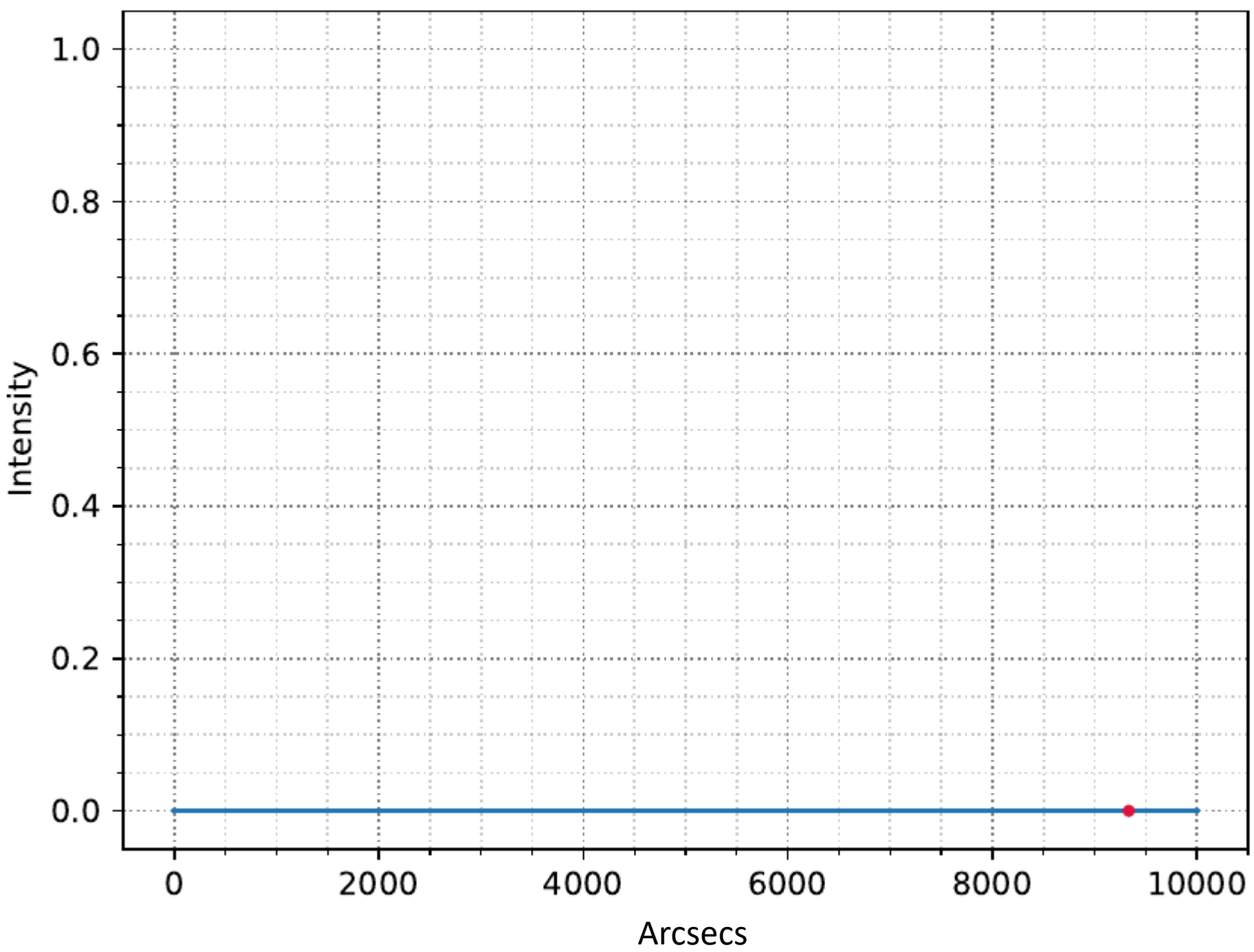

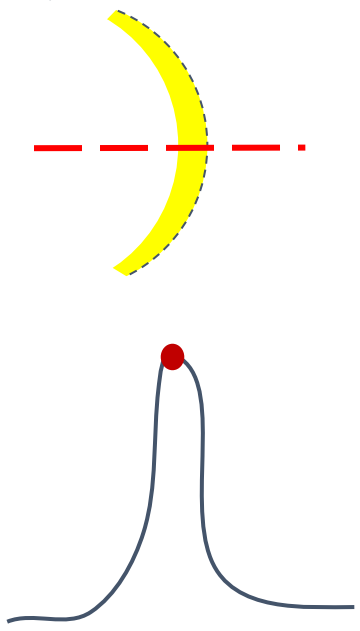

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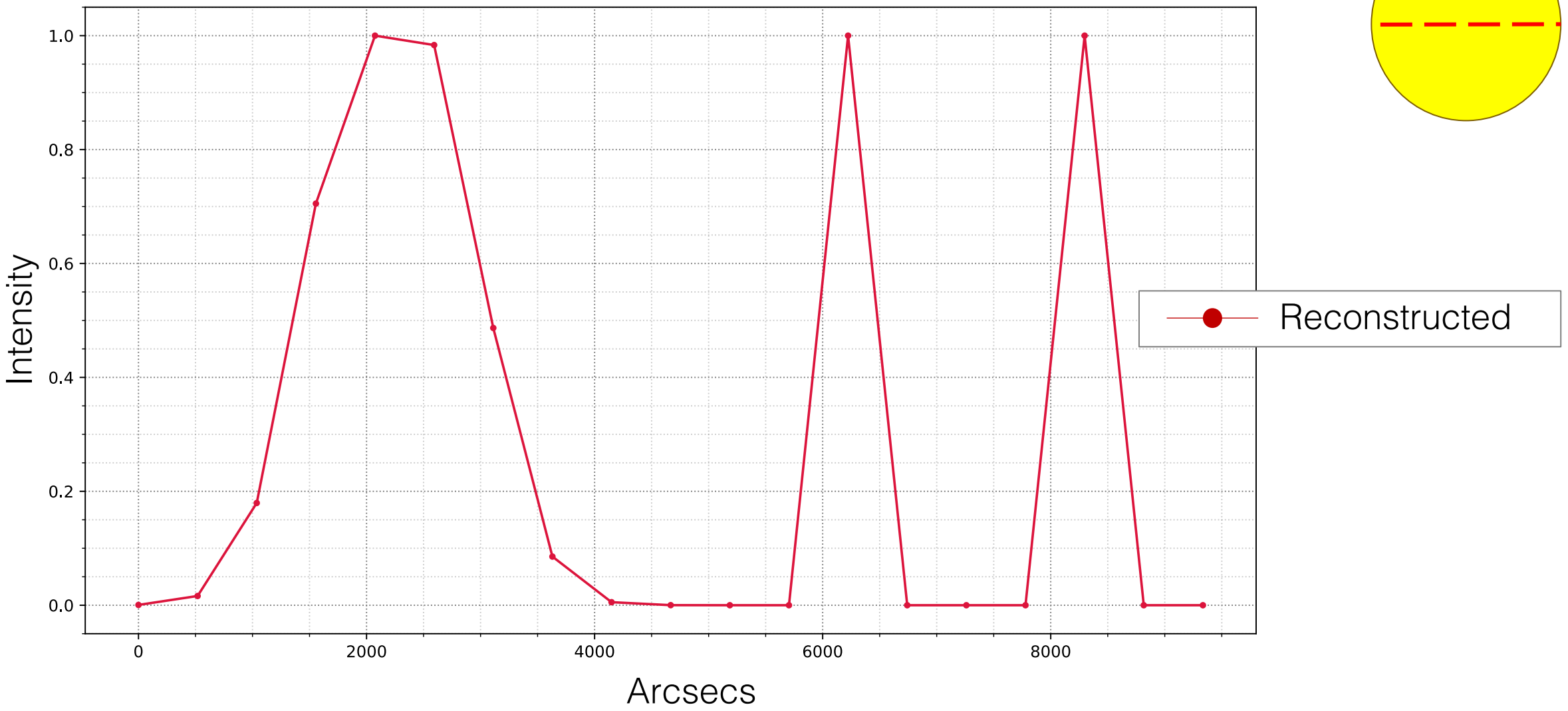

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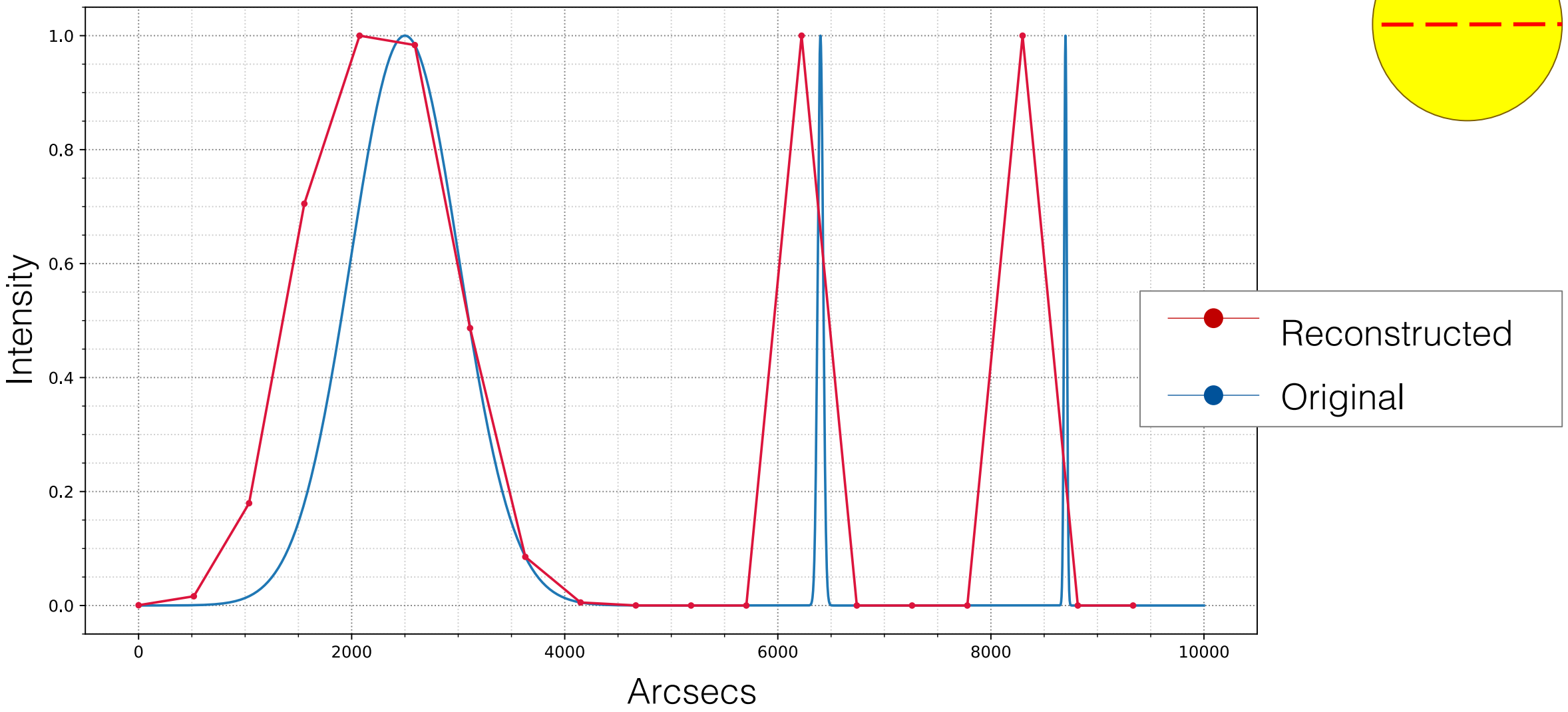

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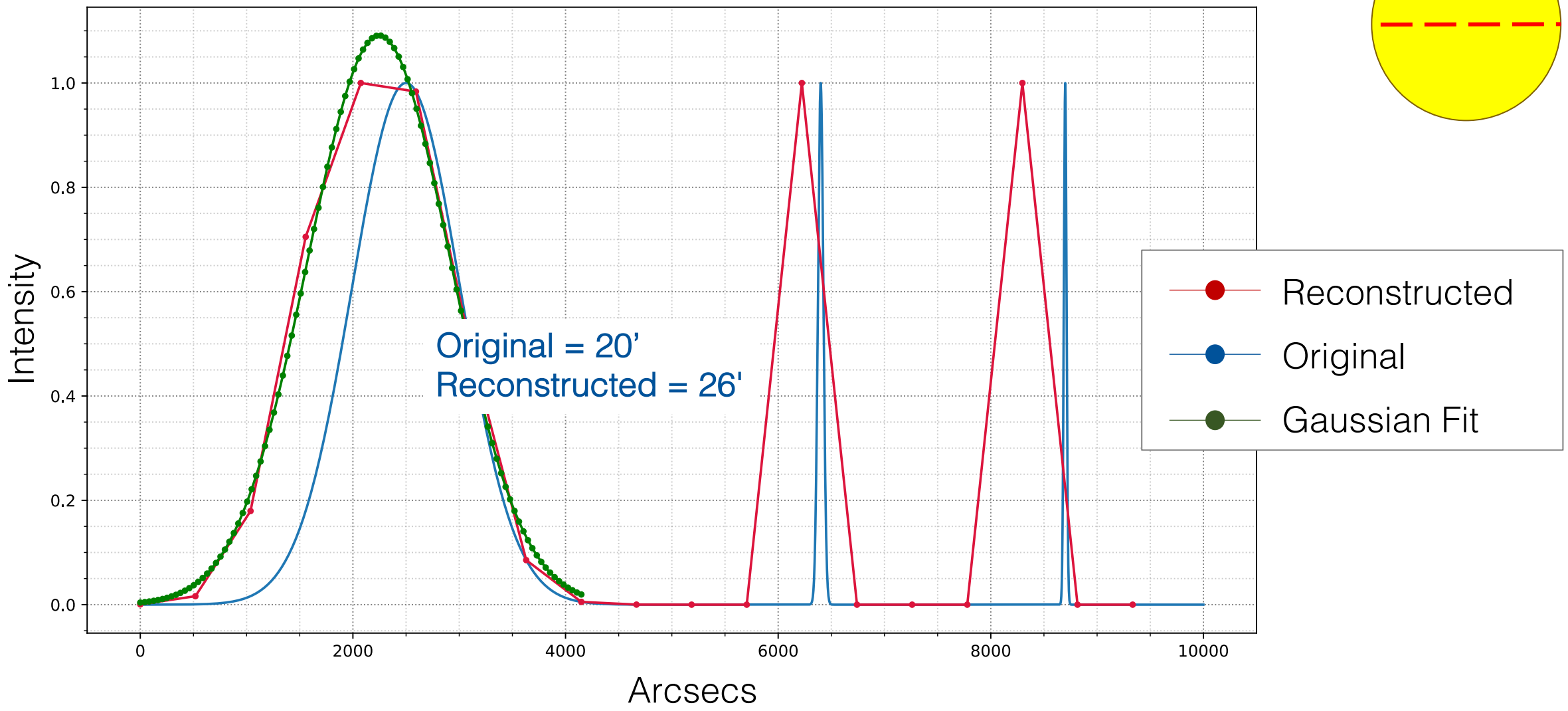

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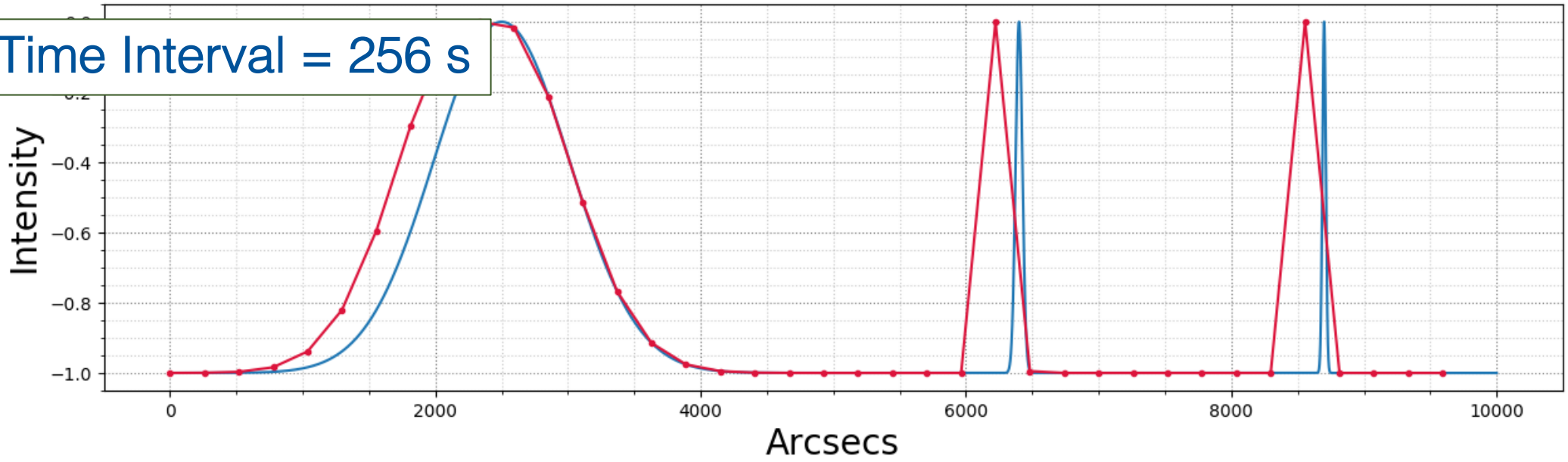
Time Interval = 256 s



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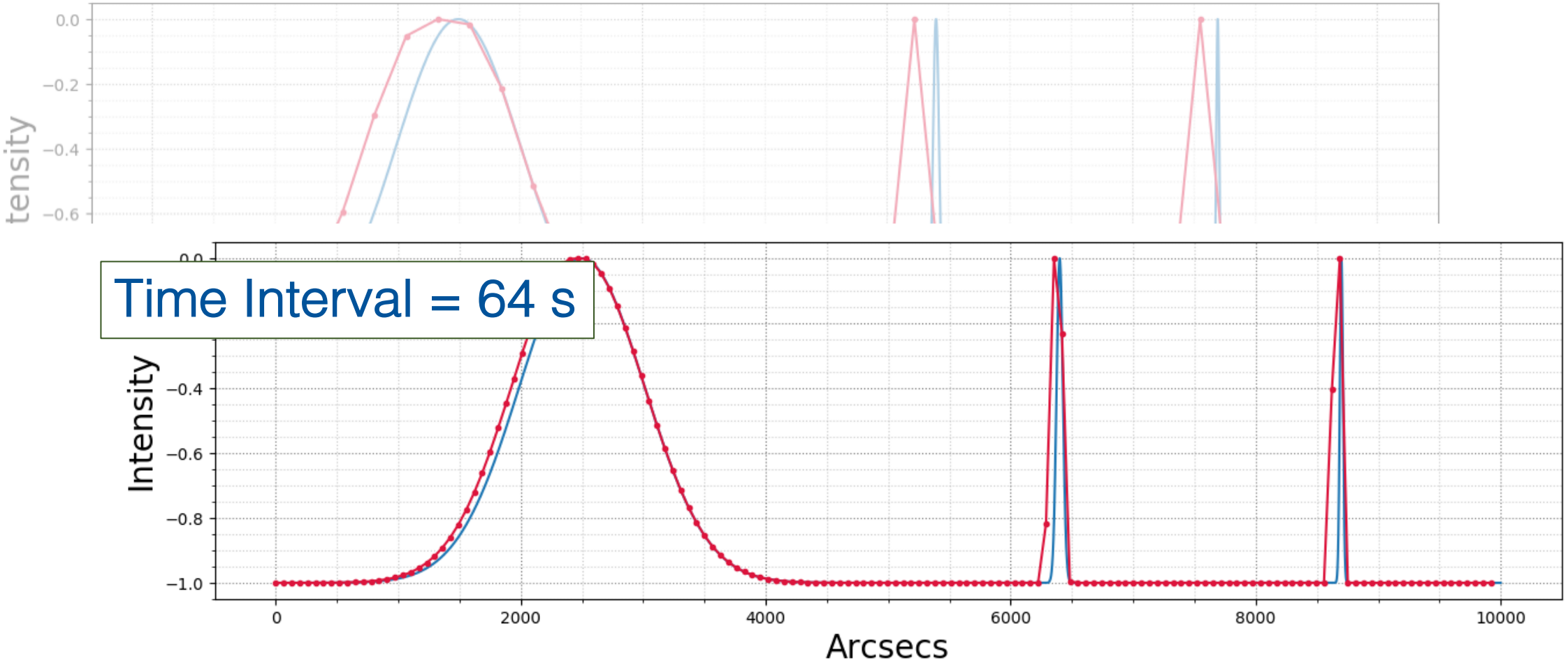

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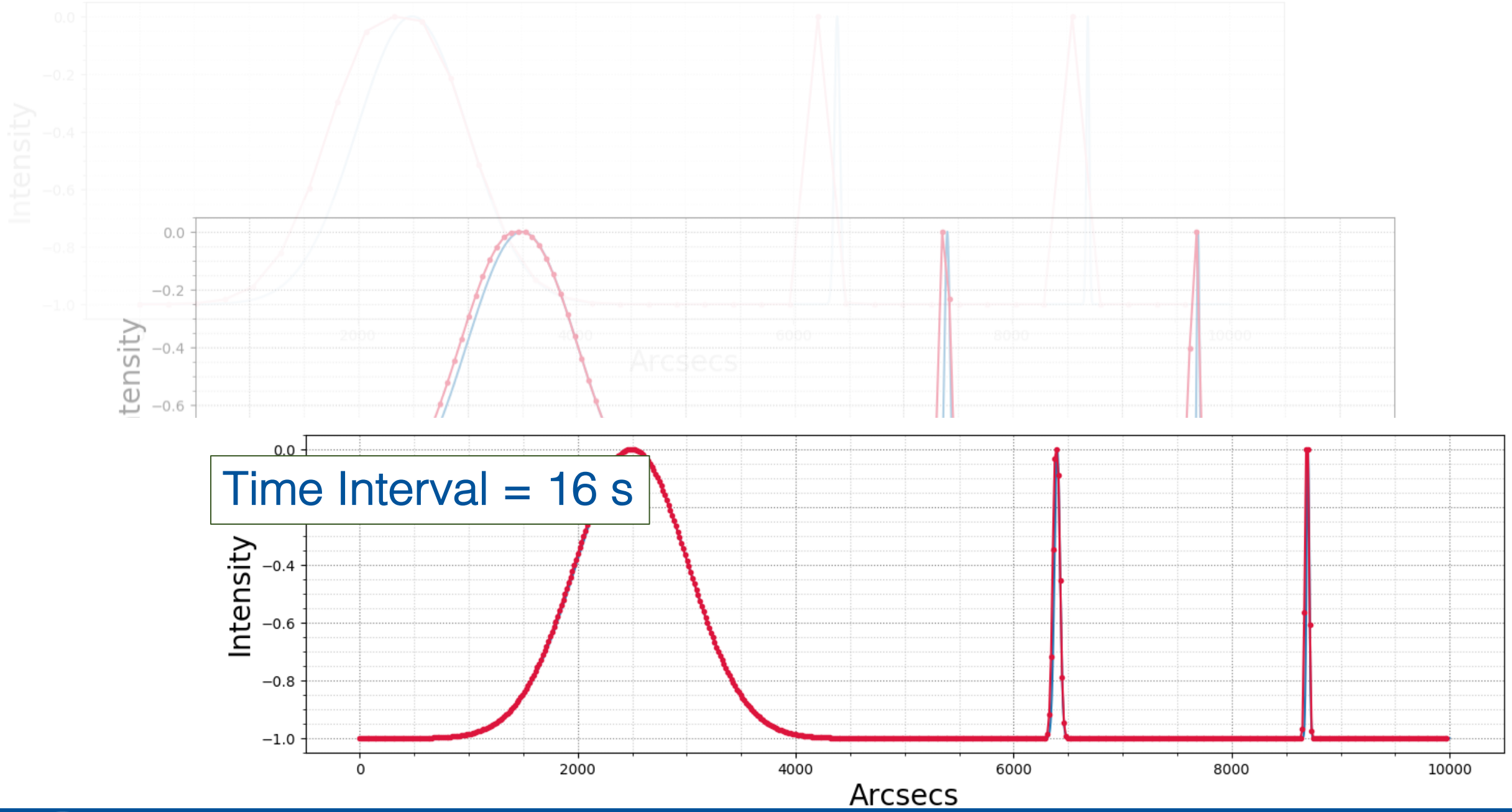

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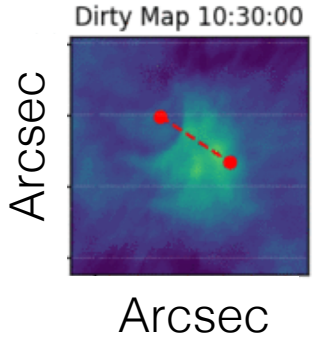
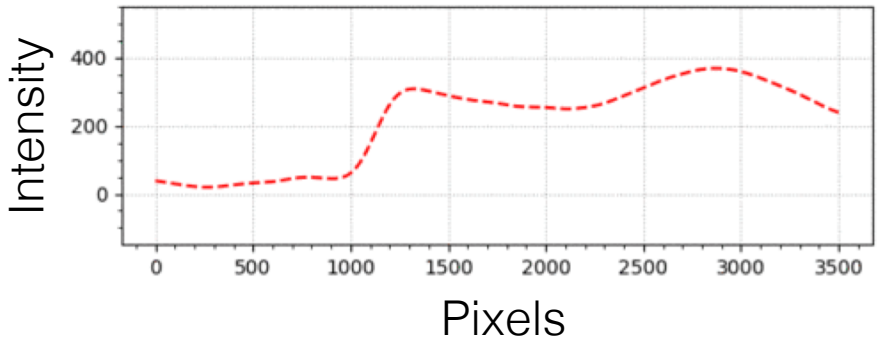
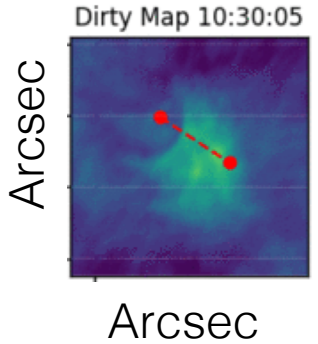
Real Data

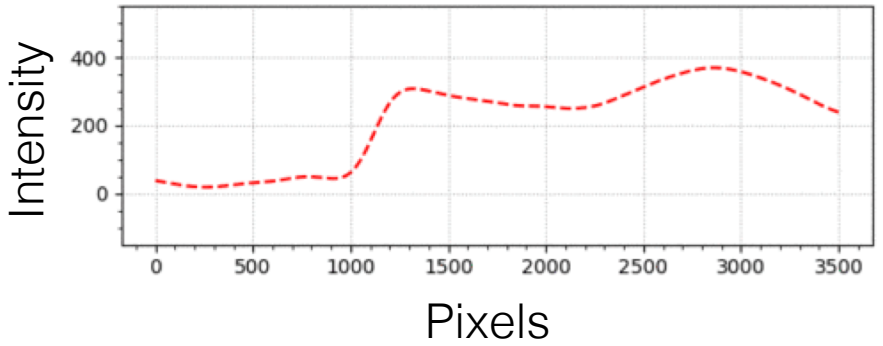
t_0



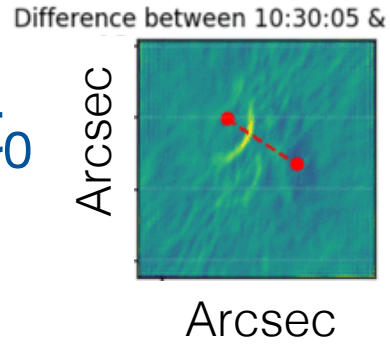


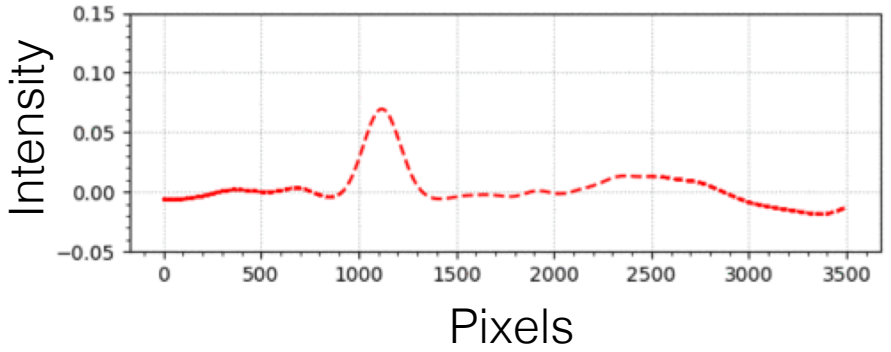
t_1





t_1-t_0





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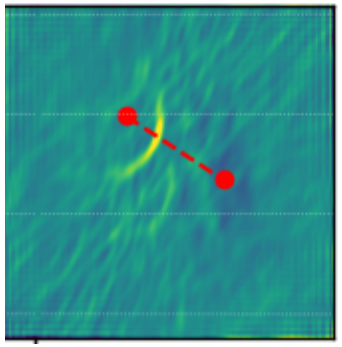

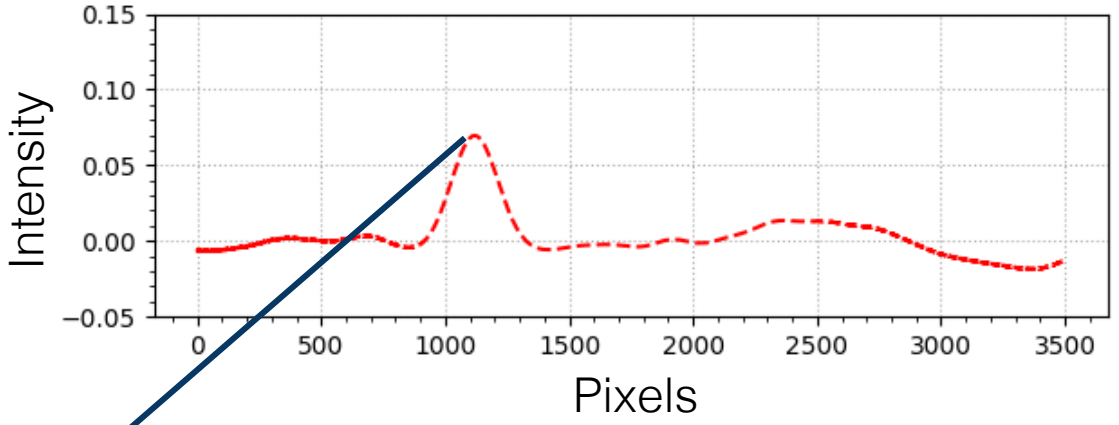

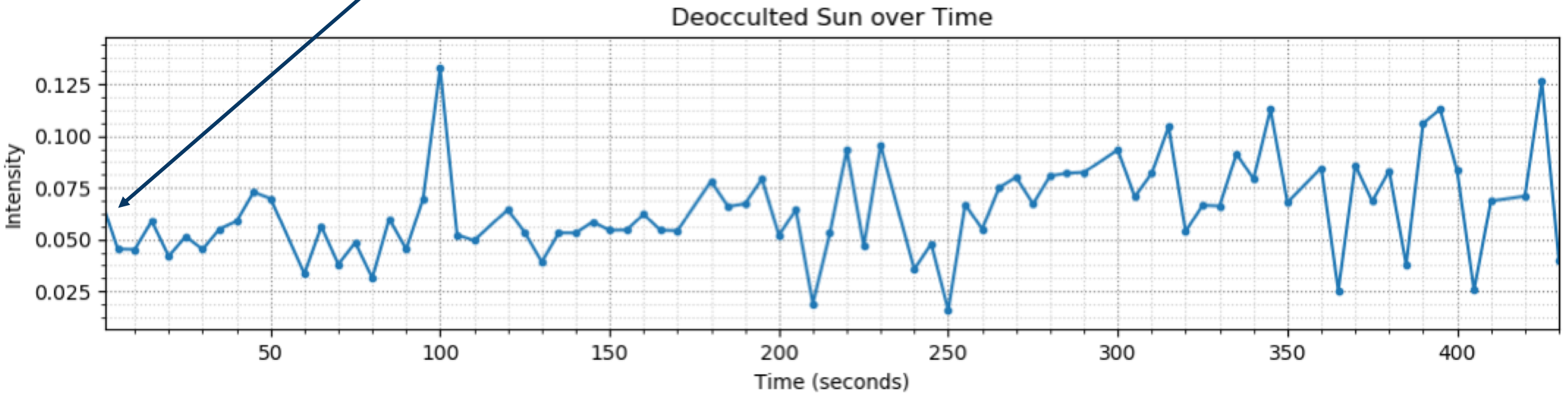

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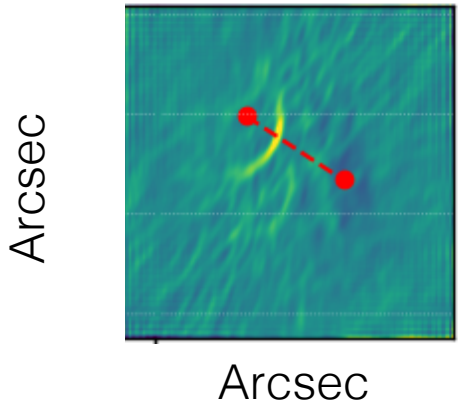

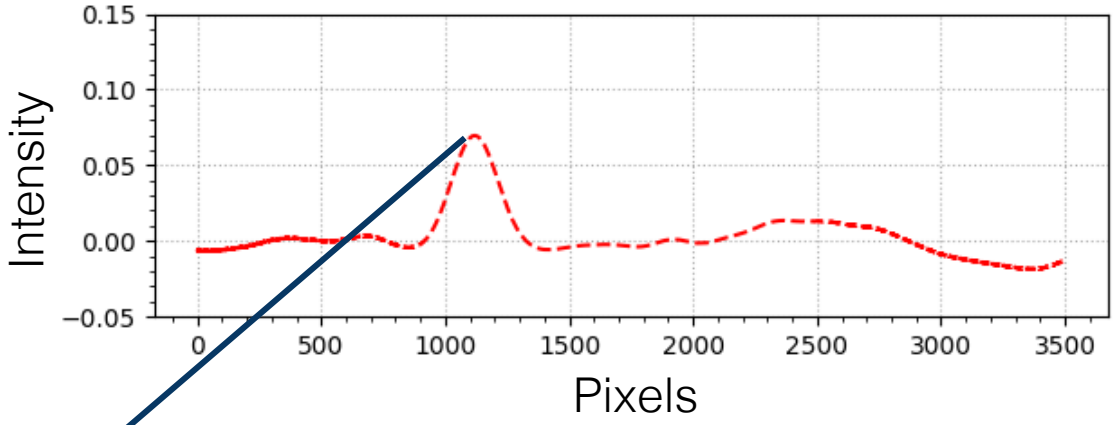

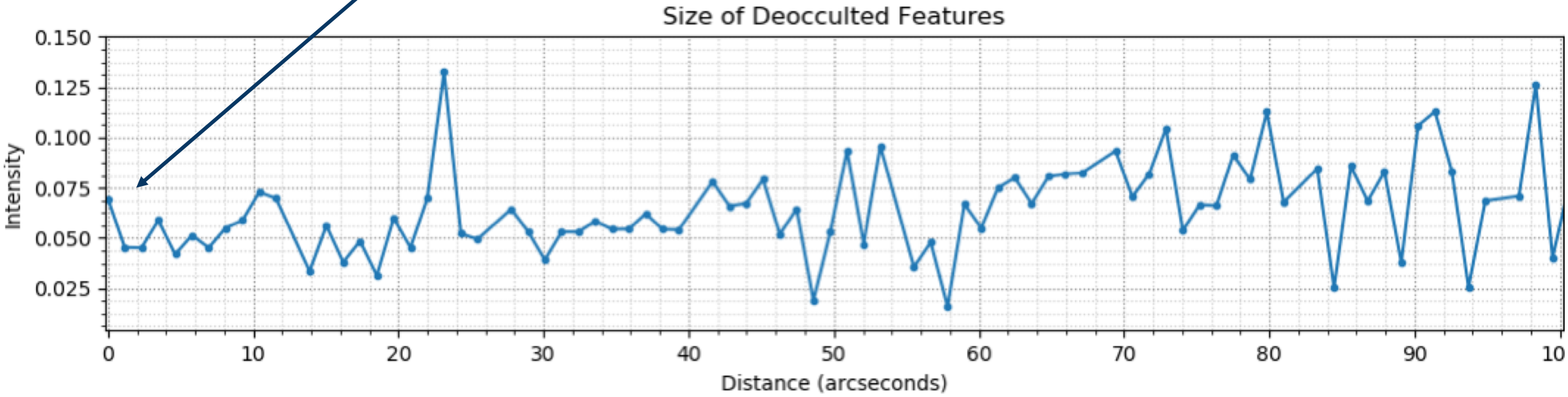

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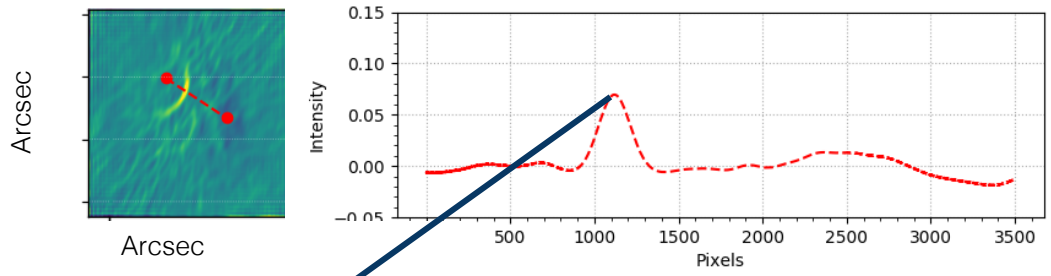
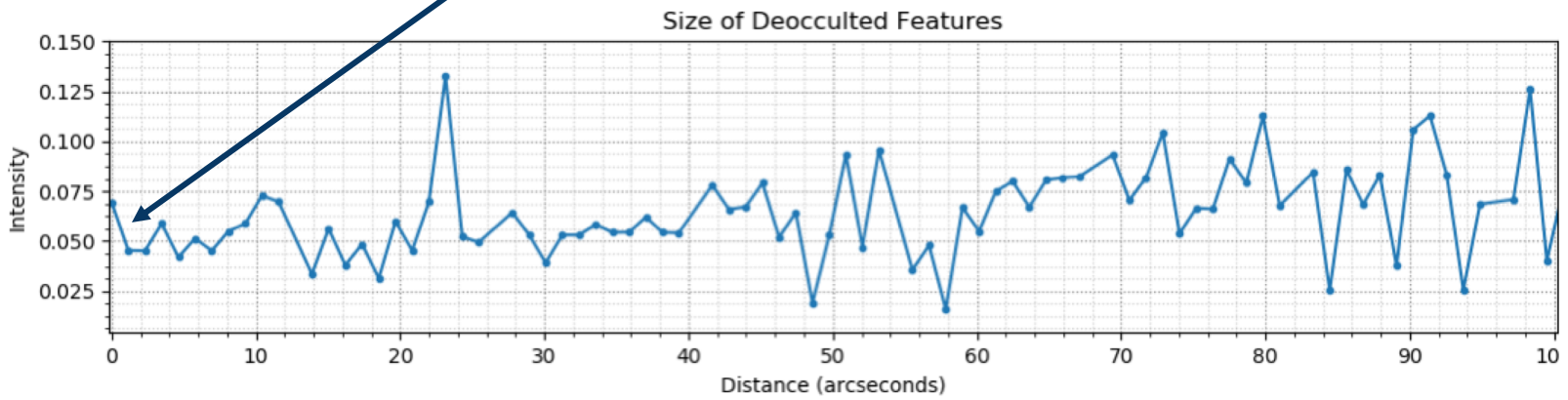
Conclusions

- Interferometric imaging of solar eclipse
- Source sizes ~5-10’ at 120–180 MHz
- Testing of lunar de-occultation technique
- Resolution beyond that of traditional interferometry





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