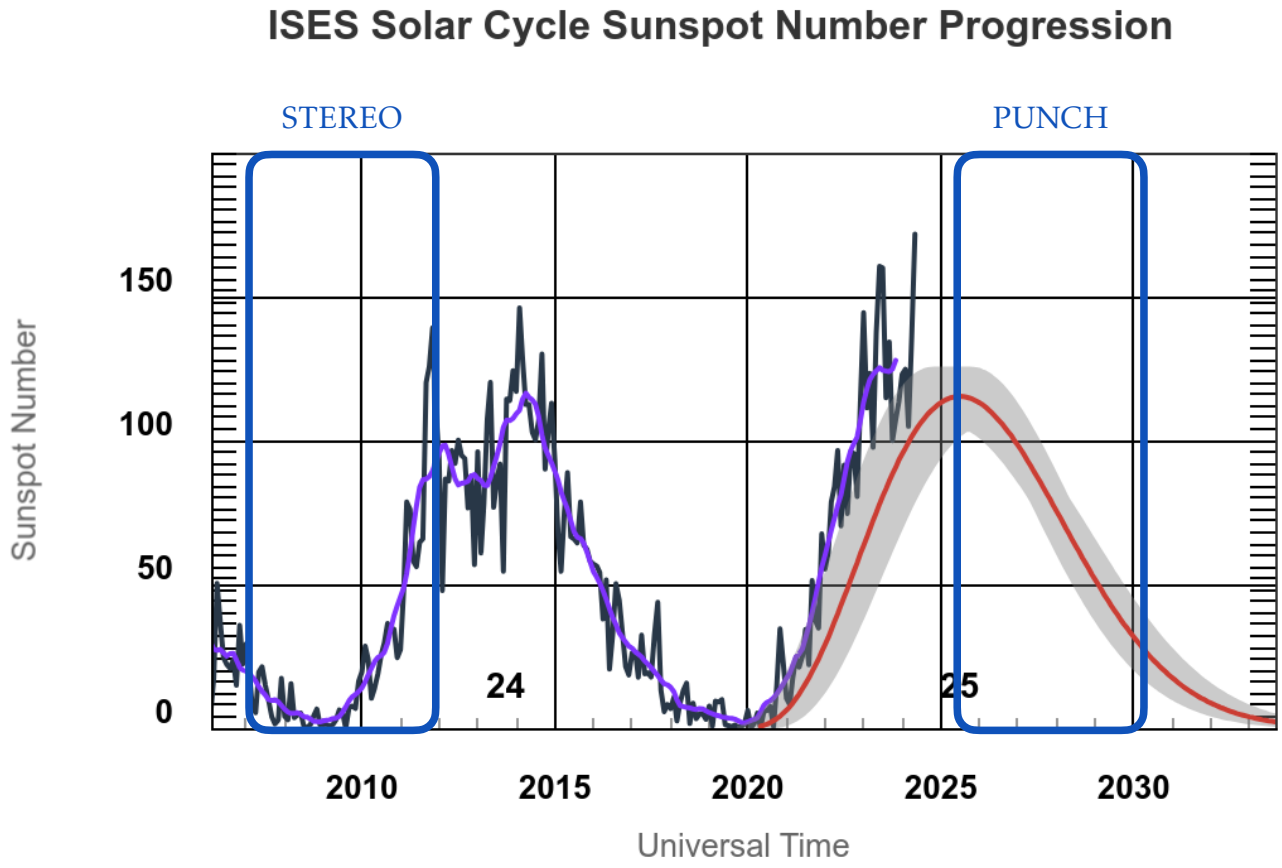
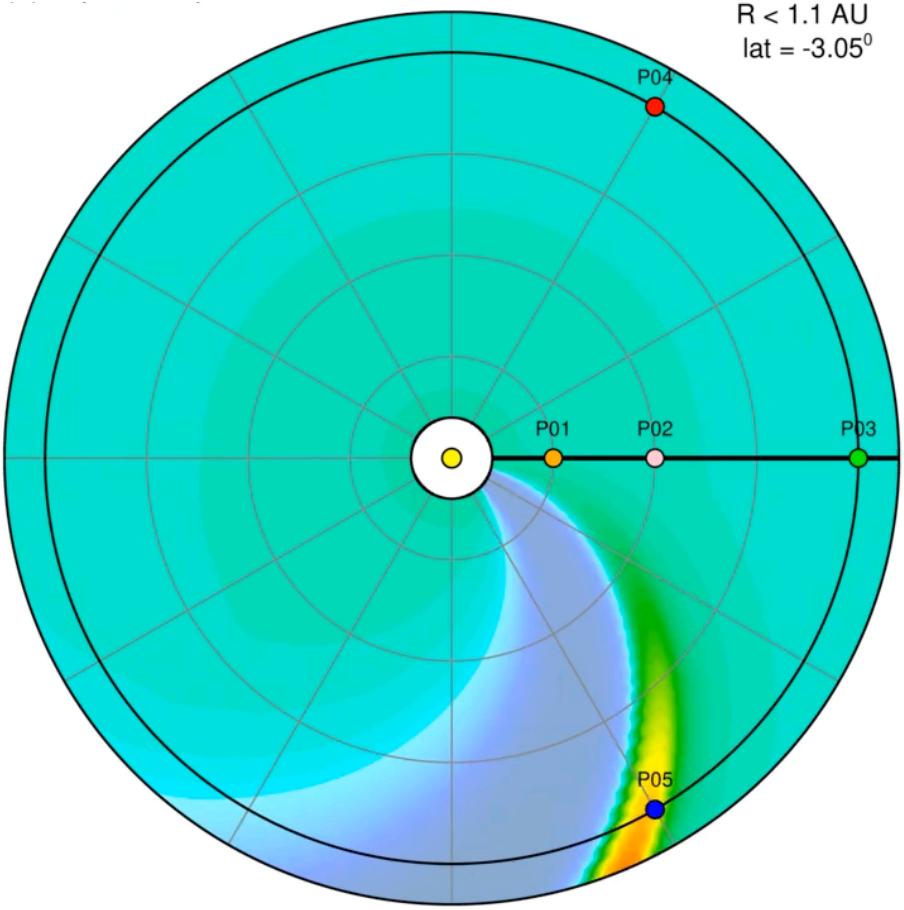
Probing CIRs With Thomson-Scattered White Light

Curt A de Koning

CIRES | University of Colorado Boulder

V. Pizzo, C. Scott, D. Odstrcil, C. DeForest, S. Gibson


ISES Solar Cycle Sunspot Number Progression
STEREO
PUNCH
Sunspot Number
150
100
50
0
24
25
2010
2015
2020
2025
2030
Universal Time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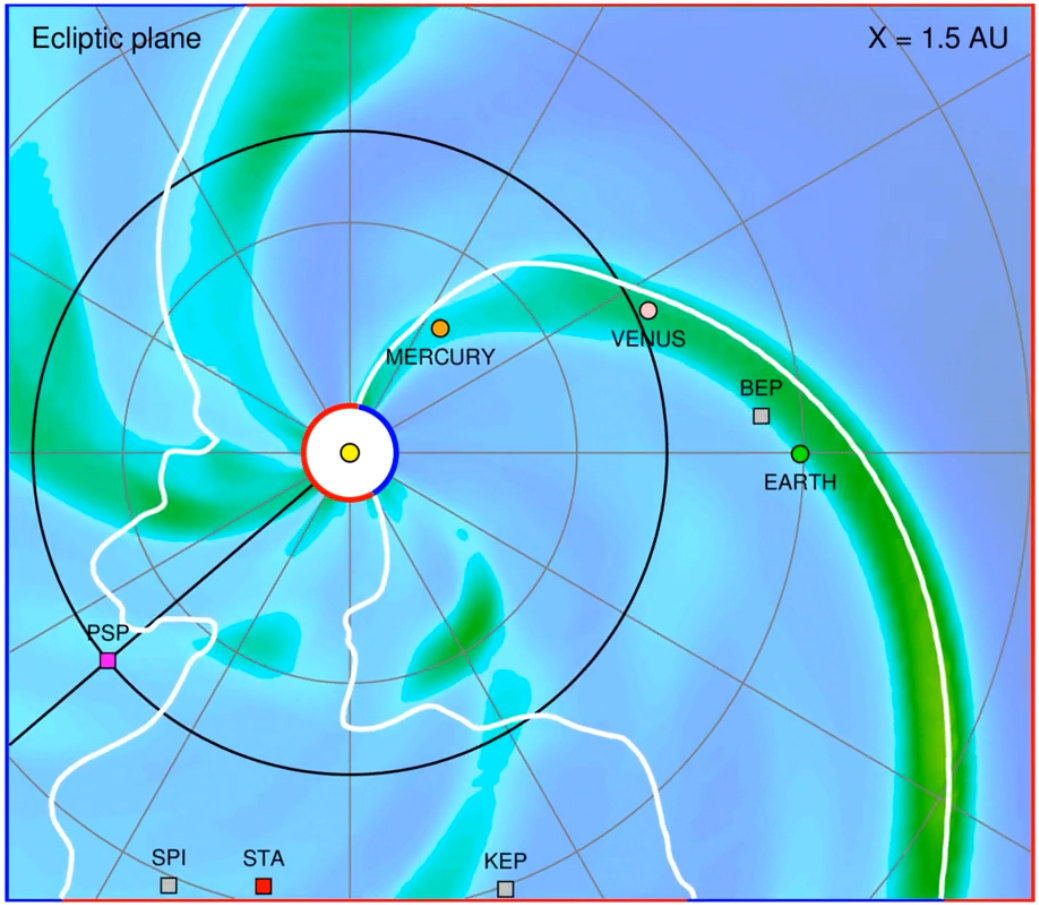
P04
P01
P02
P03
P05


Ecliptic plane
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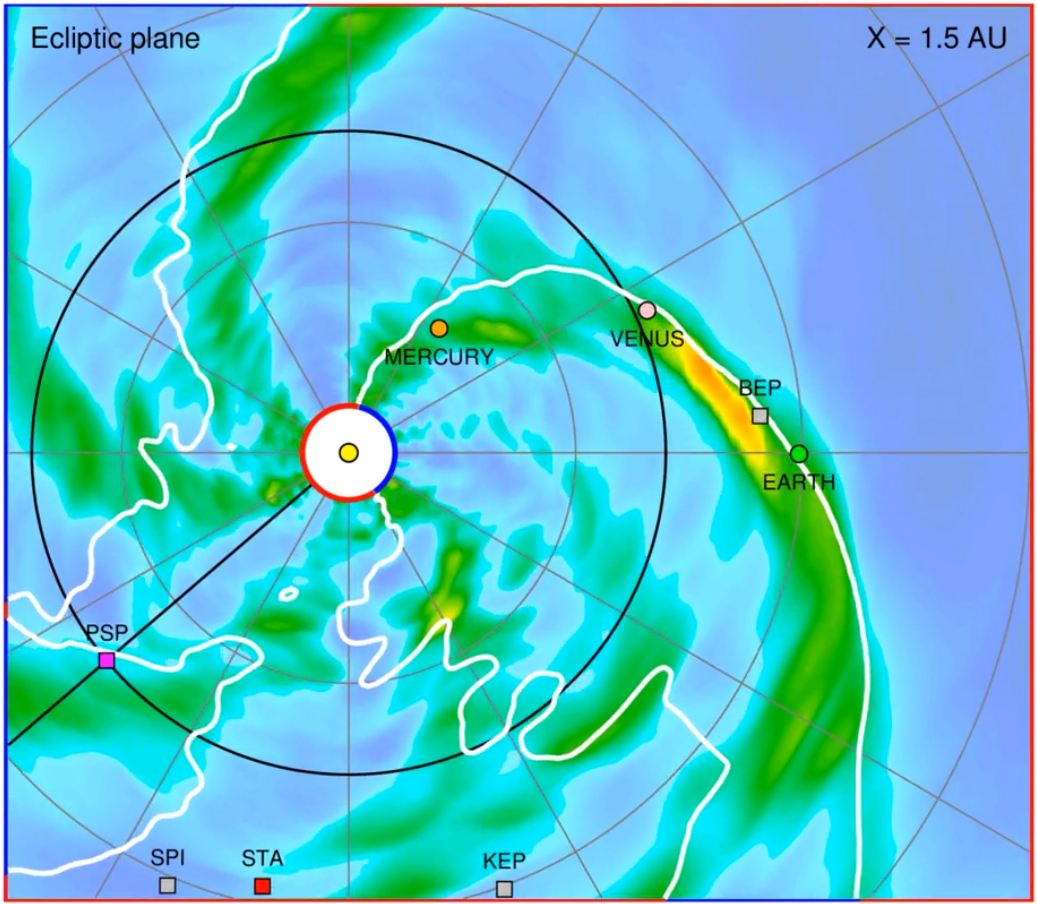
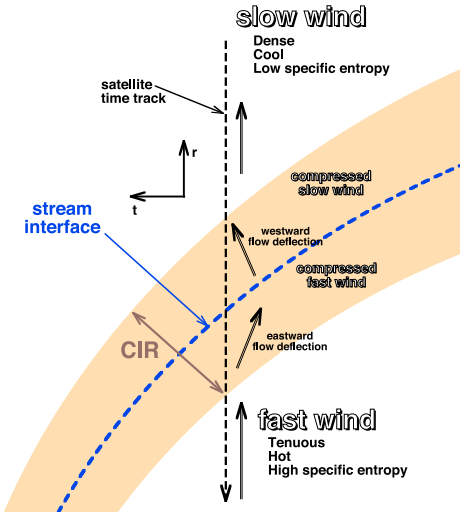
MERCURY
VENUS
BEP
EARTH
PSP
SPI
STA
KEP


Ecliptic plane
X = 1.5 AU
MERCURY
VENUS
BEP
EARTH
PSP
SPI
STA
KEP

What is a CIR? A Schematic View

Satellite View in RTN Coordinate System

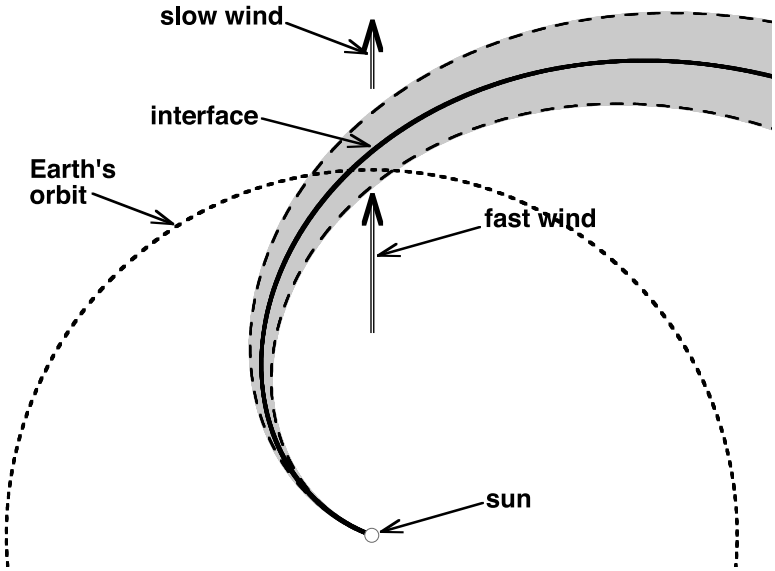


From:

Borovsky &

Denton, 2010.

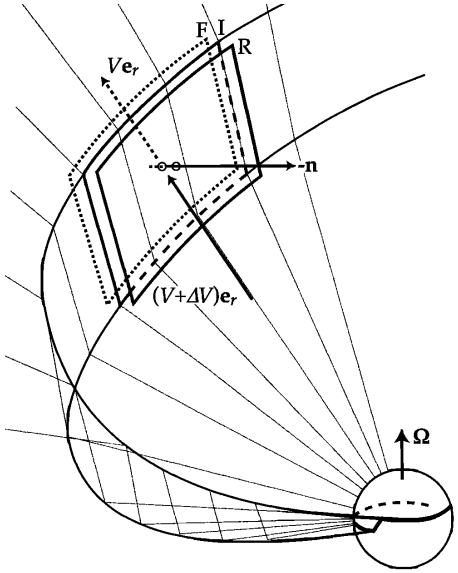
What is a CIR? Global Structure



From:

Borovsky & Denton, 2010.

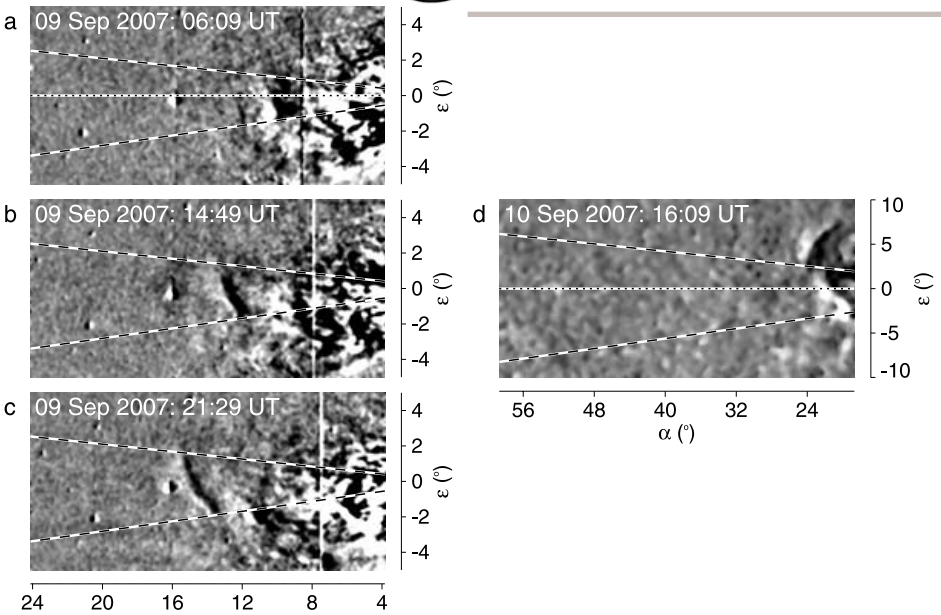
What is a CIR? Local Structure



From:

Lee, 2000.

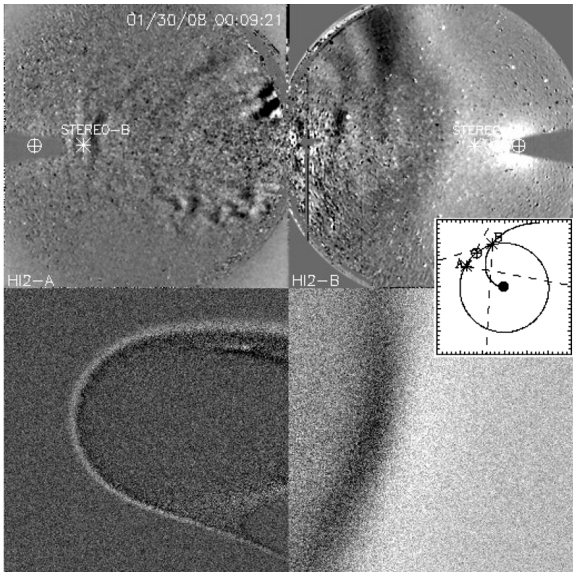
STEREO/HI CIR Science
We saw them!



From:

Rouillard et al., 2008.

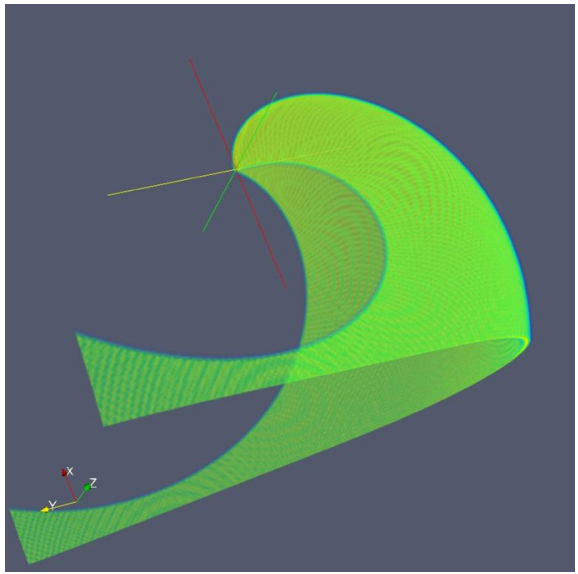
STEREO/HI CIR Science
We reconstructed one



From:

Wood et al., 2010.

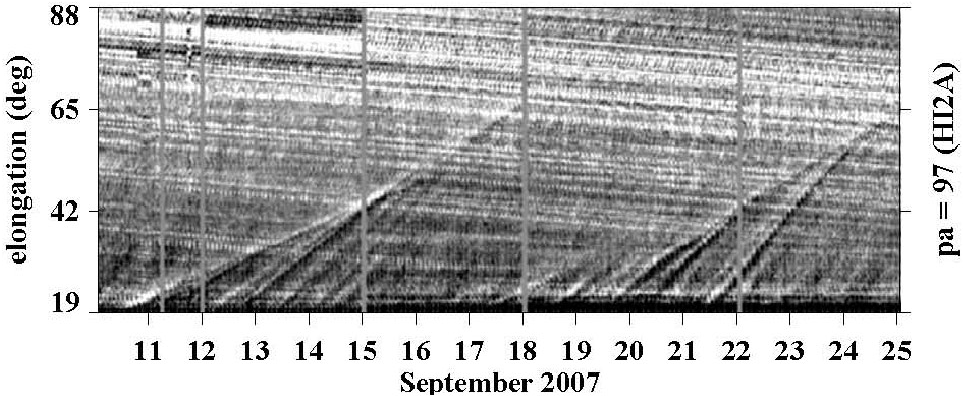
STEREO/HI CIR Science
We reconstructed one



From:

Wood et al., 2010.

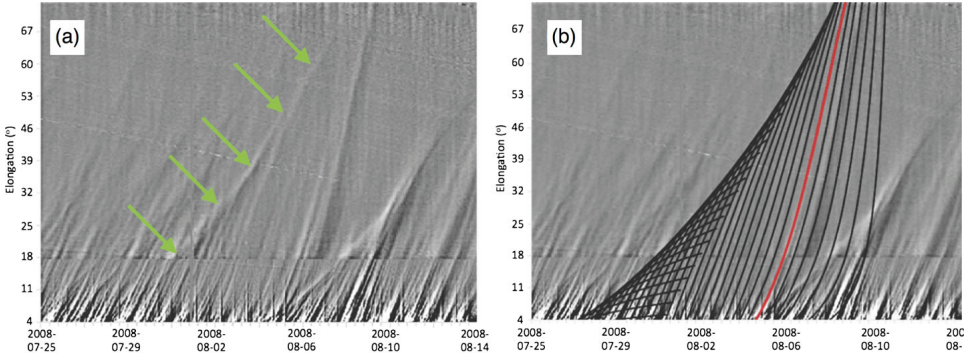
STEREO/HI CIR Science
They're blobby!



From:

Sheeley et al., 2008.

STEREO/HI CIR Science
They're blobby!



From:

Plotnikov et al., 2016.

STEREO/HI CIR Science
They're cataloged

OG www.stereo.rl.ac.uk/HIEventList.html

www.helcats-fp7.eu/catalogues/wp5_cat.html

Plotnikov et al. [2016] list properties of 190 CIRs

STEREO/HI CIR Science
Can we forecast them?

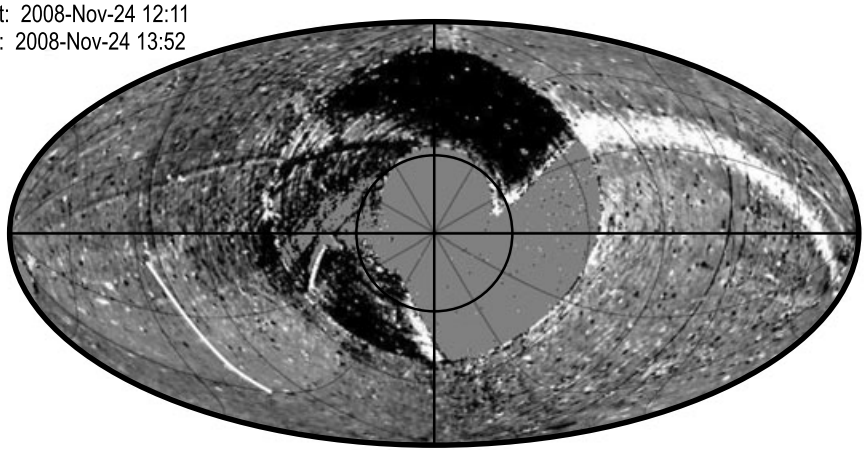
- Williams et al. [2011] – 24 events

  "We show that the estimated arrival times from ACE agree well with the arrival times at other spacecraft, whereas the estimates from STEREO/HI tend to agree less well."

- Davis et al. [2012] – 244 events

  "this technique can provide a timely prediction of the arrival of CIRs at least 1 day ahead of their arrival at Earth"

SMEI CIR Science
We saw one! (or two)



From:

Tappin & Howard, 2009.

Future CIR Science
The P from PUNCH

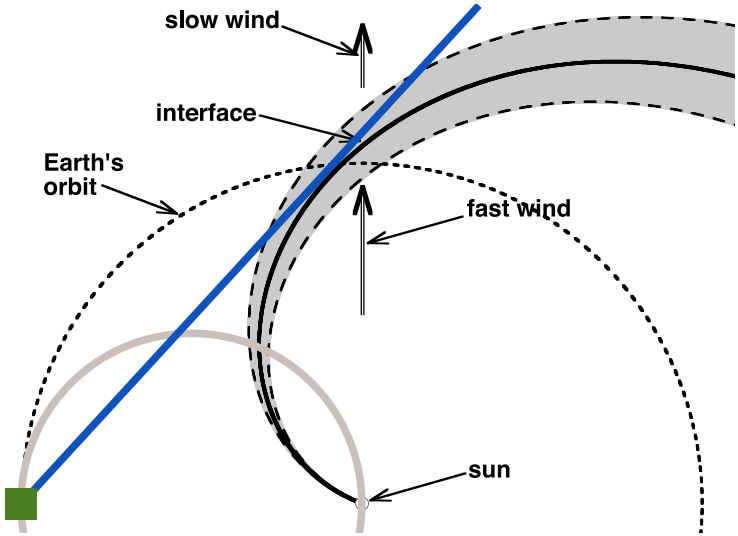
$$B_{tot} \propto \int_{obs}^{\infty} d\zeta \, \mathcal{M}_{tot}(\zeta, \varepsilon) n_e(\zeta, \varepsilon)$$

$$B_{pol} \propto \int_{obs}^{\infty} d\zeta \, \mathcal{M}_{pol}(\zeta, \varepsilon) n_e(\zeta, \varepsilon)$$

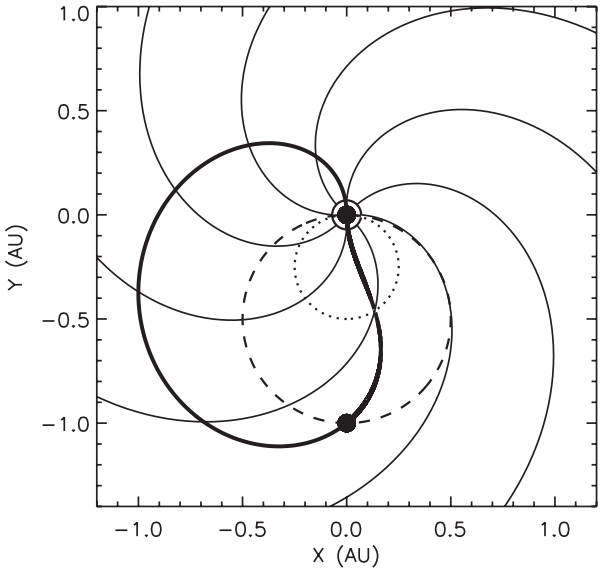
Assume $n_e \equiv n_0 \delta(\zeta - \zeta_0)$;

then B_{pol}/B_{tot} provides scattering location.

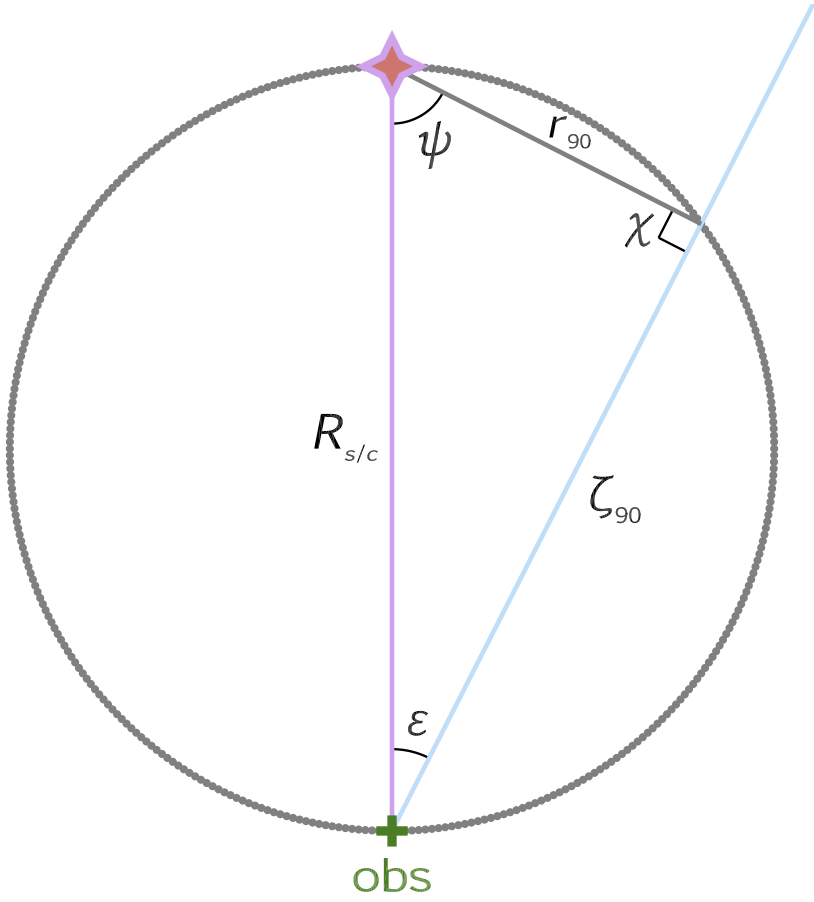
Future CIR Science
The P from PUNCH

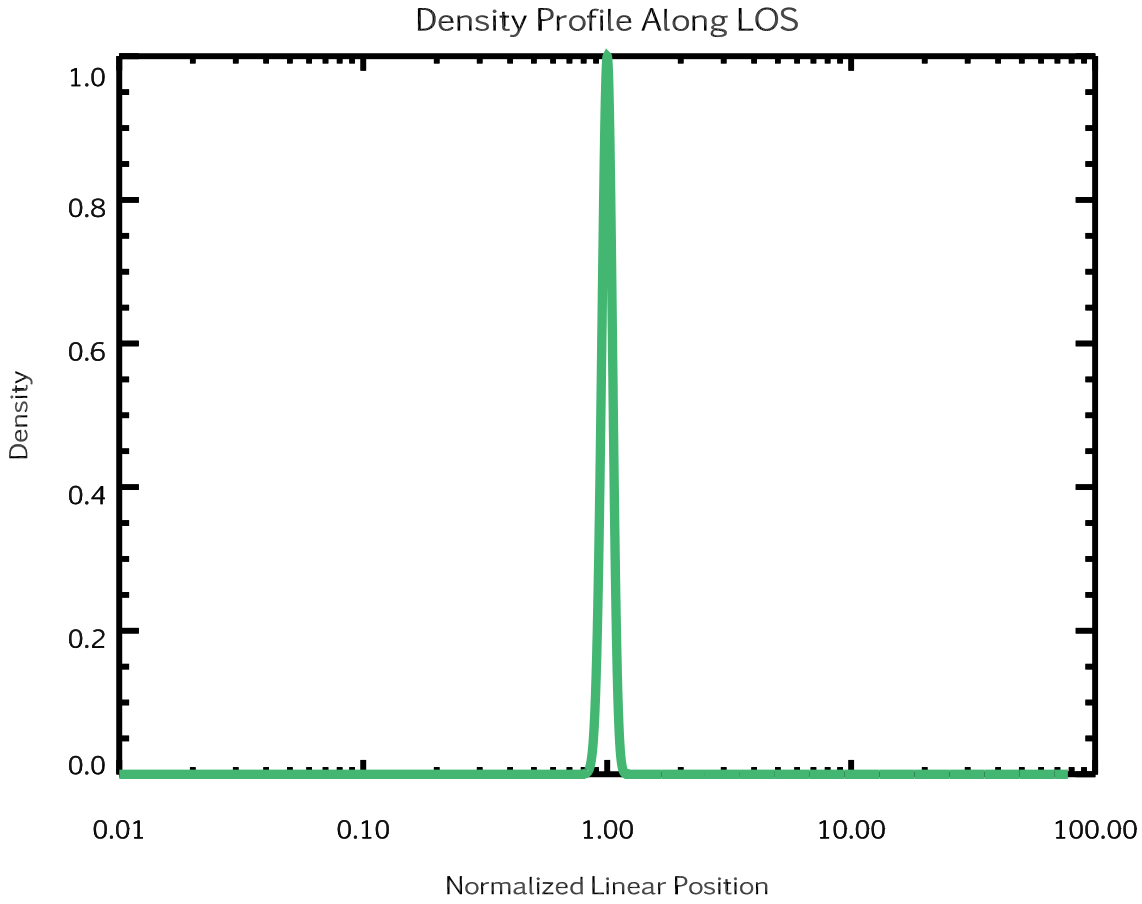


Future CIR Science
The P from PUNCH



From:
Sheeley &
Rouillard, 2010.


ψ
r_{90}
χ
$R_{s/c}$
ζ_{90}
ε
obs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Density
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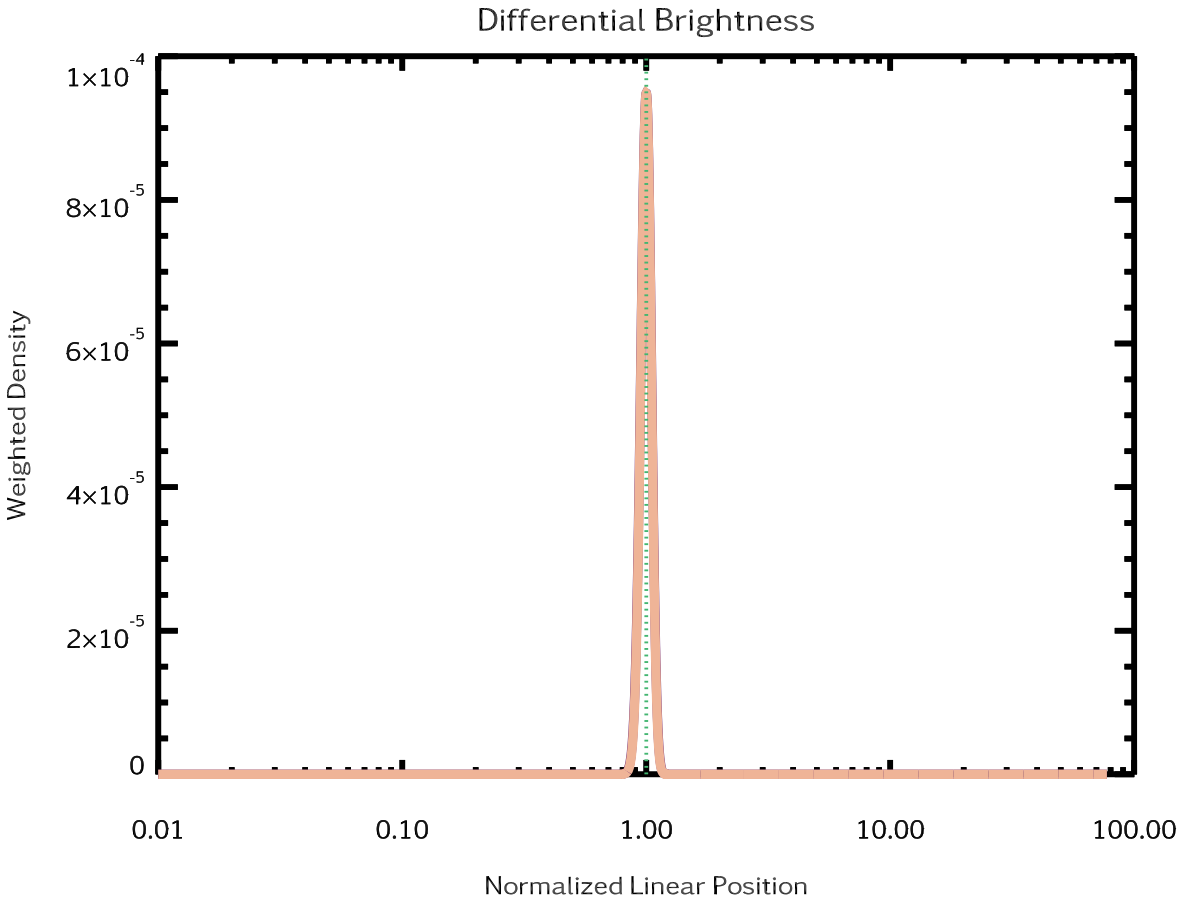
Normalized Linear Position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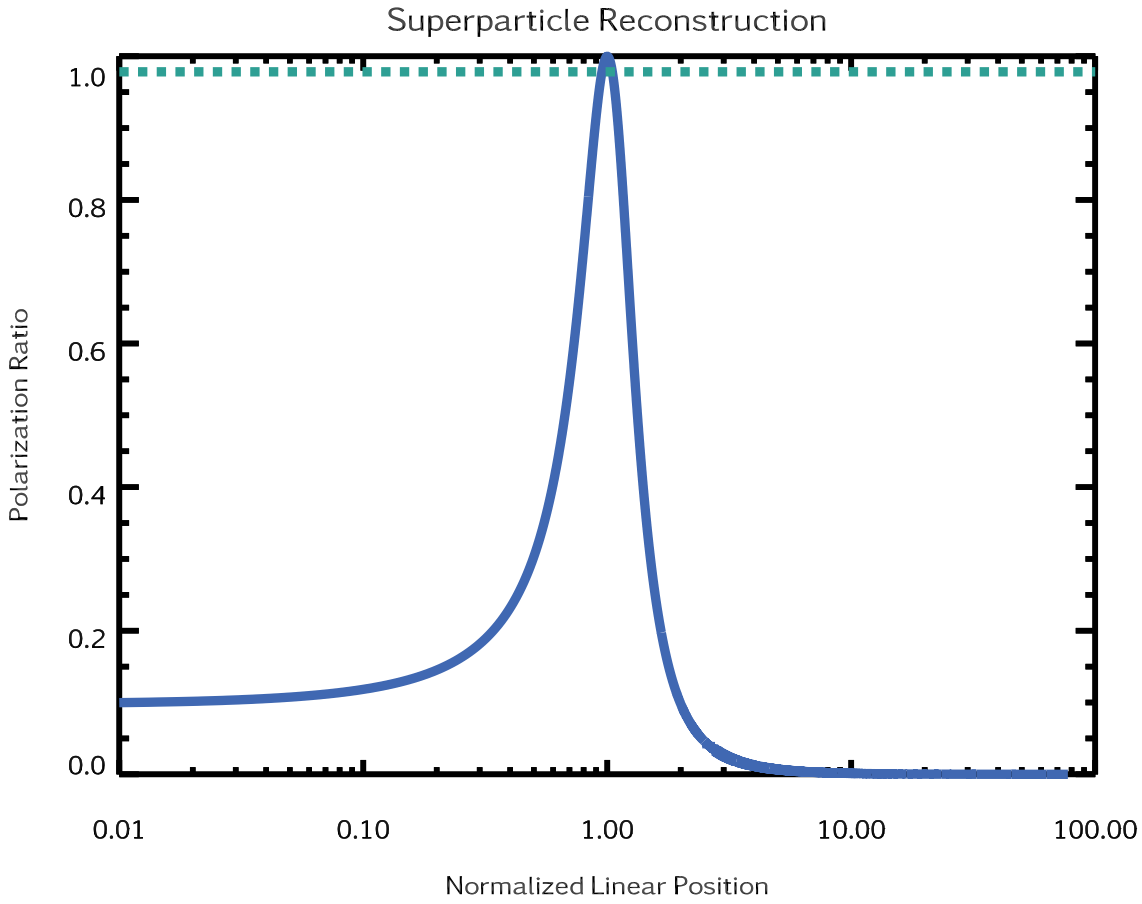
Normalized Linear Position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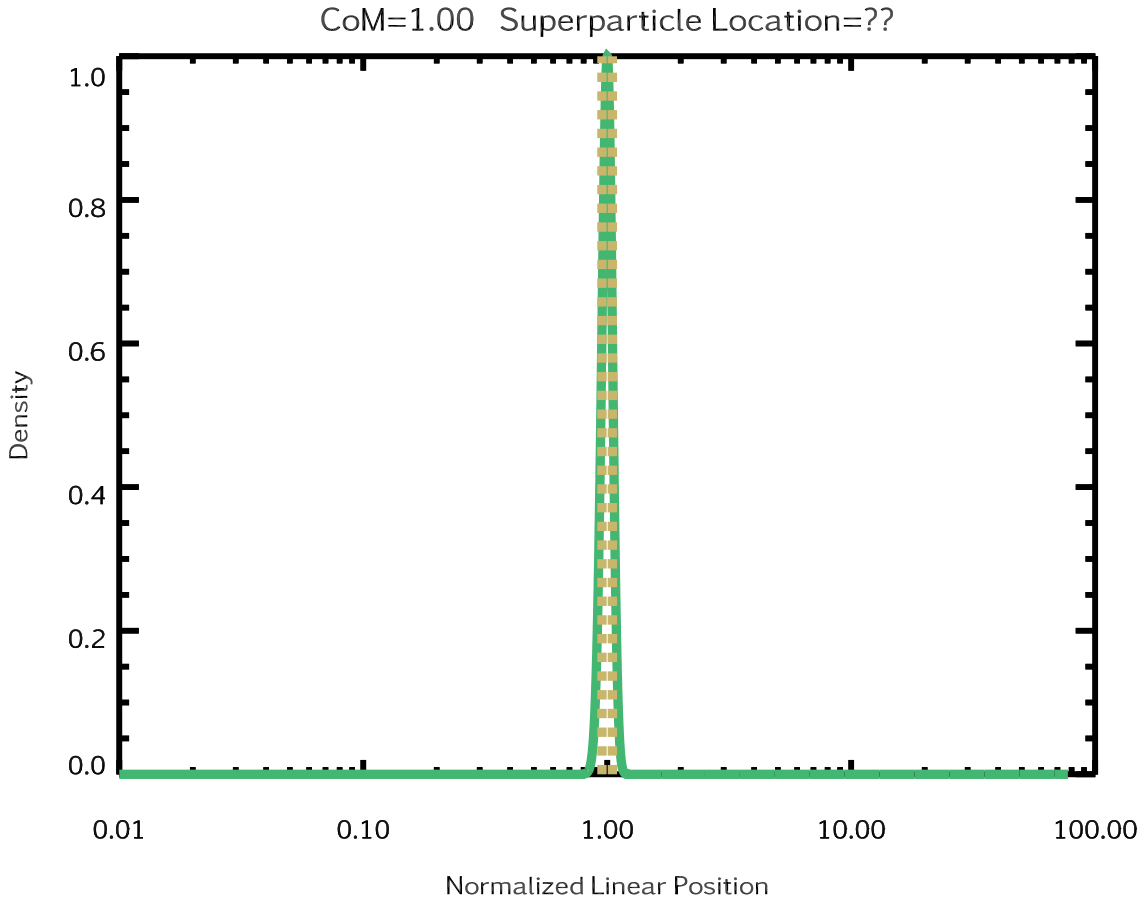
Normalized Linear Position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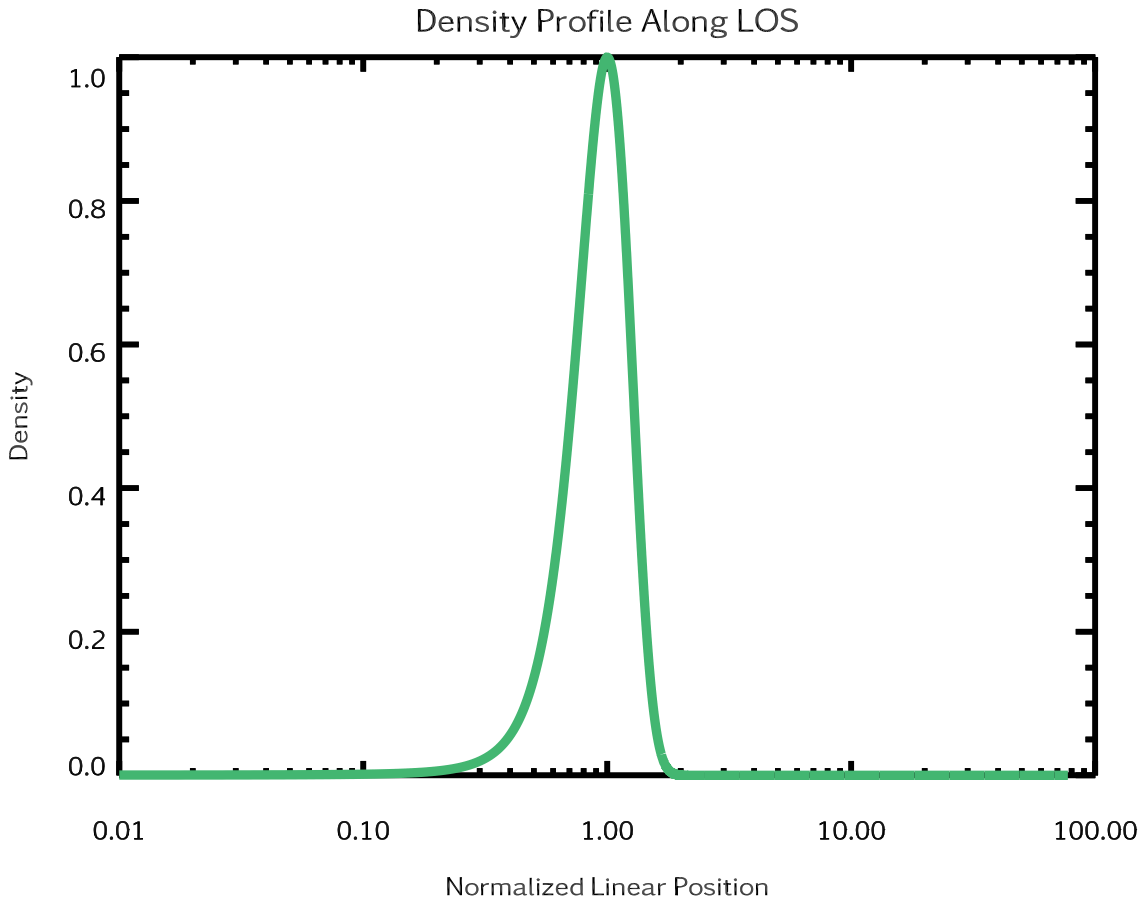
Density Profile Along LOS
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Density
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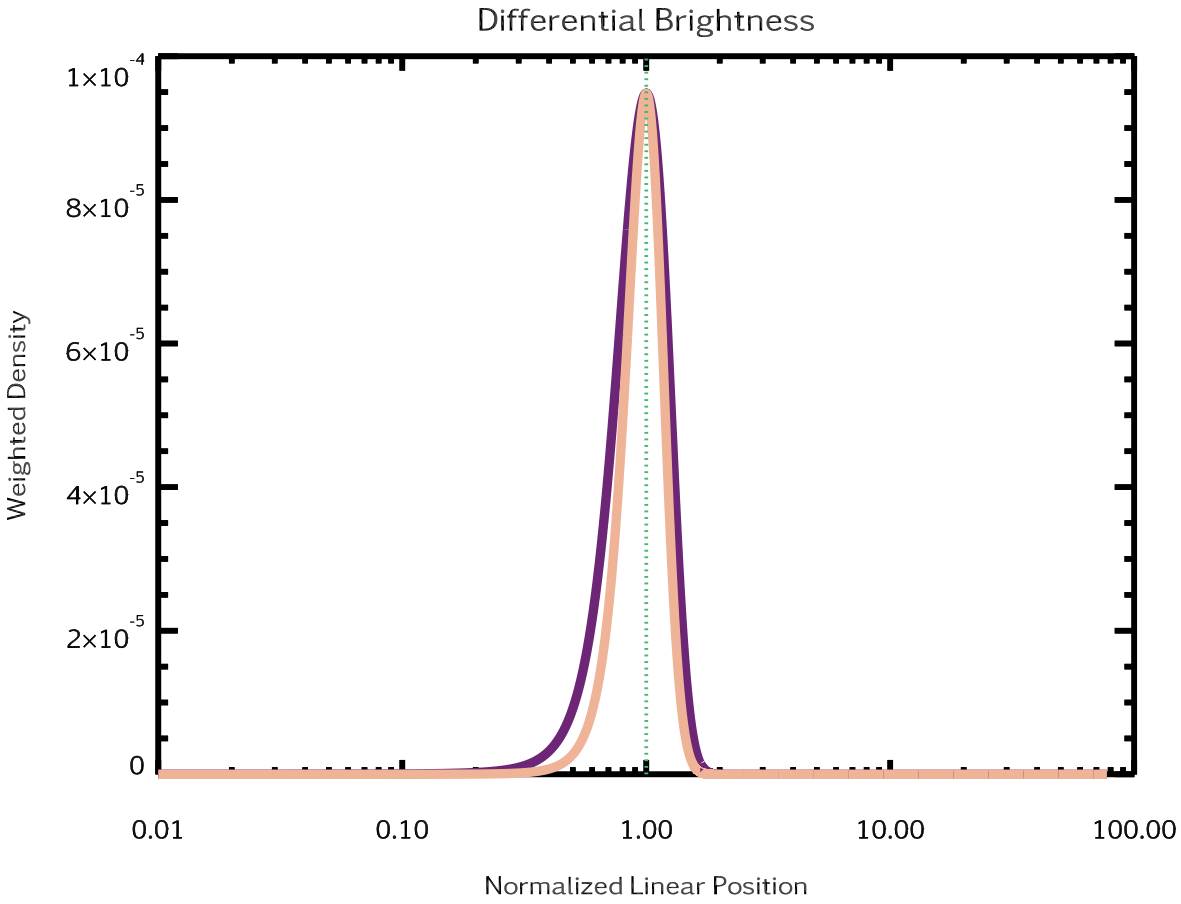
Normalized Linear Position


Differential Brightness
Weighted Density
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2×10-5
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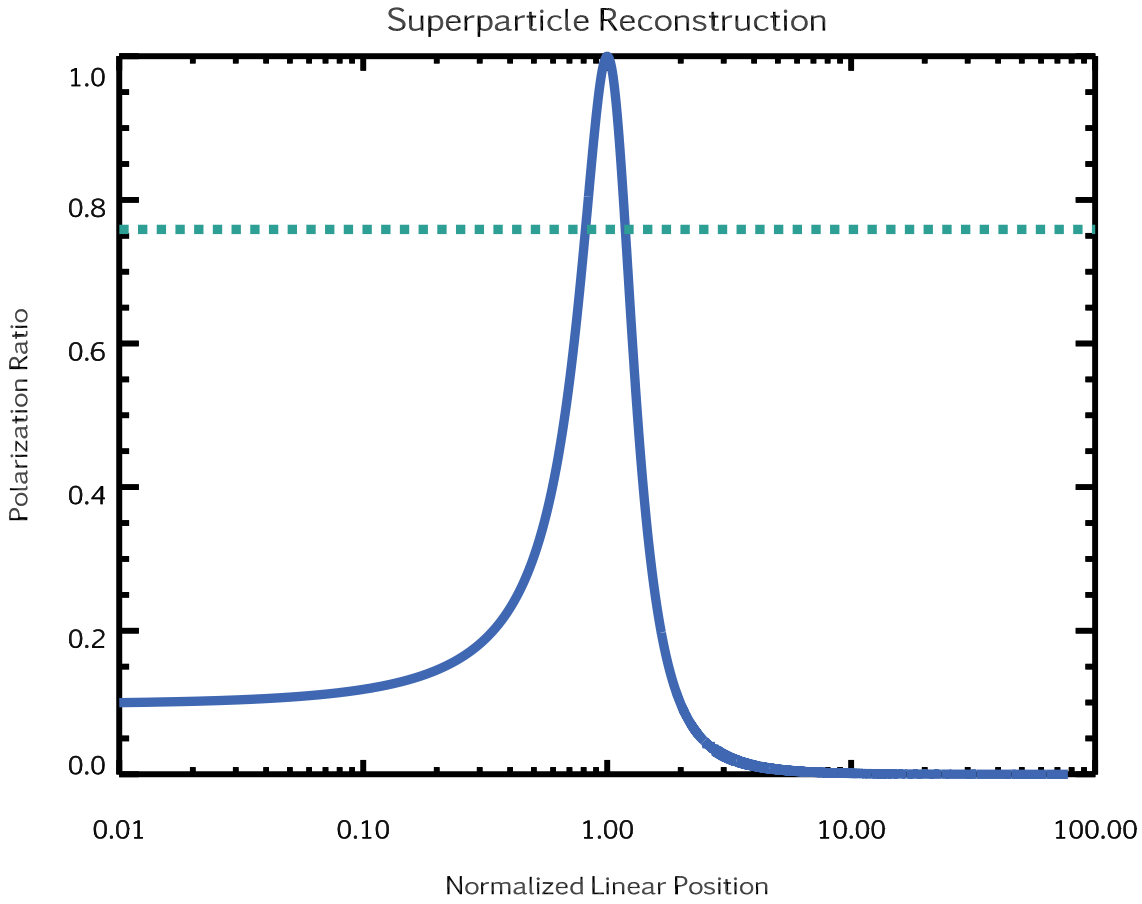
Normalized Linear Position


Superparticle Reconstruction
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Polarization Ratio
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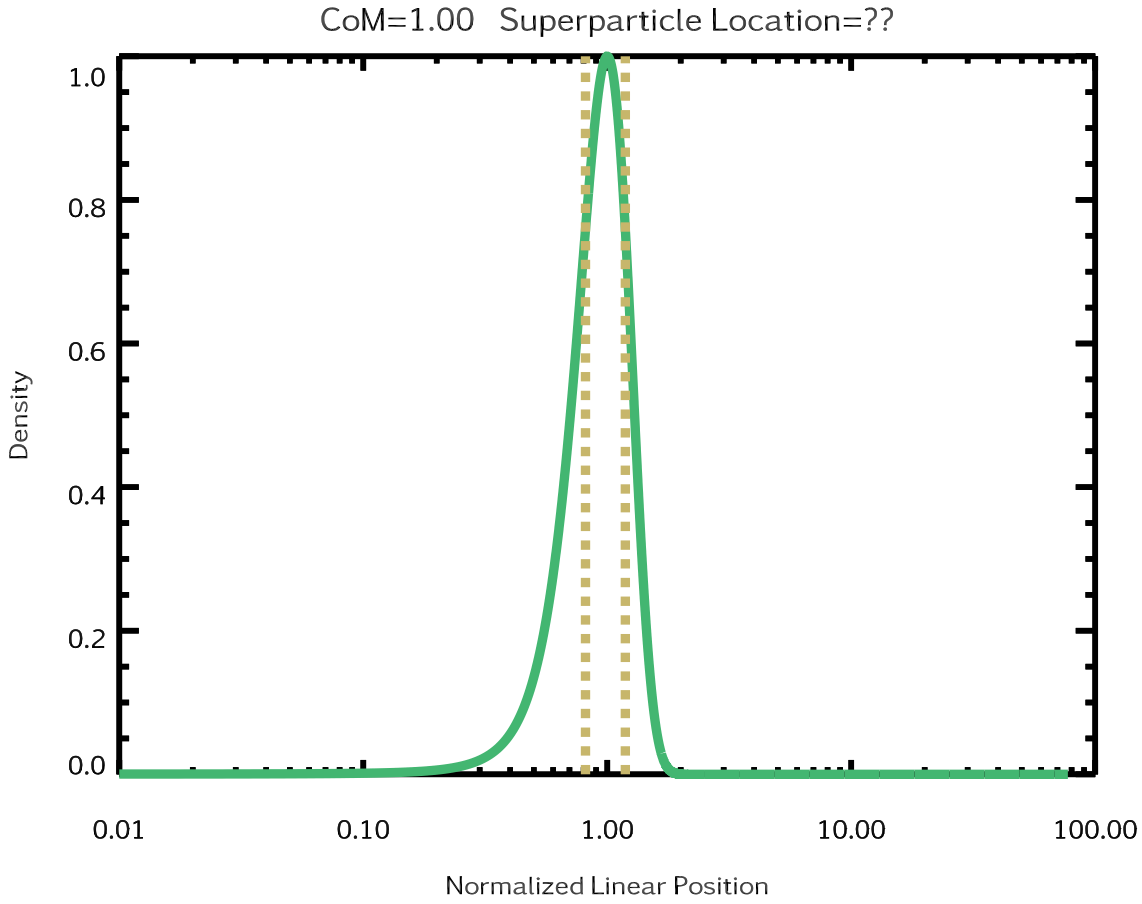
Normalized Linear Position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Density
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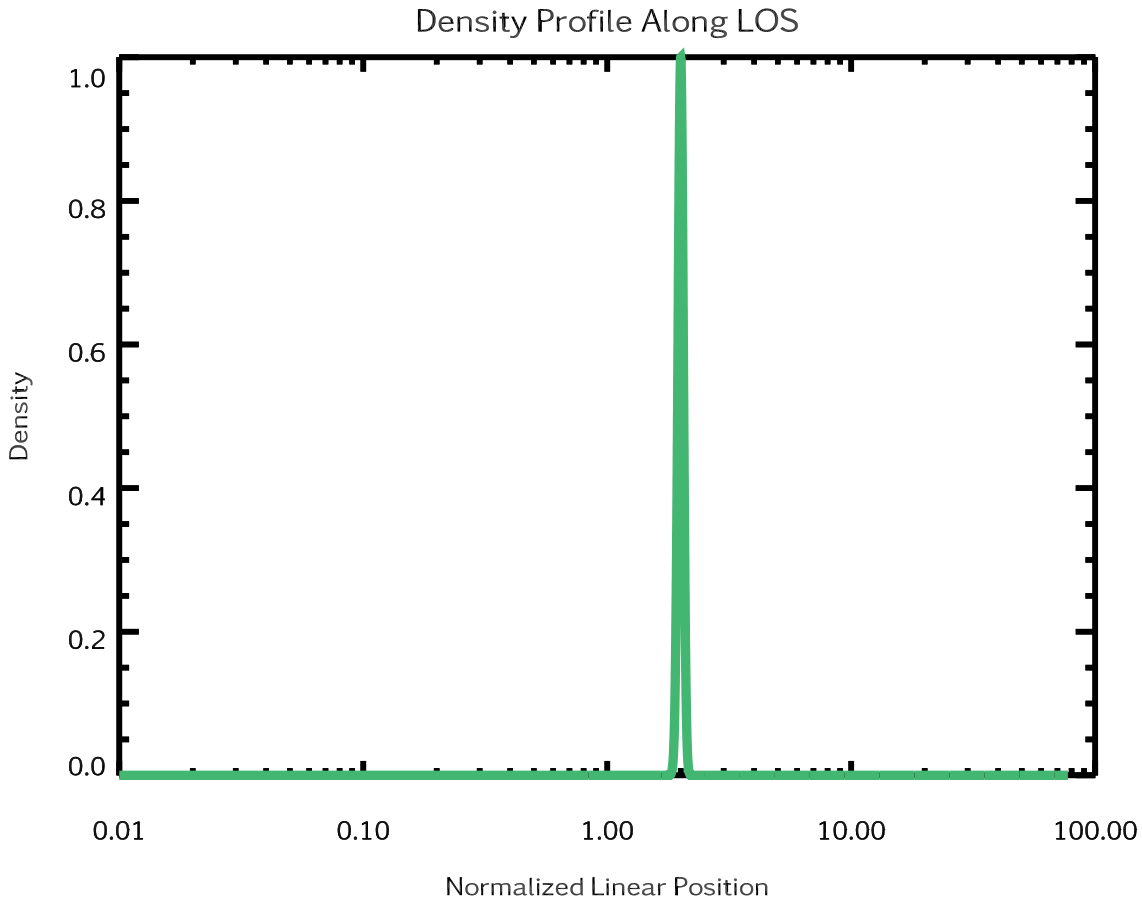
Normalized Linear Position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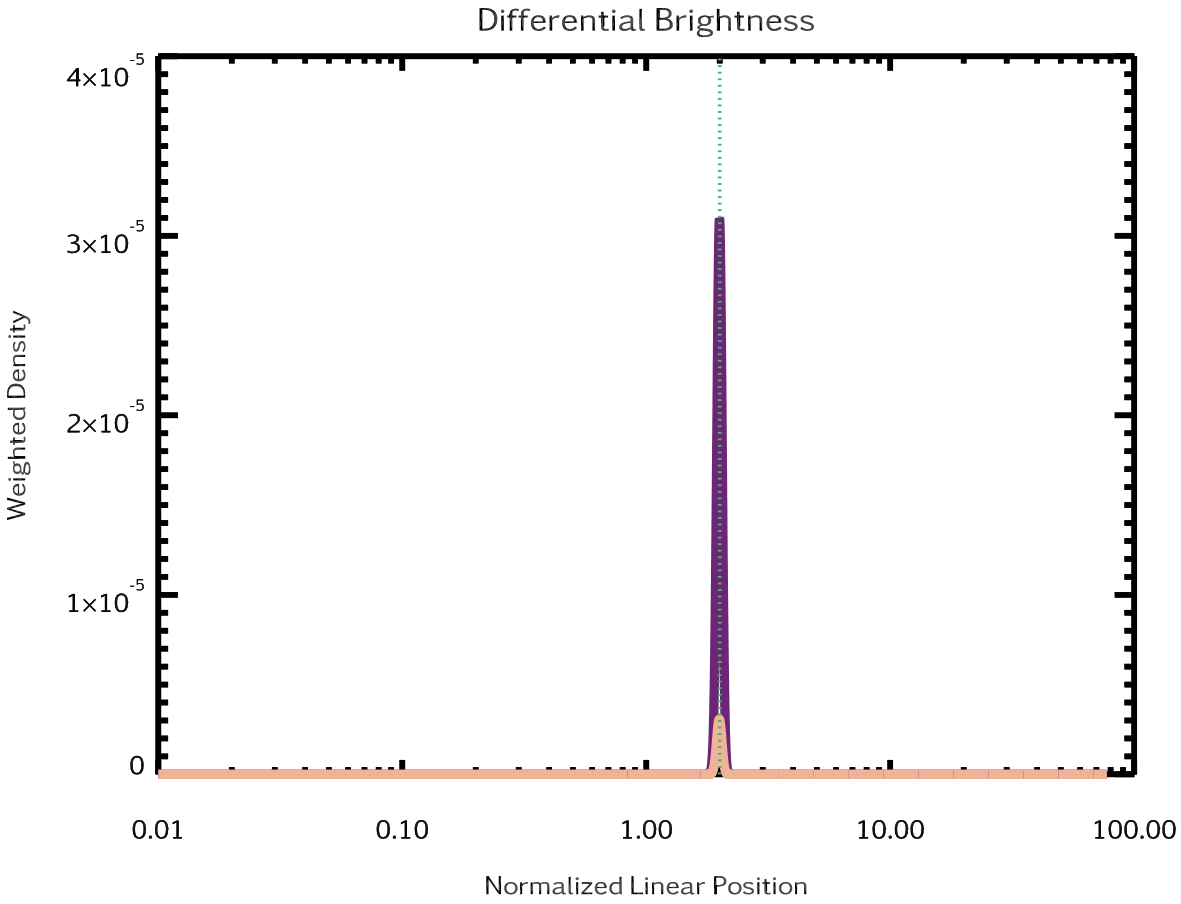
Normalized Linear Position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Weighted Density
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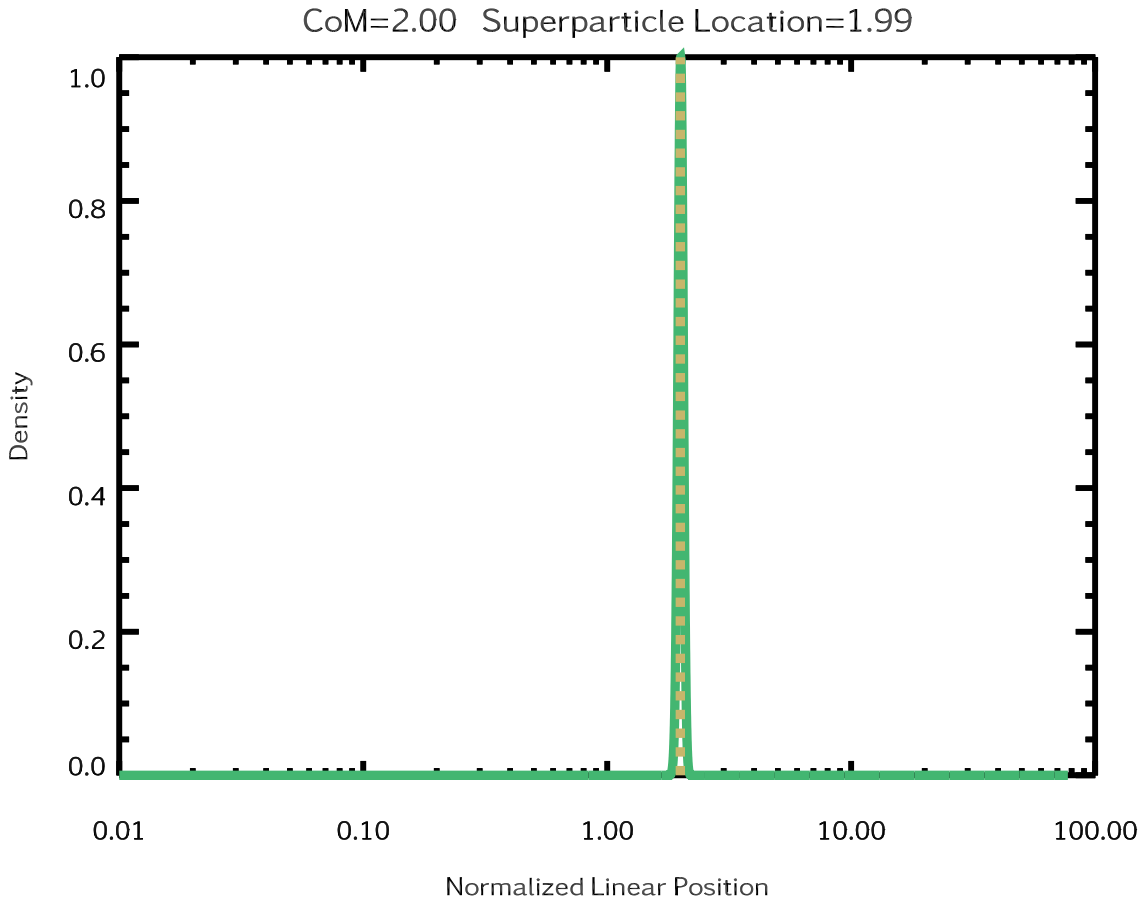
Normalized Linear Position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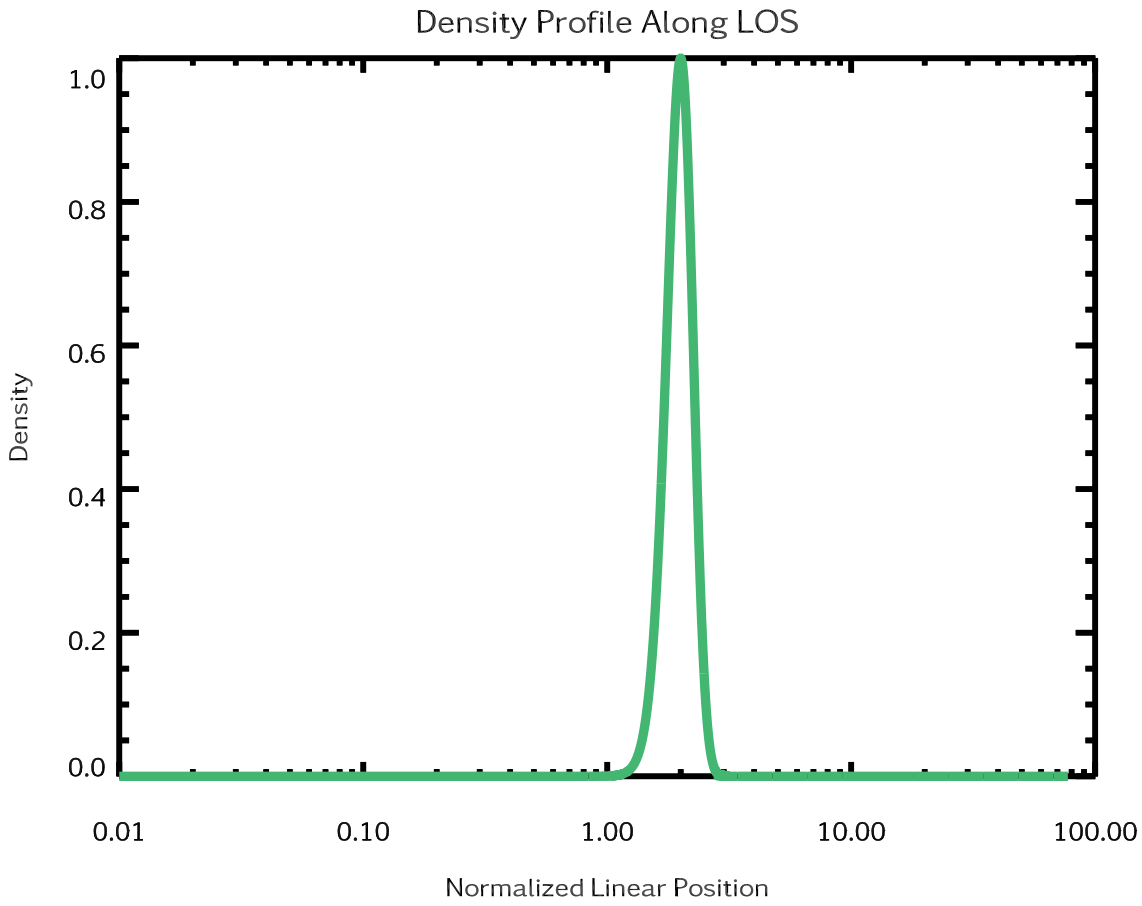
Normalized Linear Position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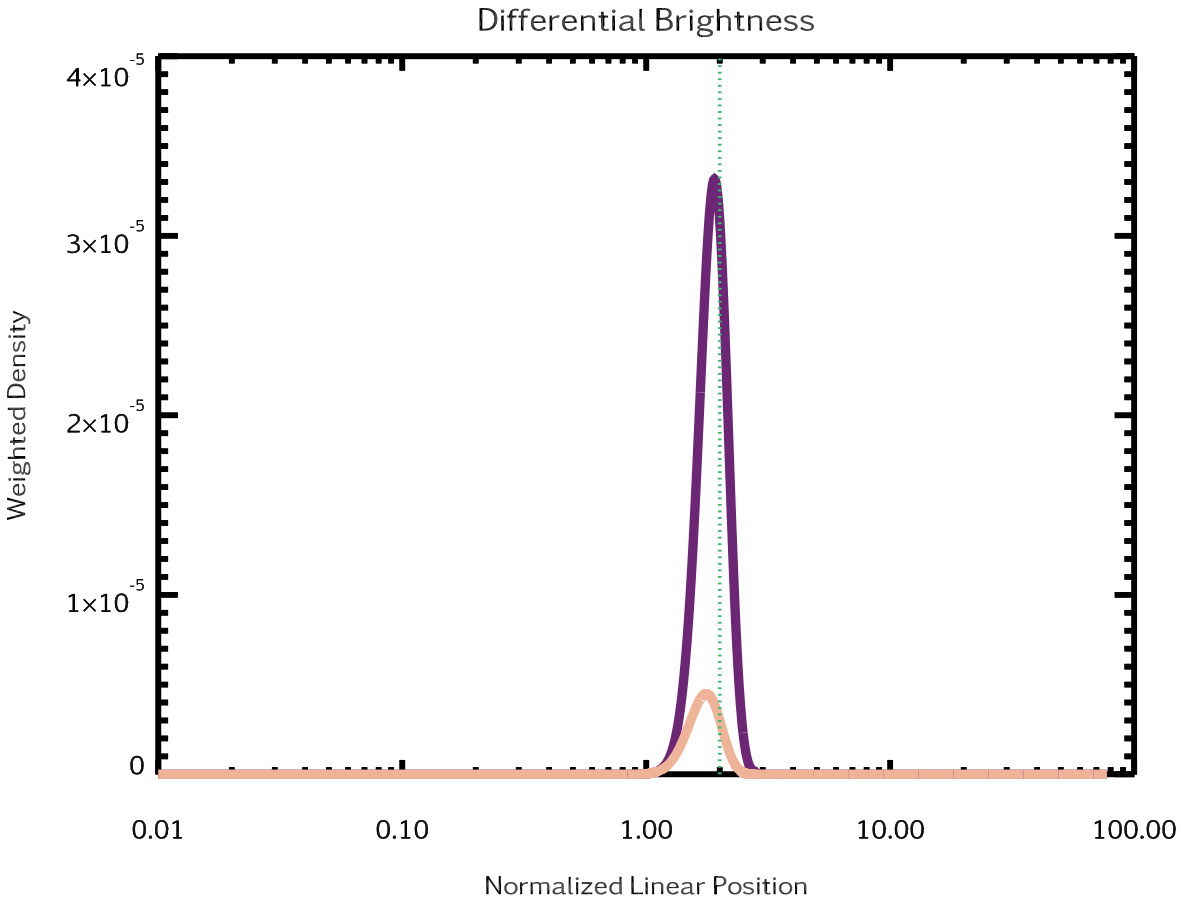
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Weighted Density
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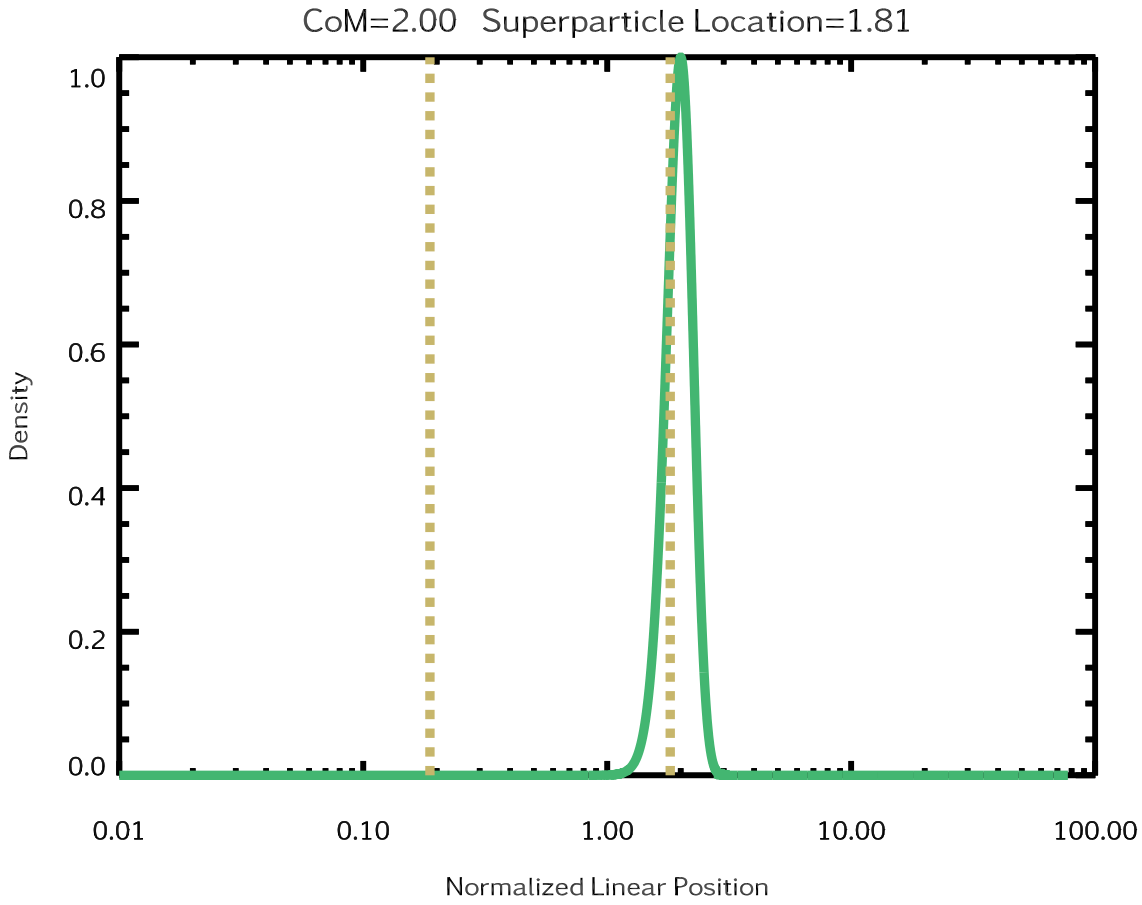
Normalized Linear Position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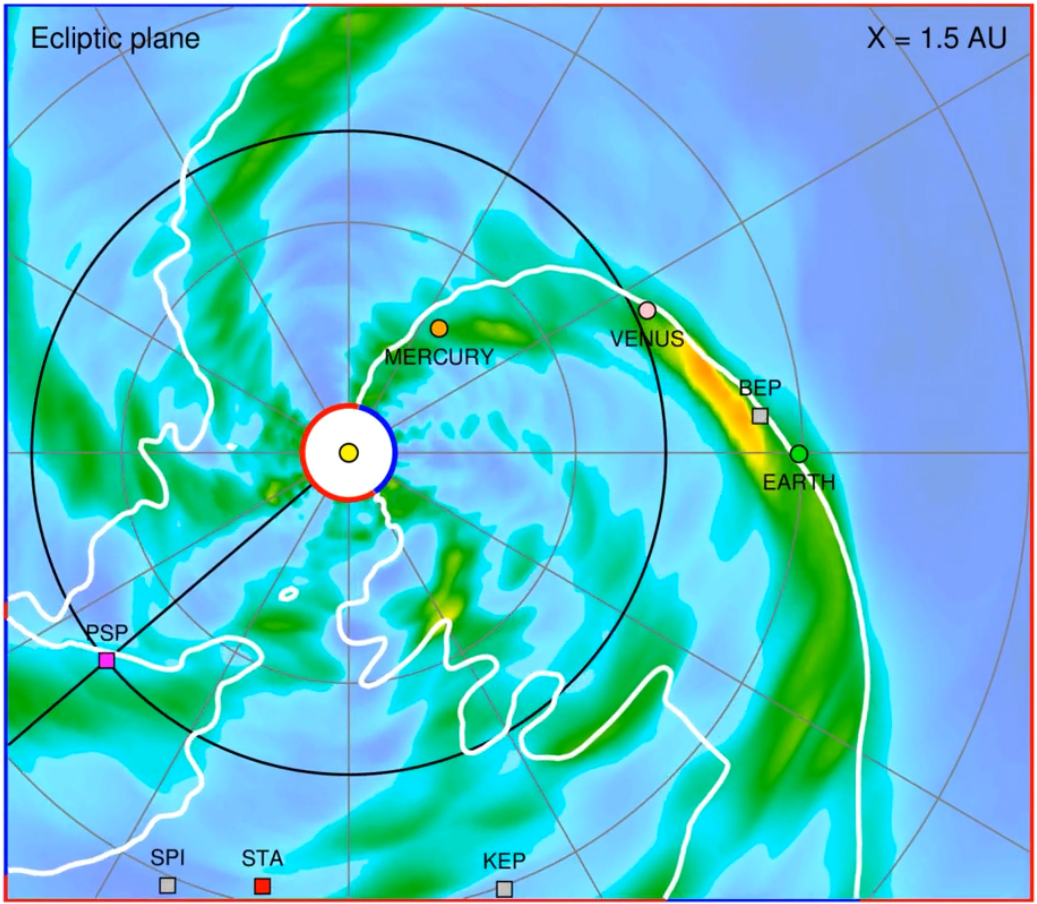
Normalized Linear Position


Ecliptic plane
X = 1.5 AU
MERCURY
VENUS
BEP
EARTH
PSP
SPI
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KEP