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A survey of corotating interaction regions observed by the STEREO HI imagers 2007 – 2010

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- Overview of a CIR
- J-maps and fixed-β fitting
- STEREO HIs do not observe all CIRs present in in-situ data
  - Possible reasons for this
- Discussion of outstanding issues and further work

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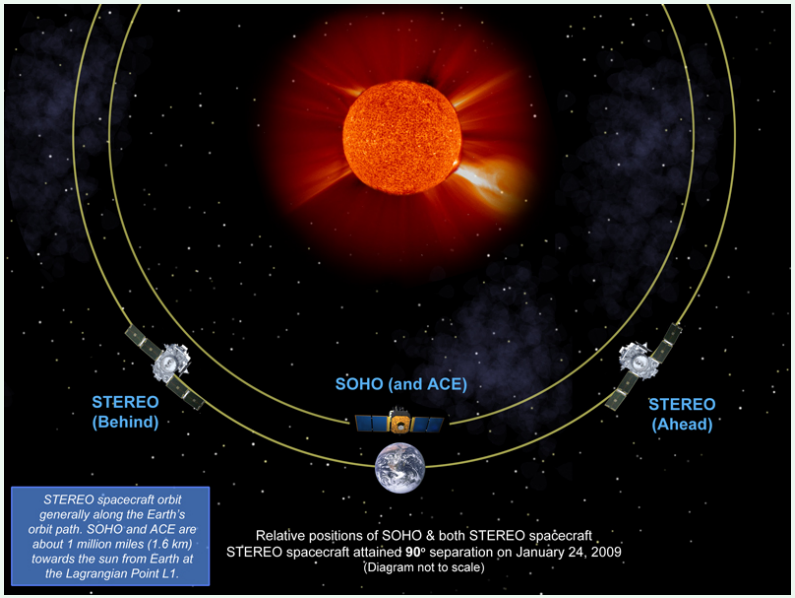
The STEREO mission

- STEREO A (Ahead)
- STEREO B (Behind)
- Separate from Earth by about 22.5° per year
- Heliospheric Imagers (HI)
  - White light cameras



cse.ssl.berkeley.edu/stereo_solarwind/img/newsFolder/article_09_01_28_pic1.jpg (11/01/2012)

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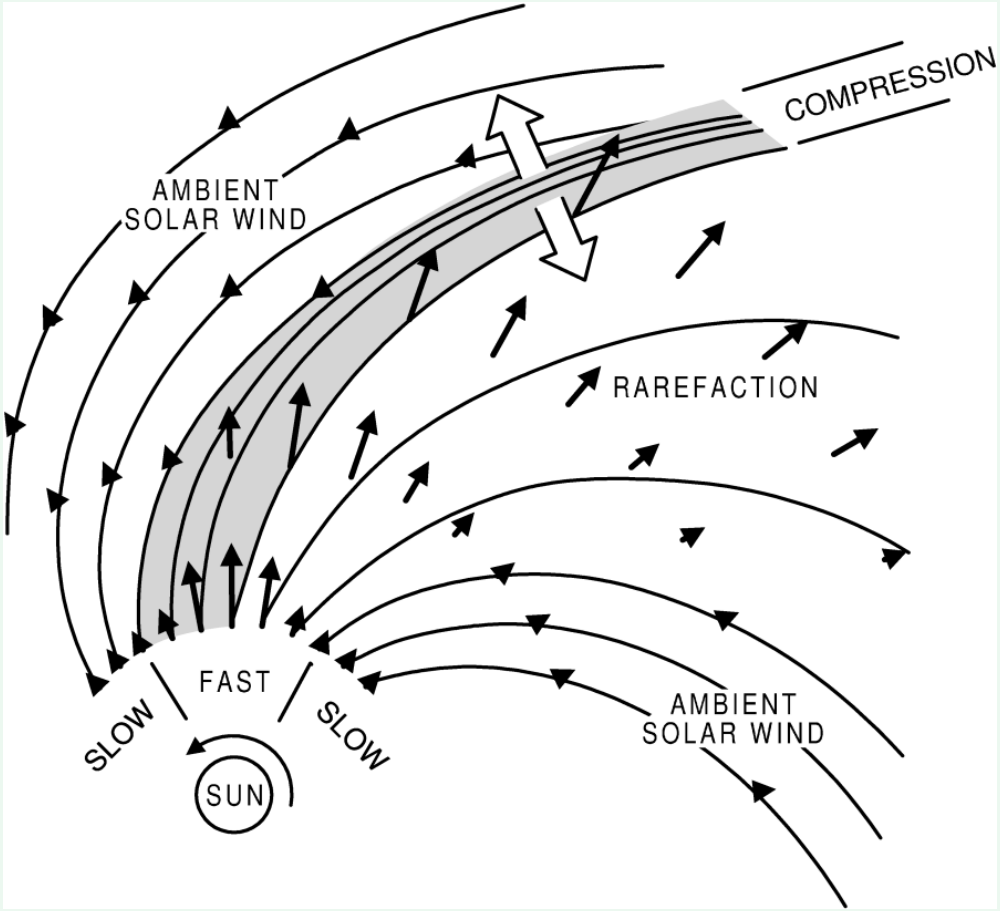
Overview of a corotating interaction region (CIR)



Gosling and Pizzo (1999)

- Two dominant solar wind speeds:
  - Fast: ≈ 700 km s^{-1}
  - Slow: ≈ 350 km s^{-1}
- Interactions between these form CIRs
- Seen as enhancements in density and velocity
- Easier to see during solar minimum

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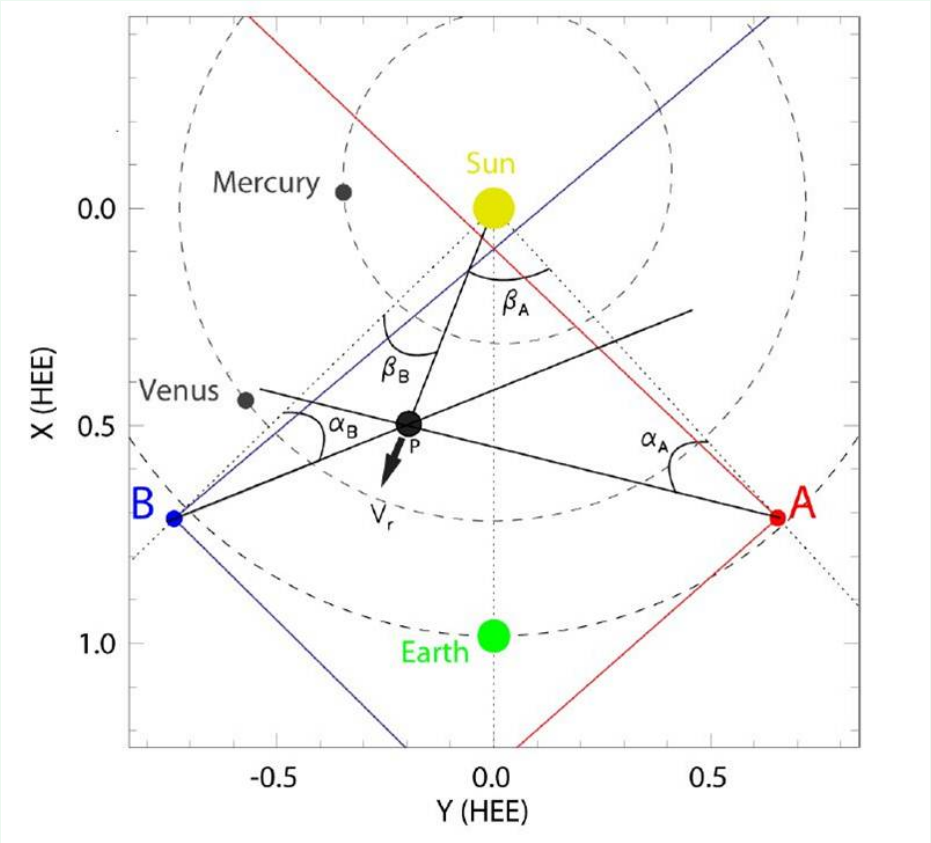
Fixed-β (or fixed-φ) fitting

$$\alpha(t) = \frac{V_r t \tan^{-1}\beta}{r_{sc}(t) - V_r t \cos\beta}$$

Rouillard et al., *Geophysical Research Letters*, **35**, 2008

- α: elongation
- β: angle between Sun-spacecraft and Sun-plasma lines
- V_r: radial plasma velocity (assumed constant)
- t: plasma element travel time
- r_{sc}: radius of orbit of spacecraft (assumed constant)
- Apparent angular acceleration



Williams et al., (2009)

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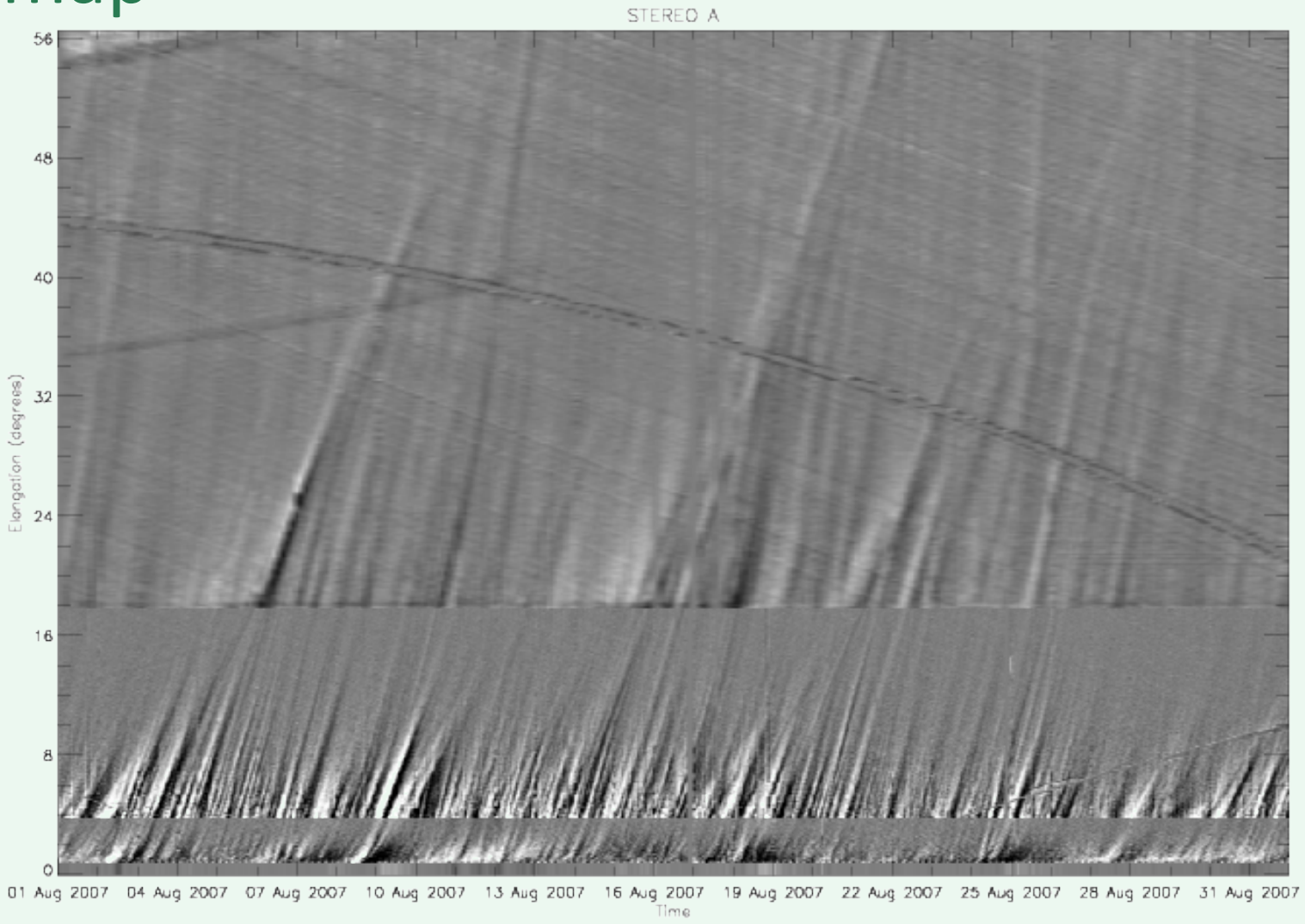
J-map



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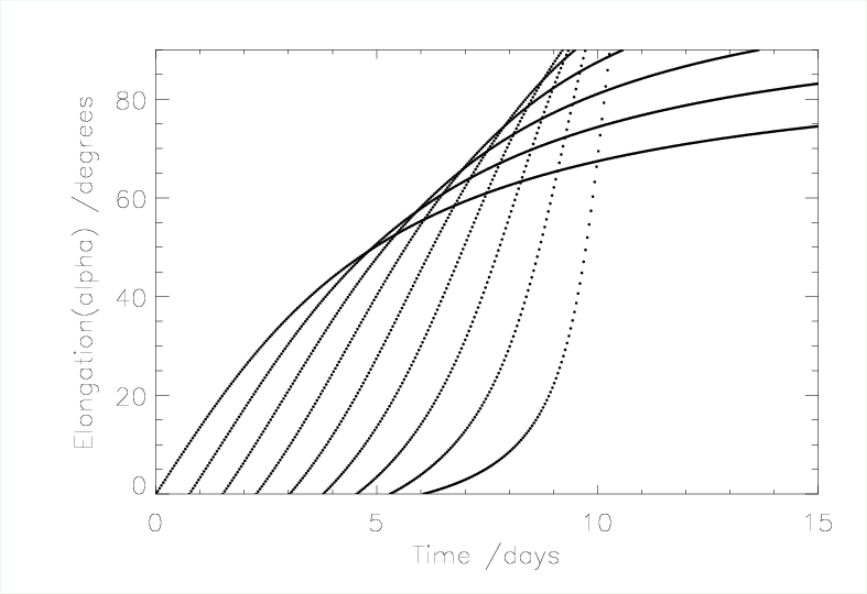
Fixed-β fitting (continued)

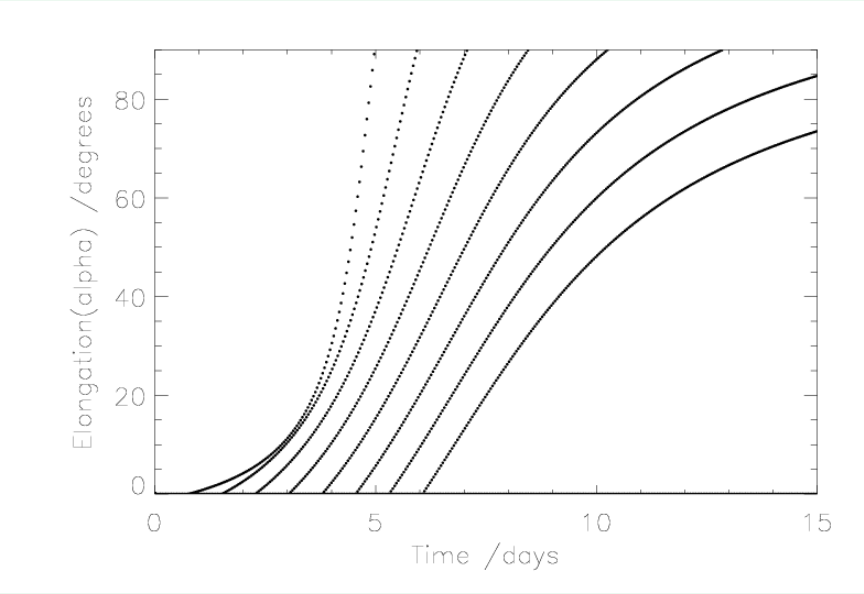
$$\alpha(t) = \frac{V_r t \tan^{-1}\beta}{r_{sc}(t) - V_r t \cos\beta}$$

- Not soluble analytically
- V_r and β are unknowns
- β: 0° - 90°

STEREO A



STEREO B



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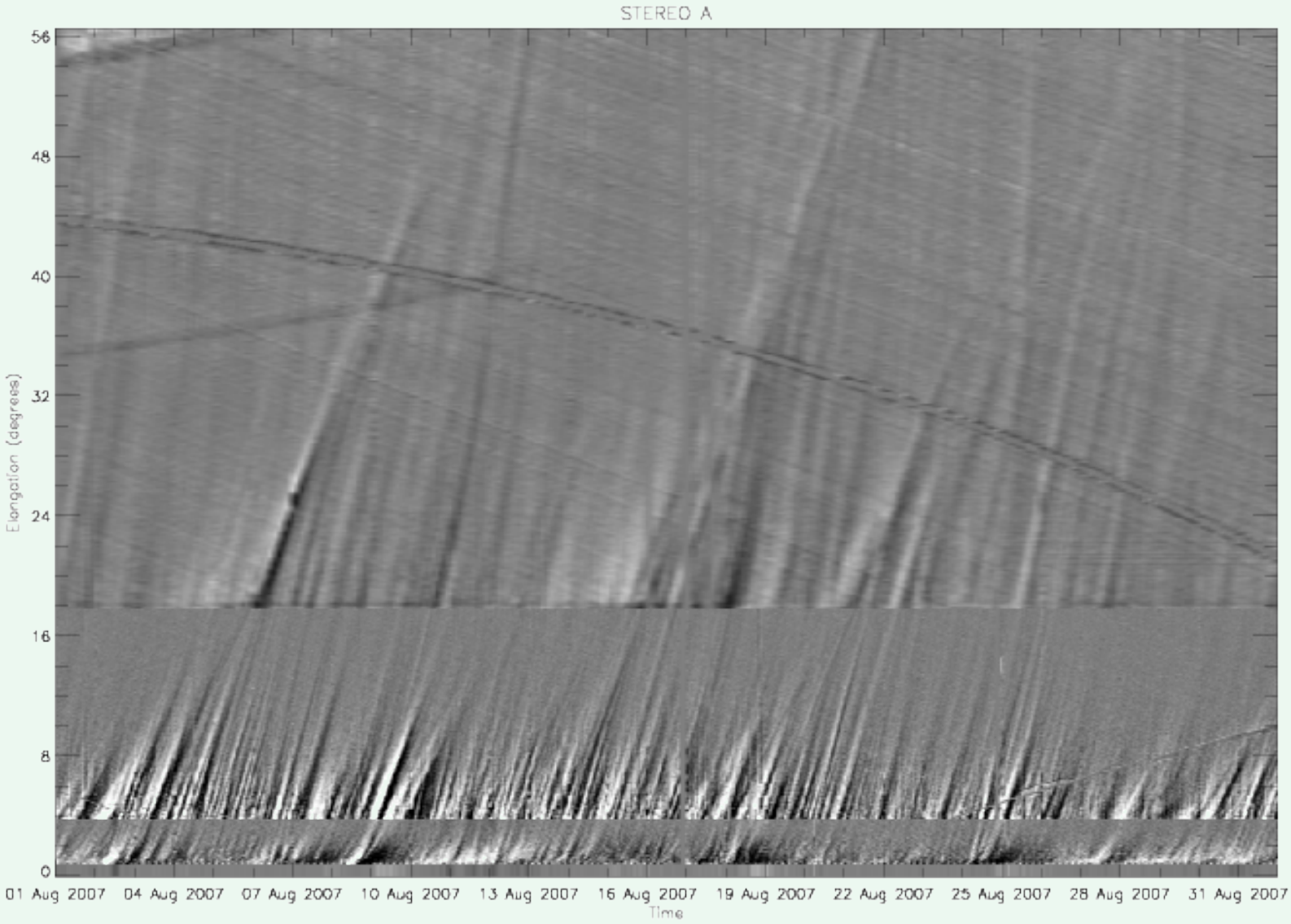

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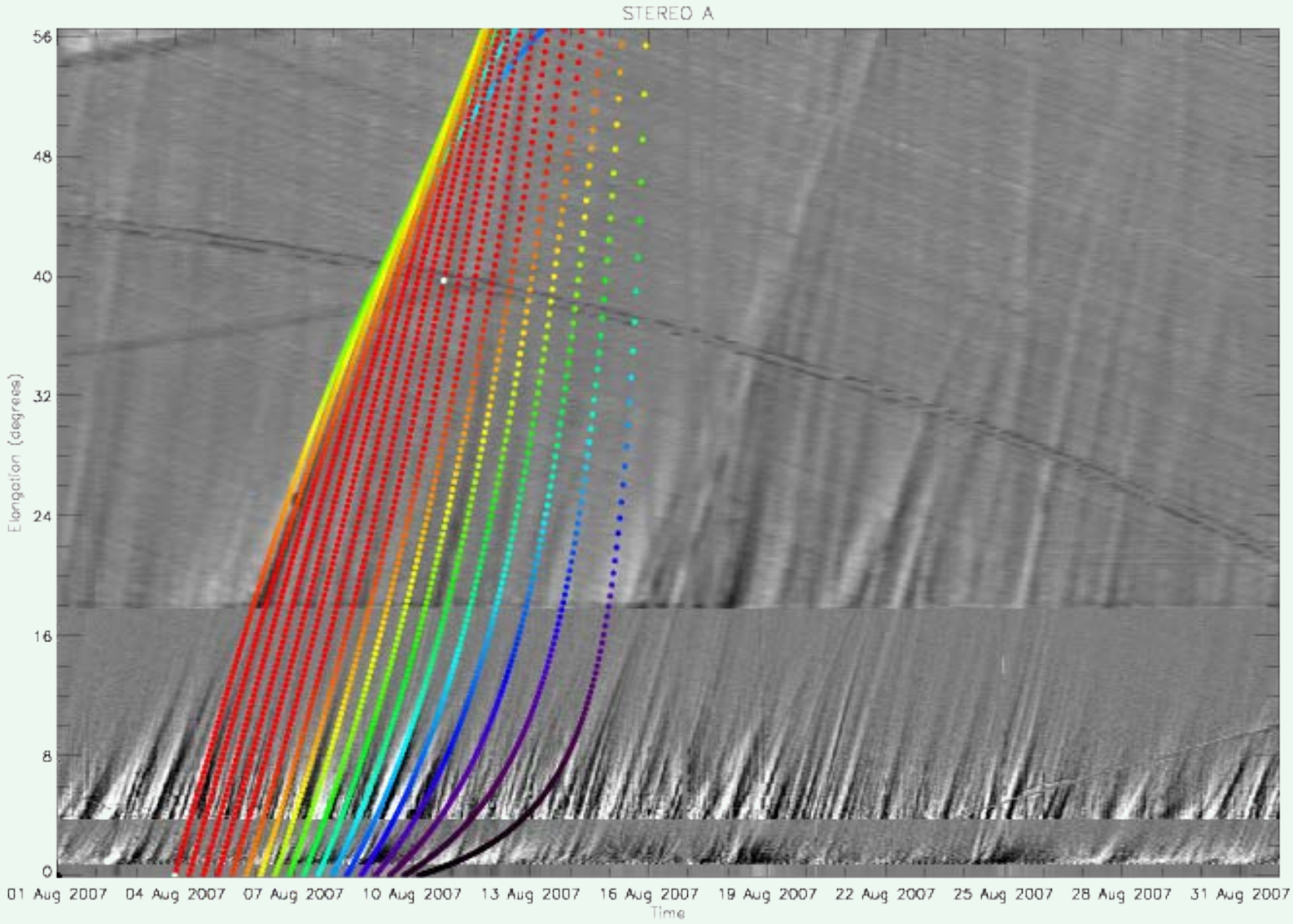

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The data

- Total of 64 events observed across both spacecraft (2007 – mid 2010)
- Time of arrival at each spacecraft ascertained
- In-situ data used from both STEREO and ACE spacecraft
- Concentrated on 42 events observed by STEREO A HI
  - STEREO B images poorer quality and hence difficult to work with directly

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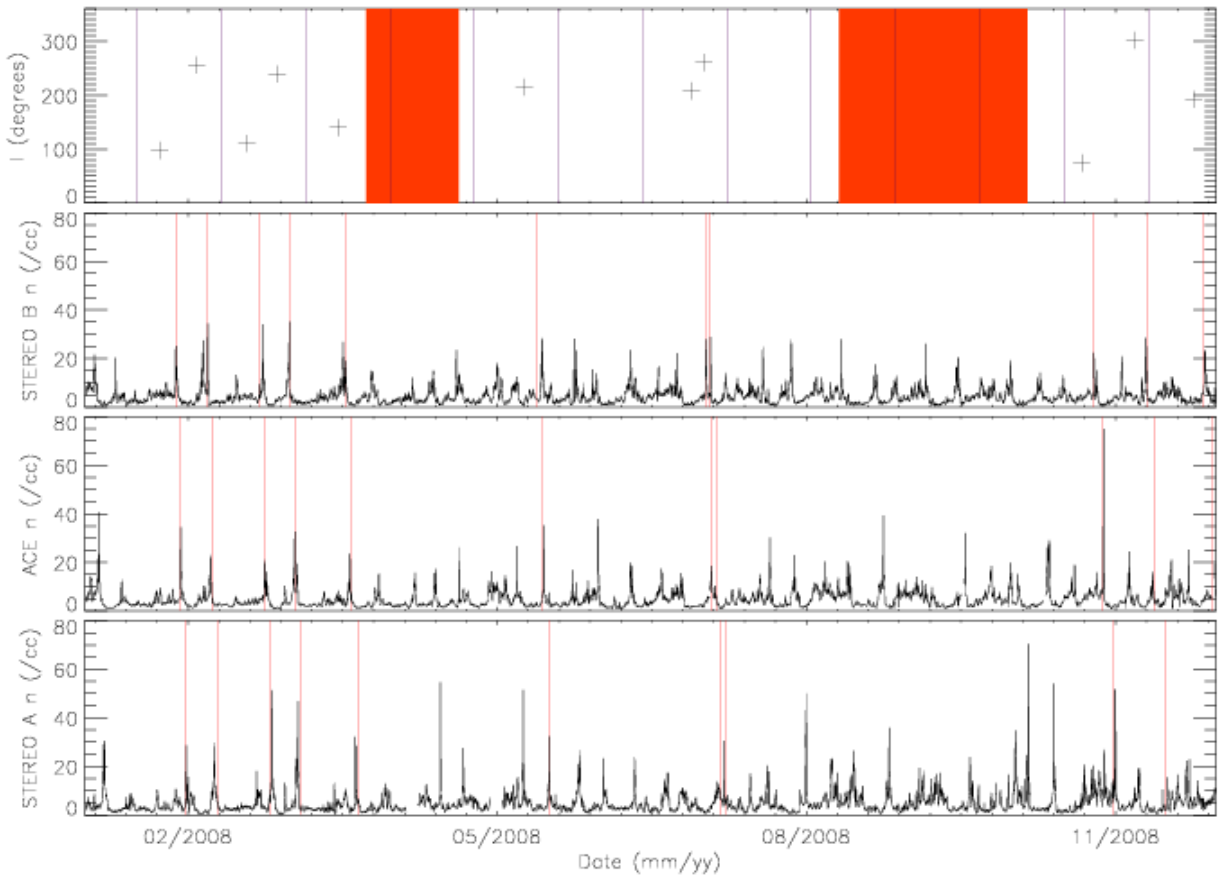
In-situ data example (density)



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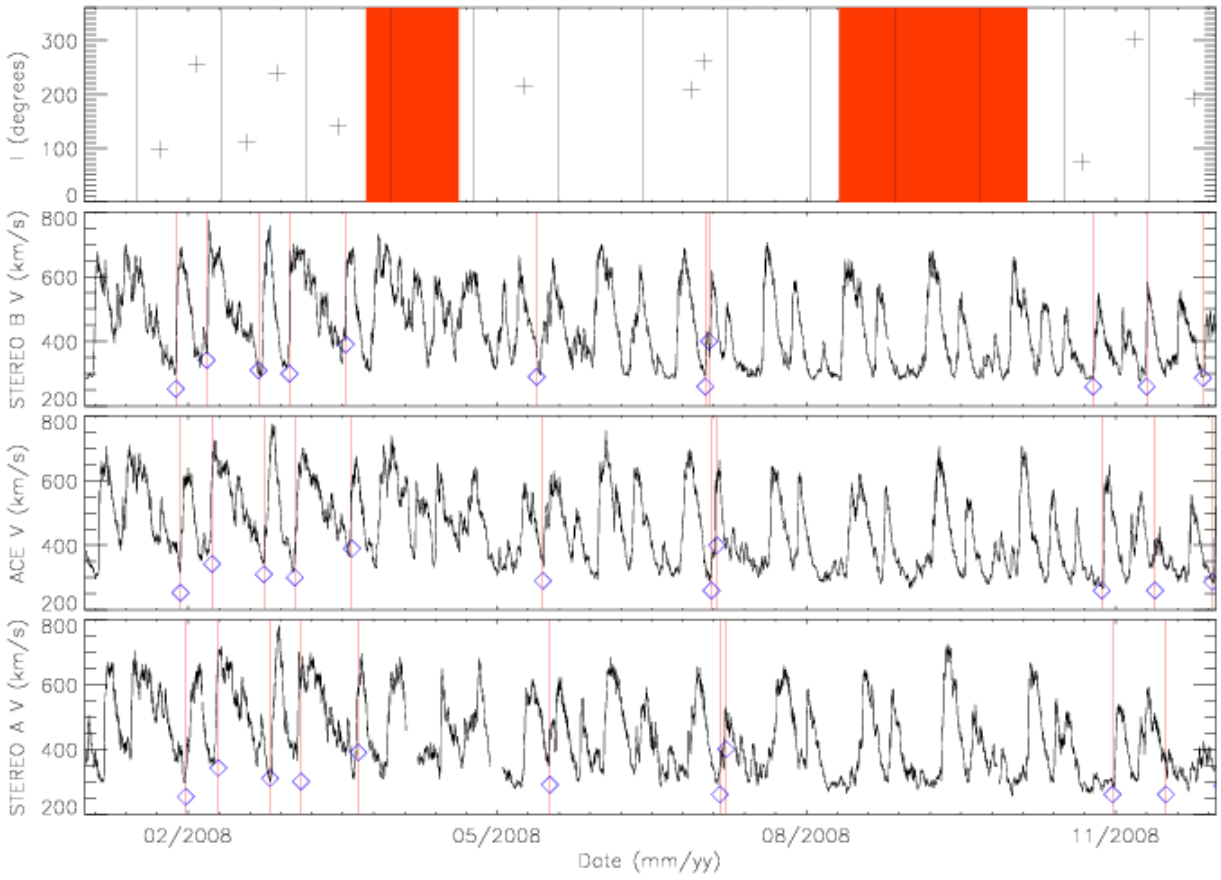
In-situ data example (velocity)



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Why aren't all CIRs seen by HI?

- Issue of density?
- Features being obscured/washed out?
- Previous studies have seen more features closer to the Sun, but fewer further into the heliosphere (Wu and Wang, (2000))
- Depends on what HI is actually observing
  - We speculate interchange reconnection between streamer and open field line (streamer blob)

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Conclusions and discussion of outstanding issues and further work

- HI does not observe all CIRs, exact reasons unclear
  - Comparing measurements relating to events seen by HI with those not seen by HI
- Relevant solar rotation period needs to be ascertained
  - Neither Carrington or Synodic rotation periods completely describe rotation period of features seen
- Technique works – possible to predict CIR arrival times, though might become less accurate with time (greater spacecraft angular separation)
- Slow solar wind speed