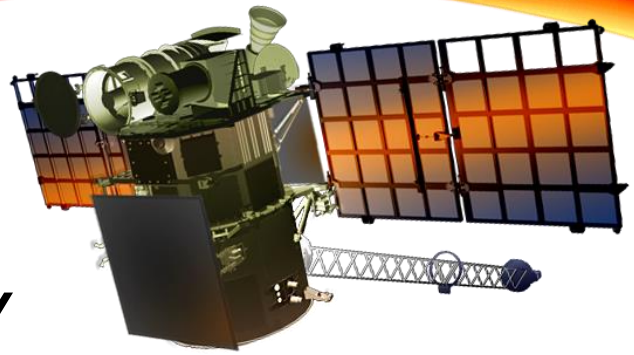


DESIGN AND EARLY OBSERVATIONS FROM THE DSCOVR SOLAR WIND FARADAY CUP

Justin Kasper (University of Michigan)

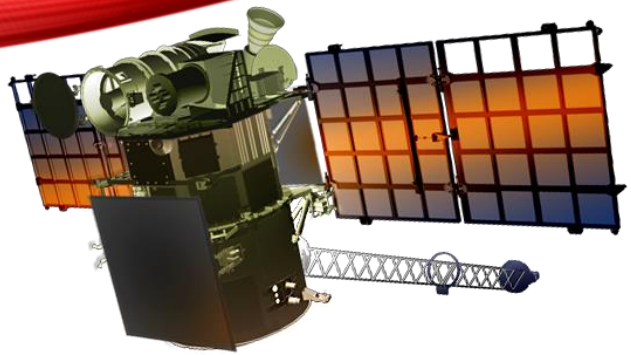
Tony Case, Mike Stevens (SAO)

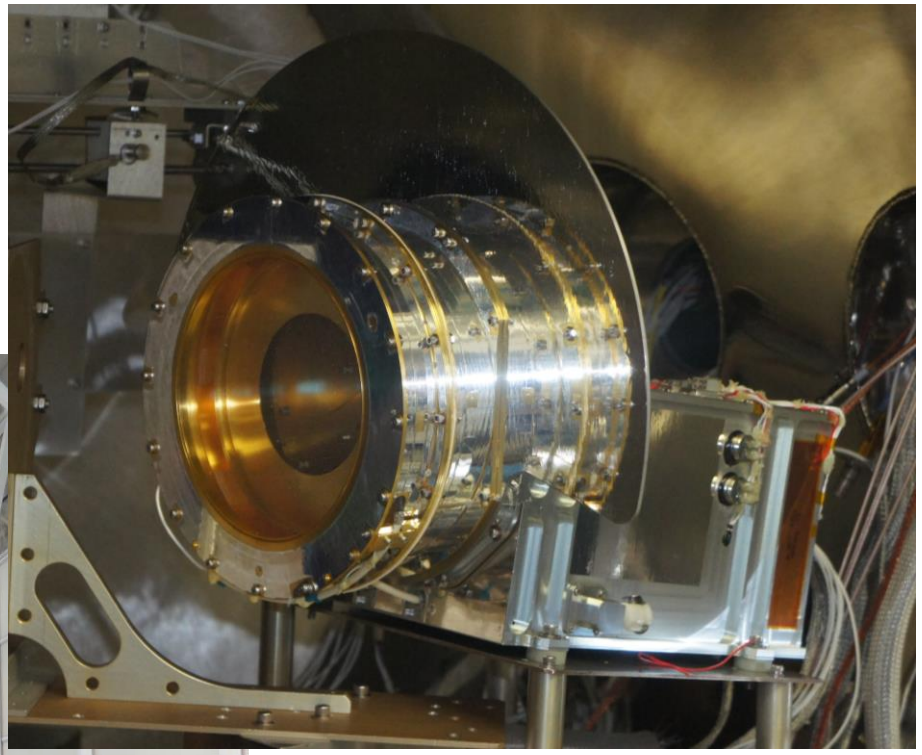
Adam Szabo, Andriy Koval (GSFC)

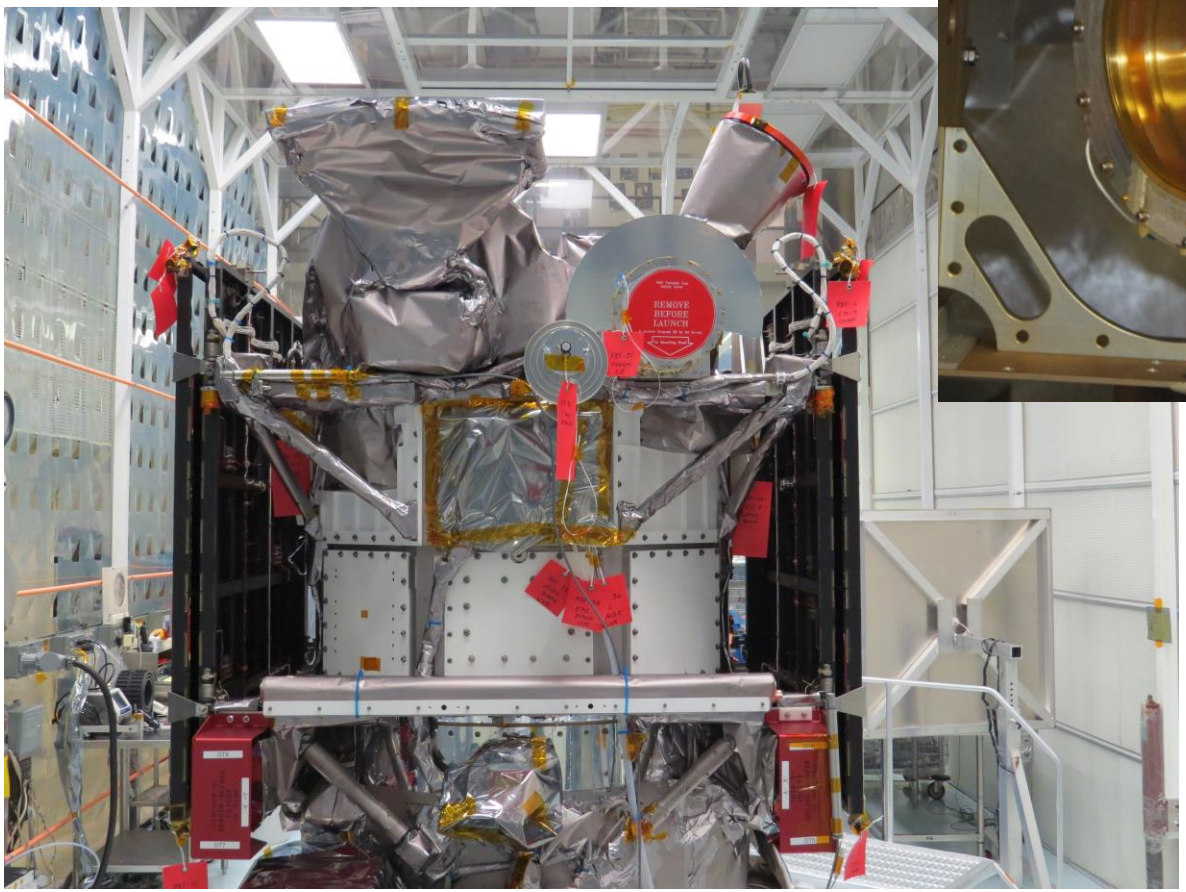
With gratitude to the incredible commissioning and operations teams at NASA and NOAA

SUMMARY

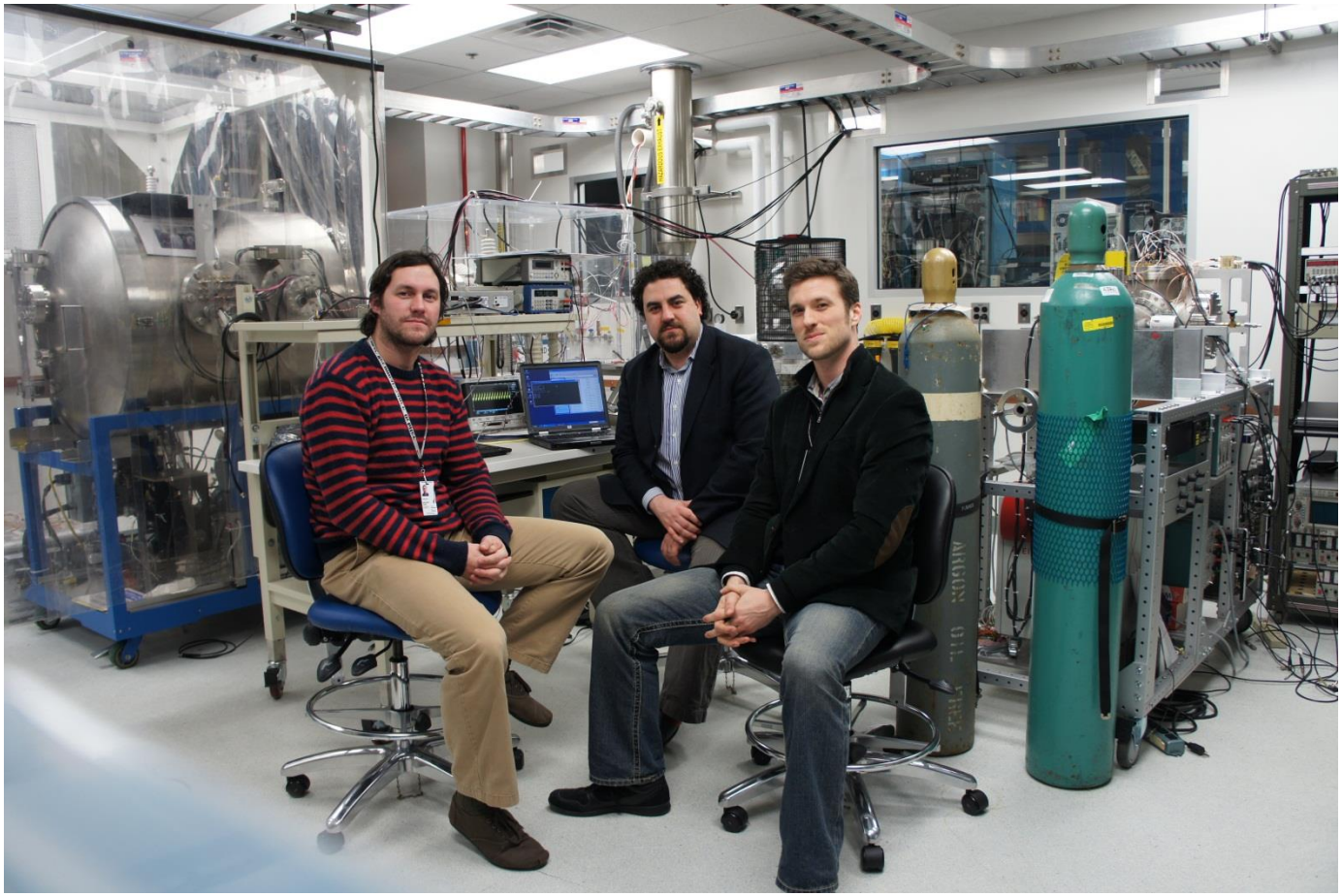
- DSCOVR/PlasMag Faraday Cup records stable and radiation tolerant measurements of solar wind velocity, density, and temperature
  - 200 – 1,200 km/s proton velocity distribution @ 3s
  - Low calibration drift ~ 0.1%/decade
  - Insensitive to ionizing radiation
- Status
  - Completed: HV ramp up, software patches, performance optimization
  - Entered optimized performance configuration in April
  - Monitoring performance, calibration, working an improvement to tracking software
- Examples here
  - Raw data, shocks, Wind-comparison, magnetic reconnection, science result: solar wind is colder than we thought!






REMOVE
BEFORE
LAUNCH

FARADAY CUP TEAM



- Left: Tony Case (SAO), hardware lead
- Middle: Justin Kasper (Michigan), instrument lead
- Right: Michael Stevens (SAO): software lead

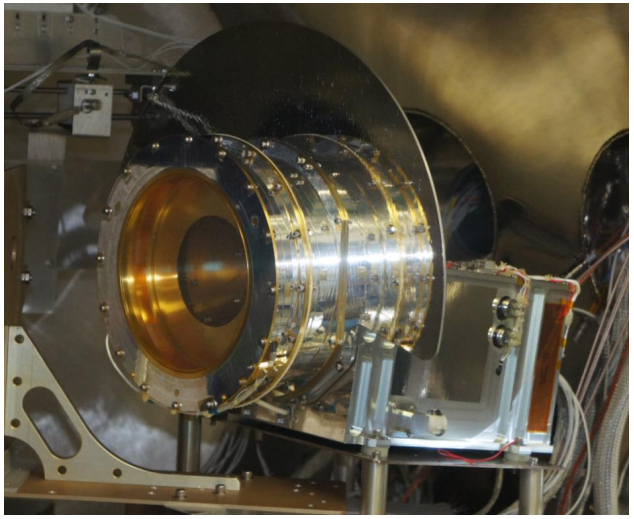
ITS BEEN A WHILE!

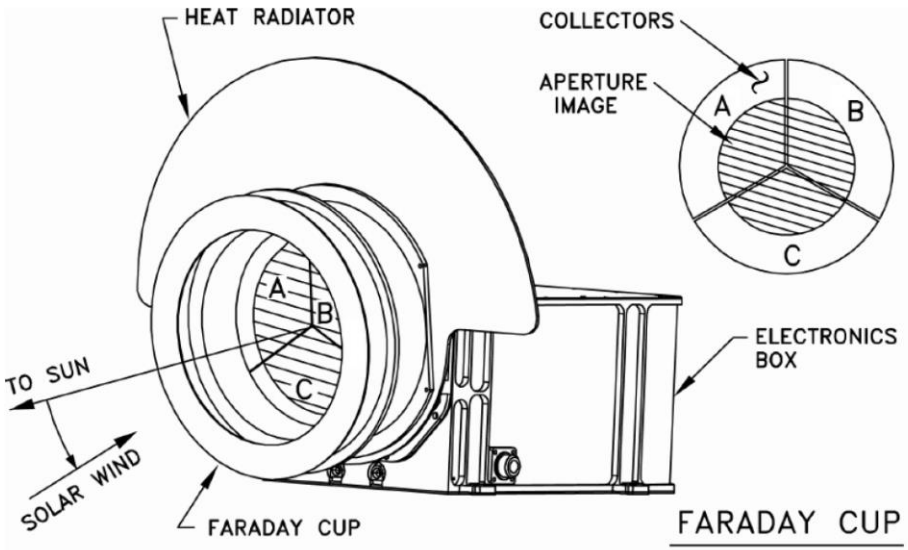
DSCOVR/FC conceived and led by Dr. Alan Lazarus

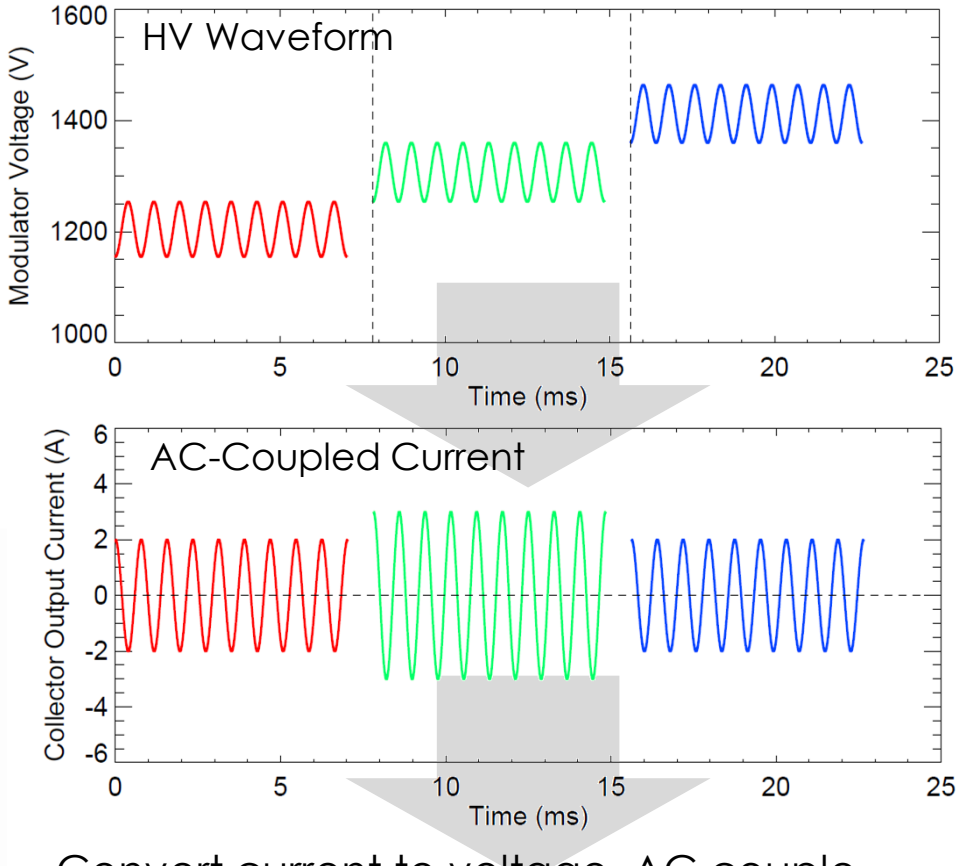
Fabricated from spare parts procured in 1988 for Wind/FC

Intended in part as technology demonstrator for Solar Probe

CONCEPT OF OPERATIONS

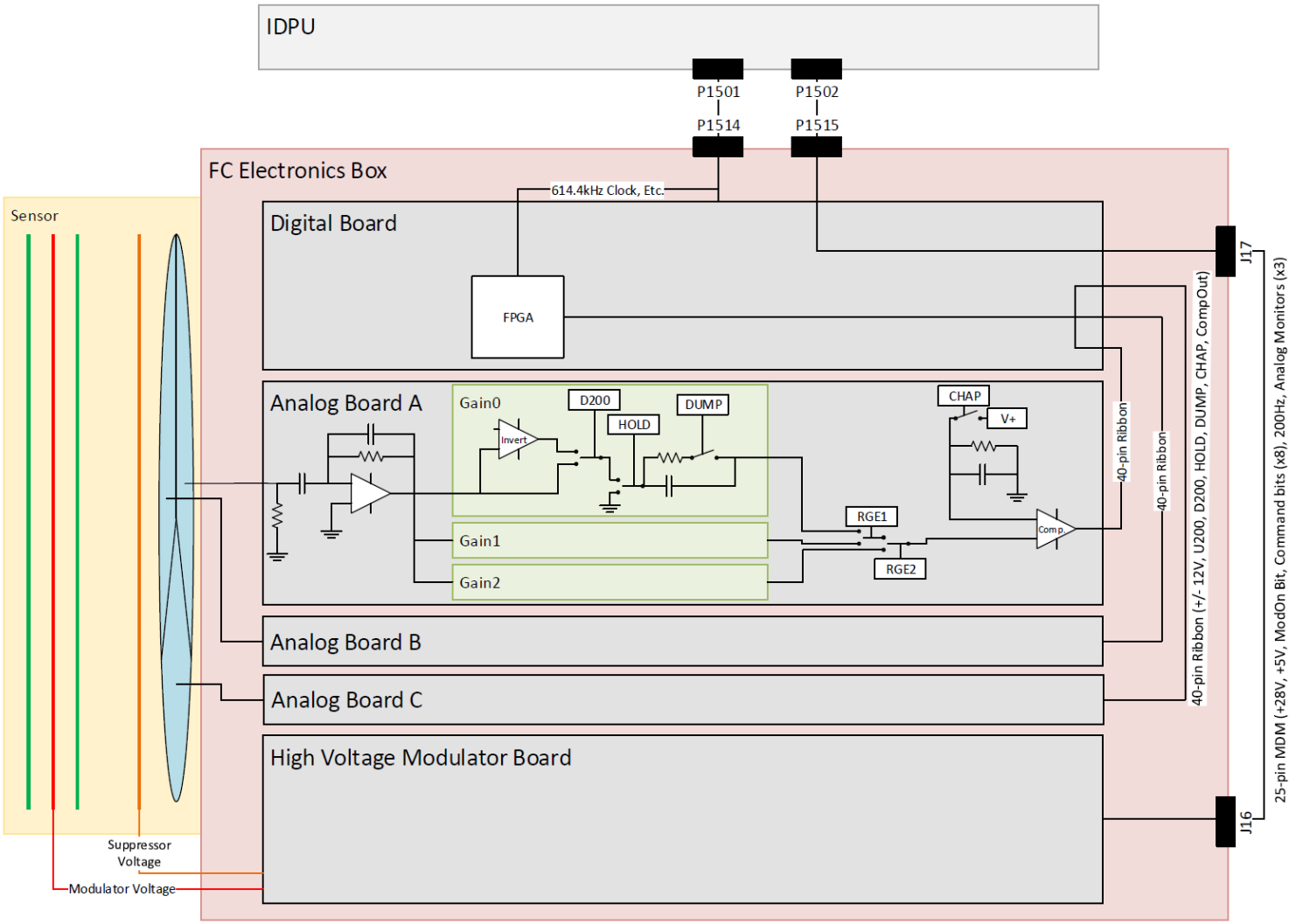






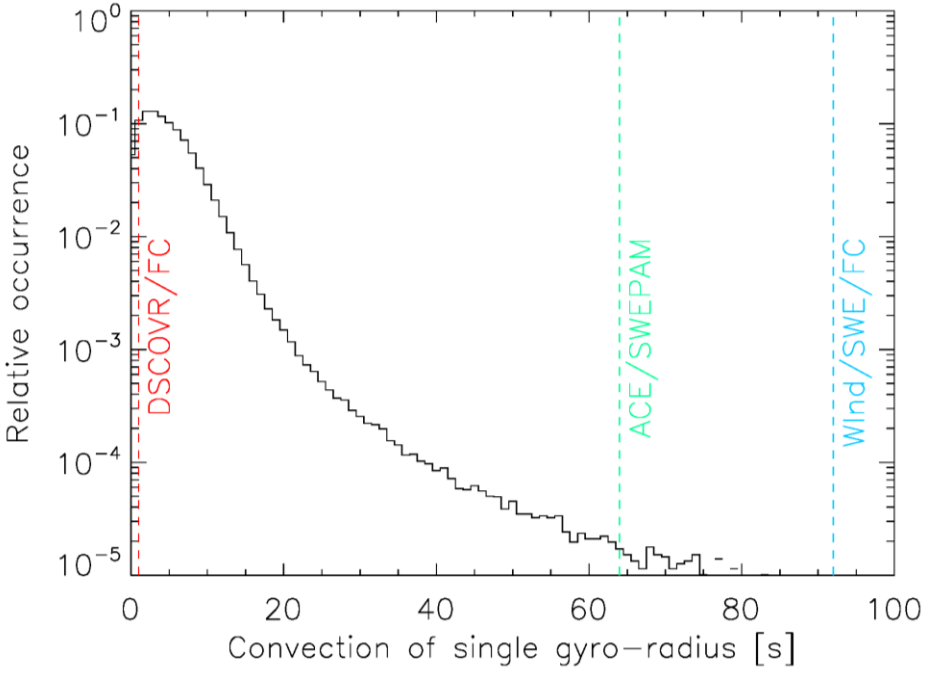
Convert current to voltage, AC couple, invert half the signal and integrate
Digitize log of integrated current
Move on to next energy window

BLOCK DIAGRAM

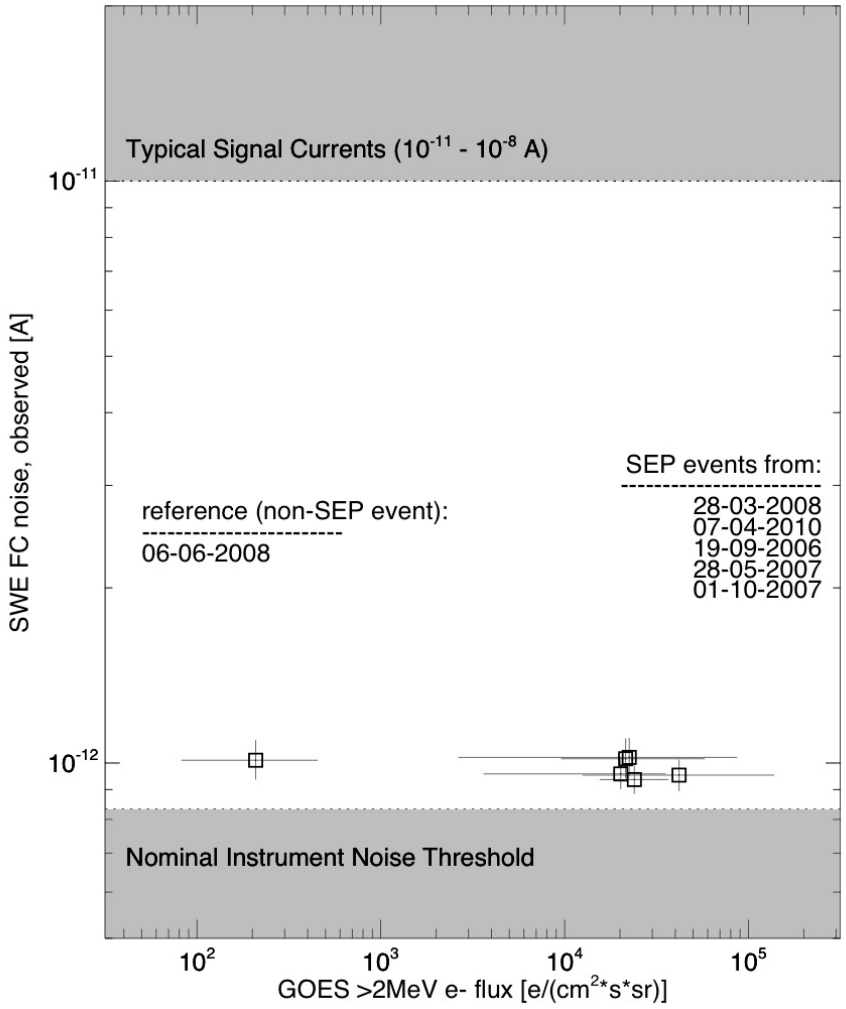


THE FARADAY CUP IS FAST!

- DSCOVR/FC can generally resolve plasma and field structure smaller than a single convected proton gyro-radius in the solar wind
- This high cadence permits robust solar wind determination with filtering for space weather, but it also permits unique new science
  - Shocks
  - Waves
  - Magnetic reconnection

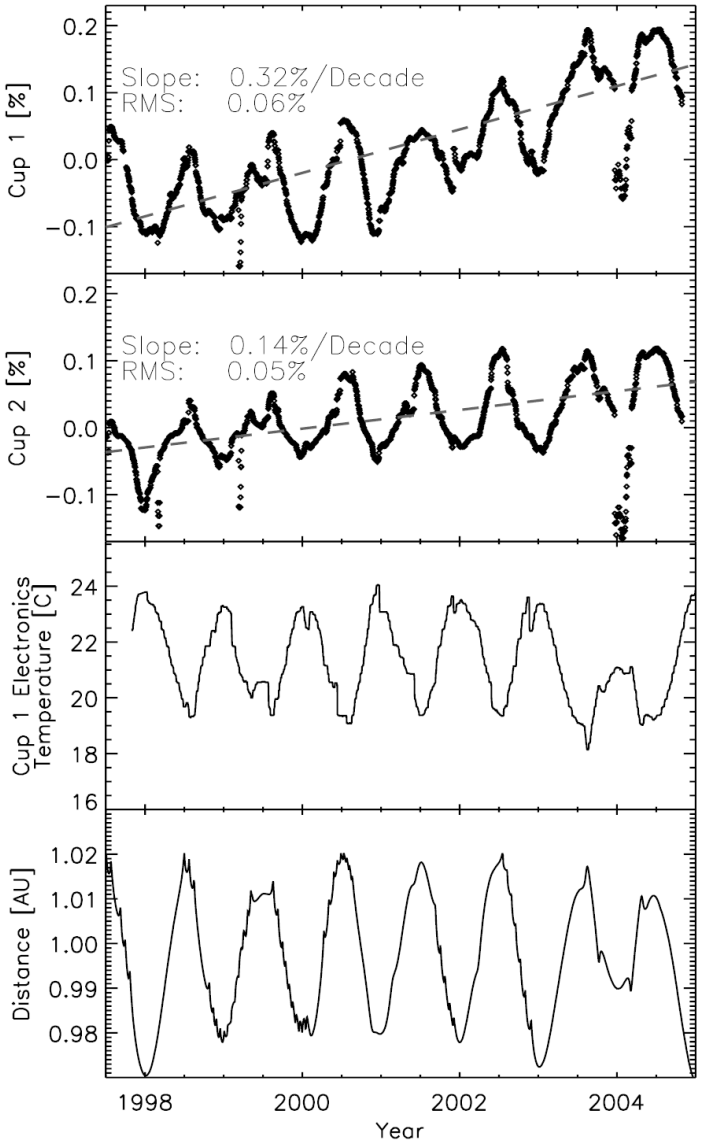


RADIATION TOLERANT



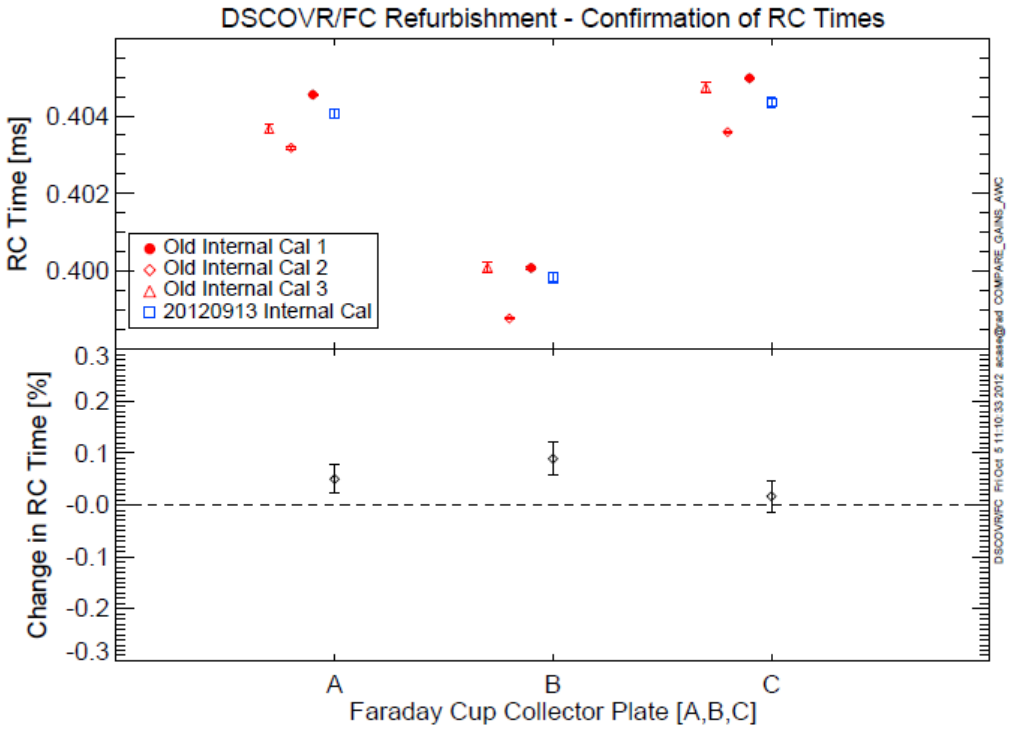
- Faraday Cup detectors are just metal plates – no radiation damage
- Synchronous detection means ionizing radiation doesn't generate detectable signal
- Surveys with Wind Faraday Cup instrument background show no trend with SEP flux (yes, understand GOES wasn't a good choice for this graphic)

RESPONSE IS VERY STABLE



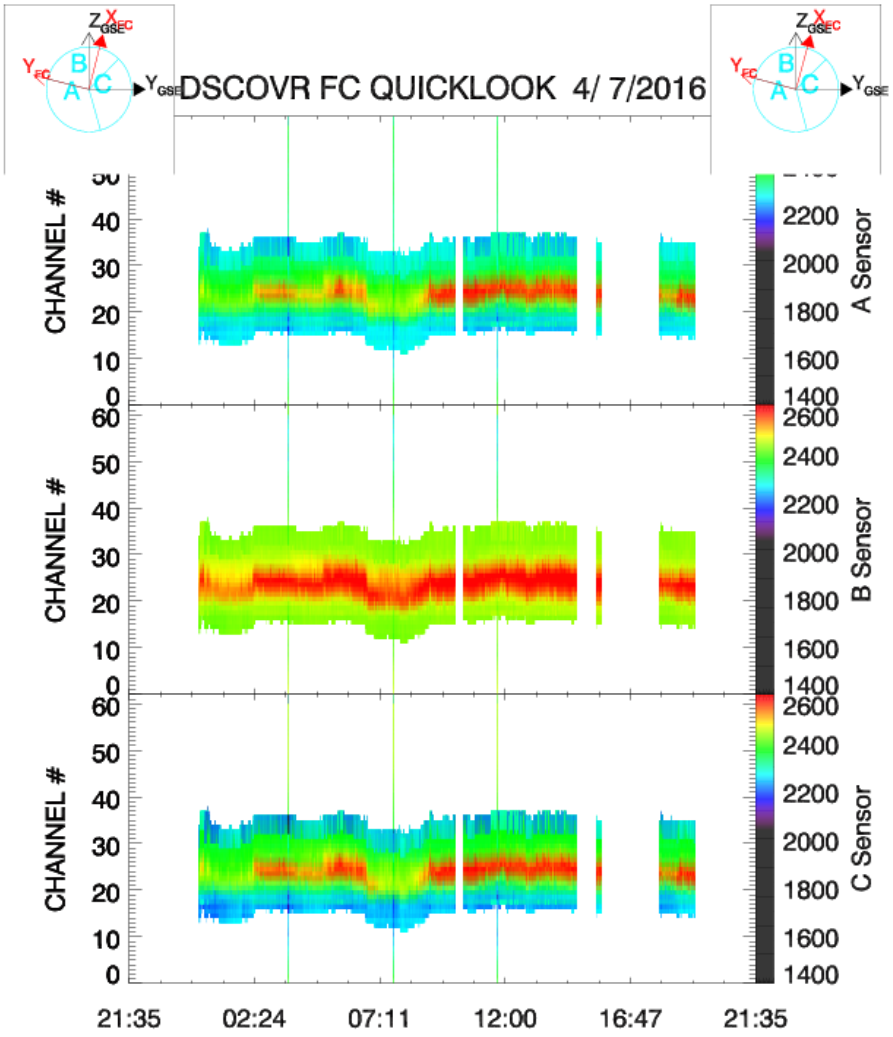
DSCOVR/FC < 0.1% drift in calibration between 2001 and 2015 (Below)

Consistent with Wind/FC in flight stability (Left; Kasper et al, 2005)

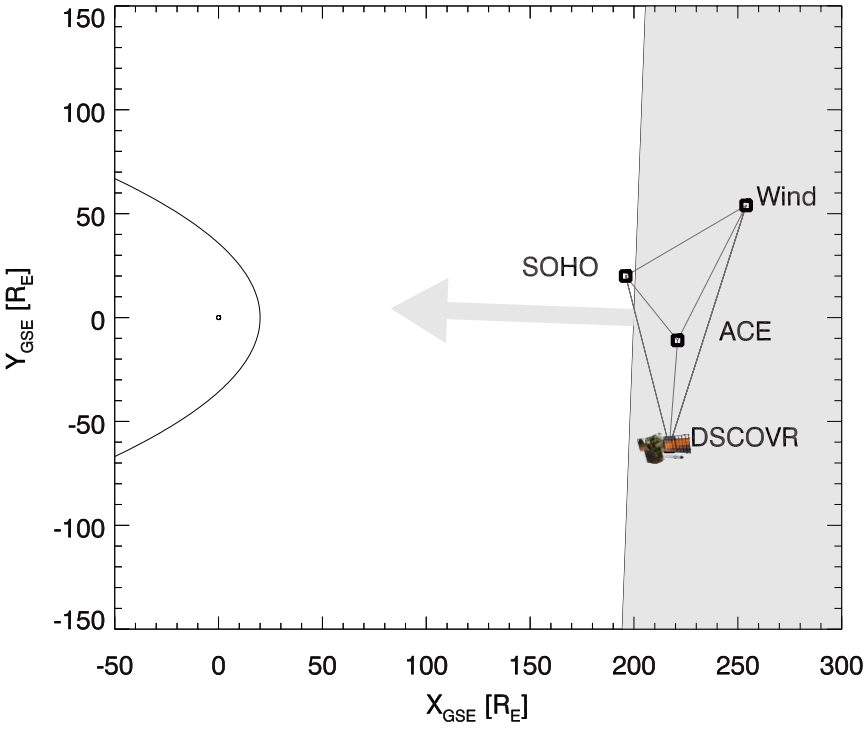


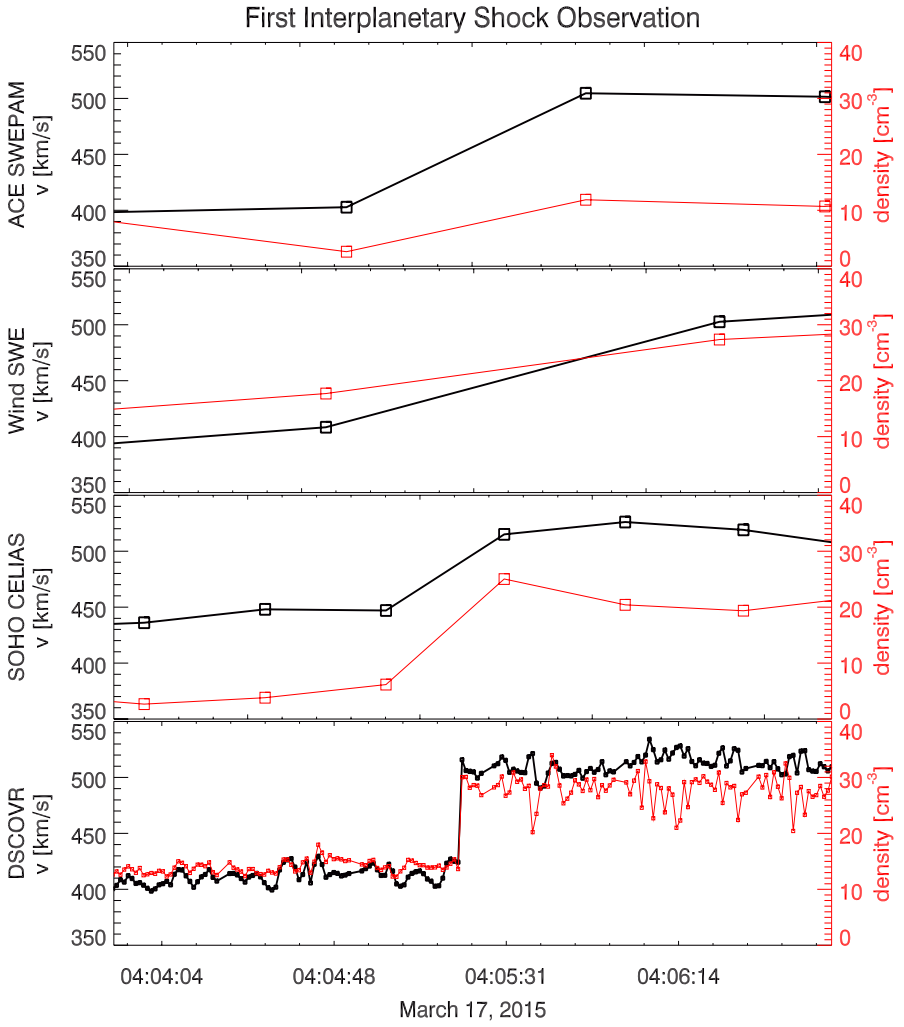
INITIAL OBSERVATIONS

RAW DATA – VELOCITY SPECTRA

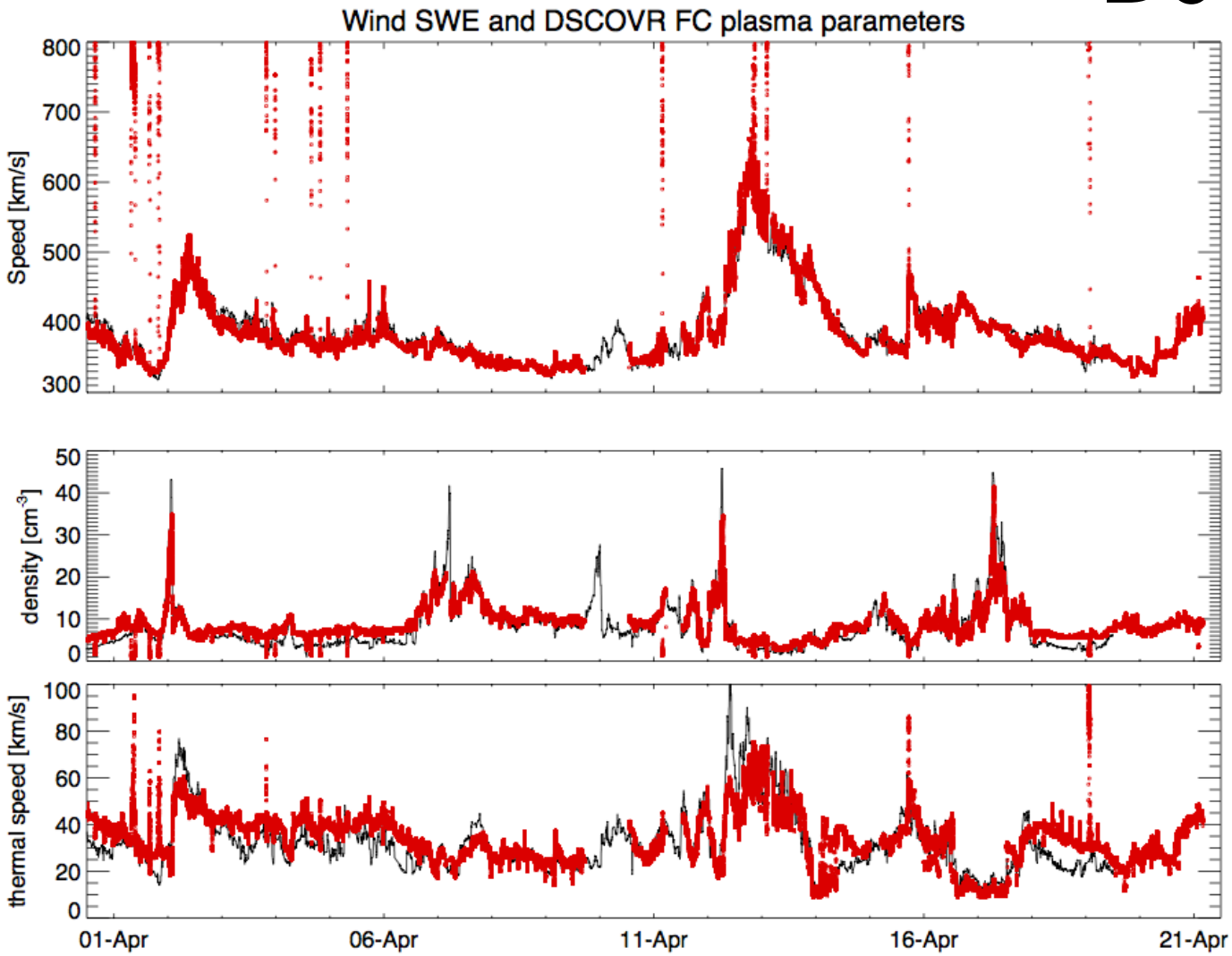


OUR FIRST SHOCK

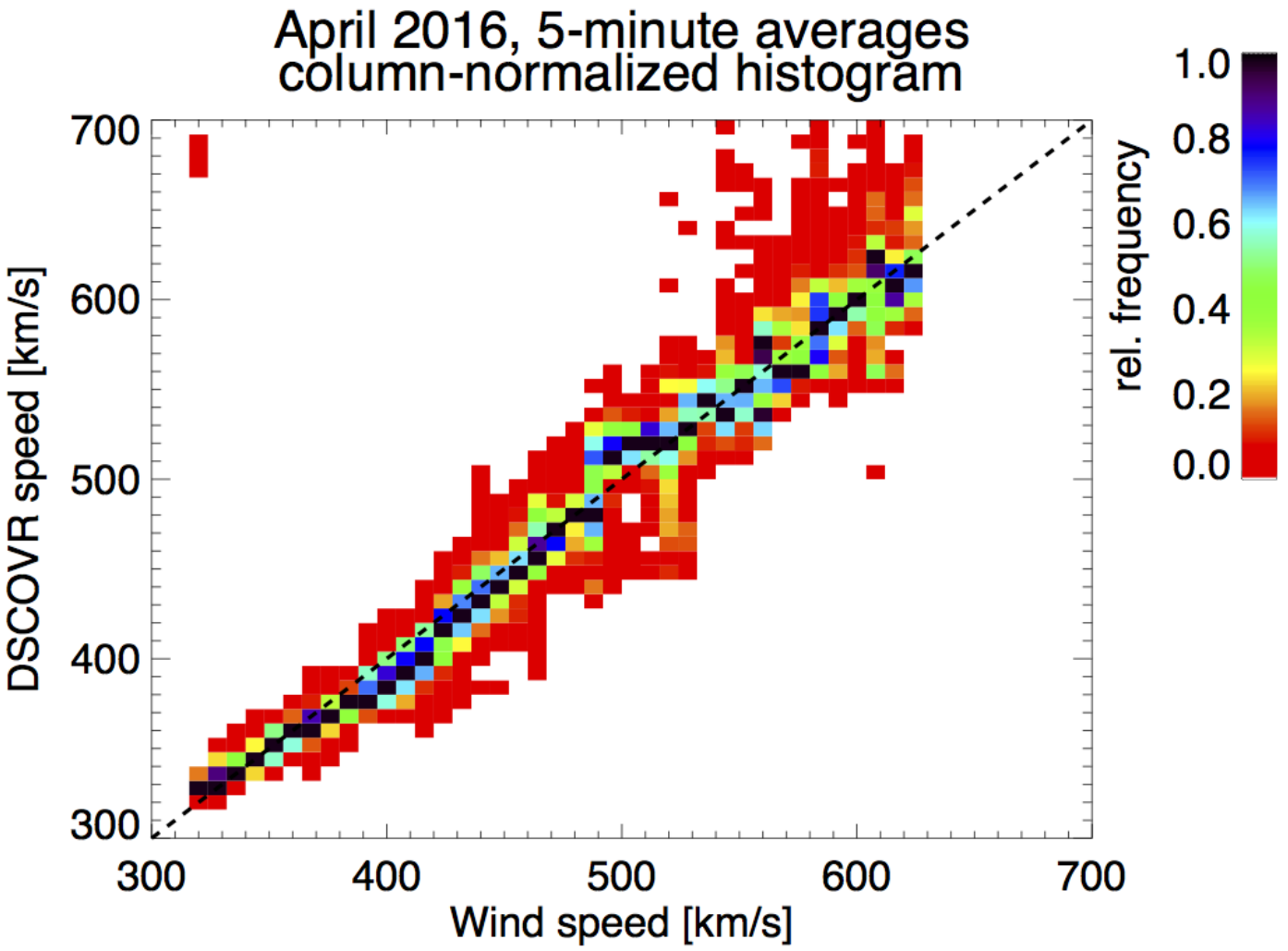




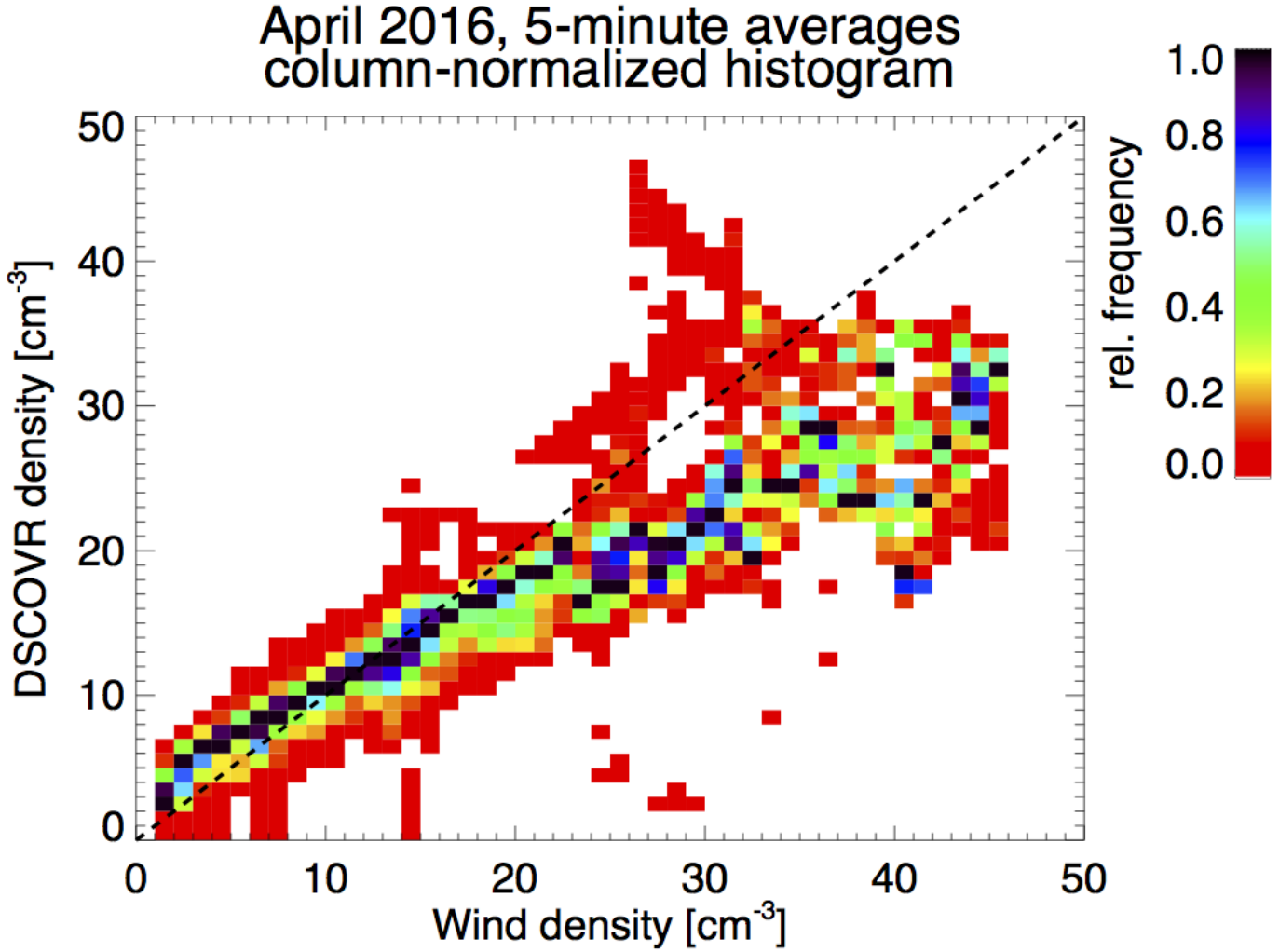
LAST 30 DAYS WIND AND DSCOVR



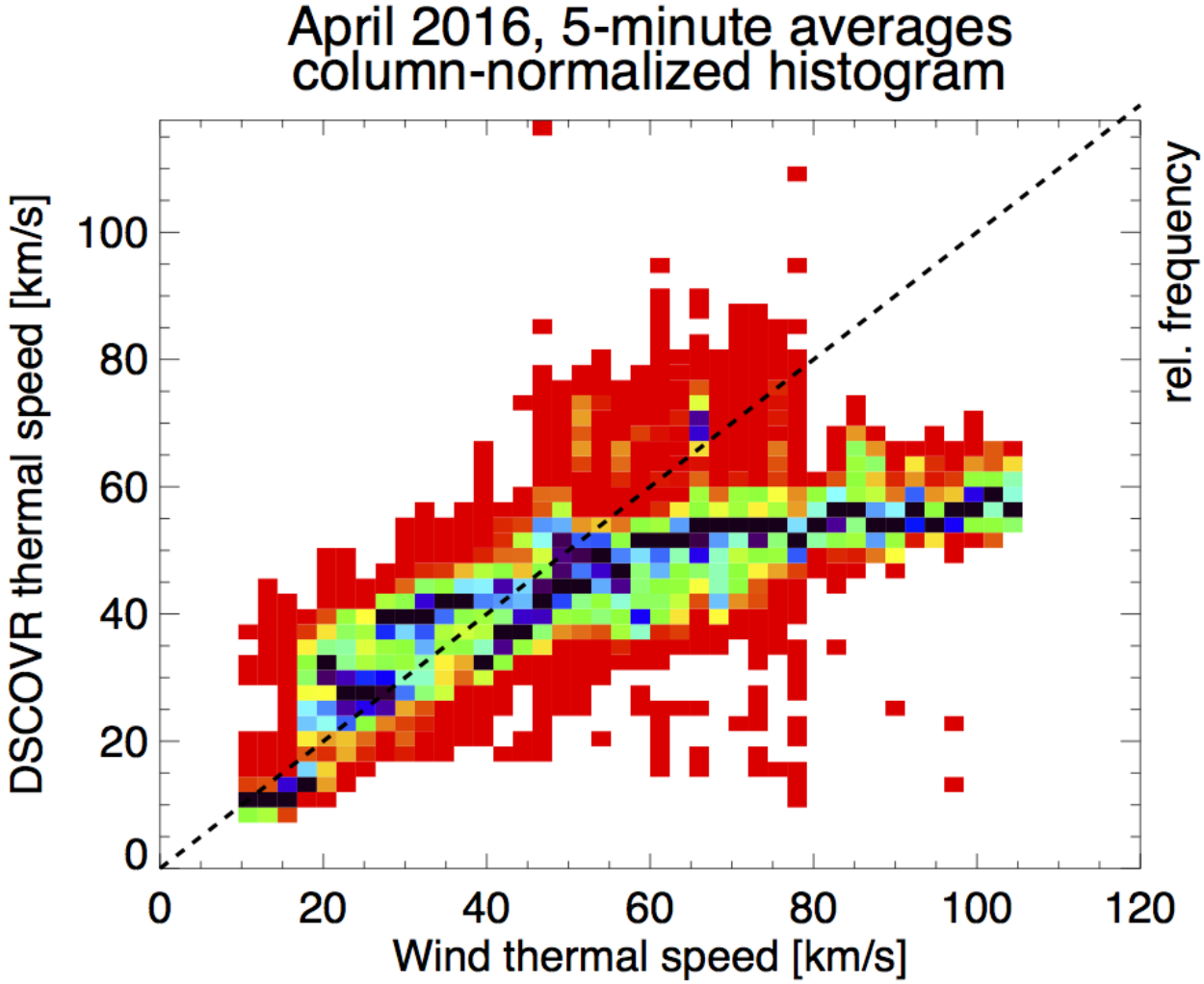
SPEED COMPARISON



DENSITY COMPARISON



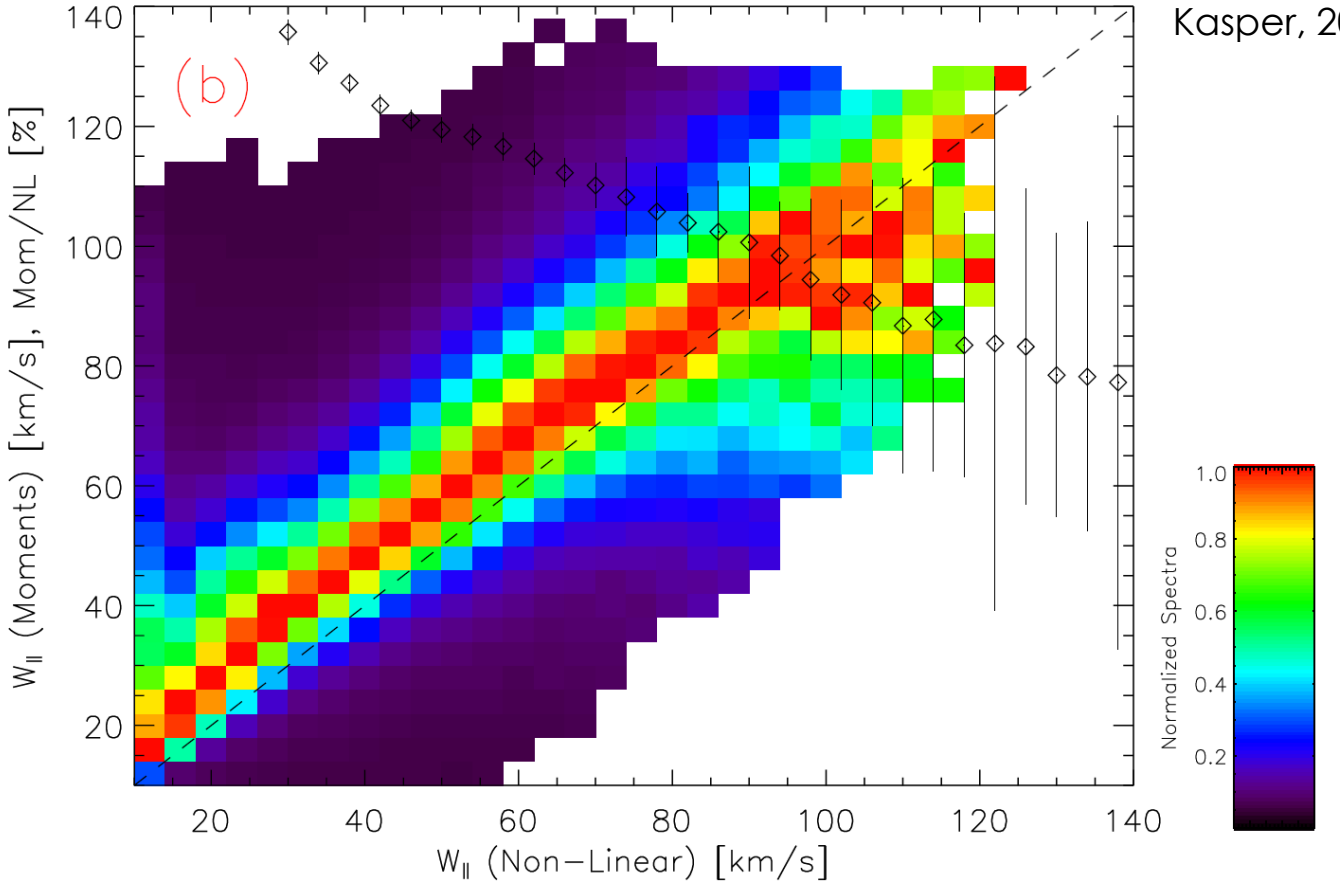
TEMPERATURE COMPARISON



Investigating sources of differences. So far: moment vs fitting and faster resolution of DSCOVR are factors (see next slides)

SIMILAR TREND SEEN IN WIND DATA

Temperature determined though robust moment calculation

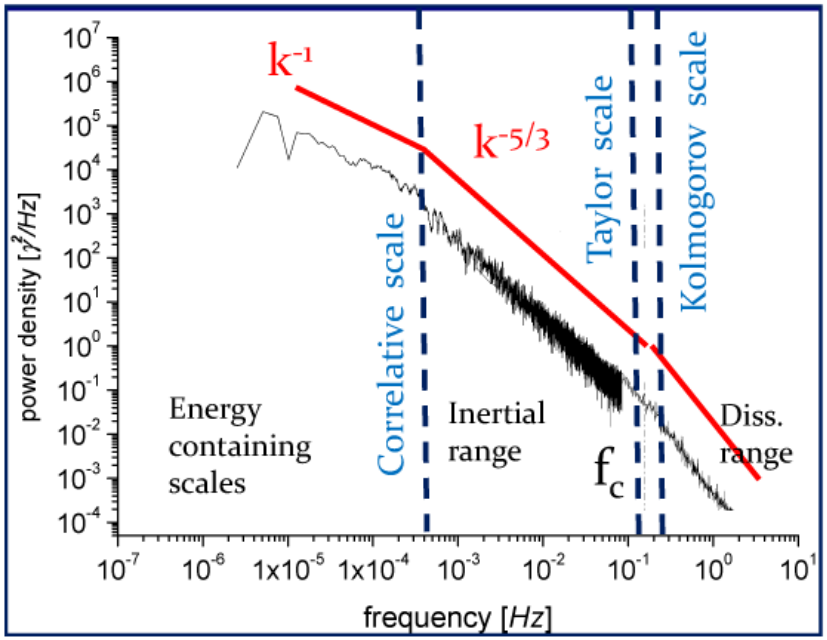


Kasper, 2002

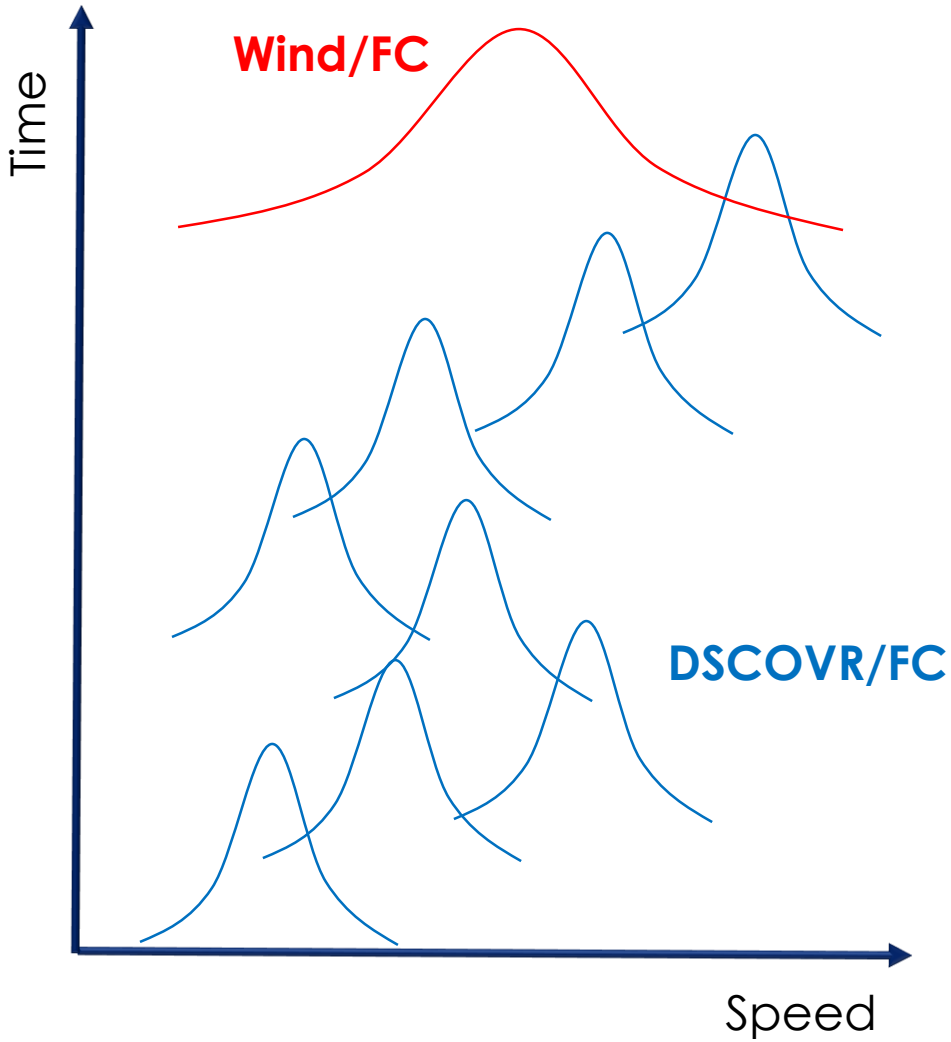
Temperature determined though non-linear fitting of model to data

ANOTHER FACTOR: DSCOVR/FC SHOWS US SOLAR WIND IS COLDER THAN WE THOUGHT!

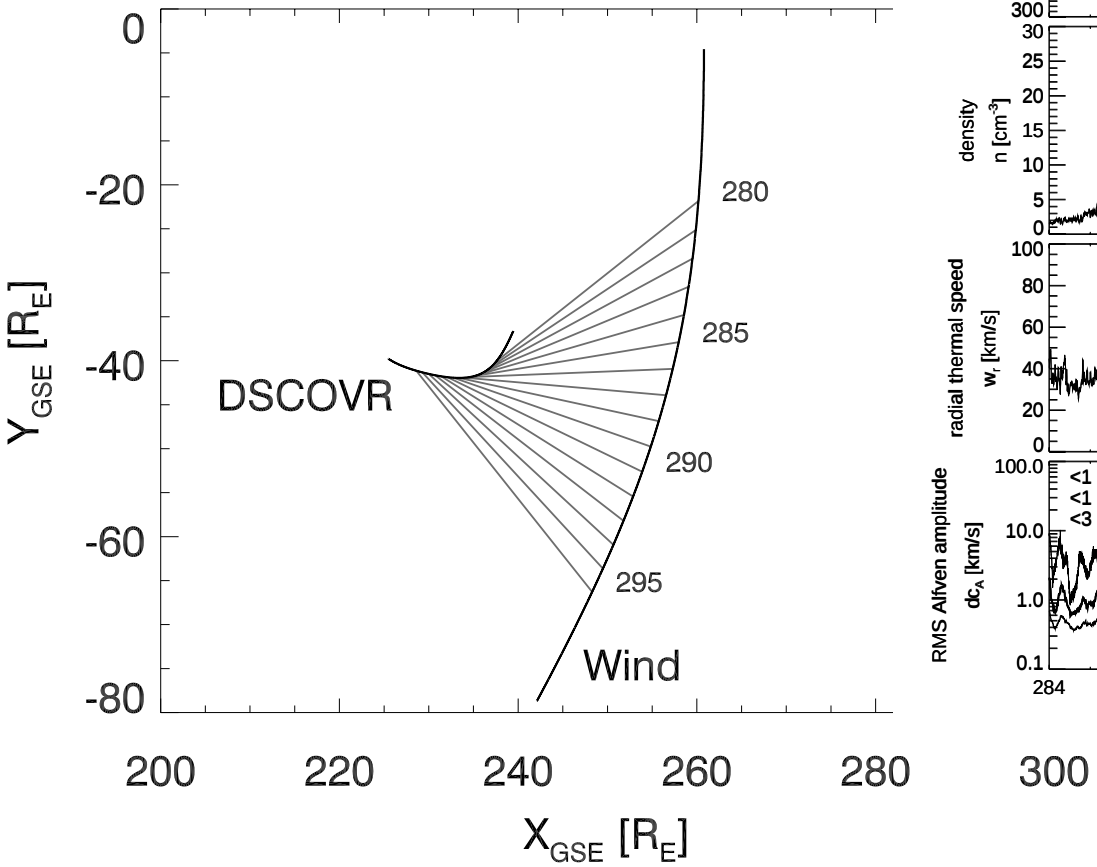
SOLAR WIND IS FULL OF TURBULENCE

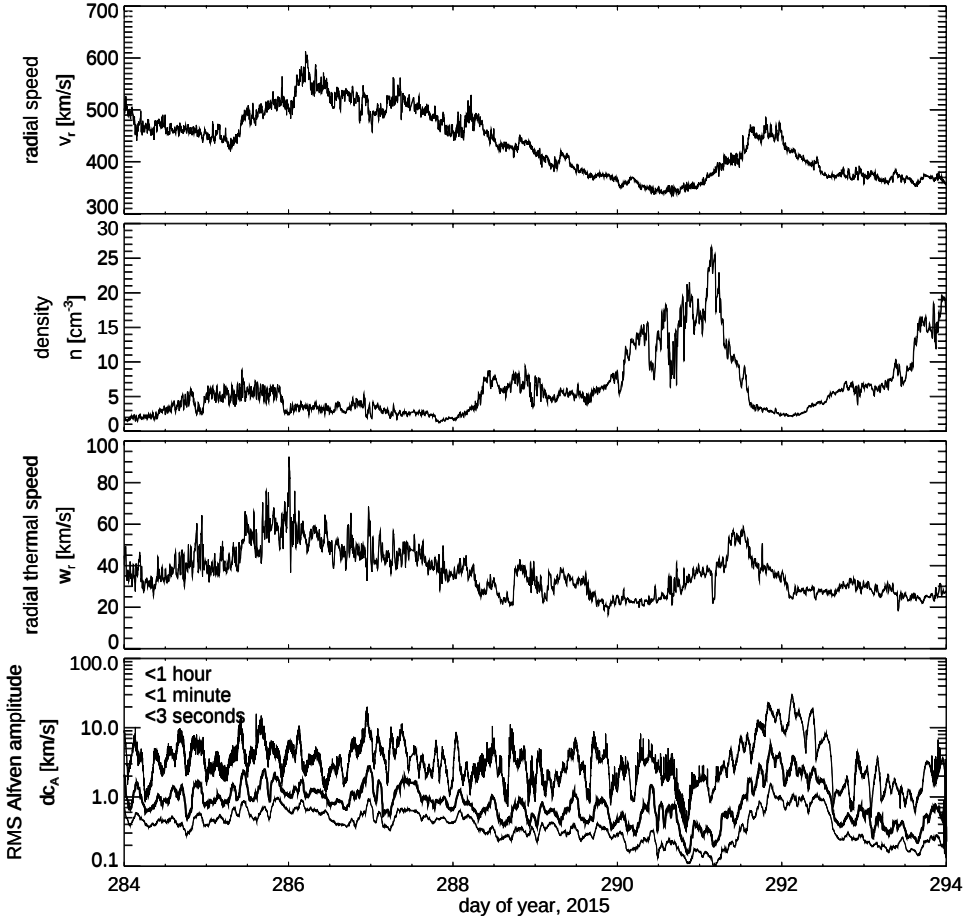


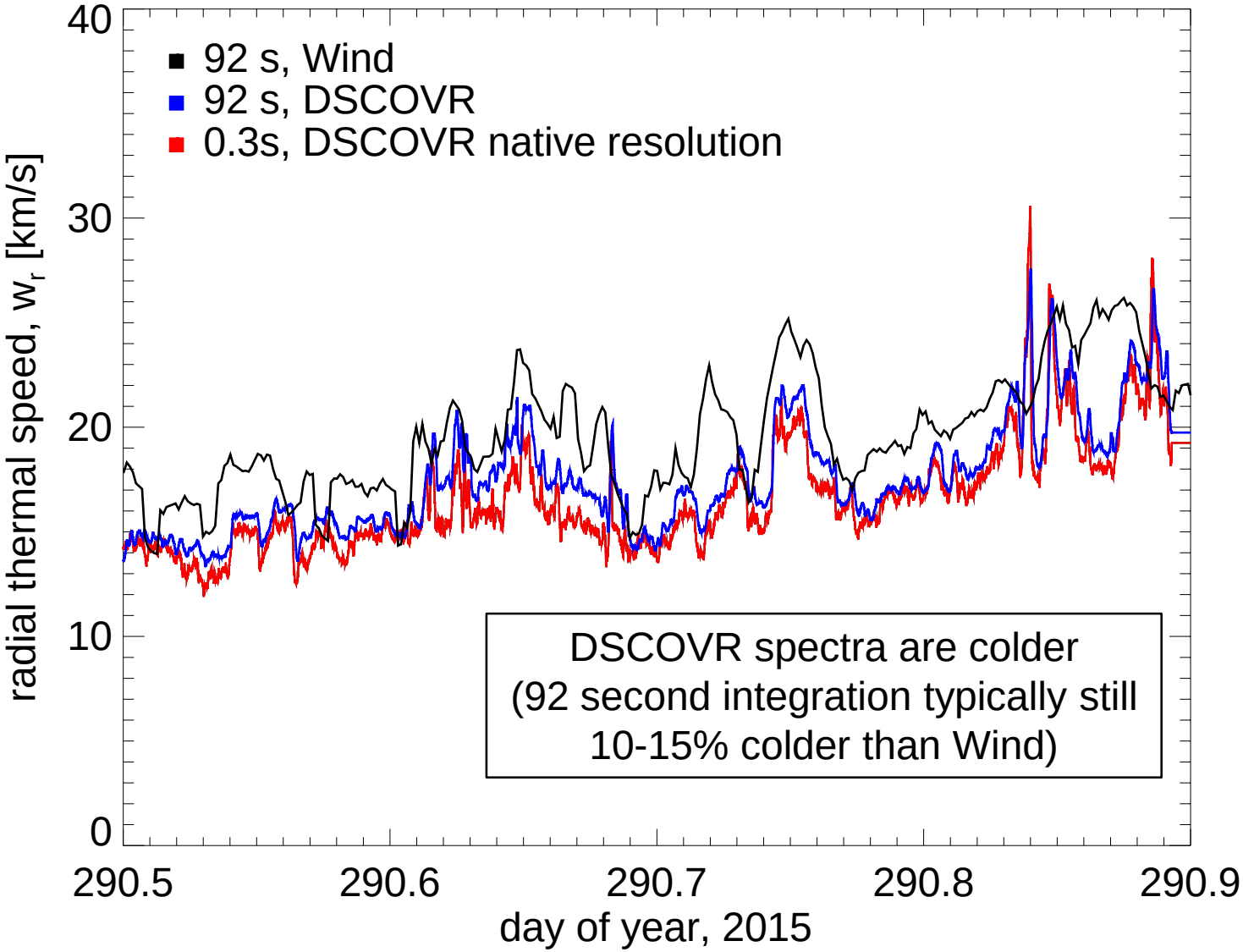
Bruno et al, 2015 (ad. Bruno et al 2009, Leamon et. Al 1998)



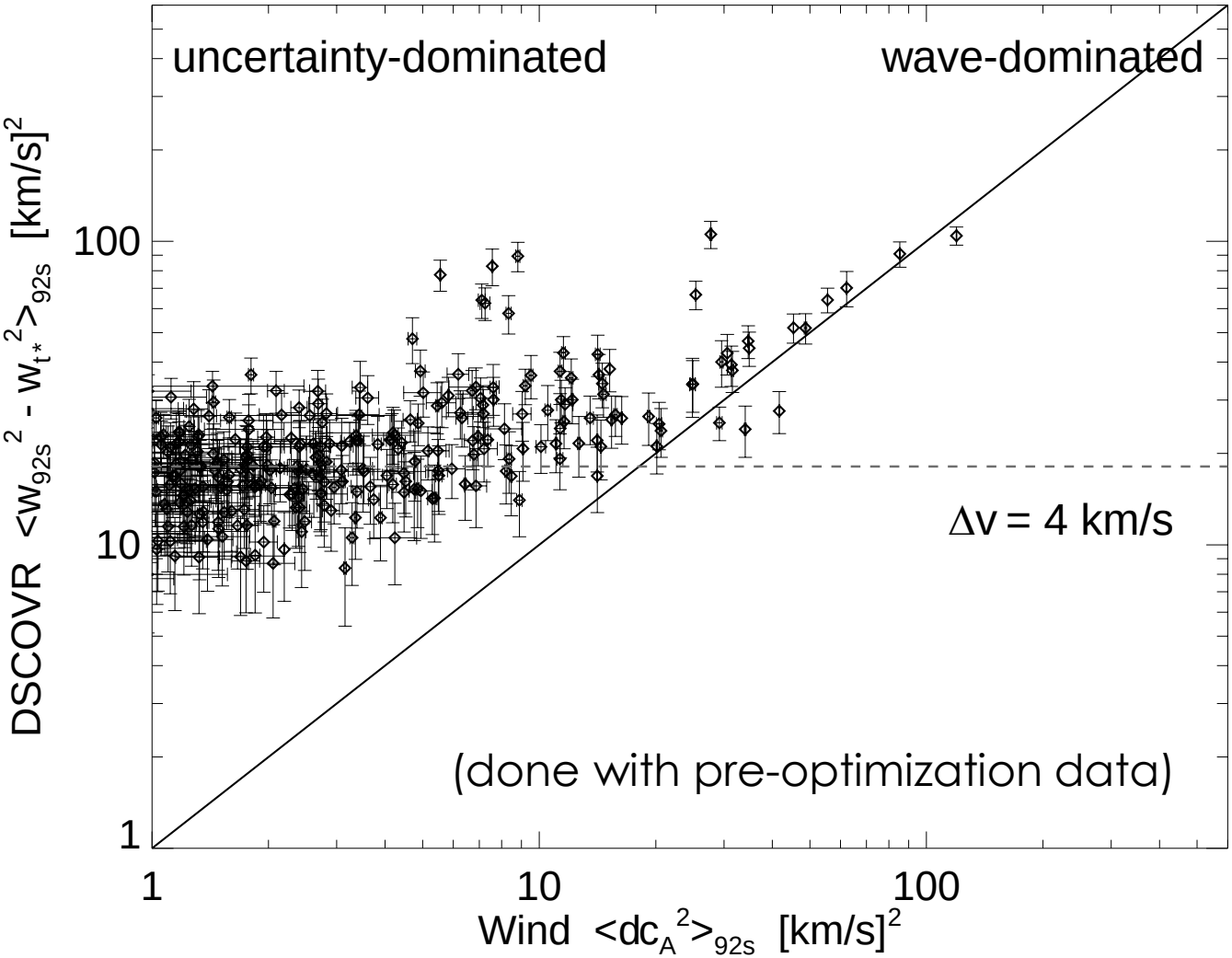
CONJUNCTION COMPARISON



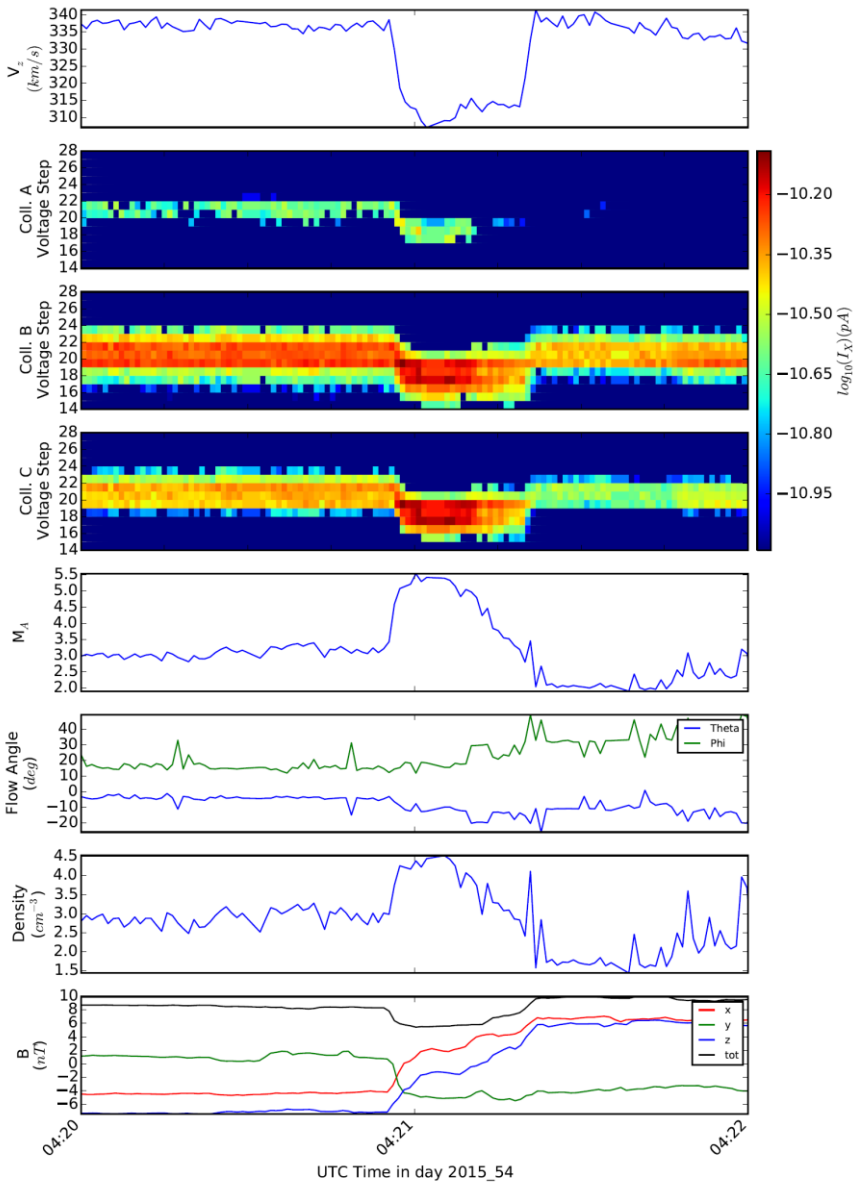


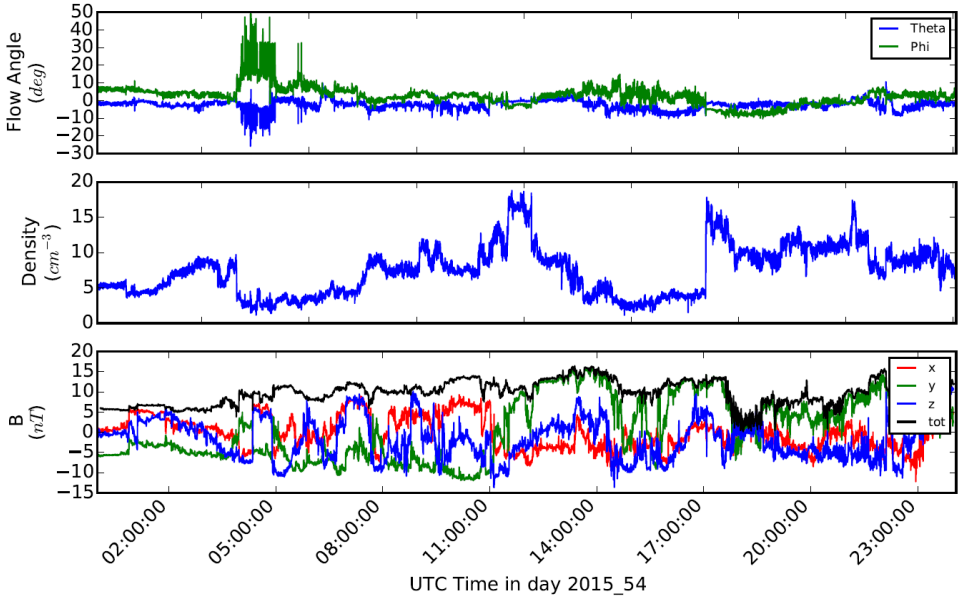

92 s, Wind
92 s, DSCOVR
0.3s, DSCOVR native resolution
radial thermal speed, w_r [km/s]
40
30
20
10
0
290.5
290.6
290.7
290.8
290.9
day of year, 2015
DSCOVR spectra are colder
(92 second integration typically still
10-15% colder than Wind)

WAVE BROADENING OF THERMAL SPEED



RECONNECTION JETS





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