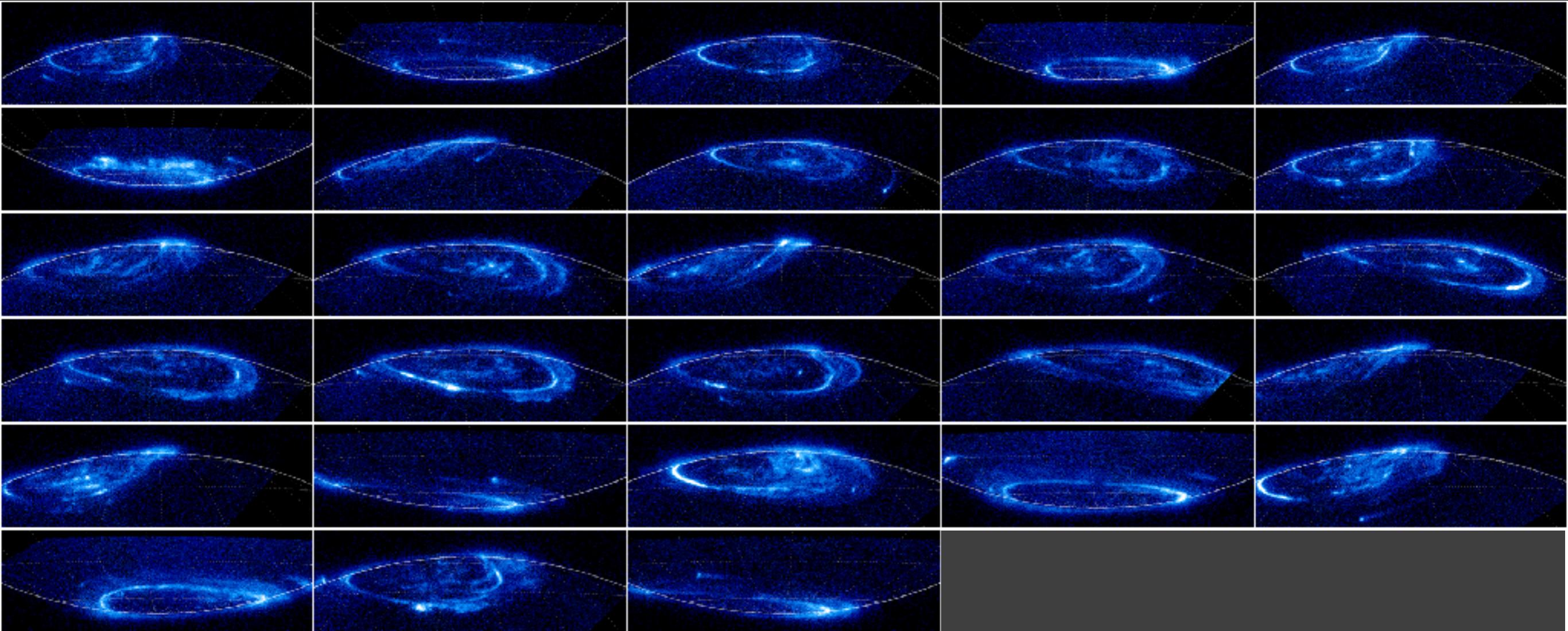


Jupiter is alive!

HST observations of Jupiter's aurora
during Juno orbits 18, 19 and 20



Denis Grodent

Zhonghua Yao

Bertrand Bonfond

Benjamin Palmaerts

Jean-Claude Gérard

Aikaterini Radioti

Sarah V. Badman

Emma J. Bunce

Jonathan D. Nichols

Lorenz Roth

Joachim Saur

William Dunn

Carl Schmidt

John T. Clarke

Jack E. Connerney

G. Randall Gladstone

Tomoki Kimura

William S. Kurth

Barry Mauk

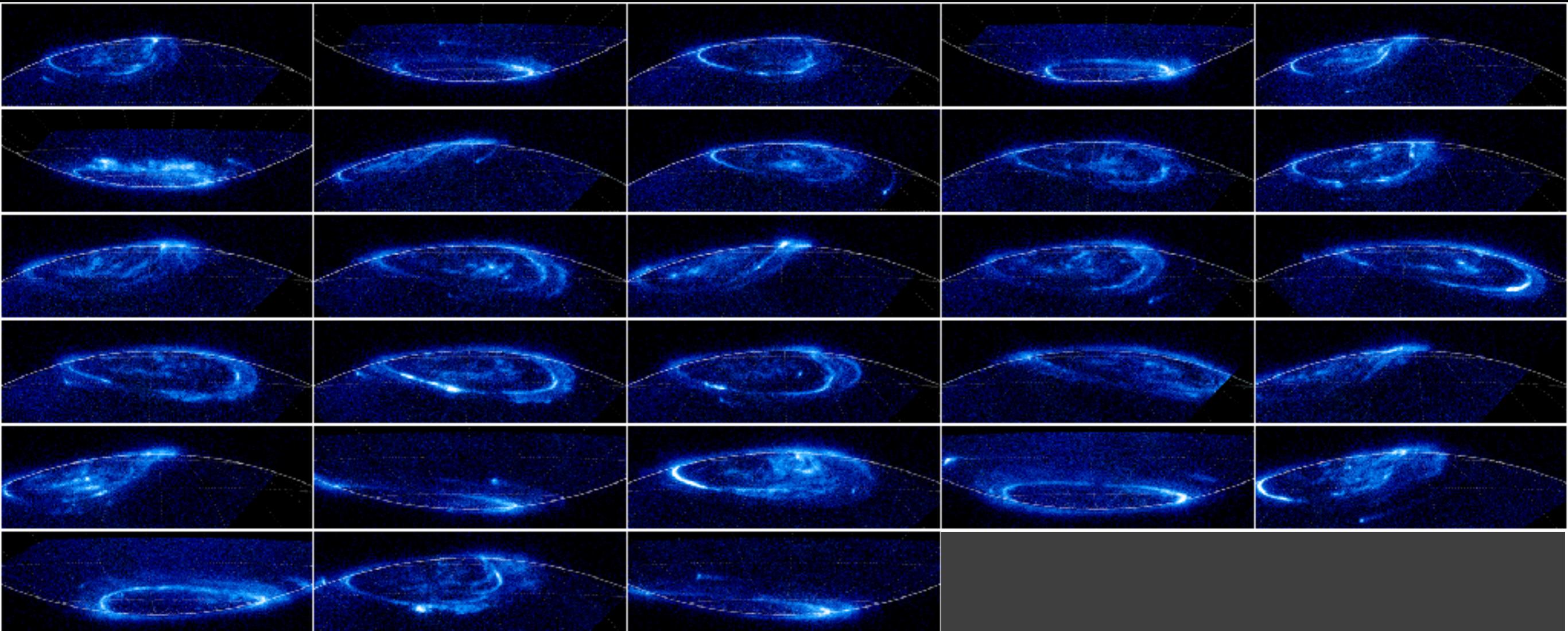
David J. McComas

Alessandro Mura

Glenn S. Orton

MOP Meeting, Sendai, Japan,
3-7 June 2019 - d.grodent@uliege.be

HST Movie Wall PJ18 - PJ19 - PJ20



<https://www.ipap.uliege.be/>
google keywords: **Ipap, jupiter, hst**

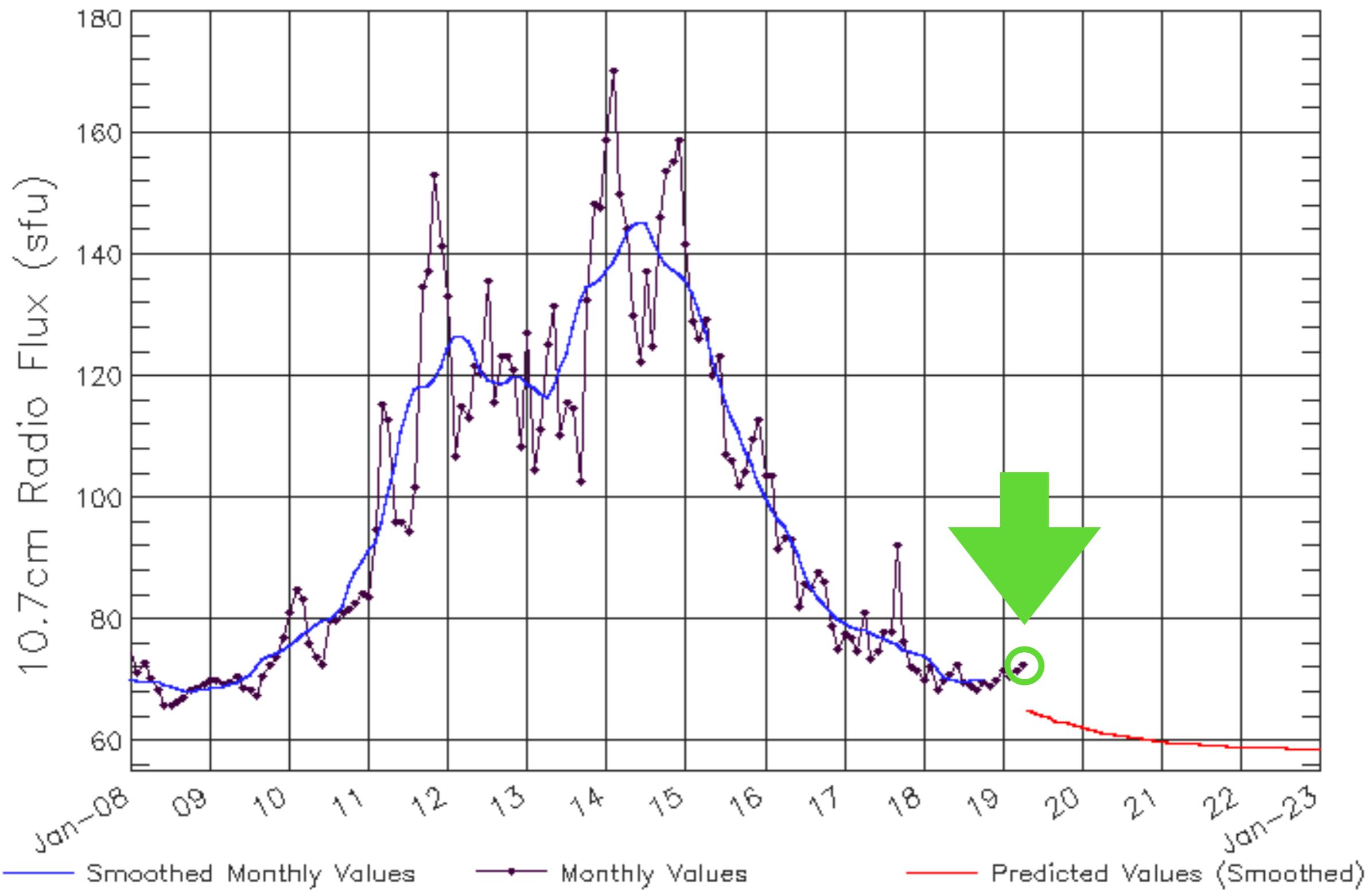
New HST campaign
near solar minimum

GO 15638

50 HST orbits during
Juno orbits 18-22

ISES Solar Cycle F10.7cm Radio Flux Progression

Observed data through Apr 2019



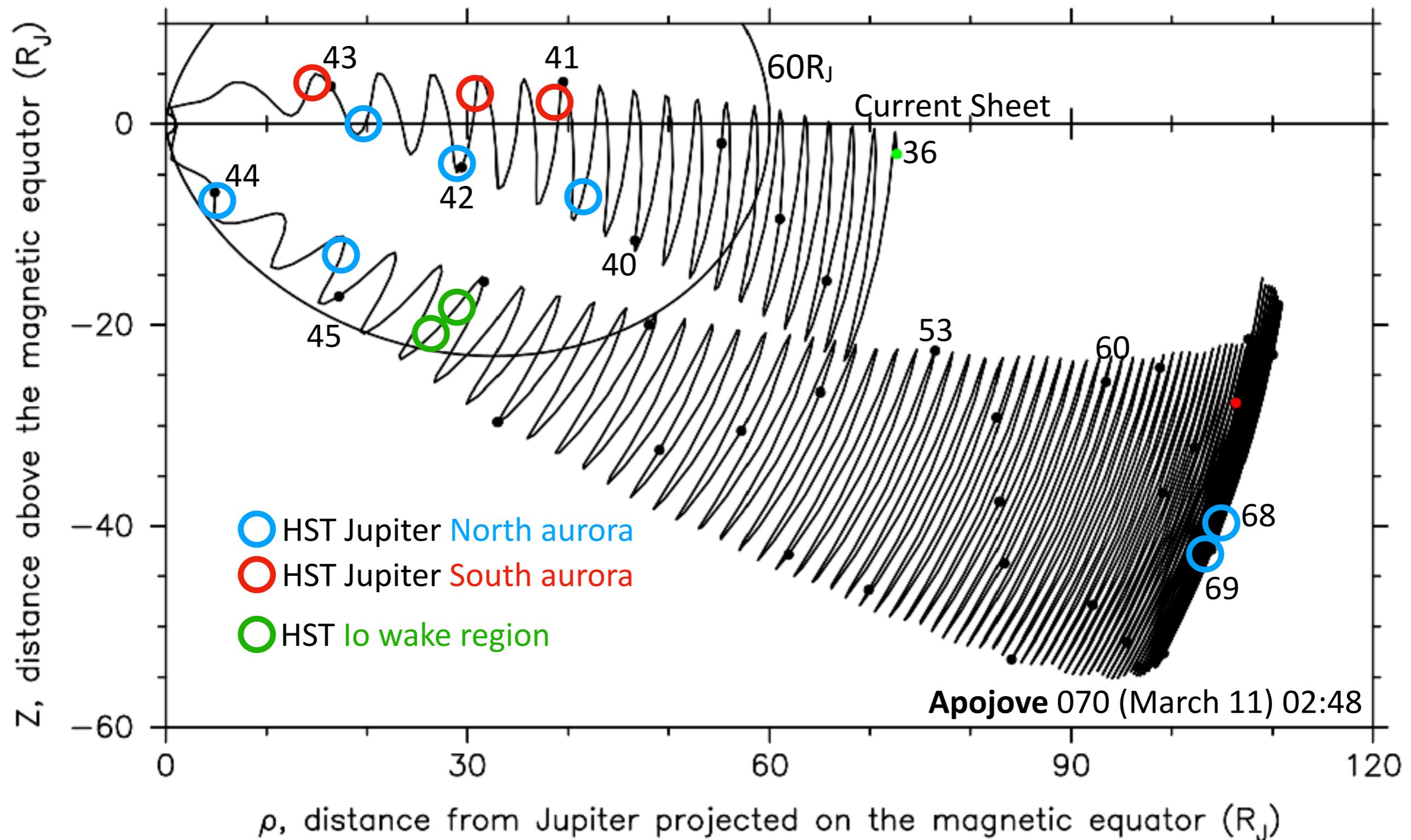
Updated 2019 May 6

NOAA/SWPC Boulder, CO USA

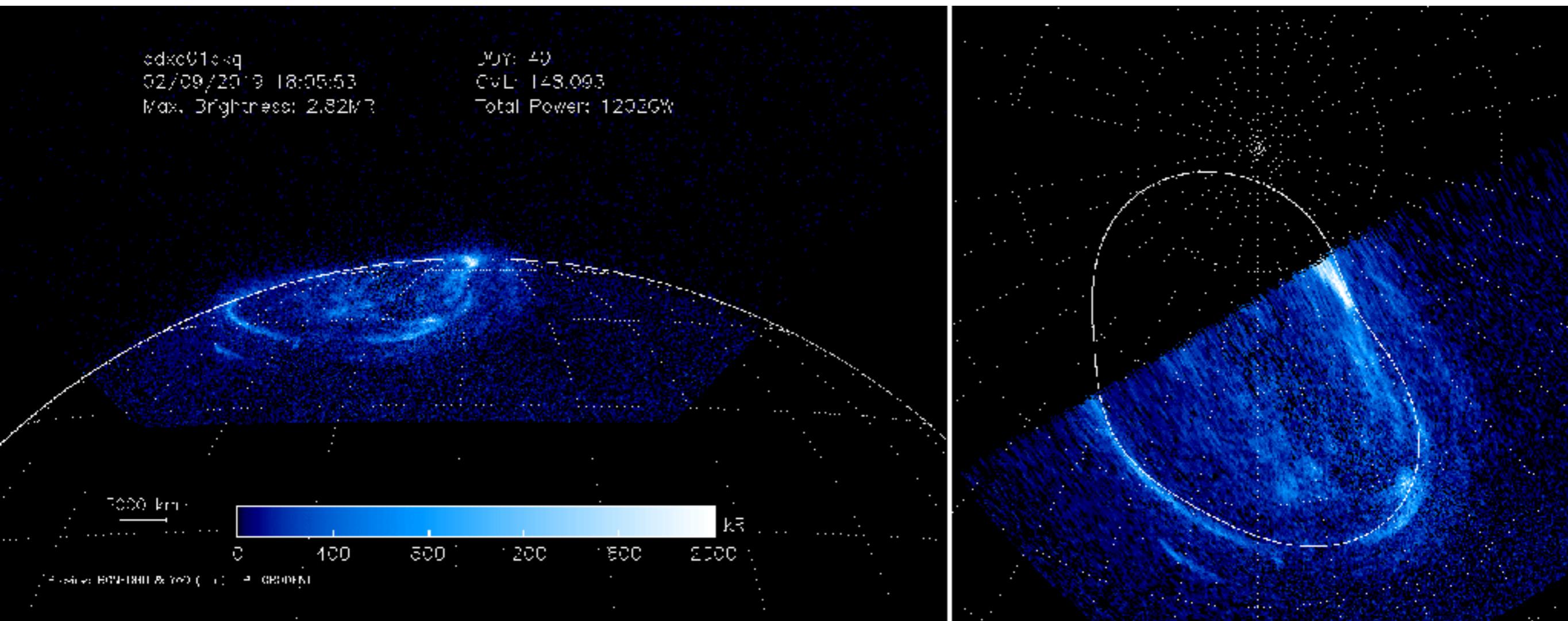
HST observations (STIS FUV) of Jupiter's aurora during Juno orbit 18

HST during Juno Orbit #18

2019 036 (February 5) 00:00:00 – 2019 075 (March 16) 00:00:00

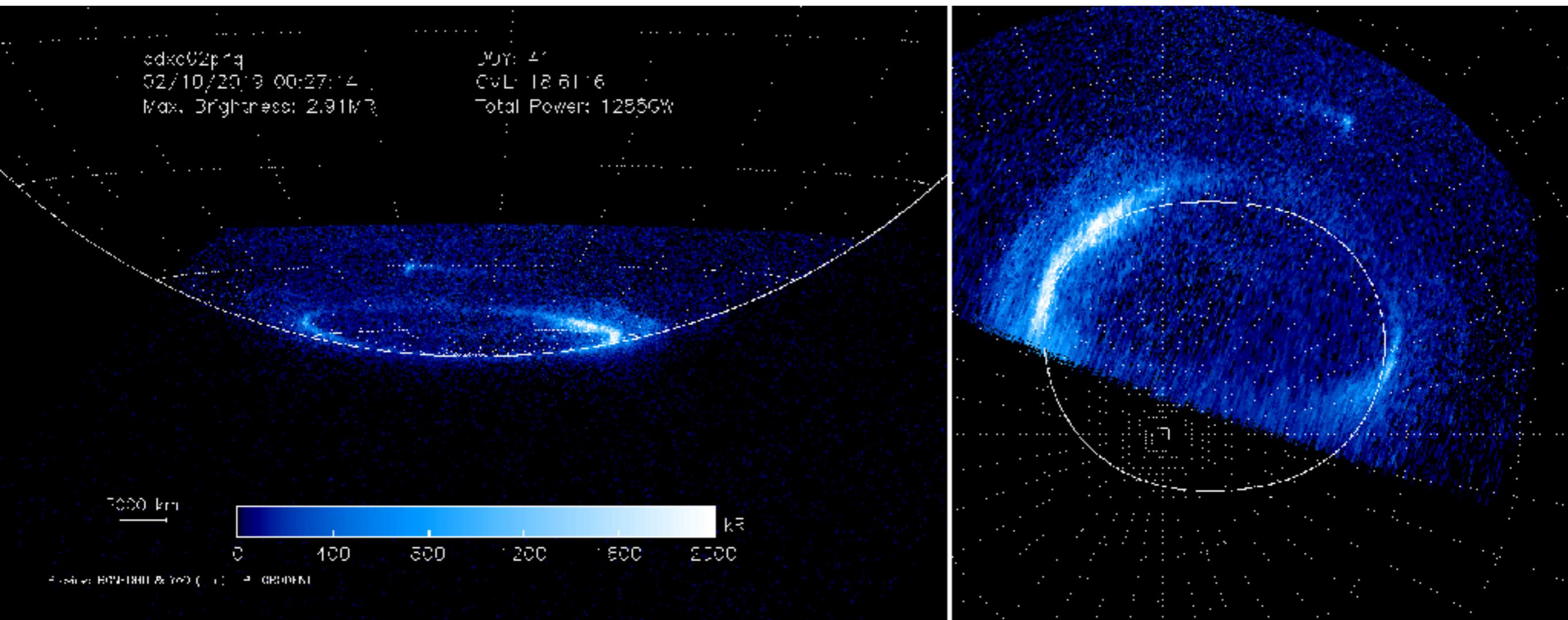


PJ18 - 3d

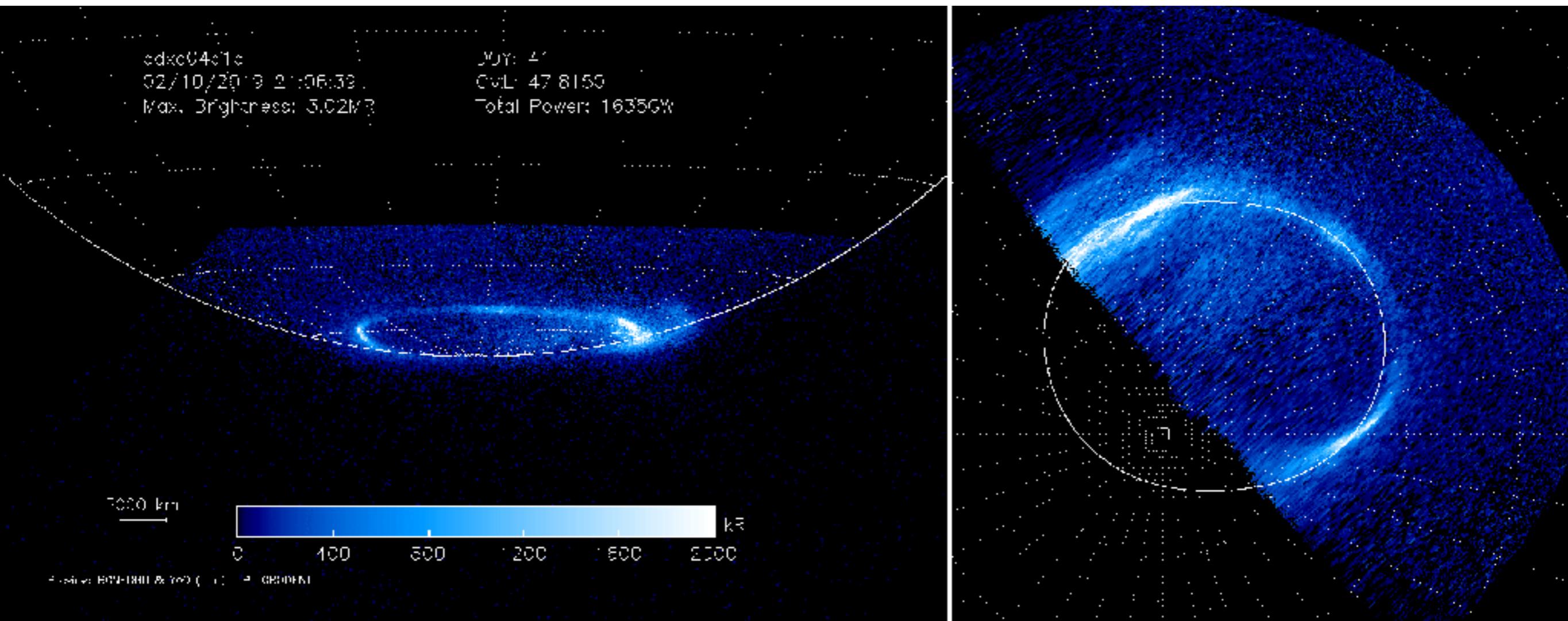


Multiple Pulsating Bridges

+ \sim 6 hr

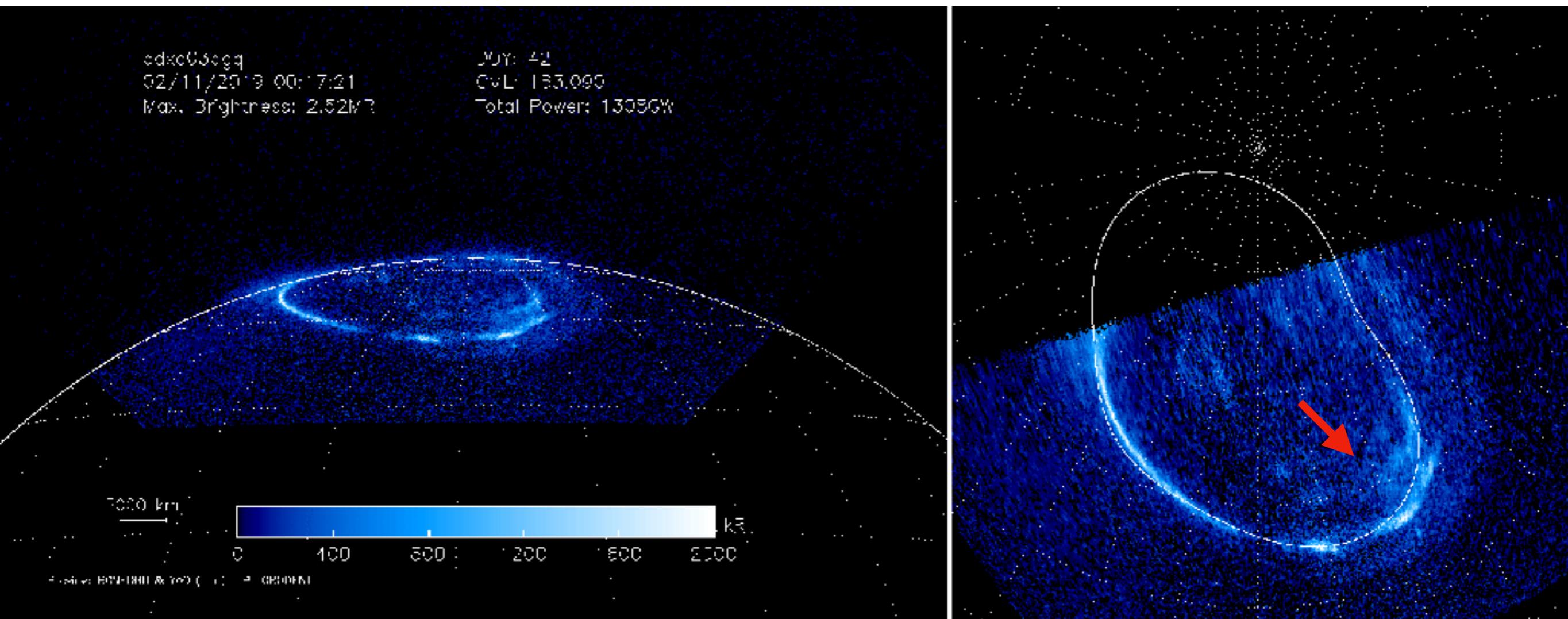


+ ~21 hr



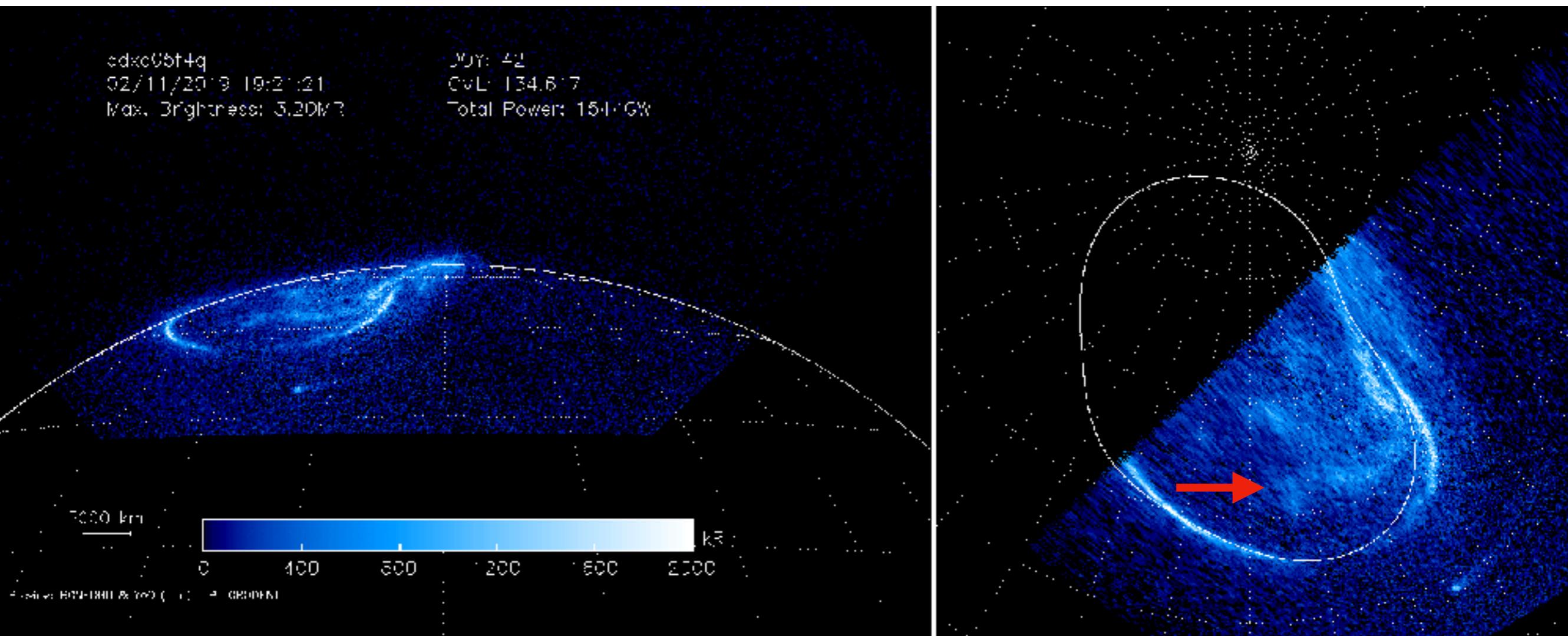
Dusk Brightening of ME
Dawn Storms

+ \sim 3 hr



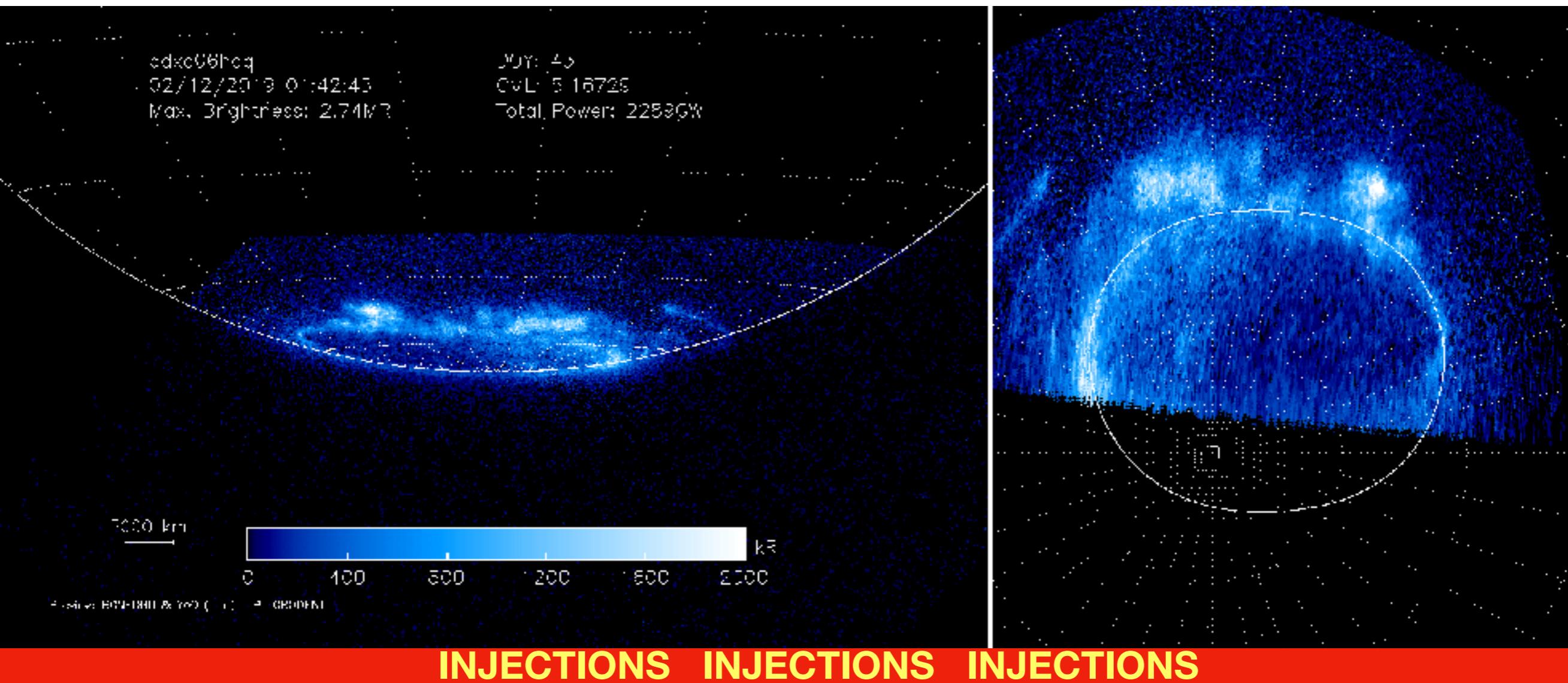
Bridge drifting equatorward
(LT effect)

+ ~19 hr PJ18 - 1d



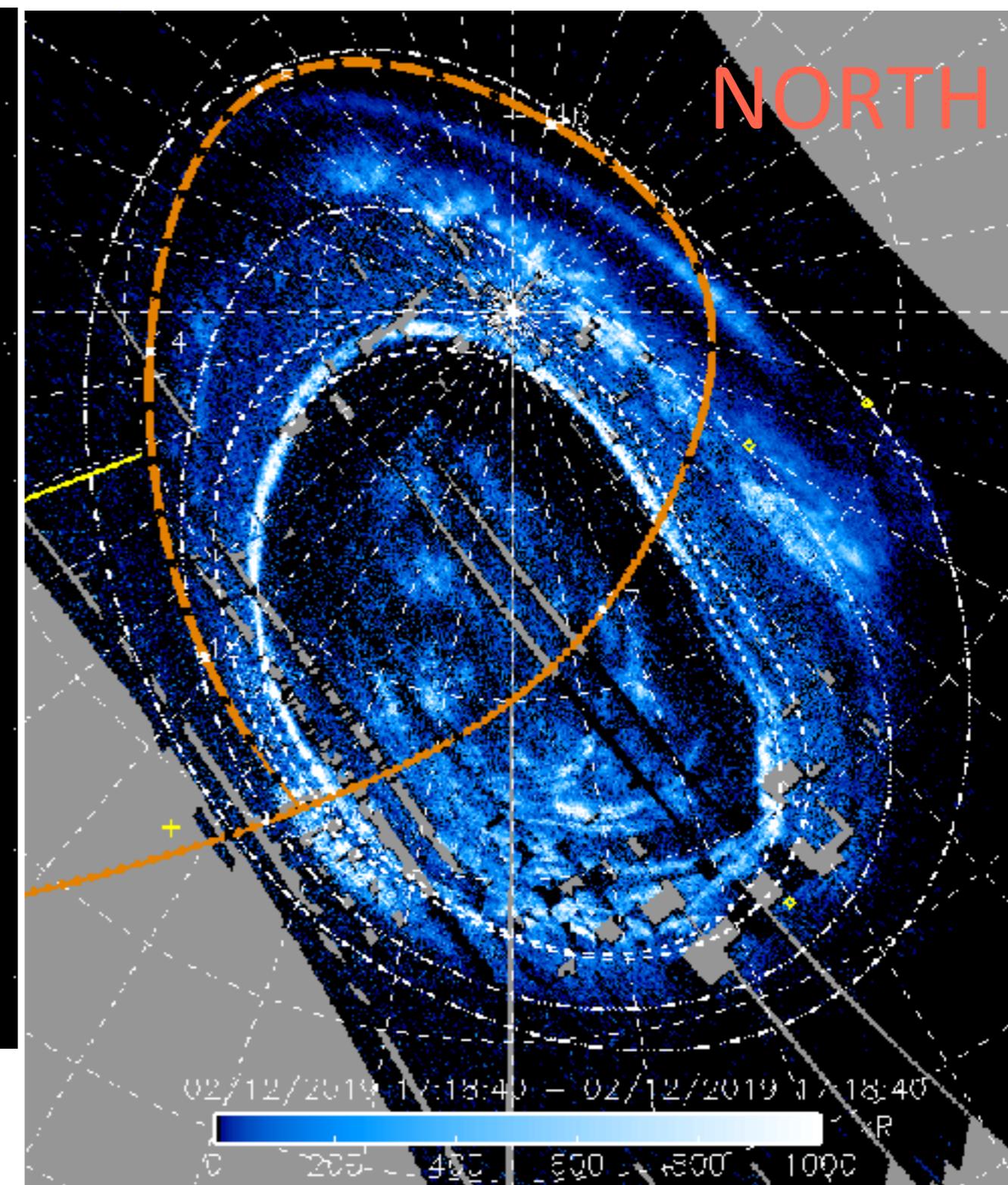
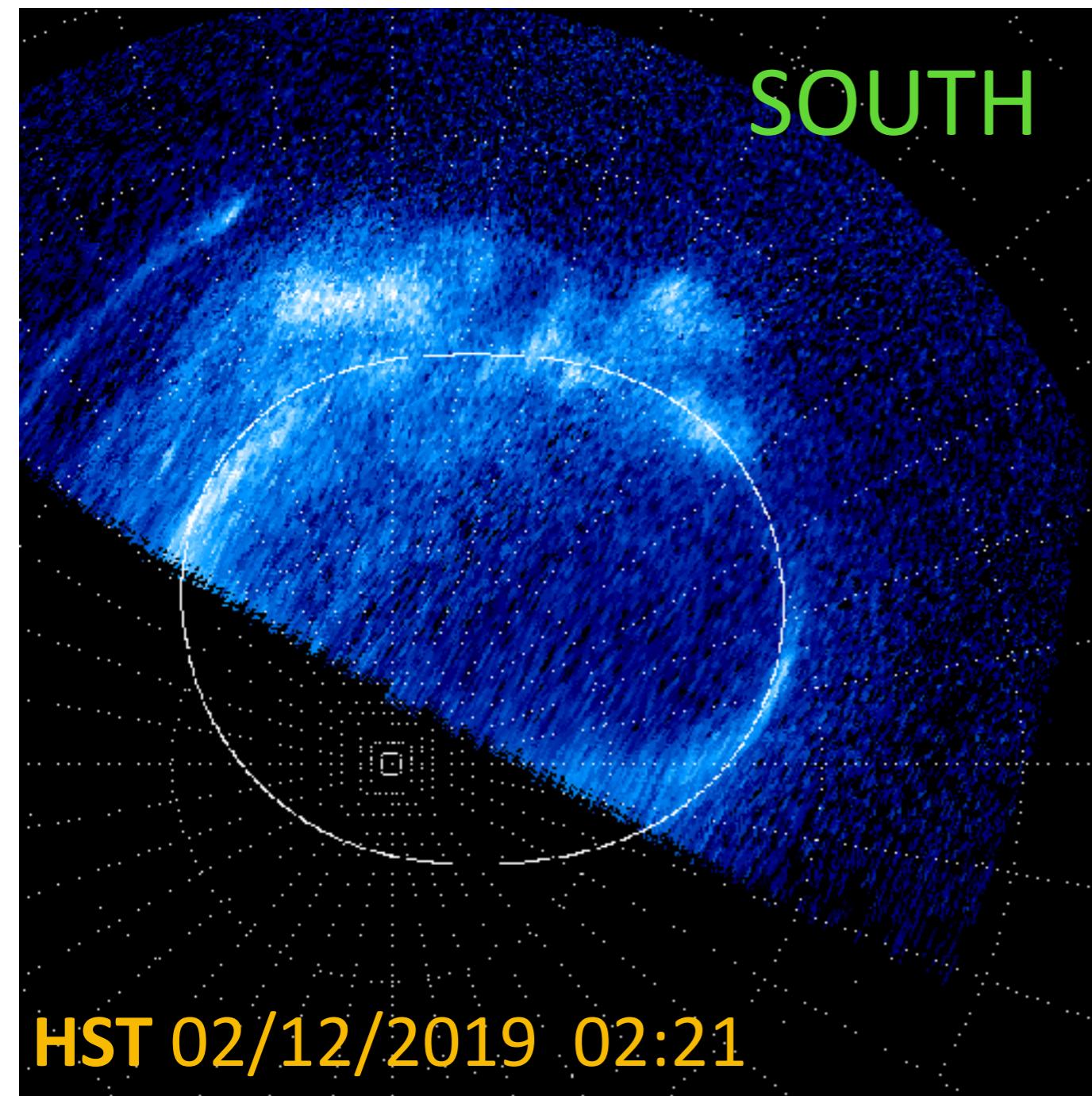
Pulsating Bridge
drifting equatorward

+ ~6 hr PJ18 - 16h



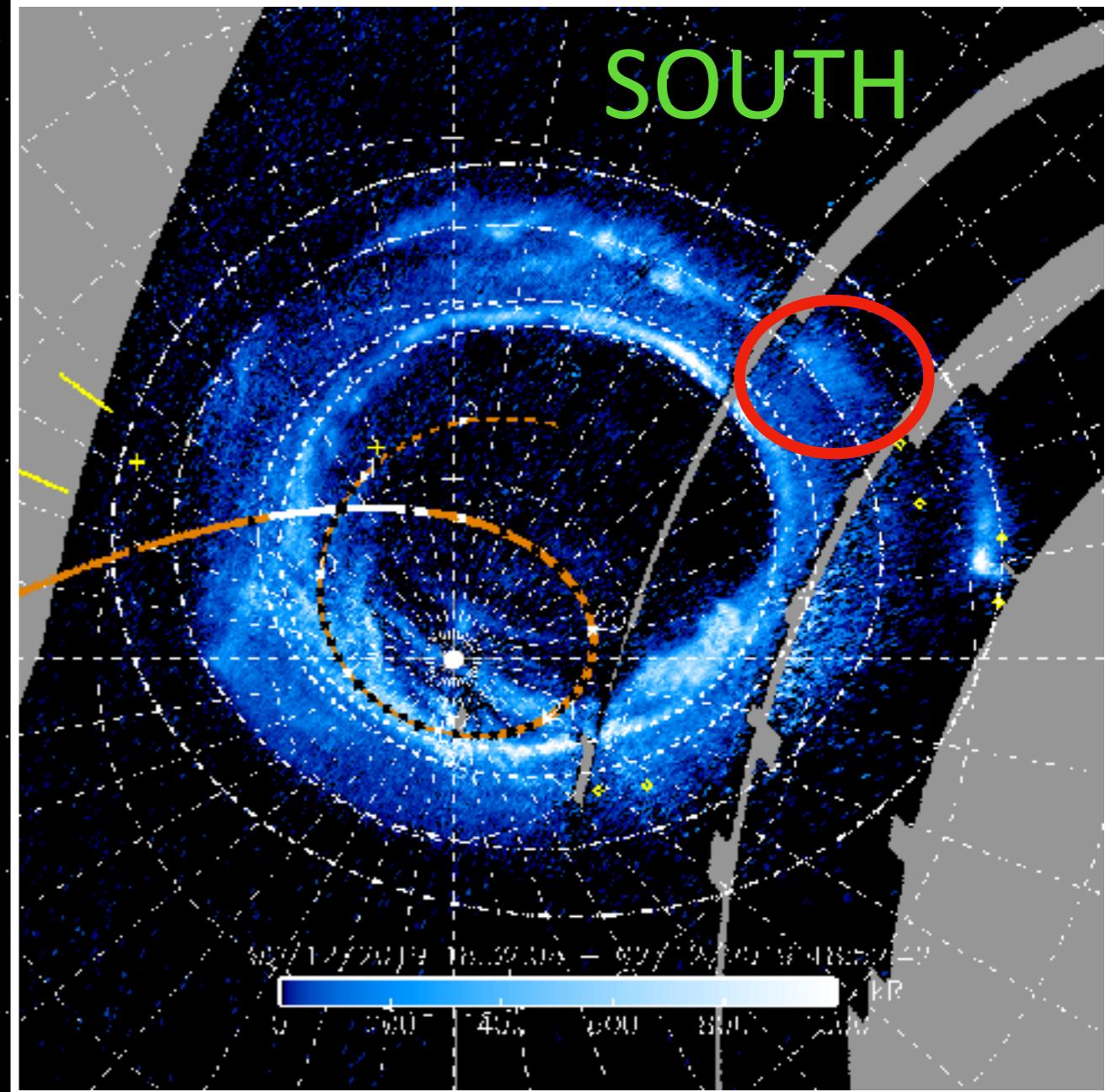
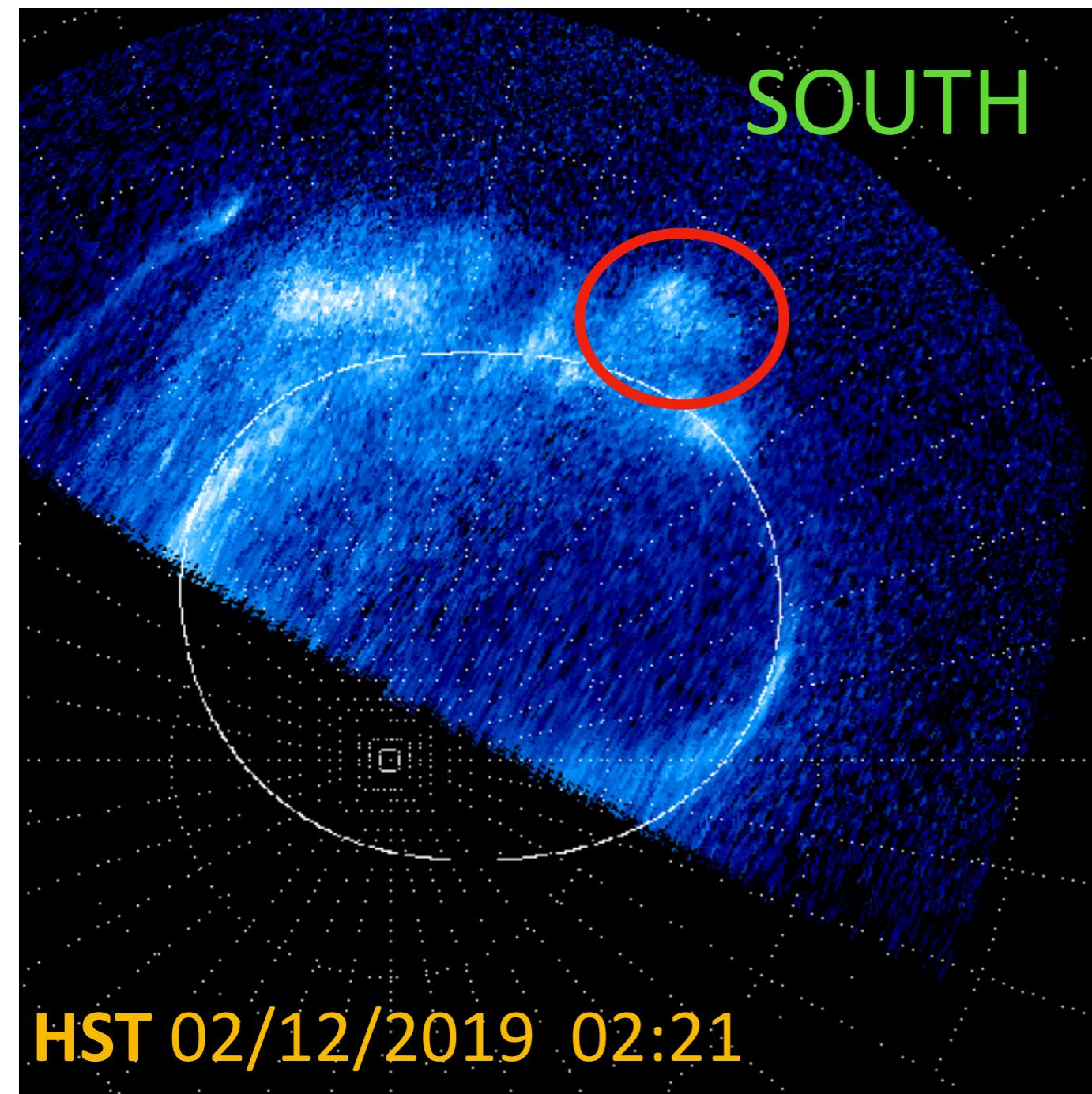
Injection "auroral blobs": corotating, moving equatorward

+ ~16 hr Juno/UVS



B. Bonfond and the Juno/UVS Team

+ ~17 hr Juno/UVS

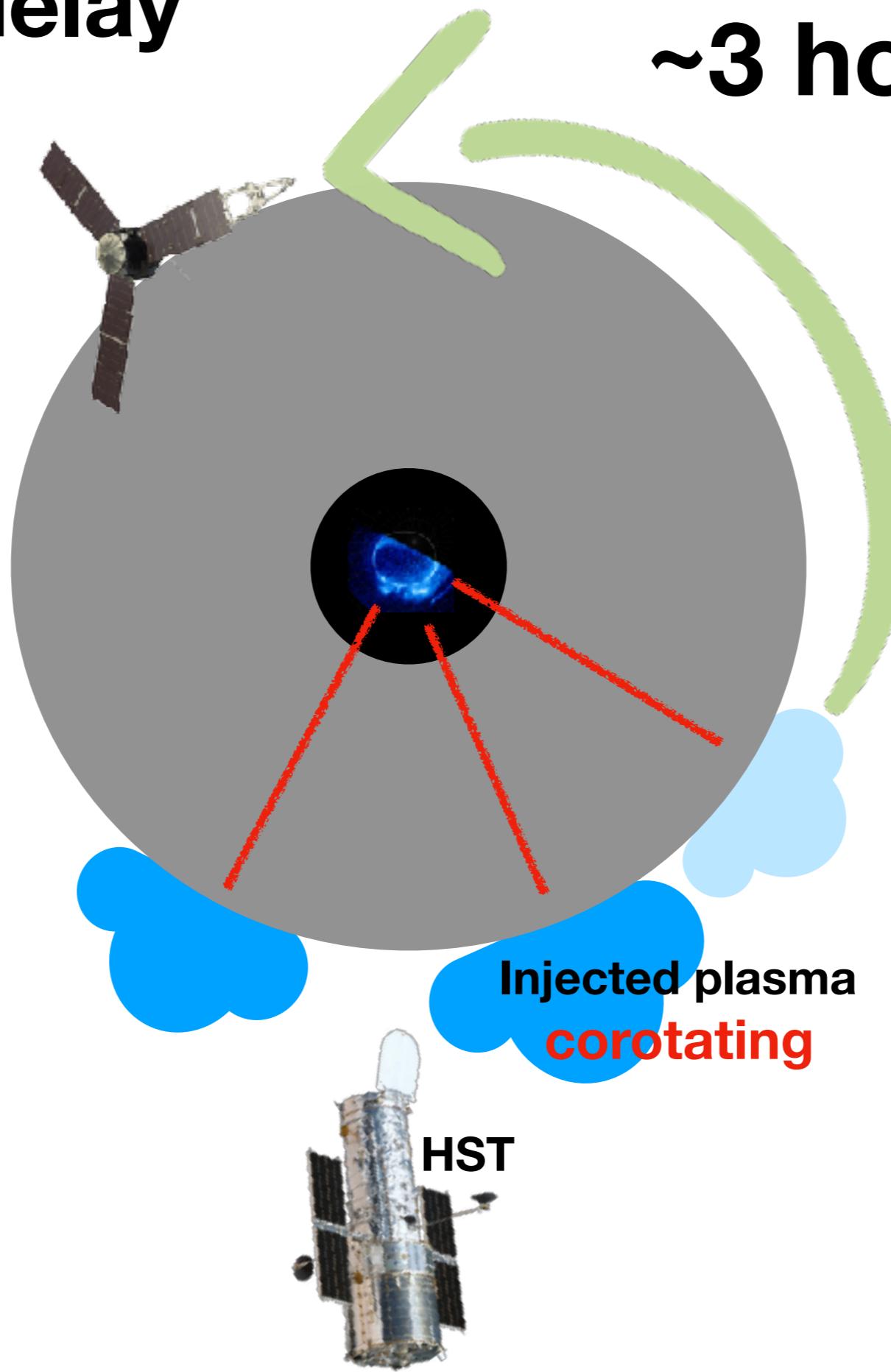


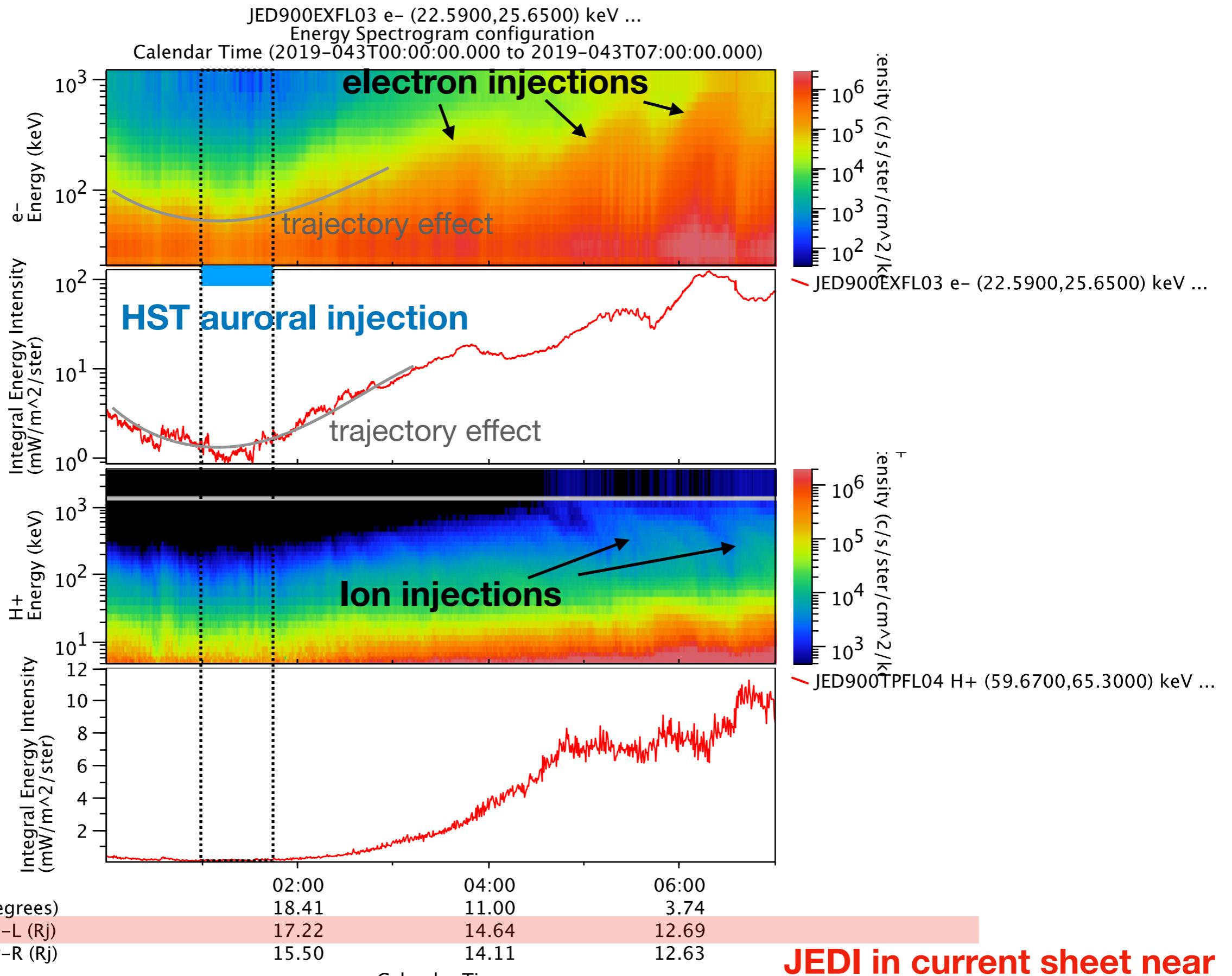
B. Bonfond and the Juno/UVS Team

sub-corotation (drift) = $\sim 10^\circ / 10\text{hr}$

HST - JEDI delay

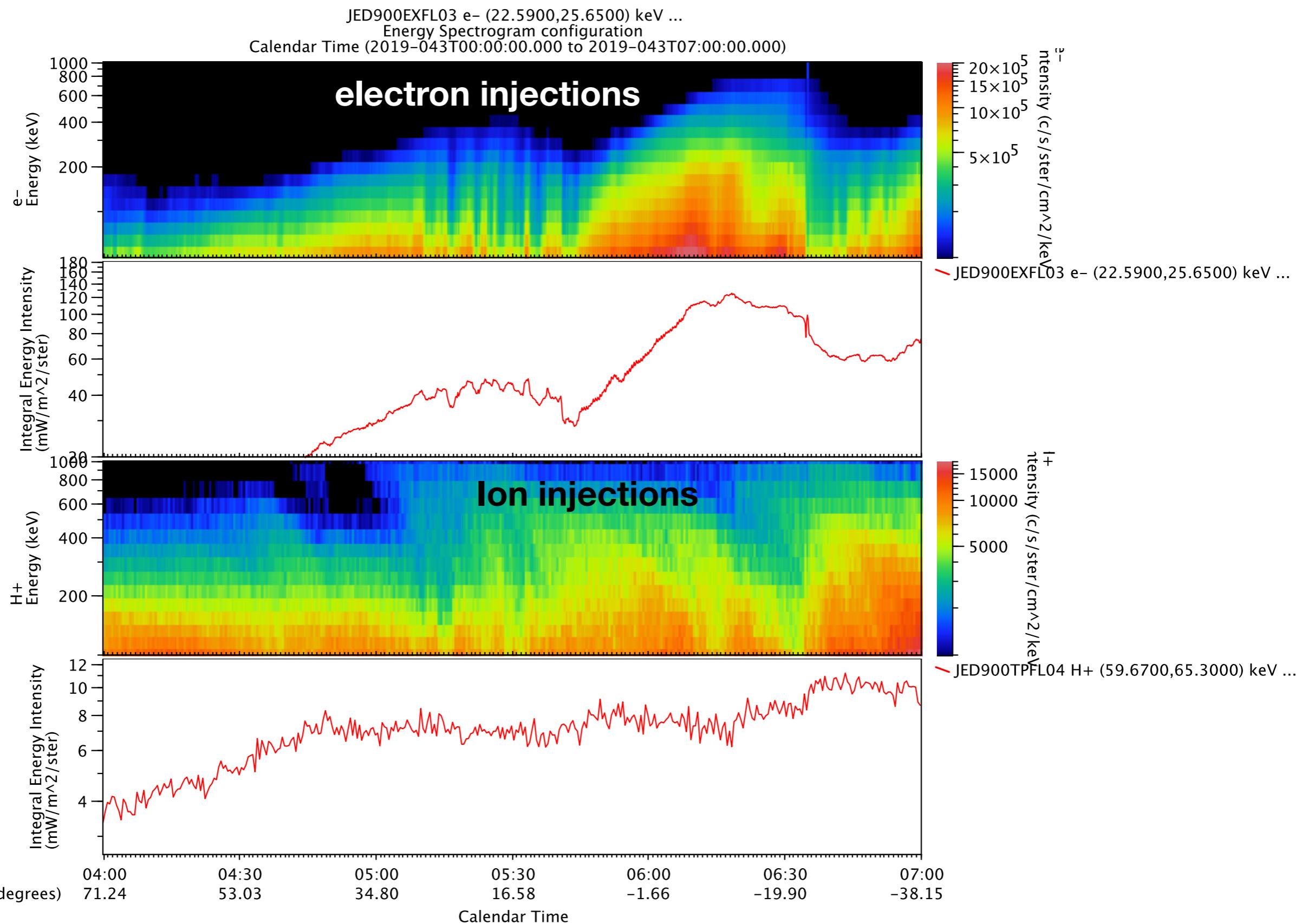
~3 hours

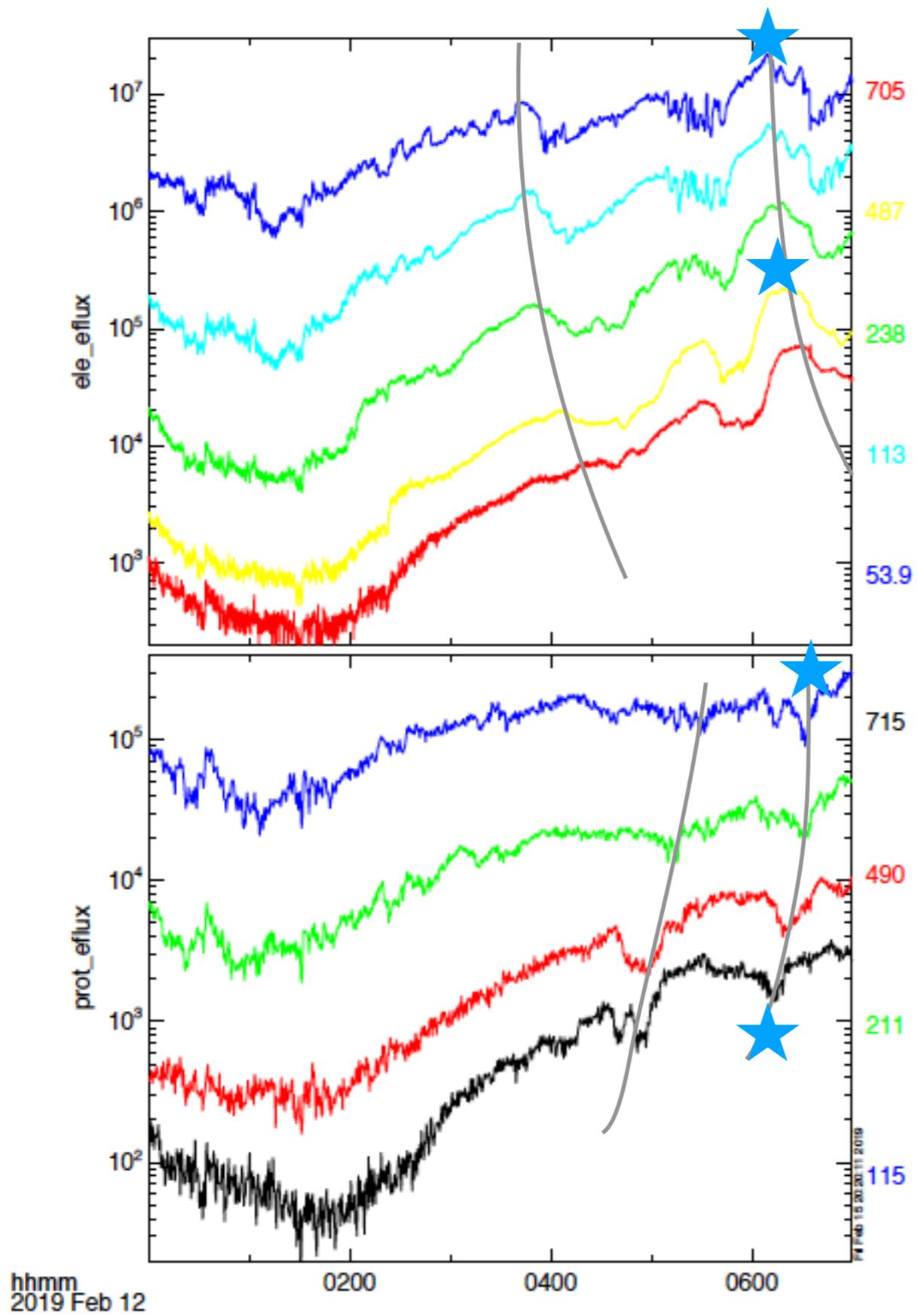




**JEDI in current sheet near
Ganymede's orbit**

Zoom 04:00 - 07:00





Tracing back the source region
(following Mauk et al., 1997)

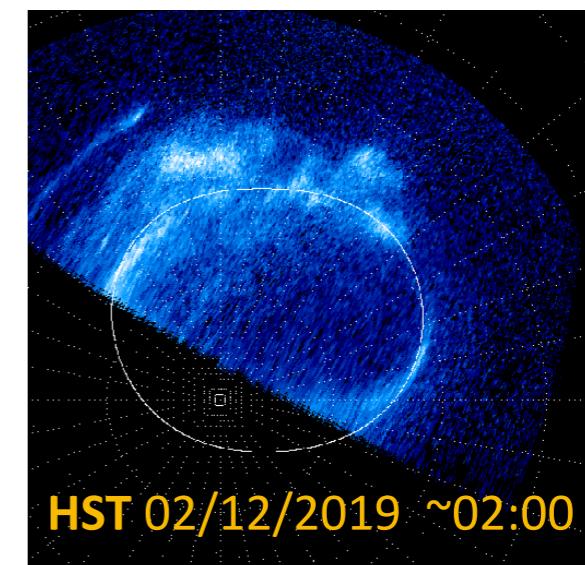
$$\Phi_l = \Delta T \cdot [(\Omega_o + \Omega_{gl})/(\Omega_{gl} - \Omega_{gh})] \cdot [\Omega_o + \Omega_{gh} - \Omega_{g/c}] \quad (1)$$

(in radians),

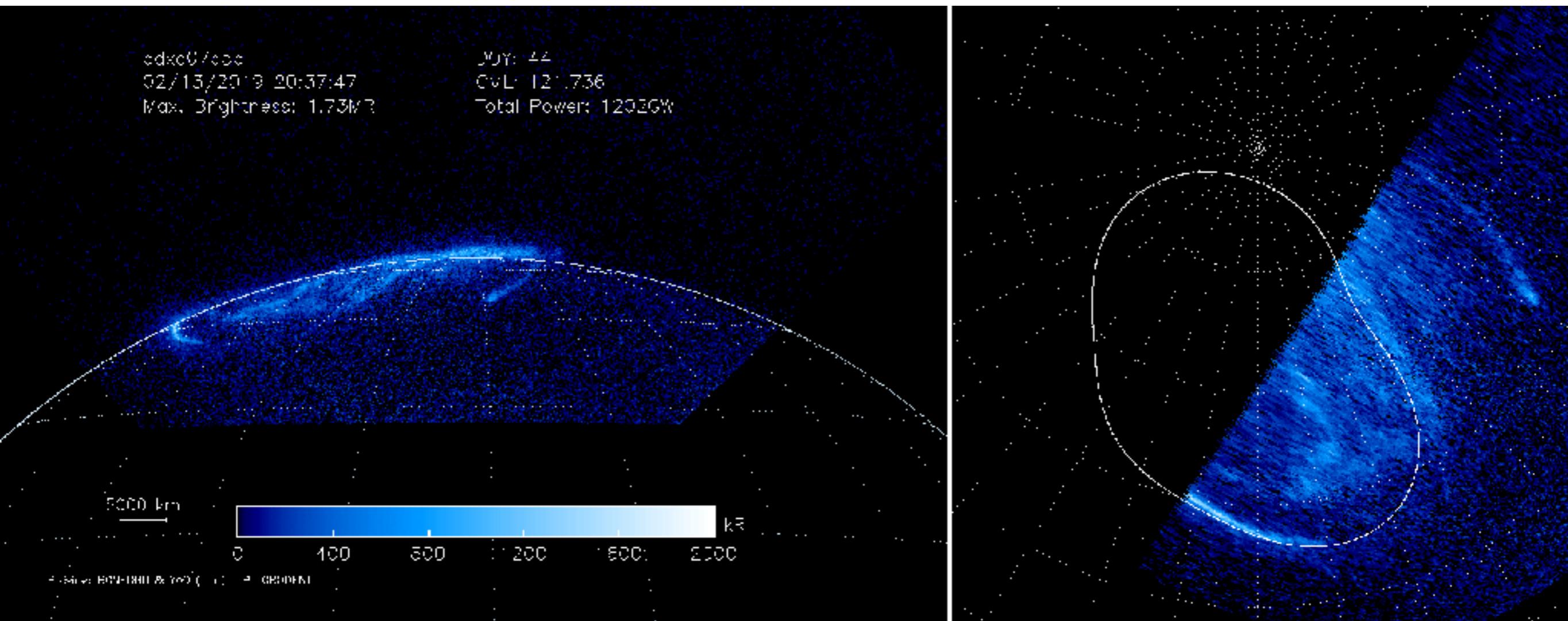
From electrons: **injection time is 5.7h ago**

From protons: **injection time is 5.3h ago**

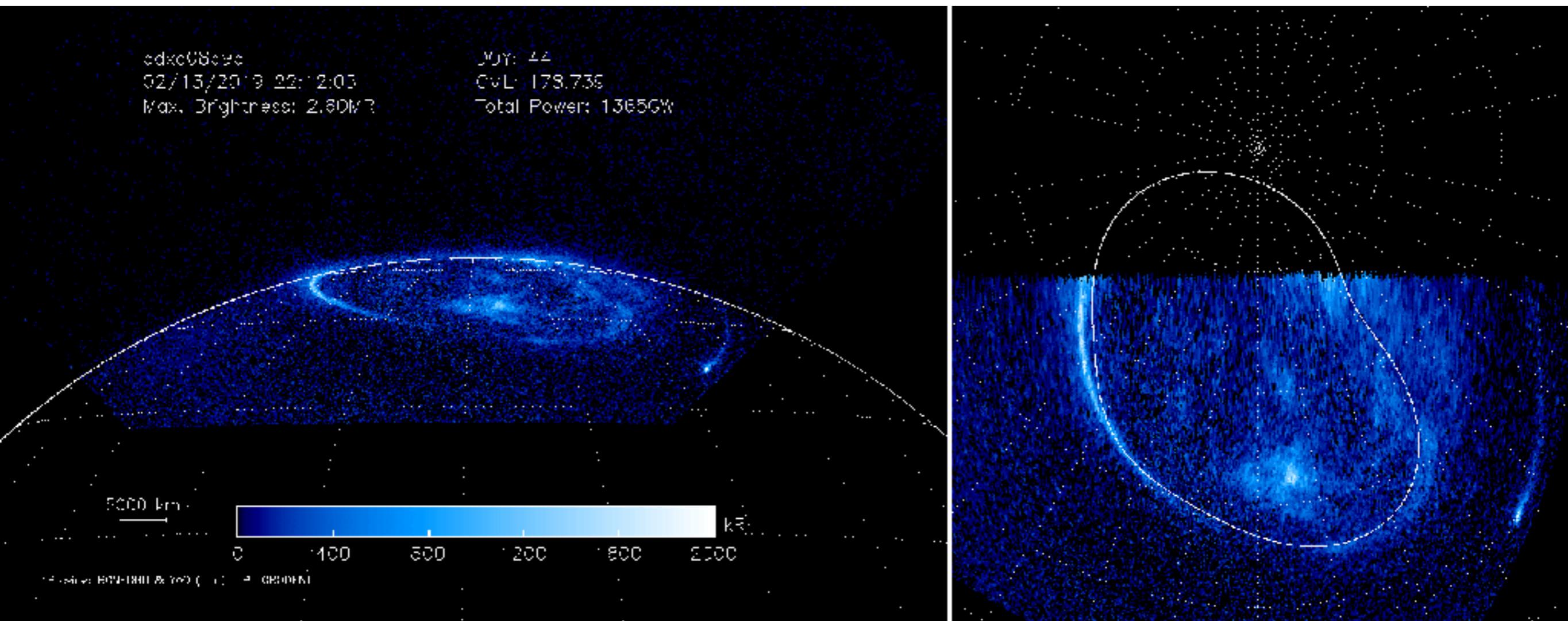
near 02/12/2019 01:00 HST time



PJ18 + 1d



+ ~ 1.5 hr

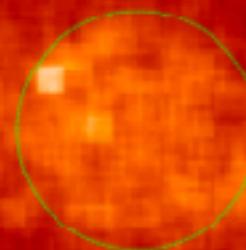


Flares (>10 MR)
Expansion of main emission (?)

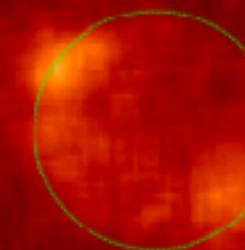
Io UV aurora

Roth et al. O53, Moon interactions

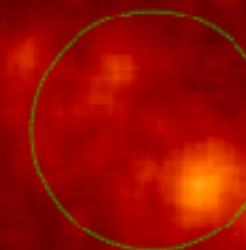
STIS G140L 52x2 Io Wake (Sum)



OI1304

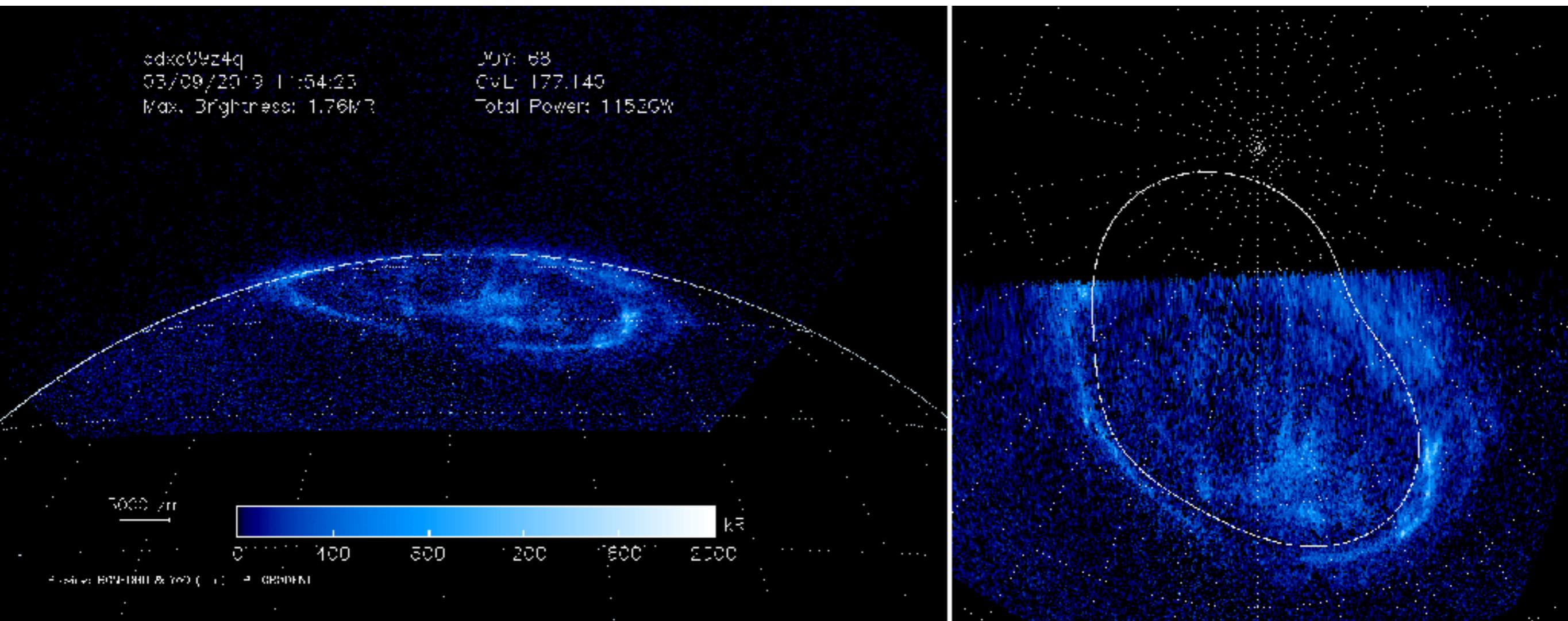


OI1356



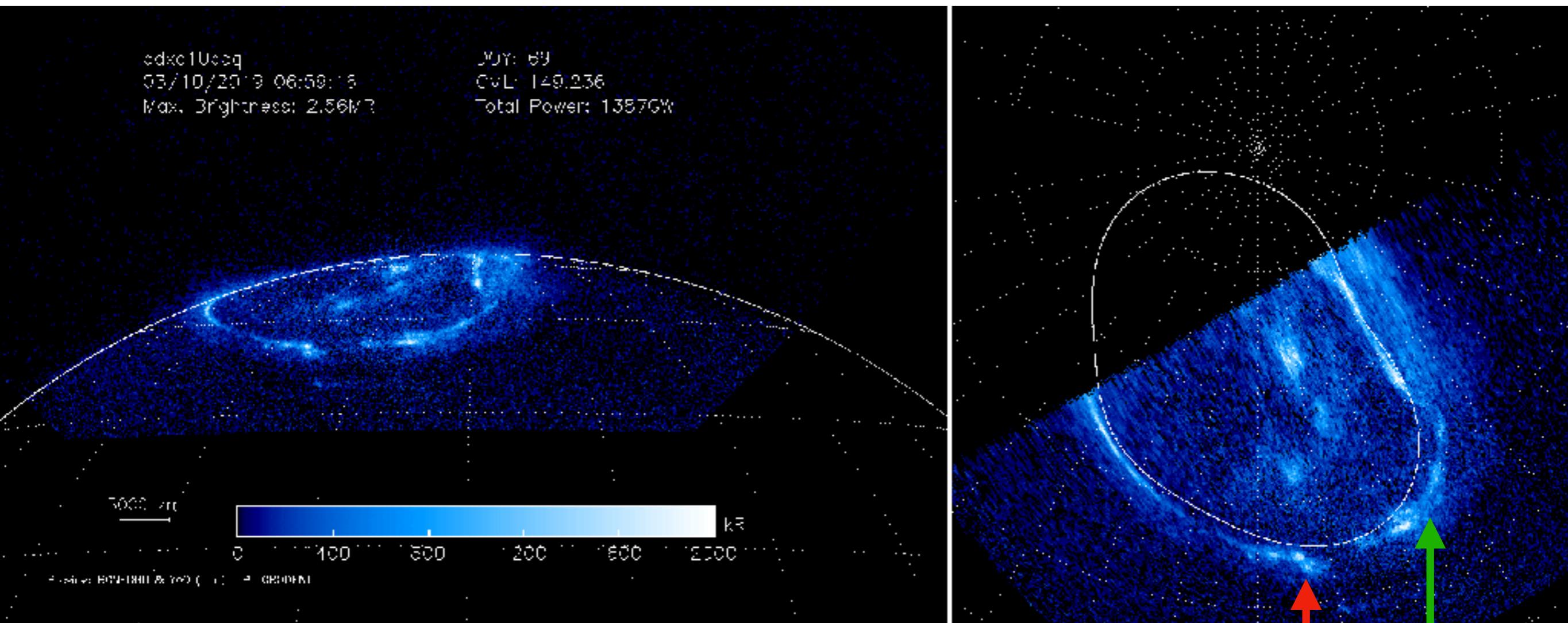
2019-02-14 22:14:29 – 24:16:36

+3 wk AJ18 - 2d



Expanded, faint main emission + Dusk beads

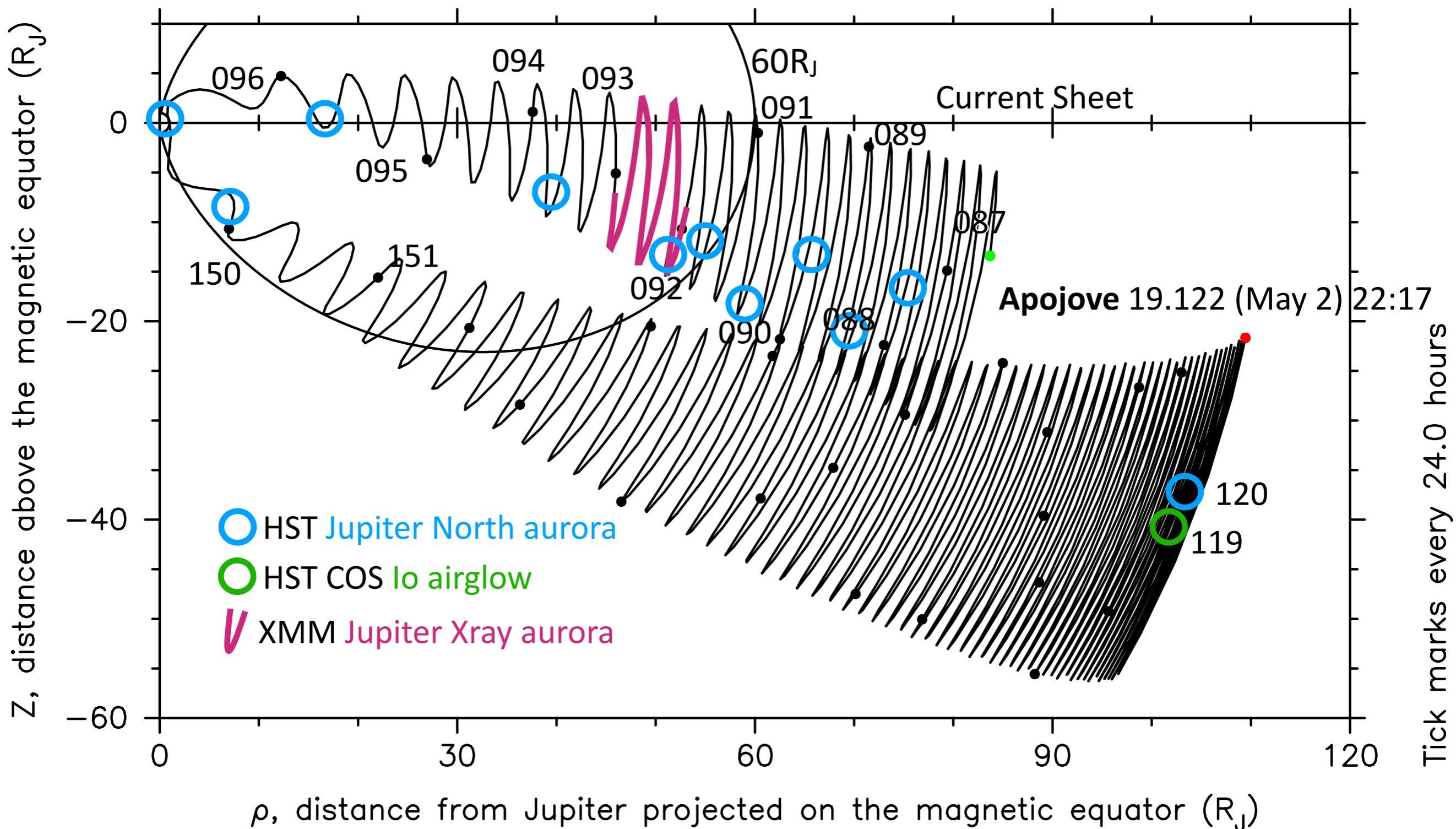
+ \sim 19 hr



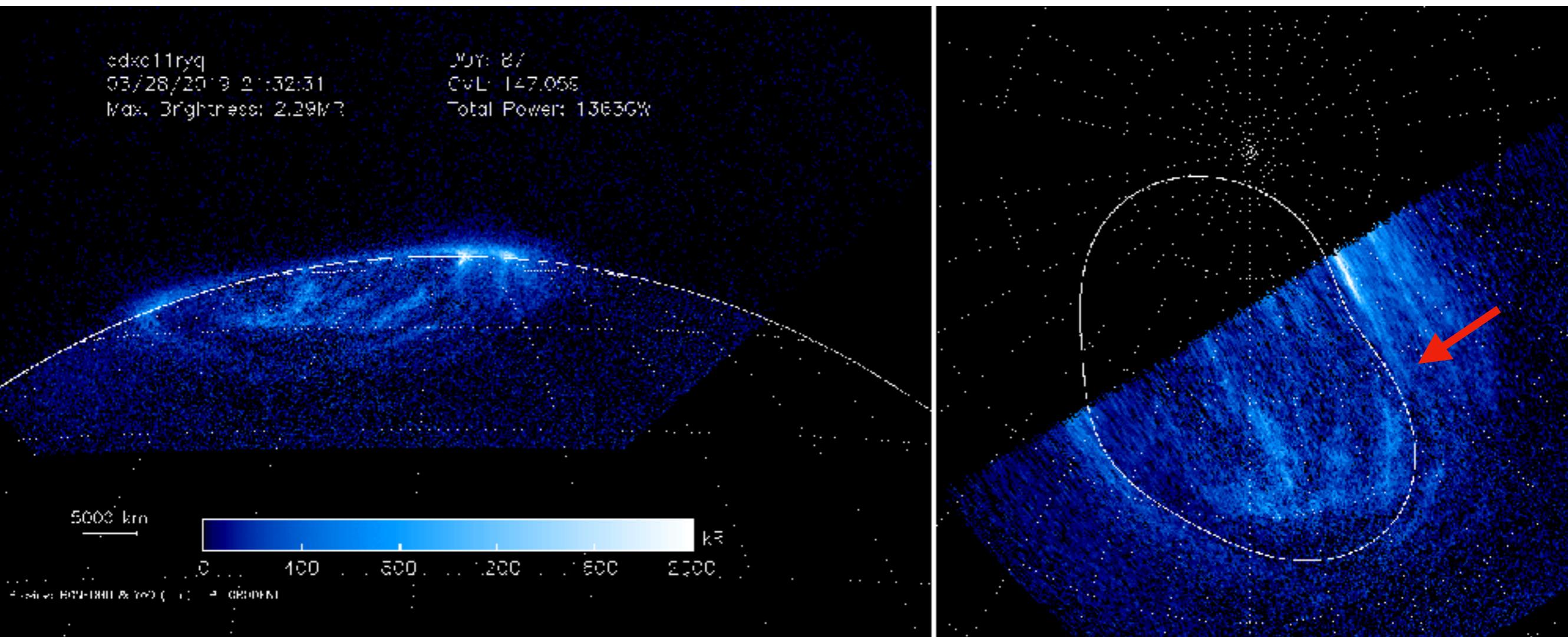
Small injection (from faint dawn storm)
broken main emission (beads)

HST observations (STIS FUV) of Jupiter's aurora during Juno orbit 19

2019 086 (March 27) 00:00:00 – 2019 120 (April 30) 00:00:00

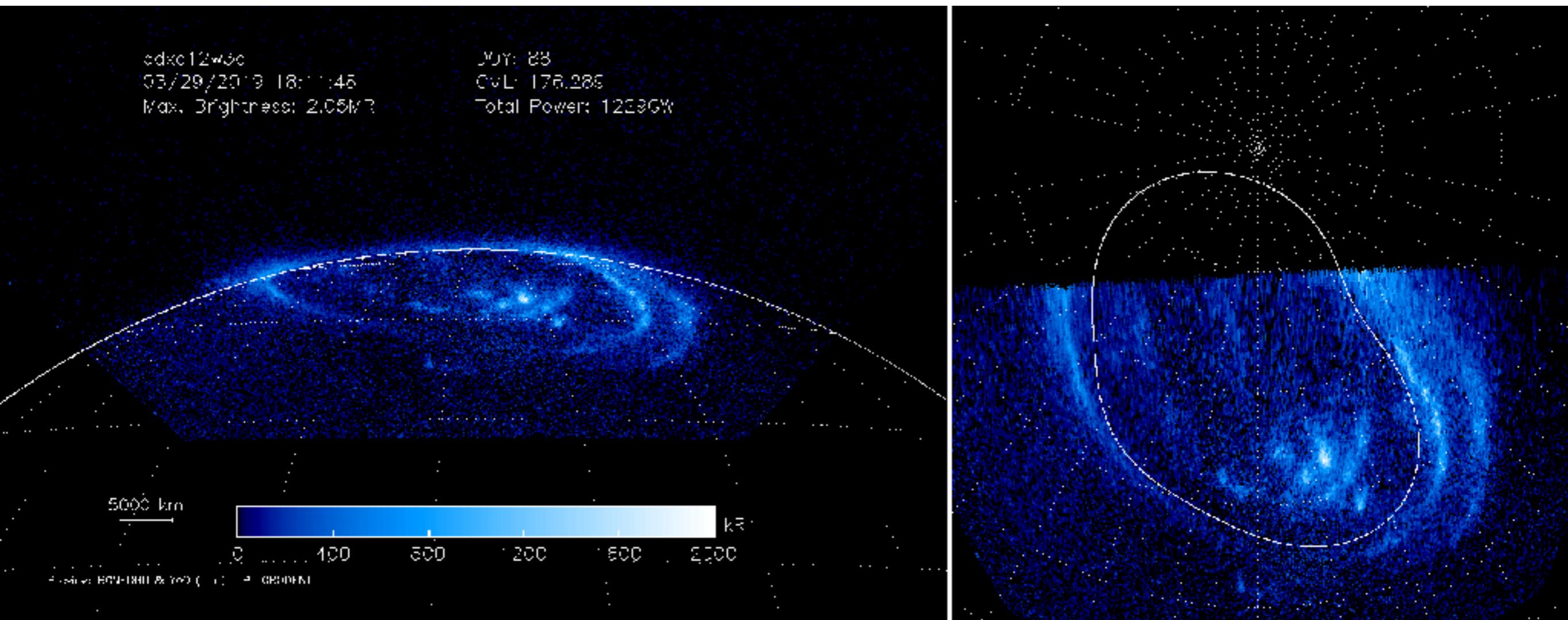


PJ19 - 9 days

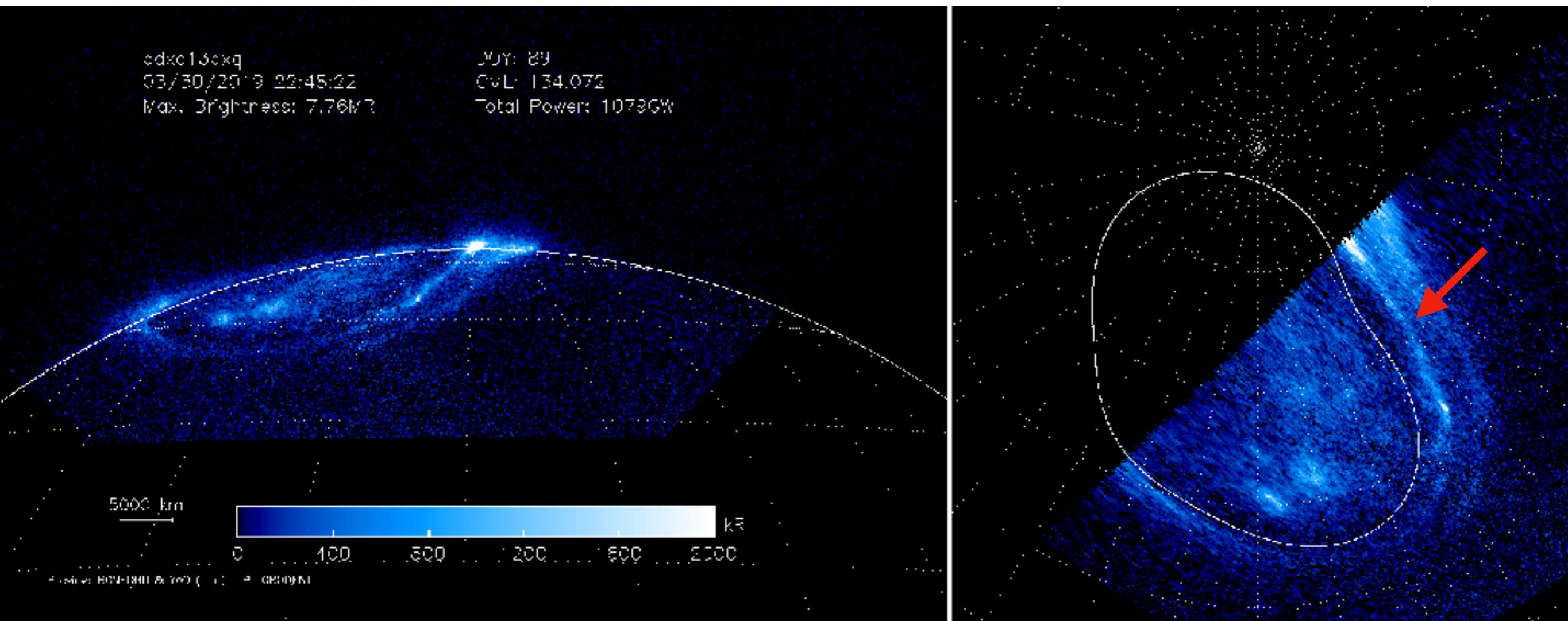


Weak expanded ME
Brightening near Dusk
Pulsating Bridge

1 day later

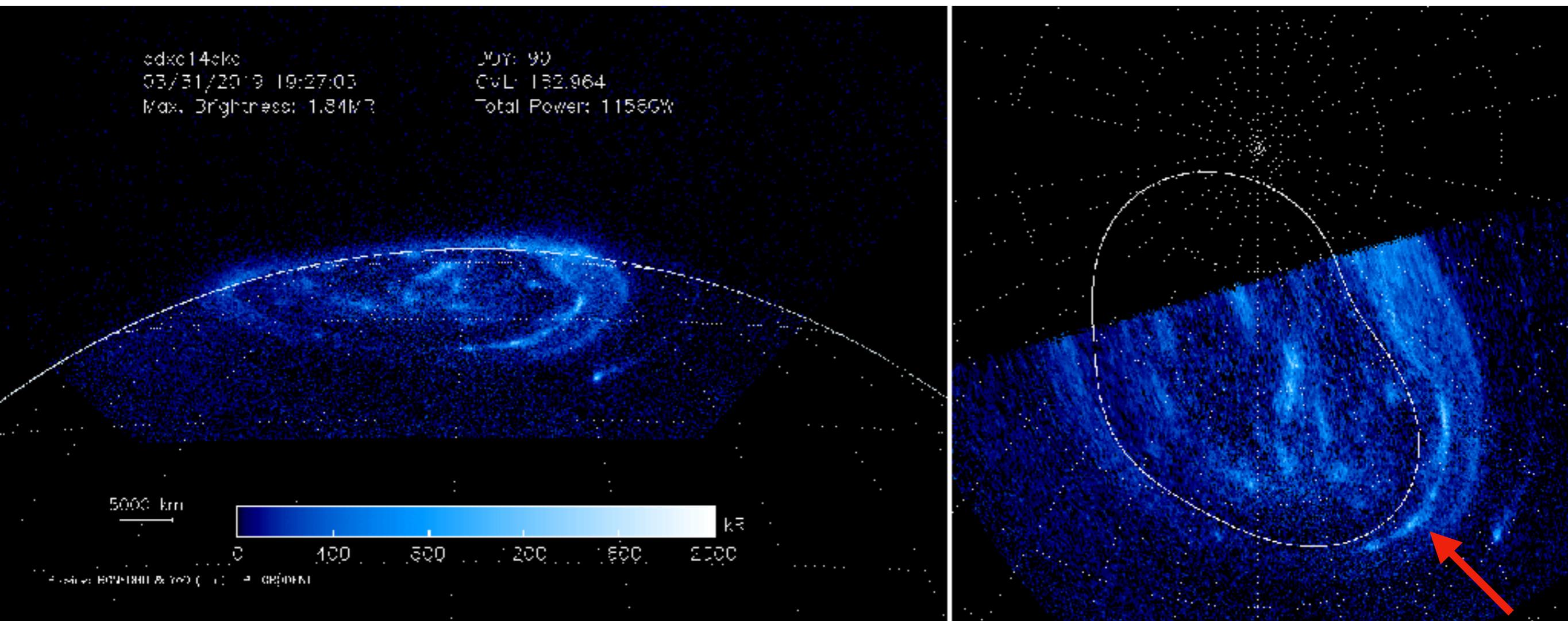


1 day later



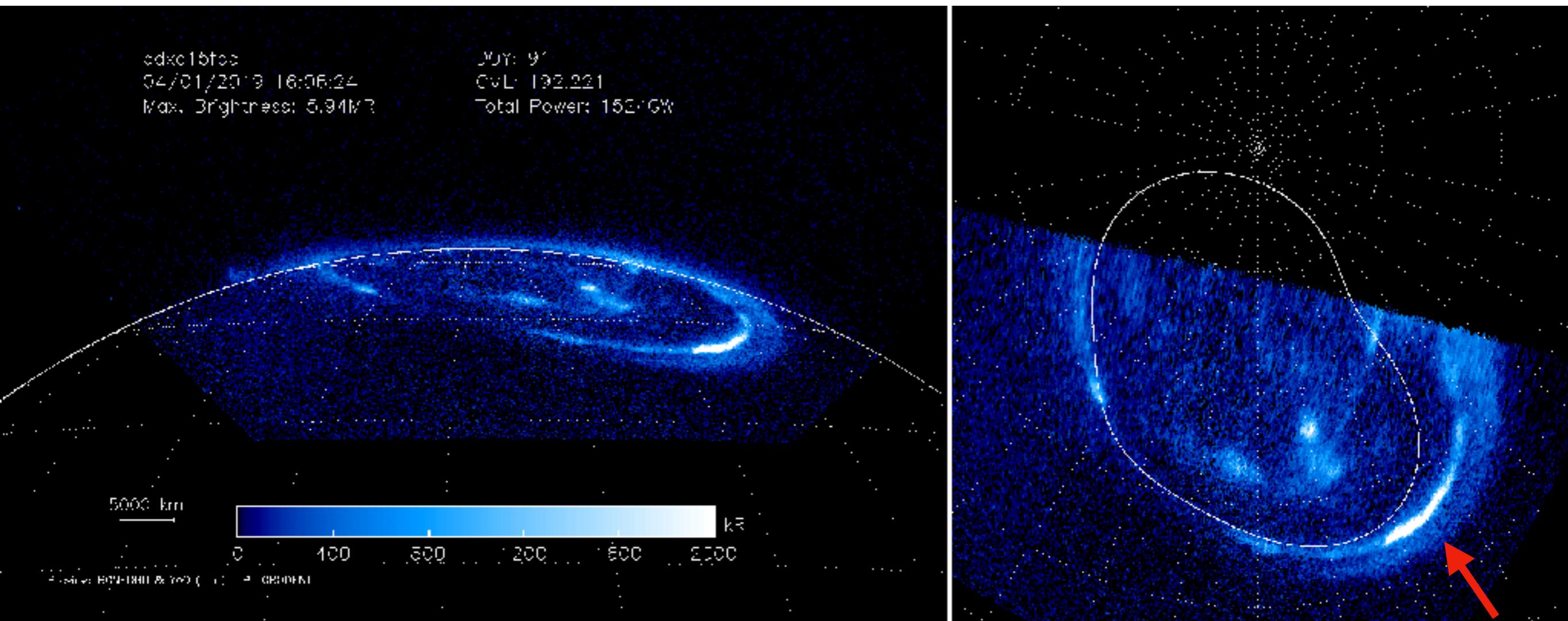
Weak expanded ME
Dawn Storm
Breaking Dusk arc

1 day later



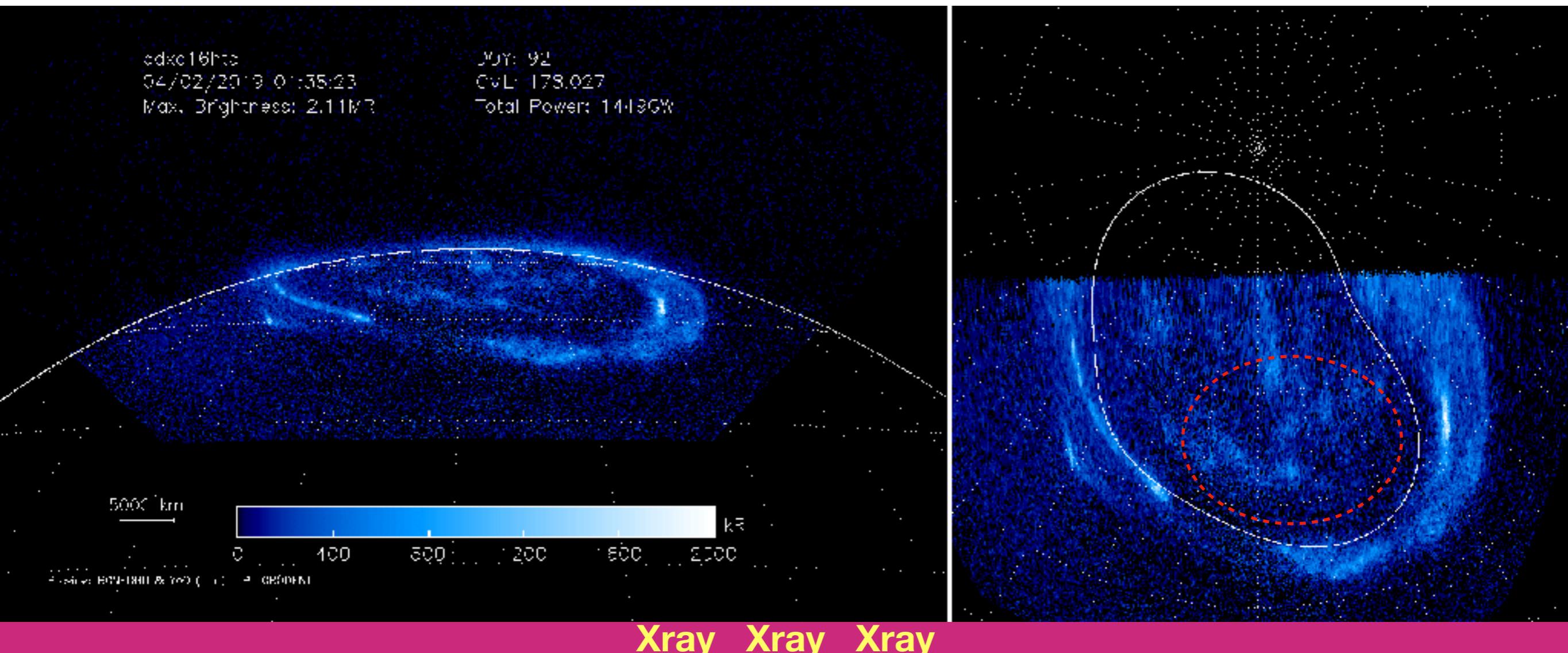
Weak ME
Dusk Beads

1 day later

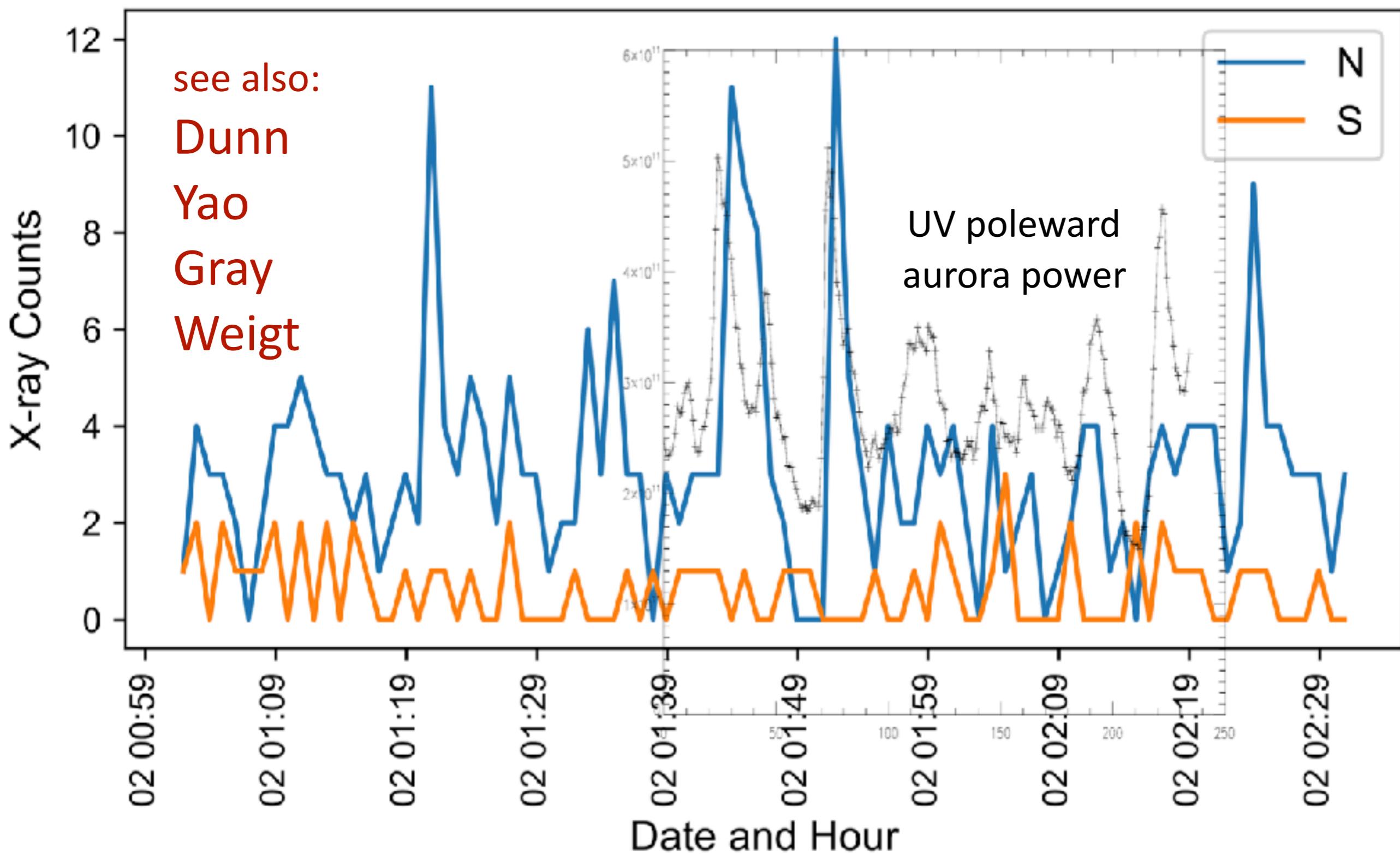


Strong dusk ME arc
Narrow SE

1 day later PJ19 - 4 days

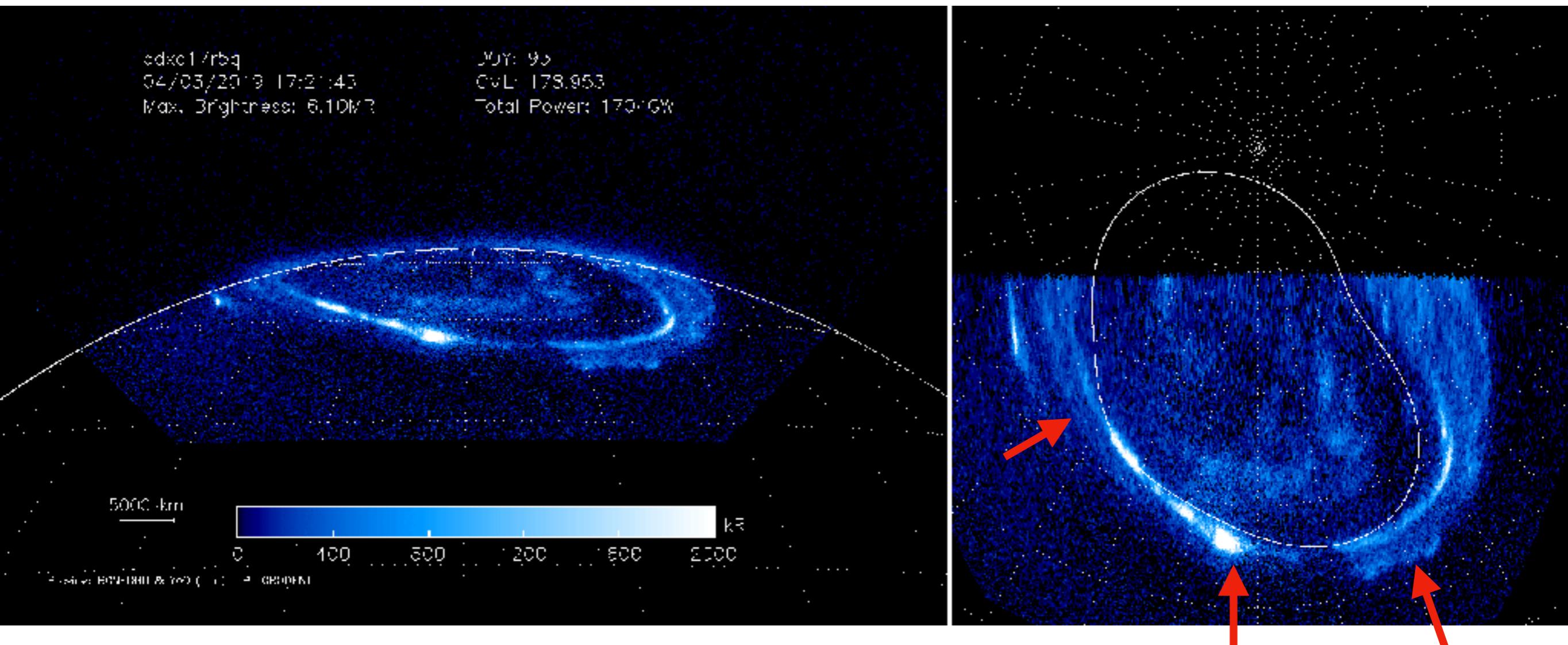


2019-04-02T01:00:00 - 2019-04-02T02:30:00



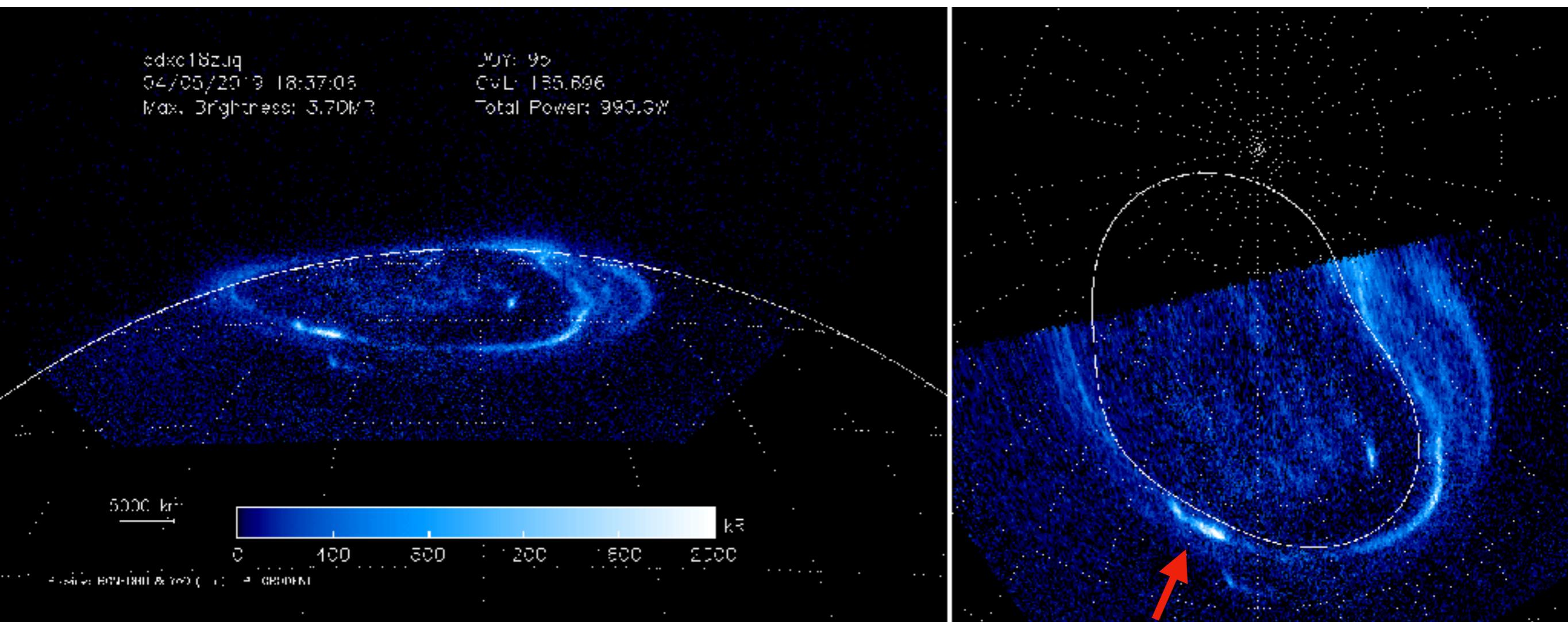
Xr plot, courtesy W. Dunn

1 day later

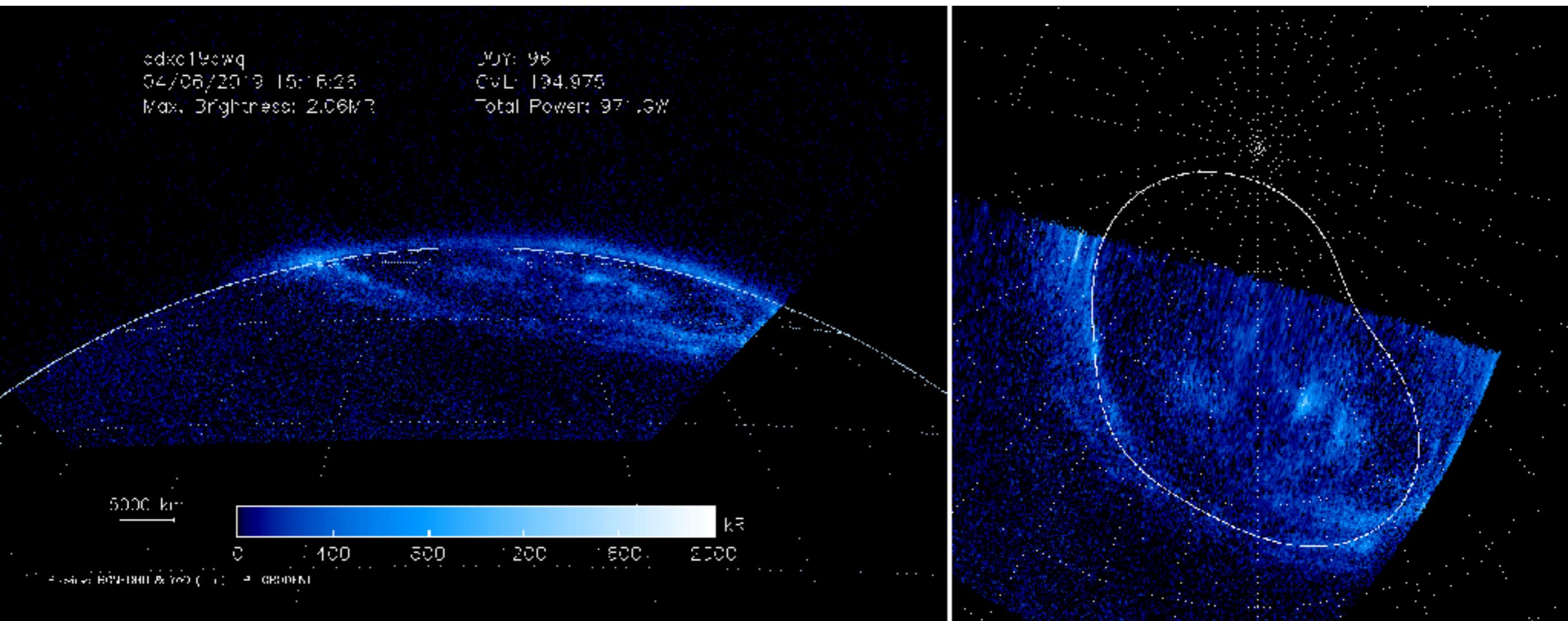


Dawn Storms Creation => Injections

2 days later

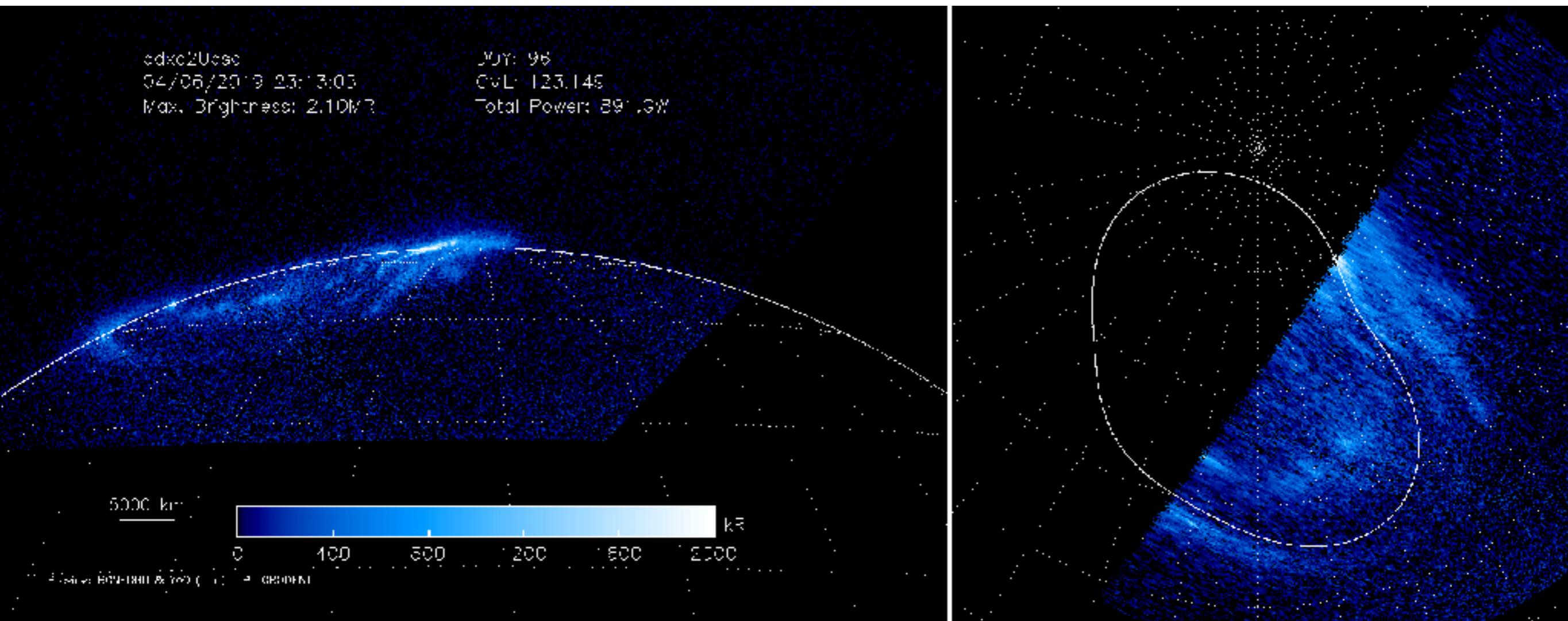


PJ19 + 2 hr



Weak expanded ME
Brightening near Dusk
Pulsating Bridge

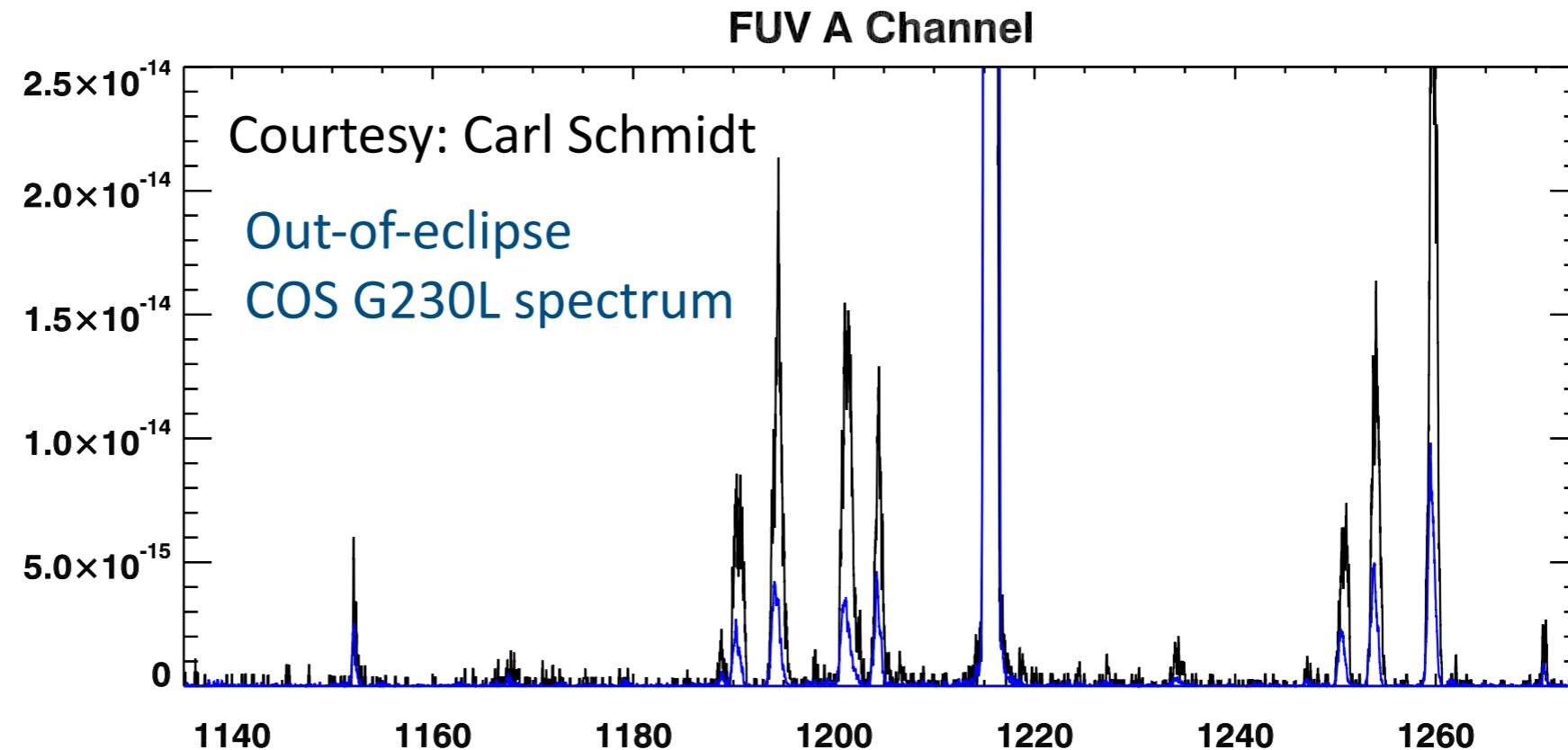
PJ19 + 10 hr



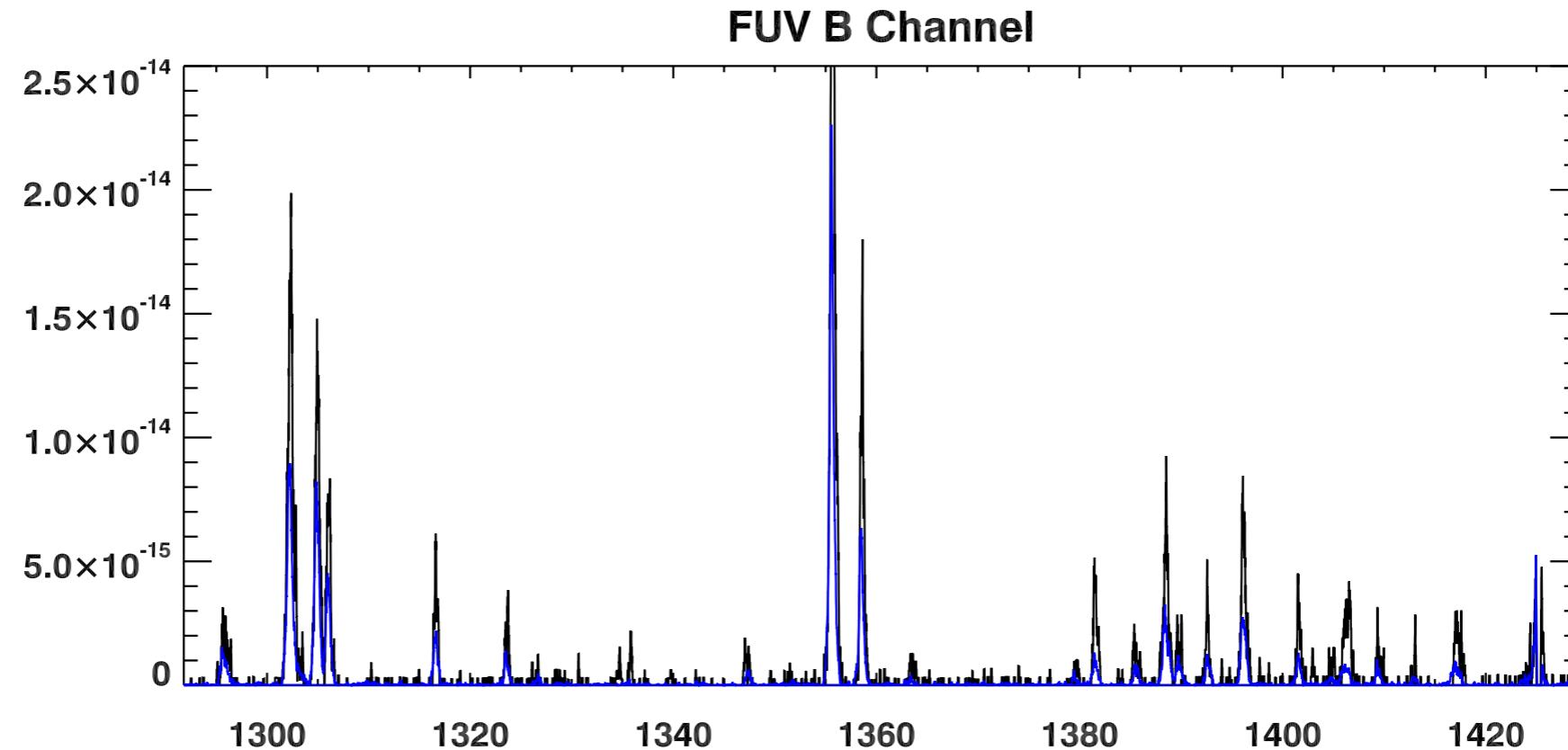
Weak expanded ME

Io in eclipse

AJ18



2019-04-29 16:04-16:12

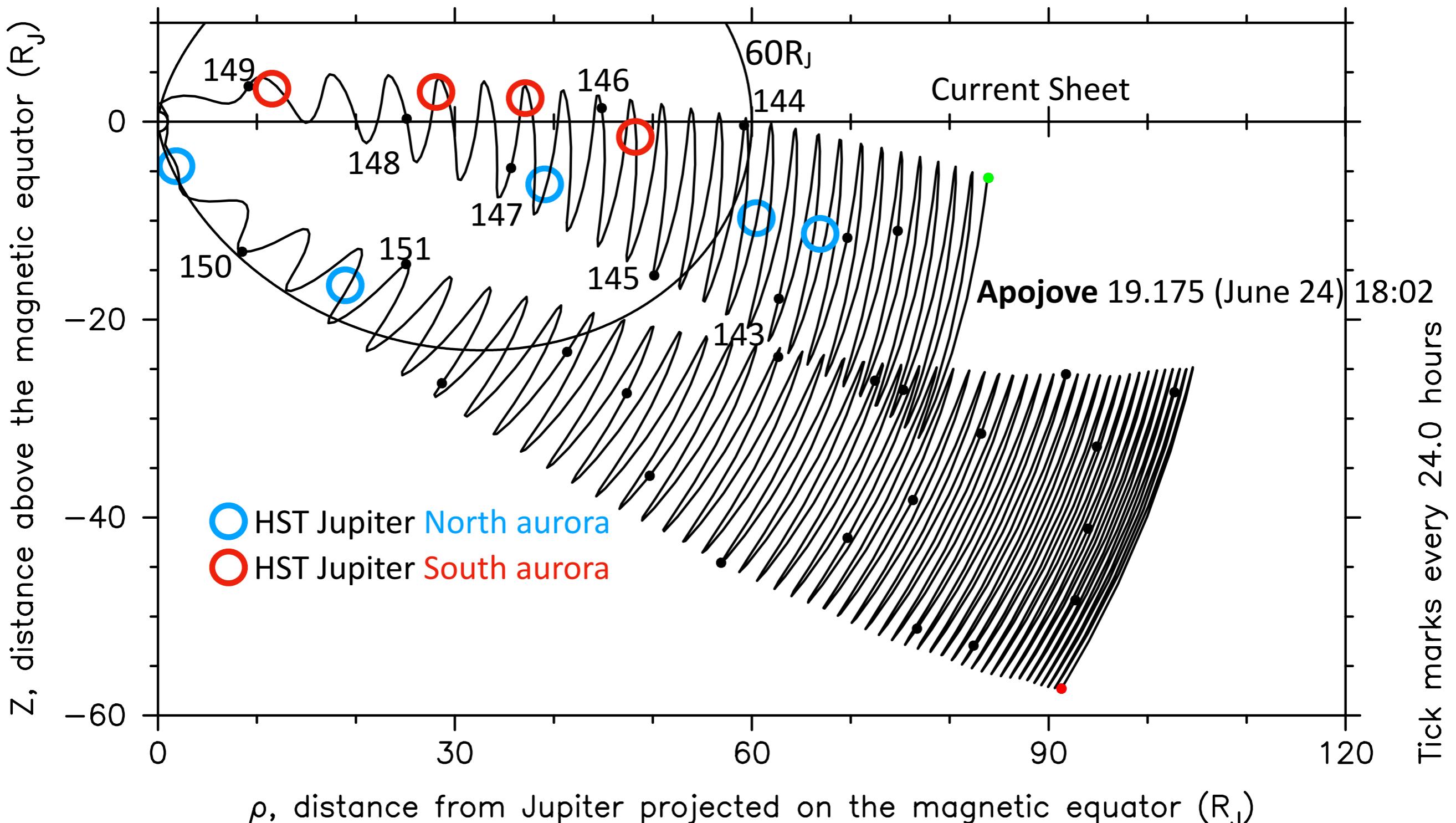


HST observations (STIS FUV) of Jupiter's aurora during Juno orbit 20

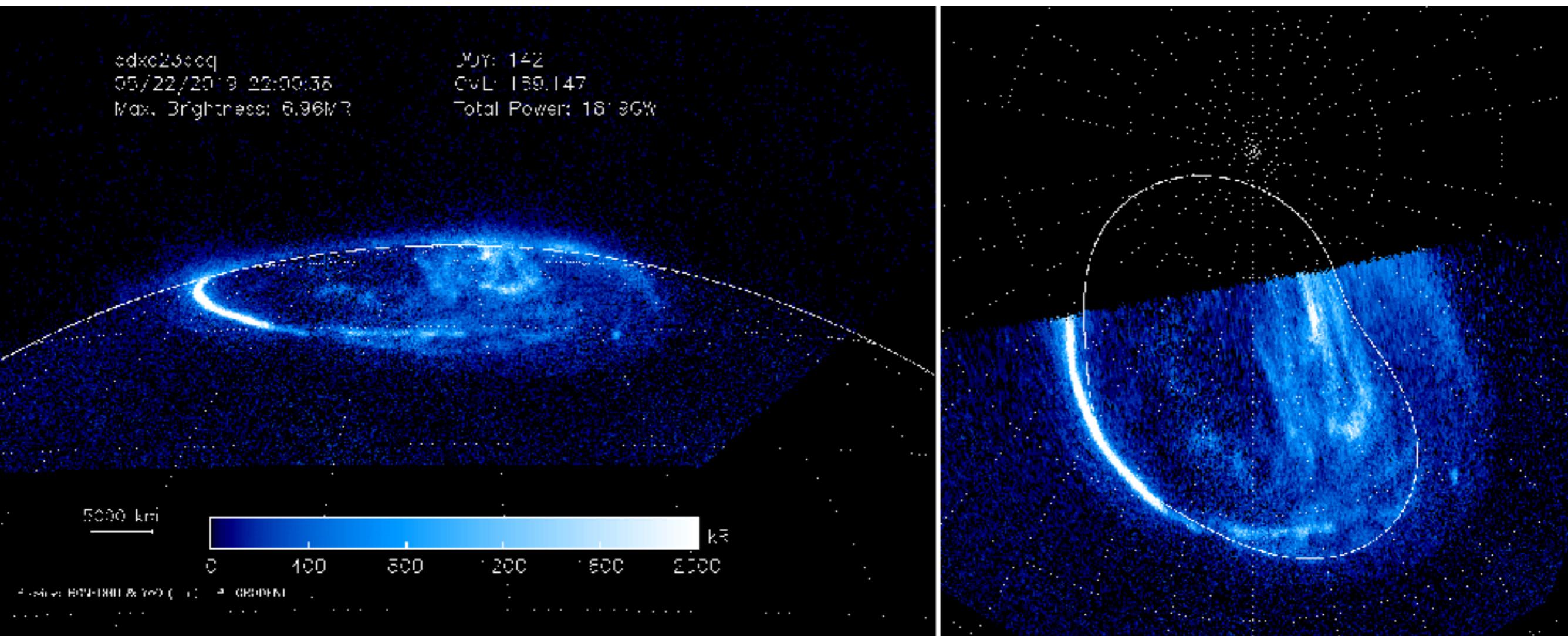
Perijove 19.149 (May 29) 08:08

PJ20 60RJ

2019 139 (May 19) 00:00:00 – 2019 169 (June 18) 00:00:00



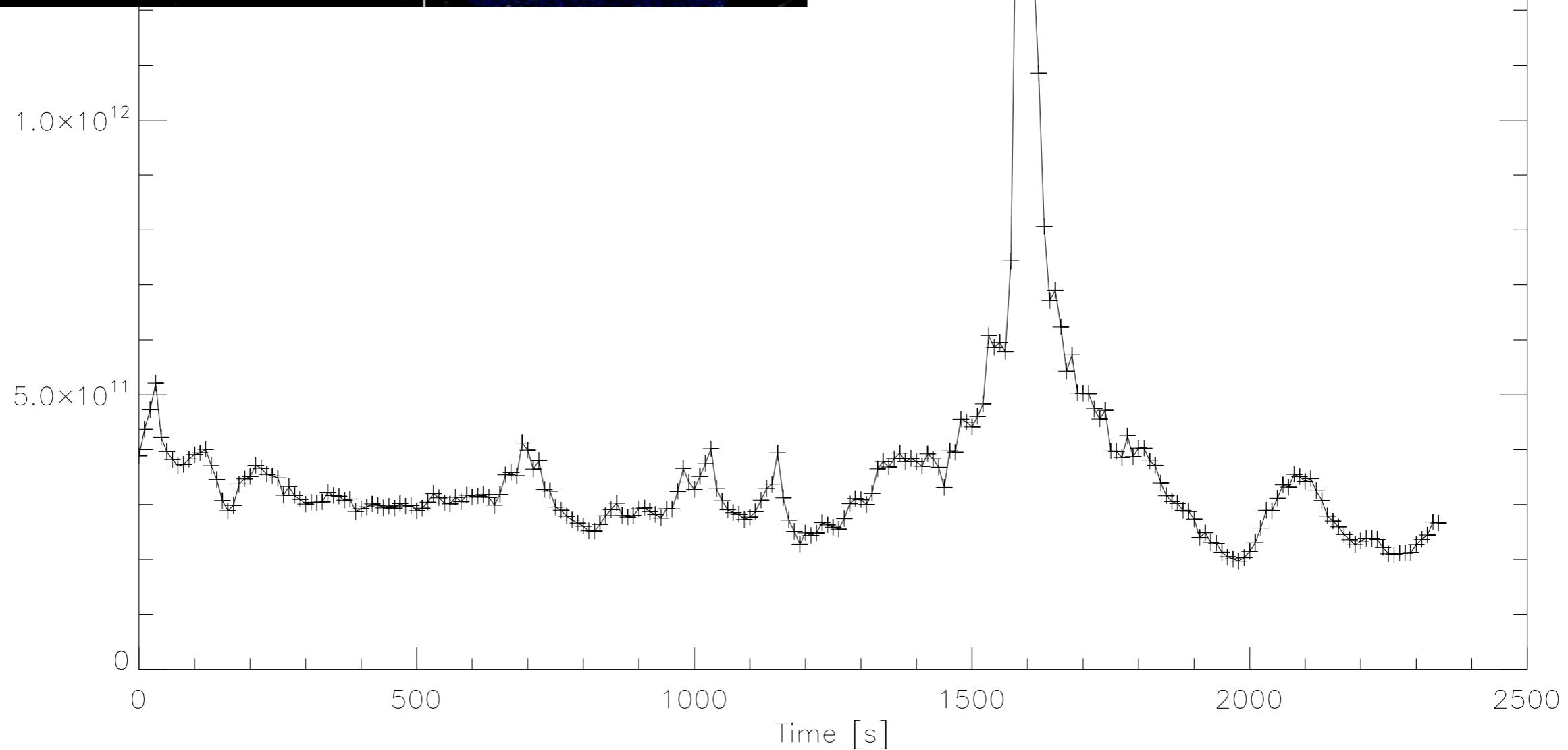
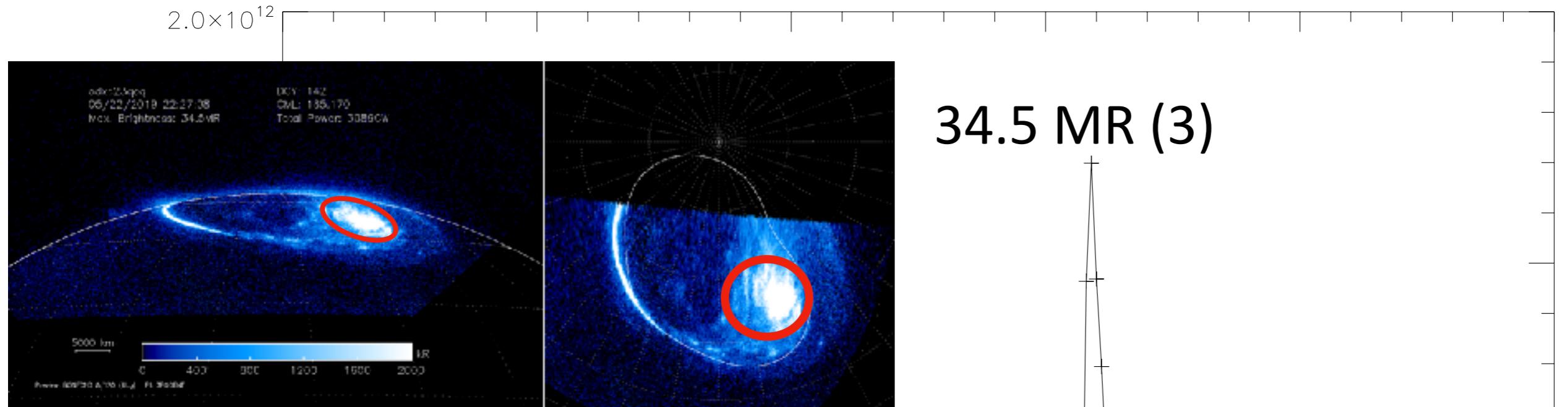
PJ20 - 1 week



Polar Explosion 35 MR
Bright dawn ME

Total auroral power ~ 3 TW (2) ~ 6 TW both hemispheres ~ 10 times power produced by all nuclear plants on Earth

20



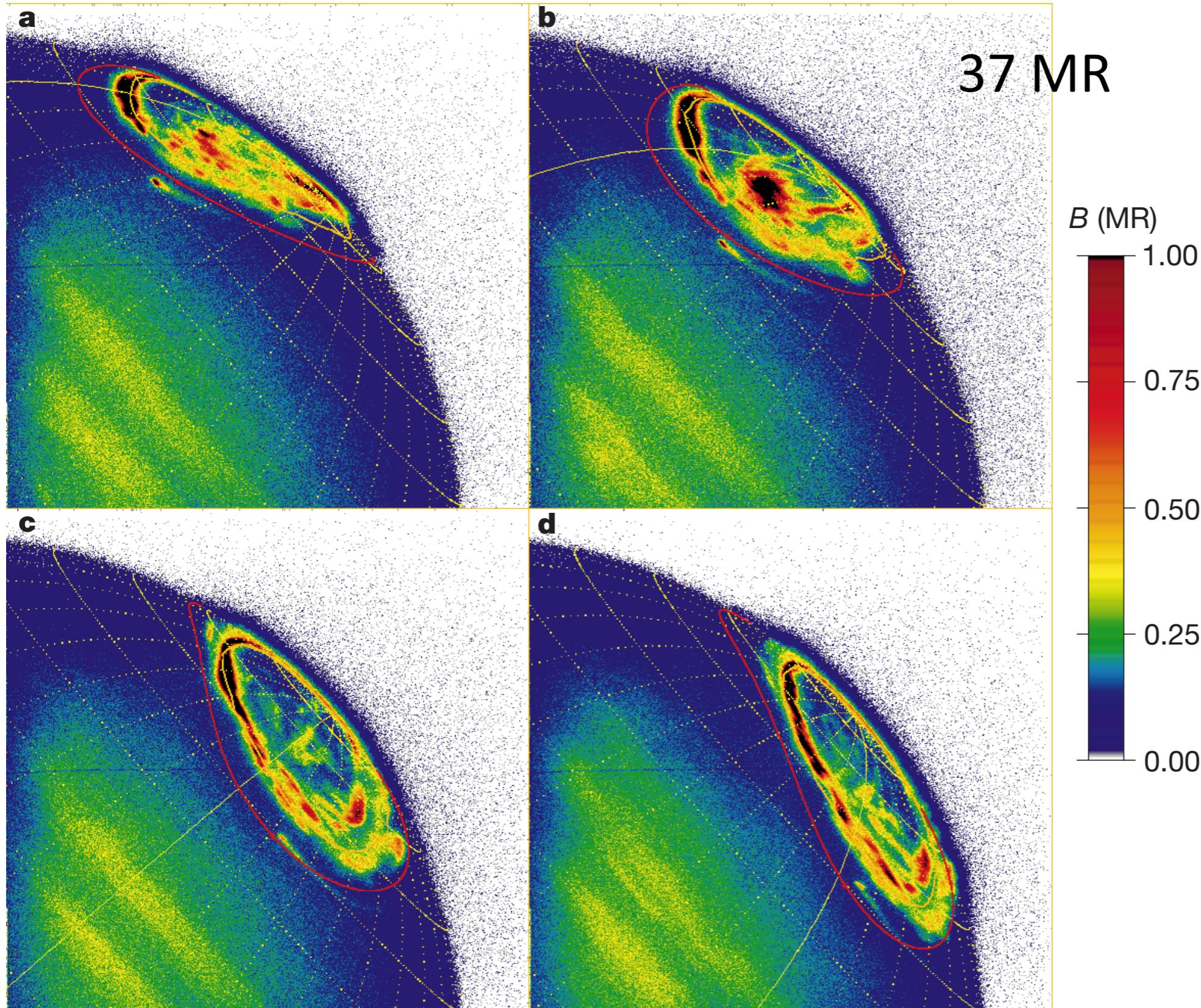
An auroral flare at Jupiter

J. H. Waite Jr*, G. R. Gladstone†, W. S. Lewis†, R. Goldstein†,
D. J. McComas†, P. Riley‡, R. J. Walker§, P. Robertson†, S. Desai||,
J. T. Clarke* & D. T. Young*

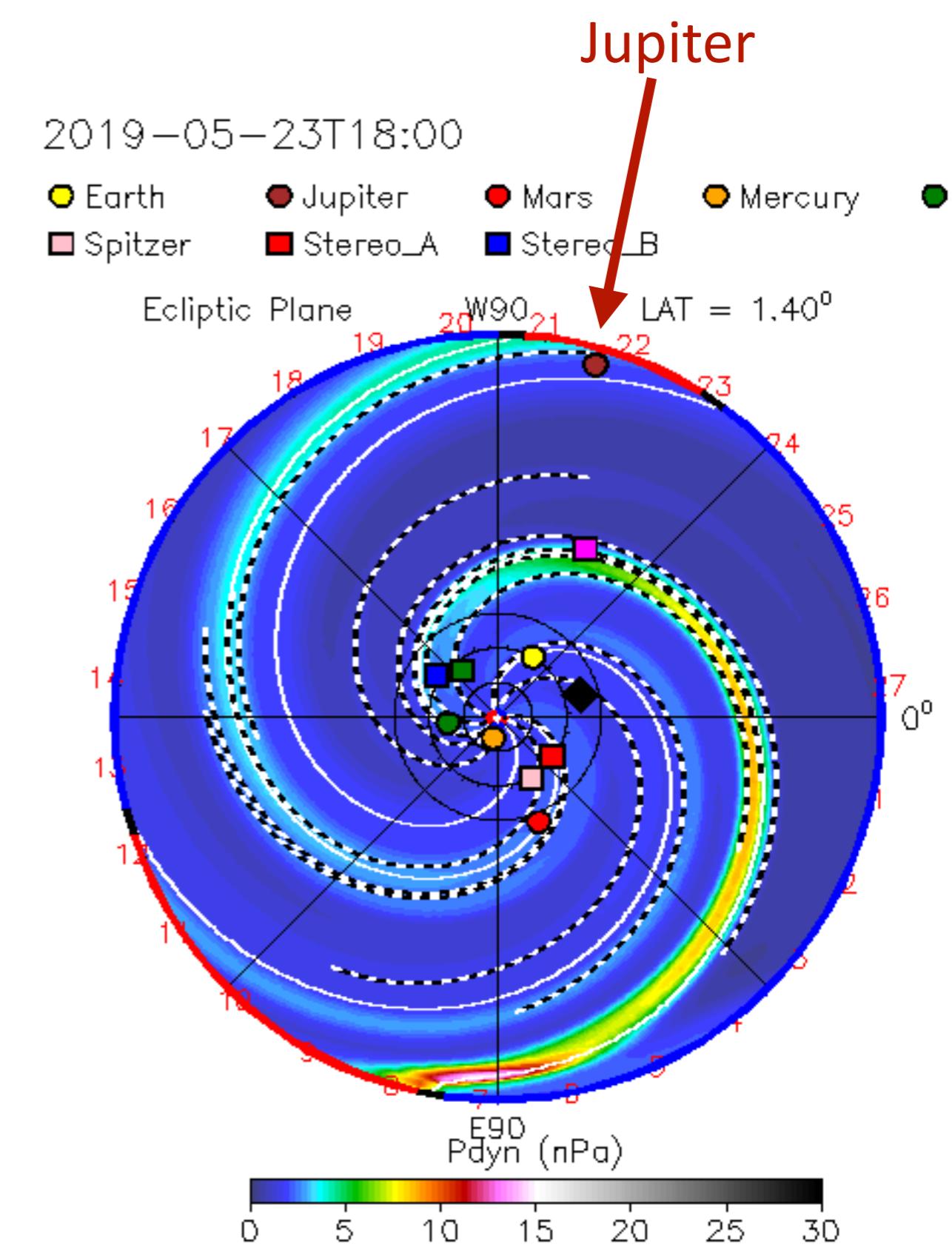
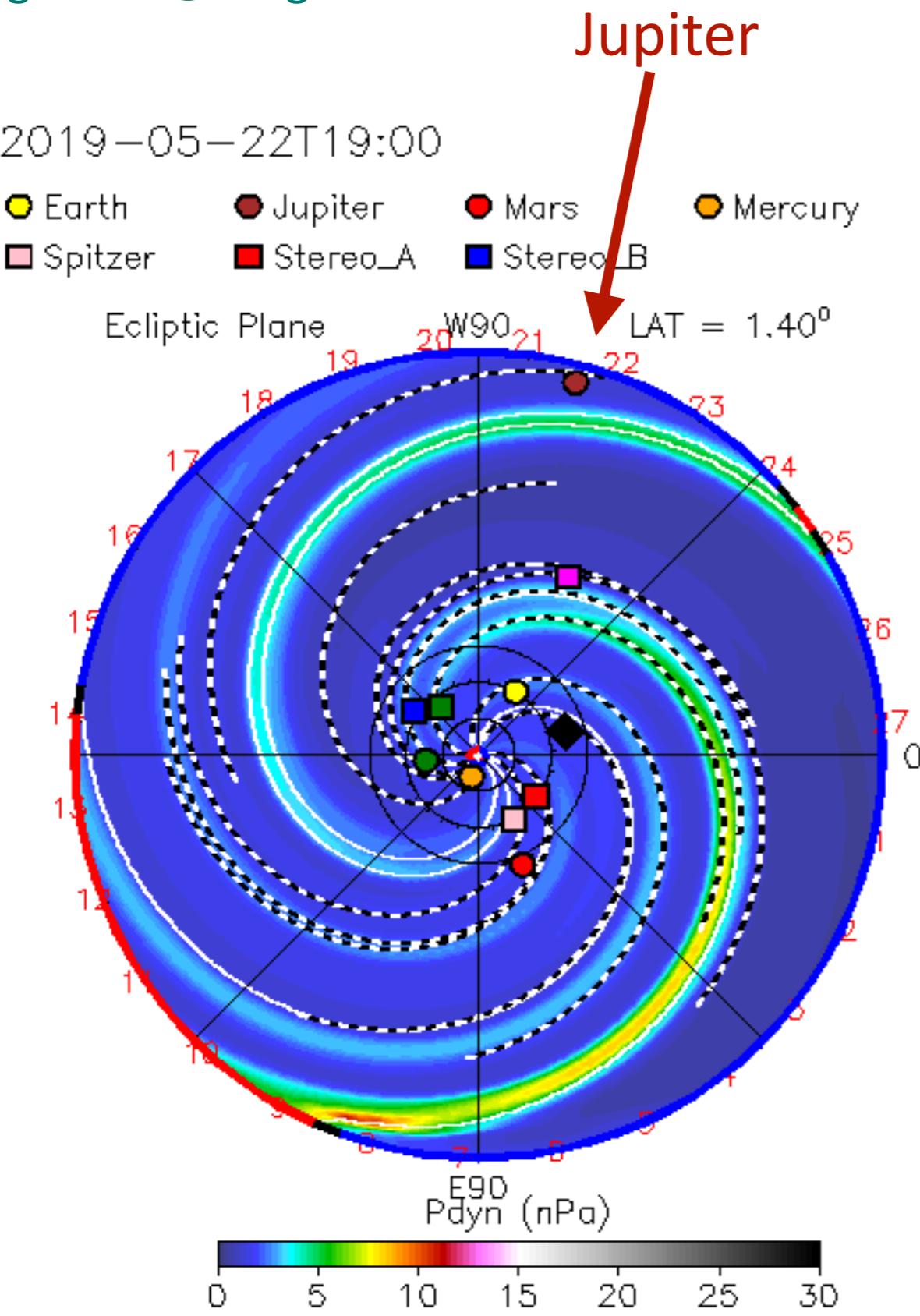
NATURE | VOL 410 | 12 APRIL 2001 | www.nature.com

Waite et al., 2001

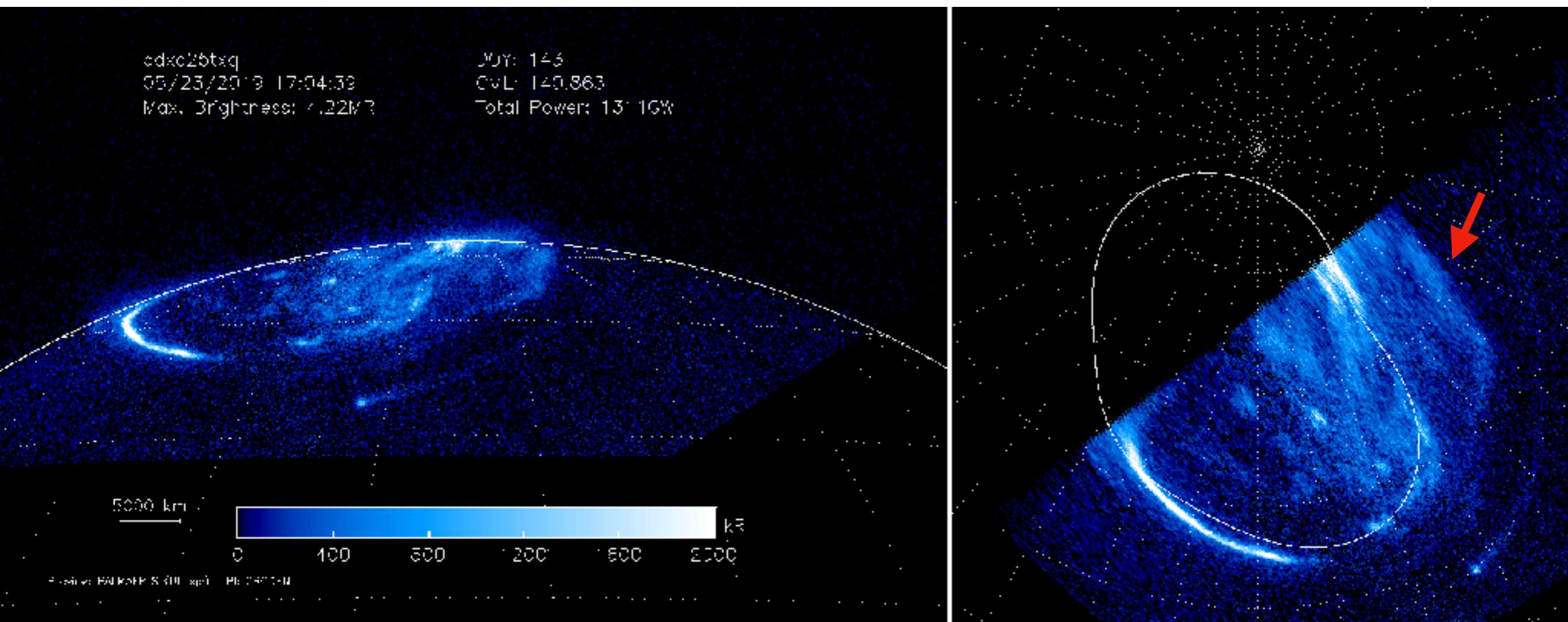
20



"This type of flaring emission has not previously been reported for Jupiter .../..., and it may be related directly to changes in the solar wind."

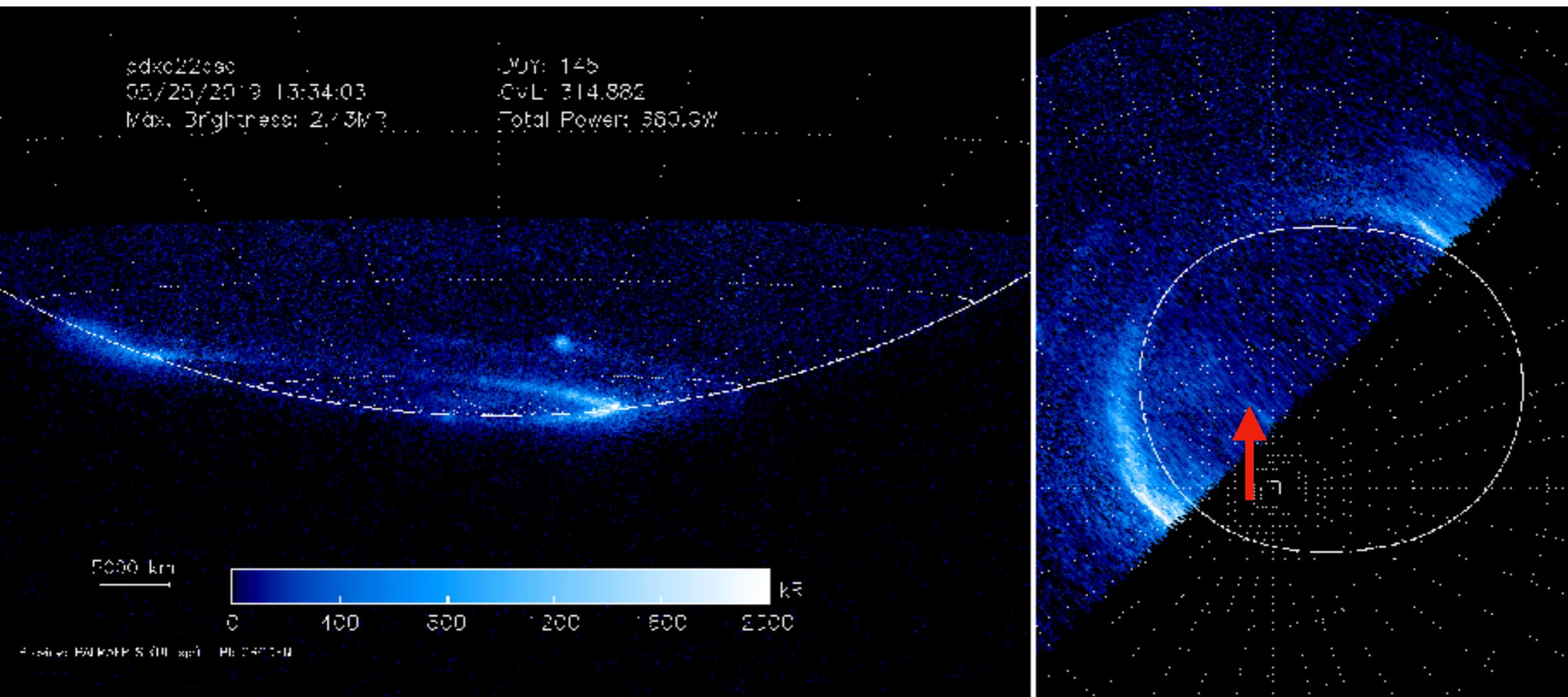


1 day later



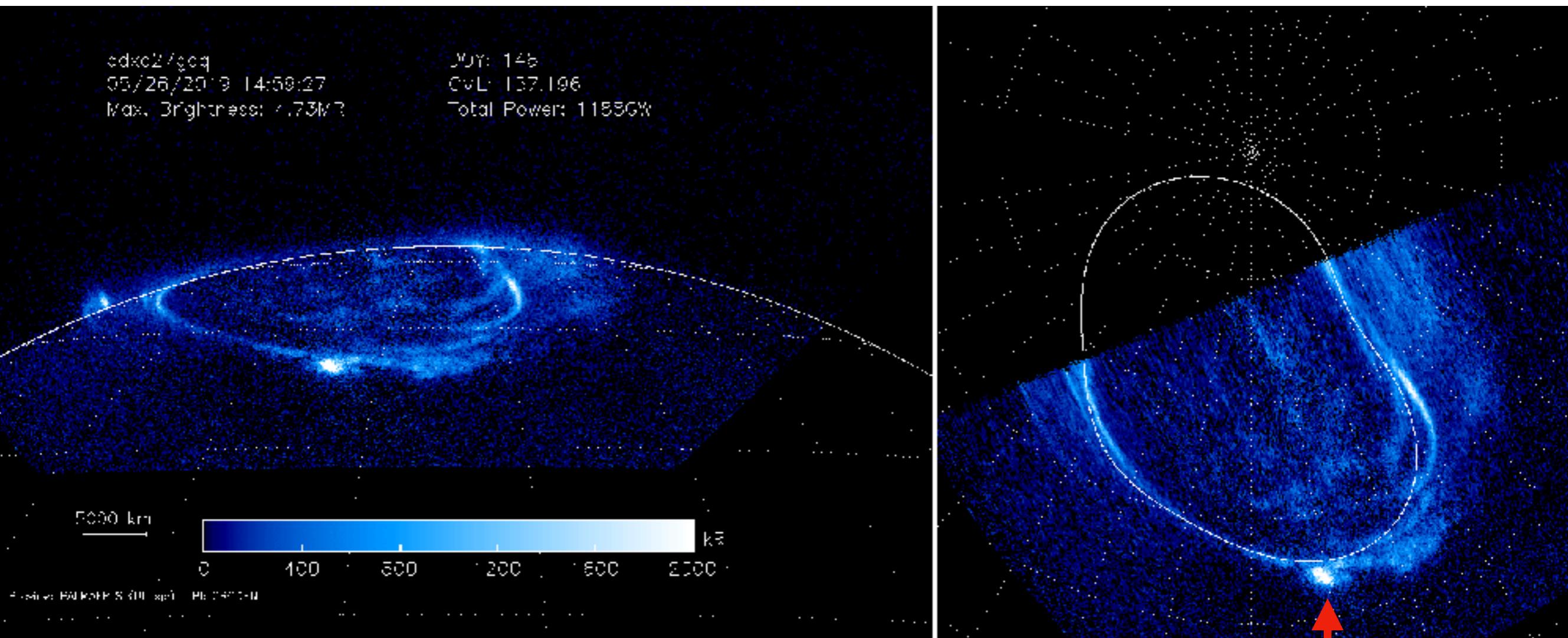
Polar Explosion 15 MR
Injections

2 days later

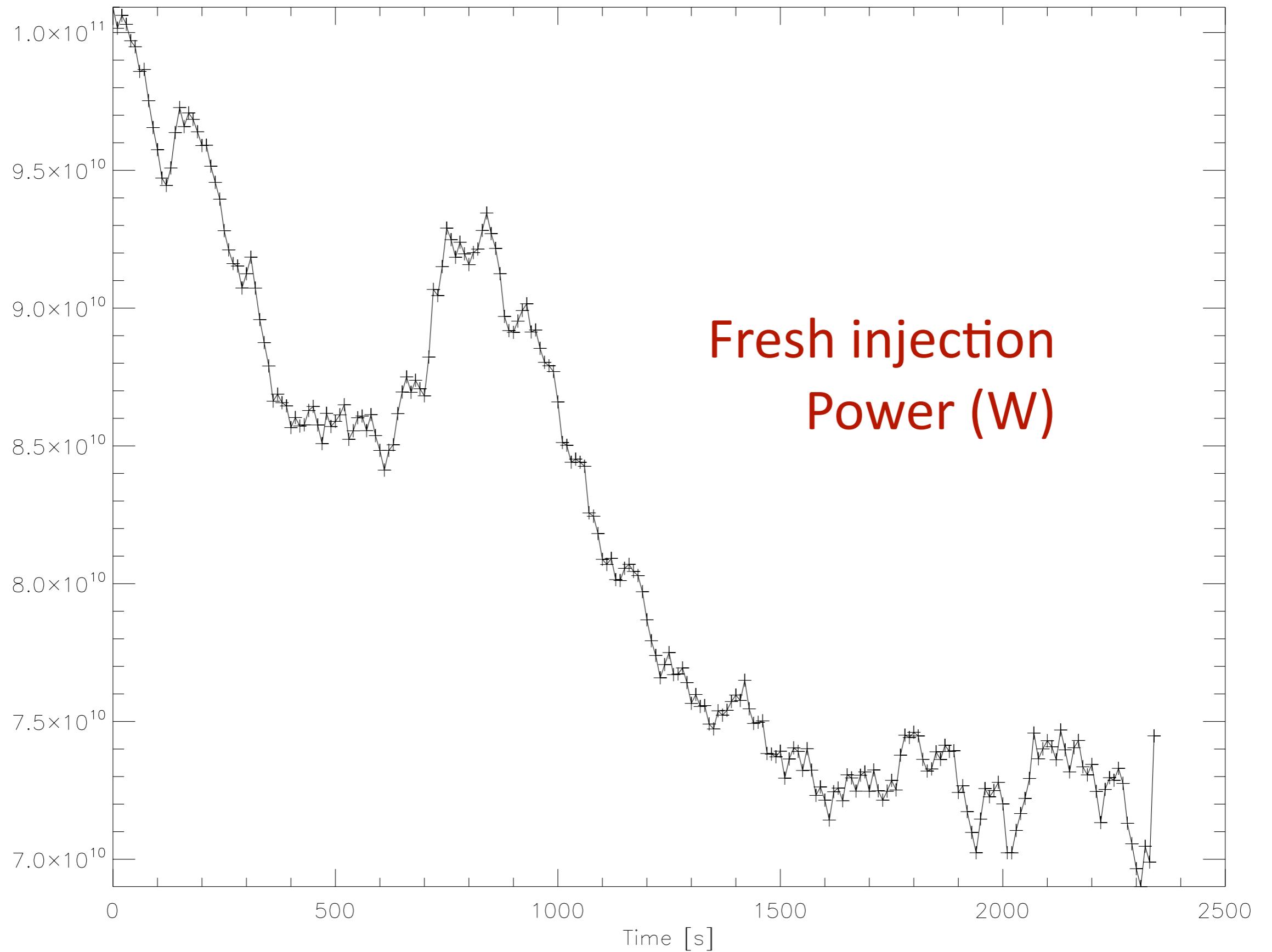


Polar Explosion >4 MR
Pulsating IFP

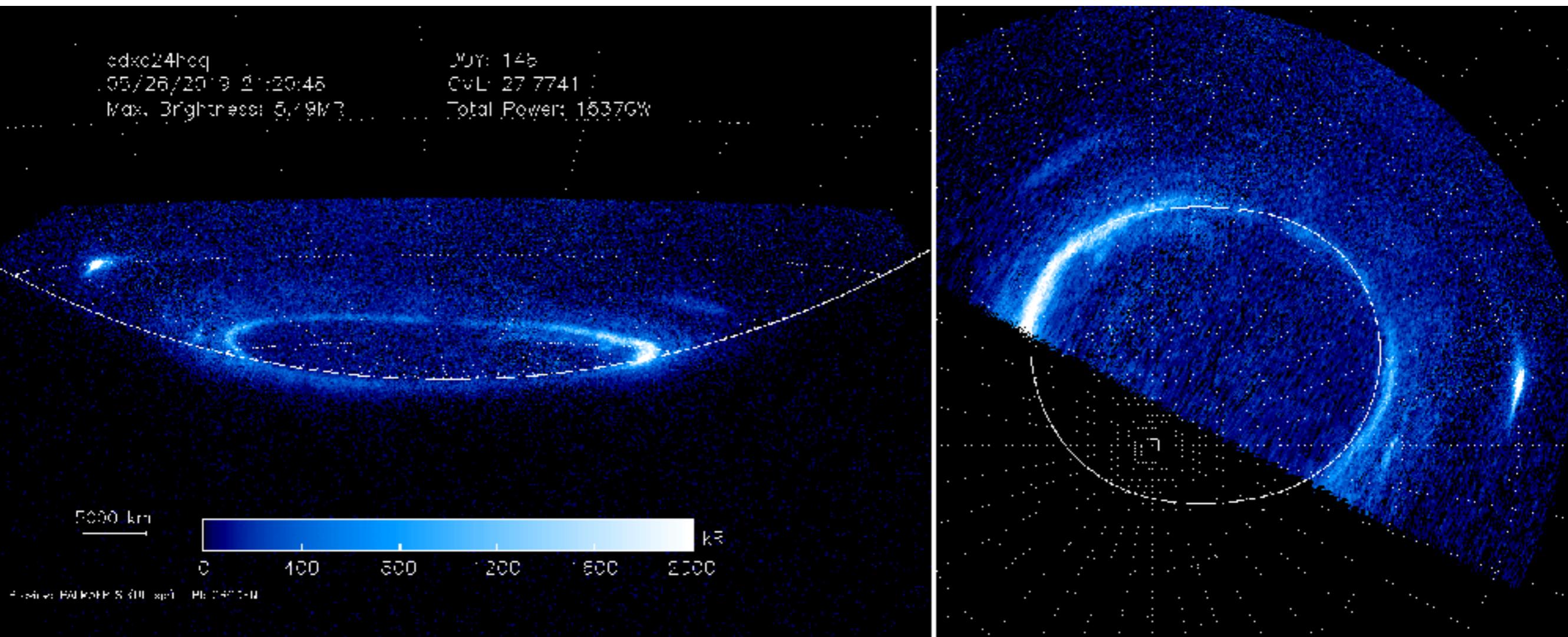
1 day later PJ20 - 3 days



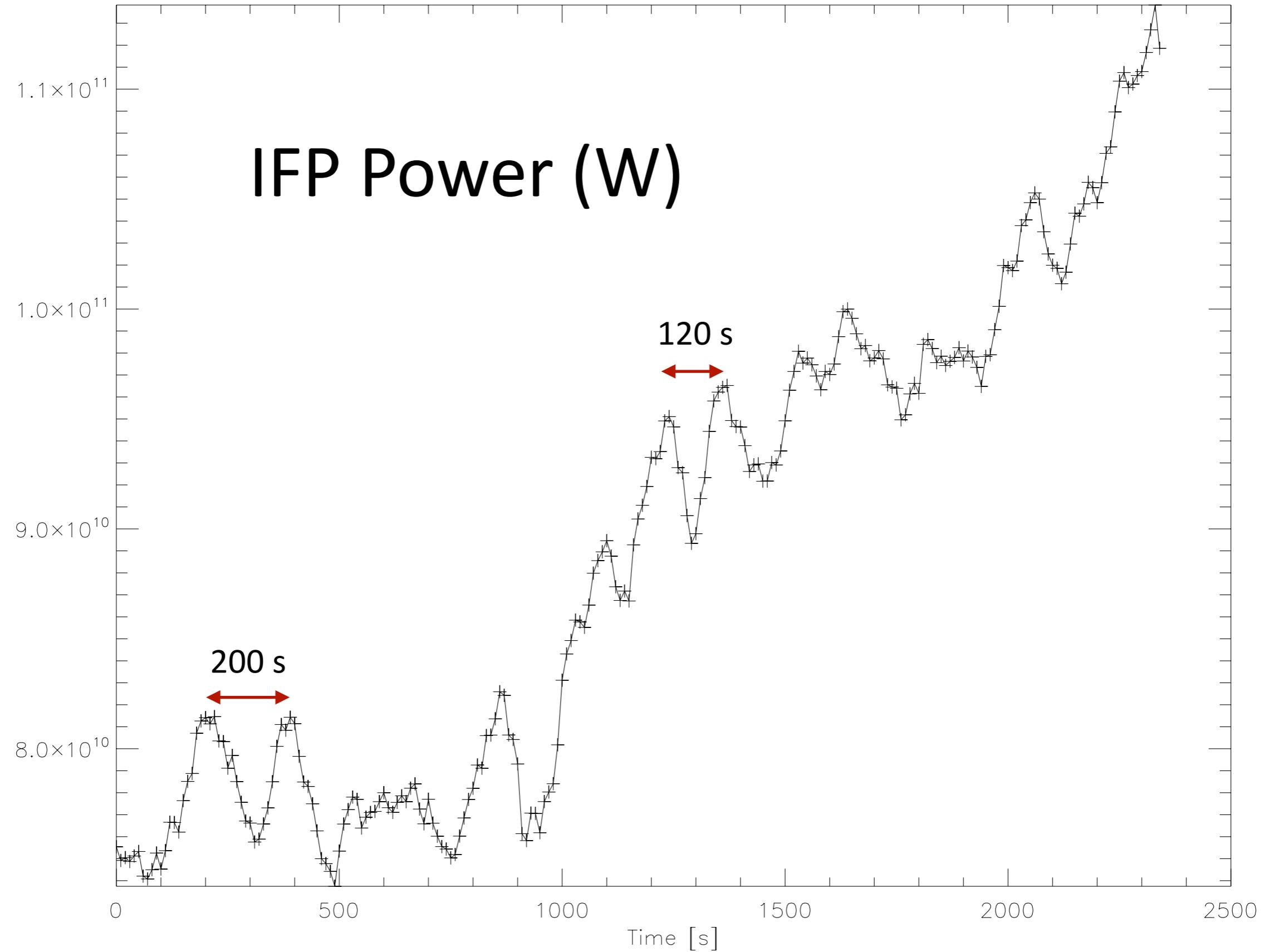
Fresh injection
Flashing bridge (100s)



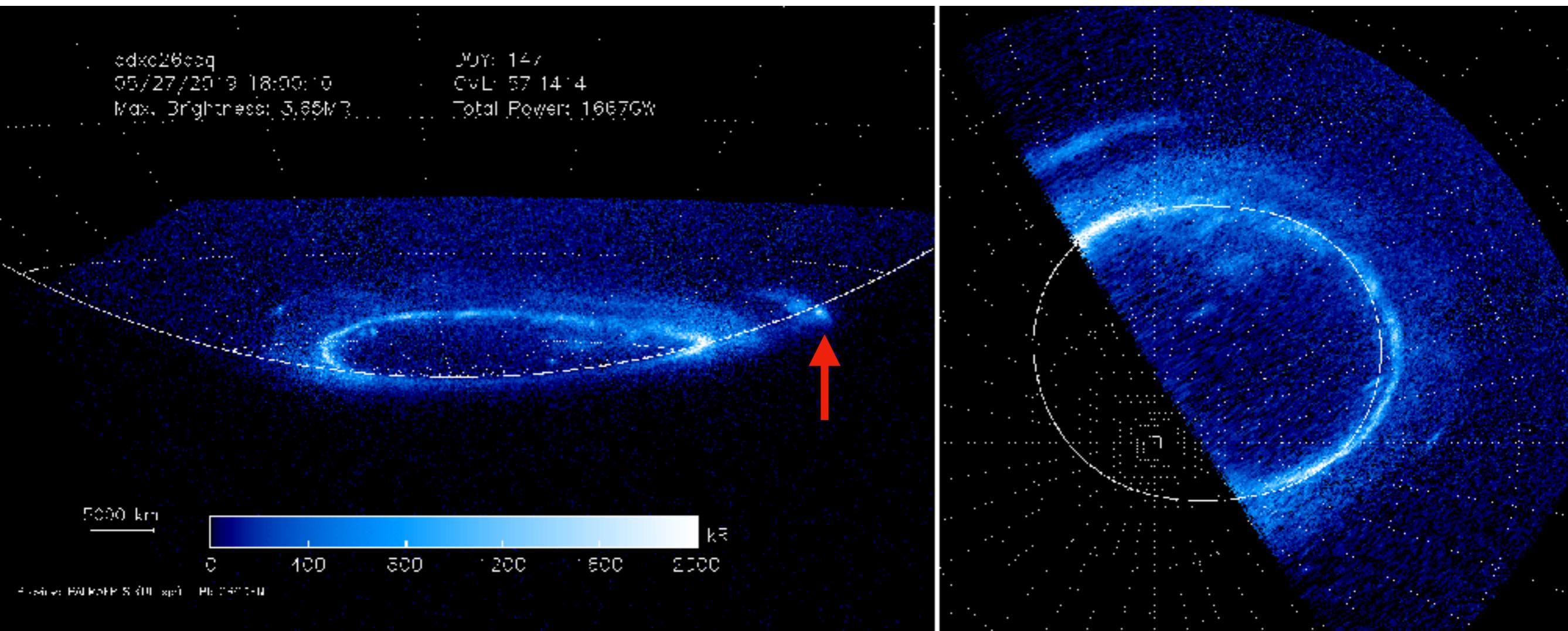
6 hours later



Io footprint peaking at >13 MR
(2x max. value ever observed)

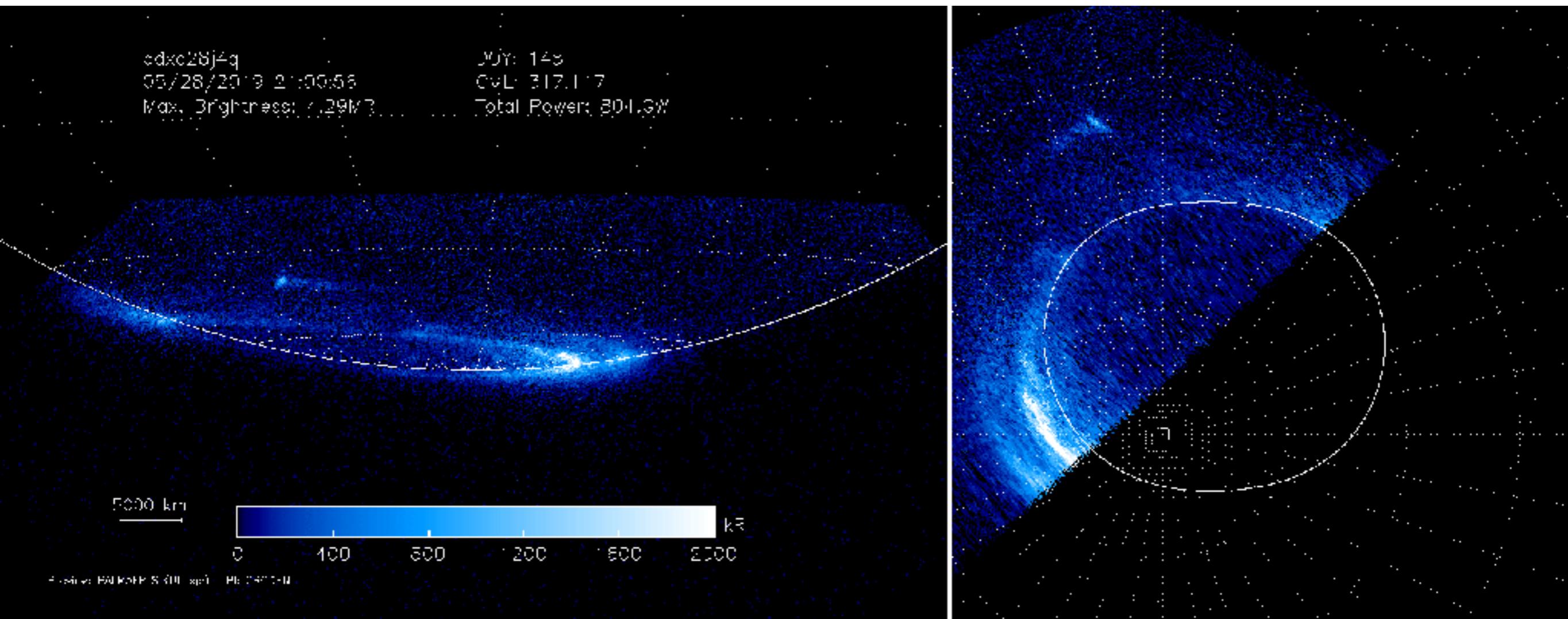


1 day later PJ20 - 2 days



Injection very close to IFP

1 day later PJ20 - 1 day

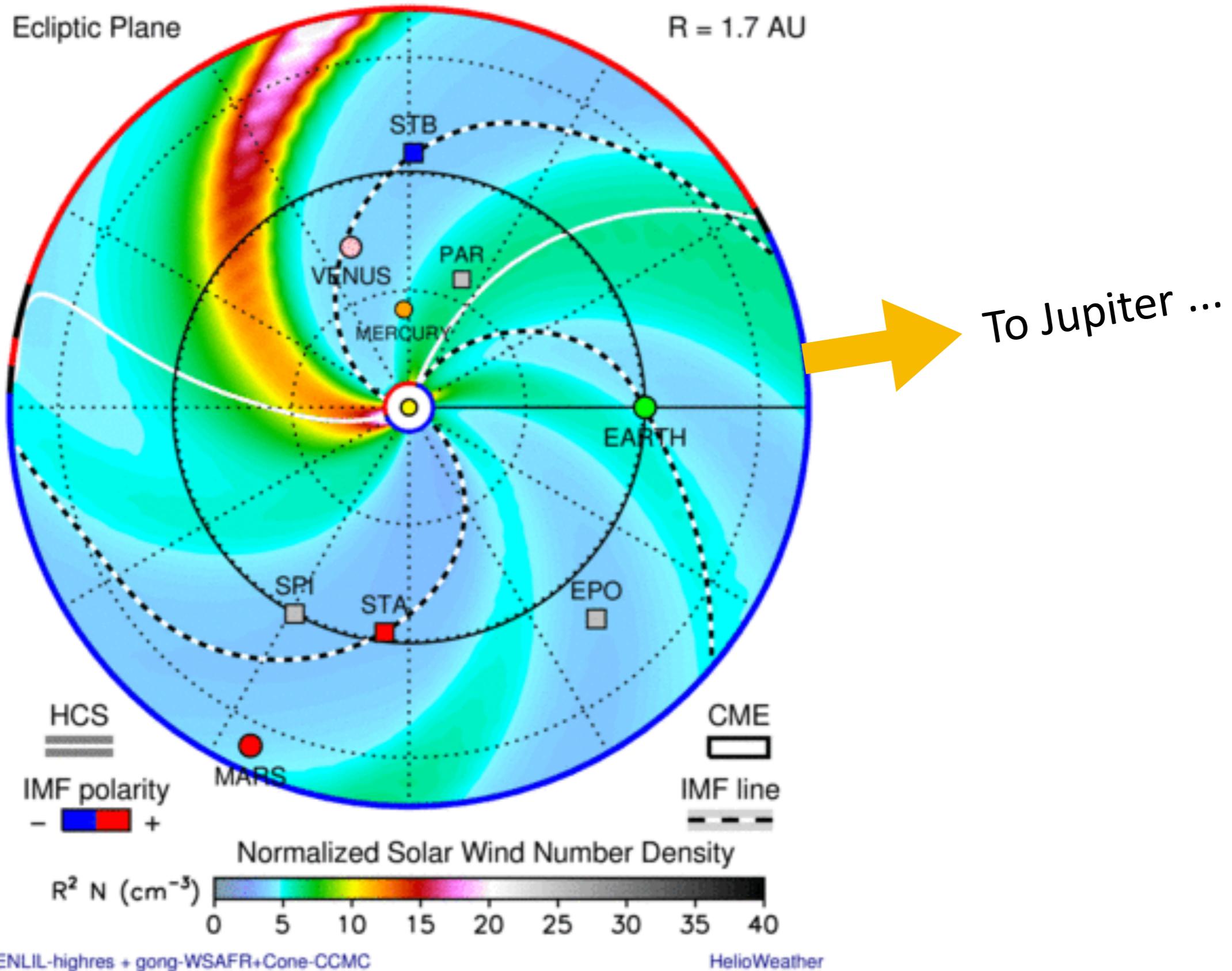


weak aurora



Movies (almost) available at:
<https://www.ipap.uliege.be/>
google keywords: ipap, jupiter, hst

2019-04-28T06



HST observation times during orbit #18

JUPITER

- *North Aurora:*

19.040 (Feb 9) 18:01-18:50

19.042 (Feb 11) 00:13-01:01

19.042 (Feb 11) 19:18-20:05

19.044 (Feb 13) 01:29-02:19

19.044 (Feb 13) 20:35-21:20

- *South Aurora:*

19.041 (Feb 10) 00:24-01:11

19.041 (Feb 10) 21:03-21:50

19.043 (Feb 12) 01:40-02:26

- *Apojove, North Aurora:*

19.068 (Mar 9) 11:43-12:42

19.069 (Mar 10) 06:48-07:47

IO

- *Io wake region (visit 51)*

19.045 (Feb 14) 20:27-21:10

19.045 (Feb 14) 21:58-22:45

Perijove: 02/12/2019 17:34

Apojove : 03/11/2019 02:48

HST observation times during orbit #19

JUPITER

- *North Aurora:*

19.087 (03/28/2019) 21:30:00

19.088 (03/29/2019) 18:09:00

19.089 (03/30/2019) 22:45:00

19.090 (03/31/2019) 19:25:00

19.091 (04/01/2019) 16:04:00

19.092 (04/02/2019) 01:36:00

19.093 (04/03/2019) 17:19:00

19.095 (04/05/2019) 18:34:00

19.096 (04/06/2019) 13:38:00

19.096 (04/06/2019) 23:11:00

Perijove: 04/06/2019 12:14

Apojove : 05/02/2019 22:17

XMM 04/01/2019 23:42

- 04/02/2019 23:02

- *Apojove, Io airglow and North Aurora:*

19.119 (04/29/2019) 17:00:00 COS spectra (1/2 success)

19.120 (04/30/2019) 03:17:00

HST observation times during orbit #20

JUPITER

- *North Aurora:*

19.142 (May 22) 22:00-22:40

19.143 (May 23) 17:03-17:47

19.146 (May 26) 14:57-15:42

19.149 (May 29) 12:52-13:36 PJ20+4h

19.150 (May 30) 17:28-18:13

- *South Aurora:*

19.145 (May 25) 13:32-14:16

19.146 (May 26) 21:18-22:03

19.147 (May 27) 17:58-18:42

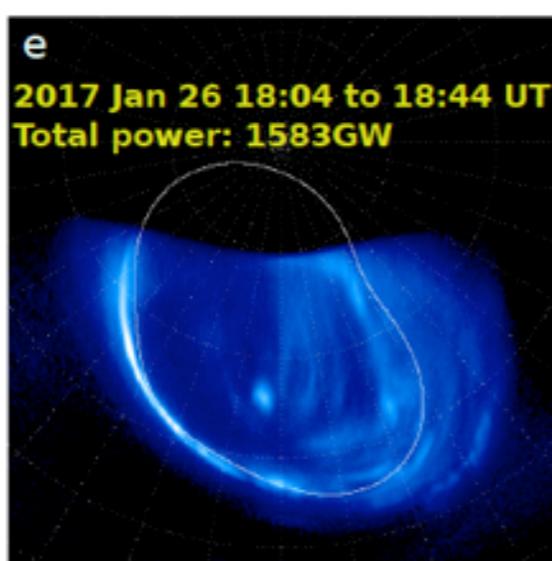
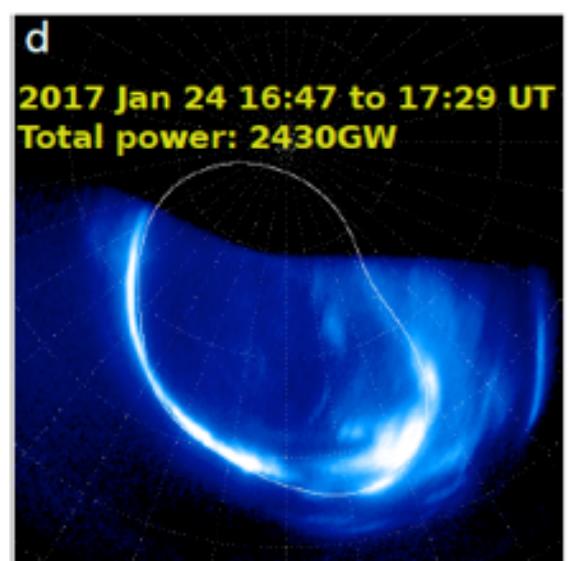
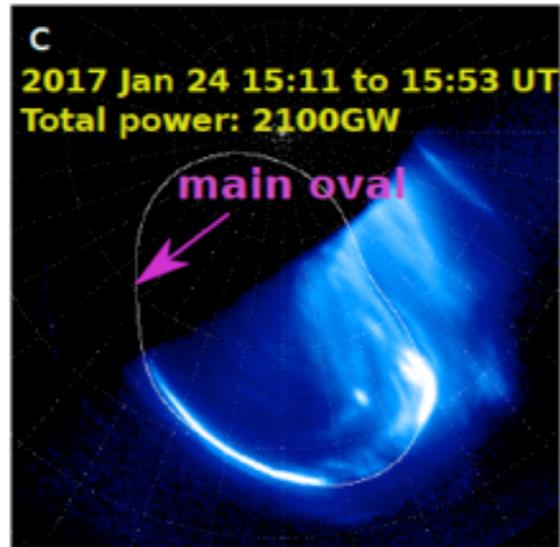
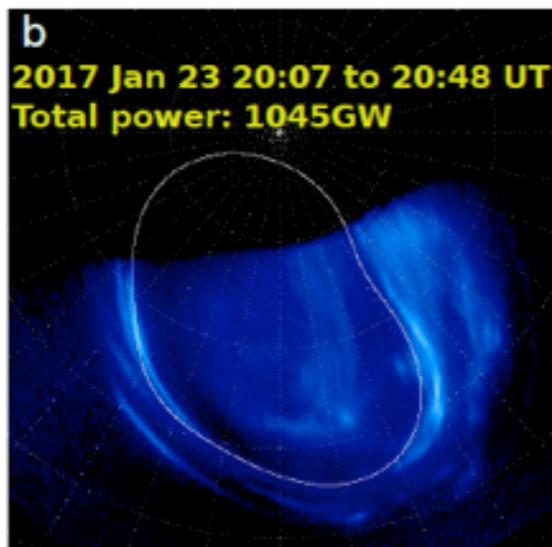
19.148 (May 28) 20:59-21:43

- *Apojove, North Aurora:*

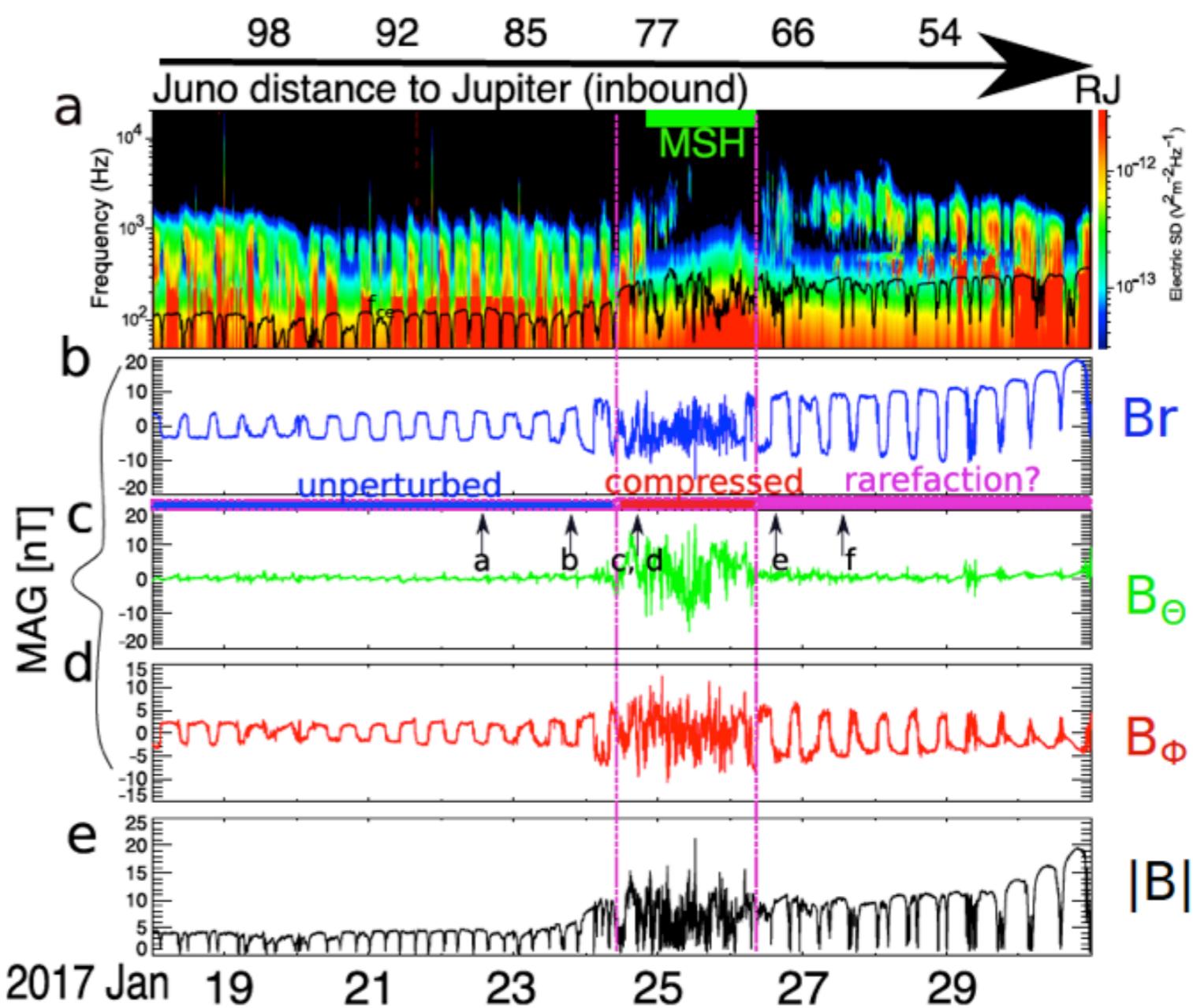
Perijove: 19.149 (05/29/2019) 08:08

Apojove : 19.175 (06/27/2019) 18:02

Polar projection of HST ultraviolet auroral images (northern pole)



Yao et al., submitted
Yao et al. poster P13

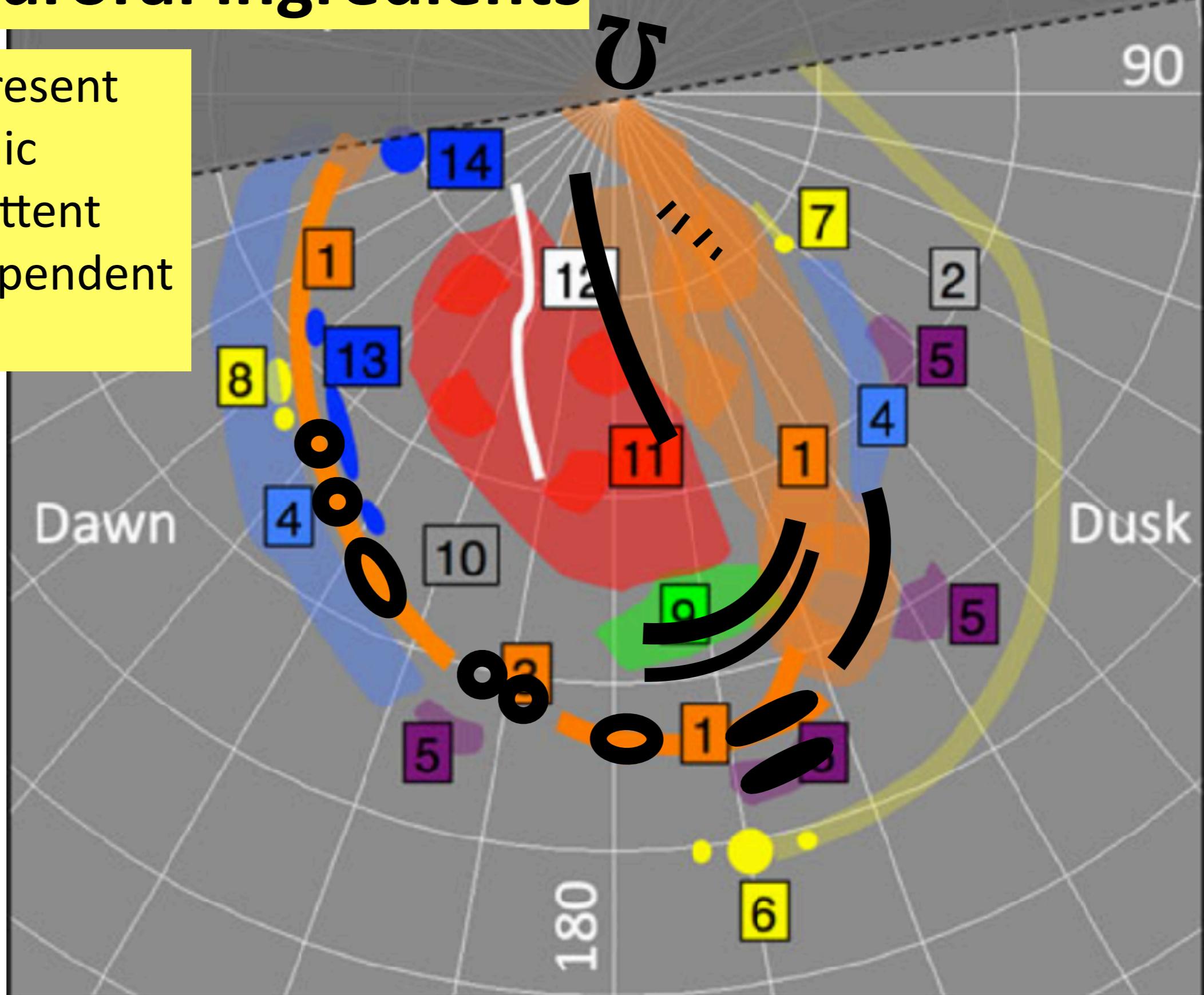


Take away message



Possible auroral ingredients

- *Not always present
- *Highly dynamic
- *Some intermittent
- *Local time dependent
- *...



Jupiter is alive!

HST observations of Jupiter's aurora during Juno orbits 18, 19 and 20



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Jonathan D. Nichols
Lorenz Roth
Joachim Saur
William Dunn
Carl Schmidt
John T. Clarke
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G. Randall Gladstone
Tomoki Kimura
William S. Kurth
Barry Mauk
David J. McComas
Alessandro Mura
Glenn S. Orton

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