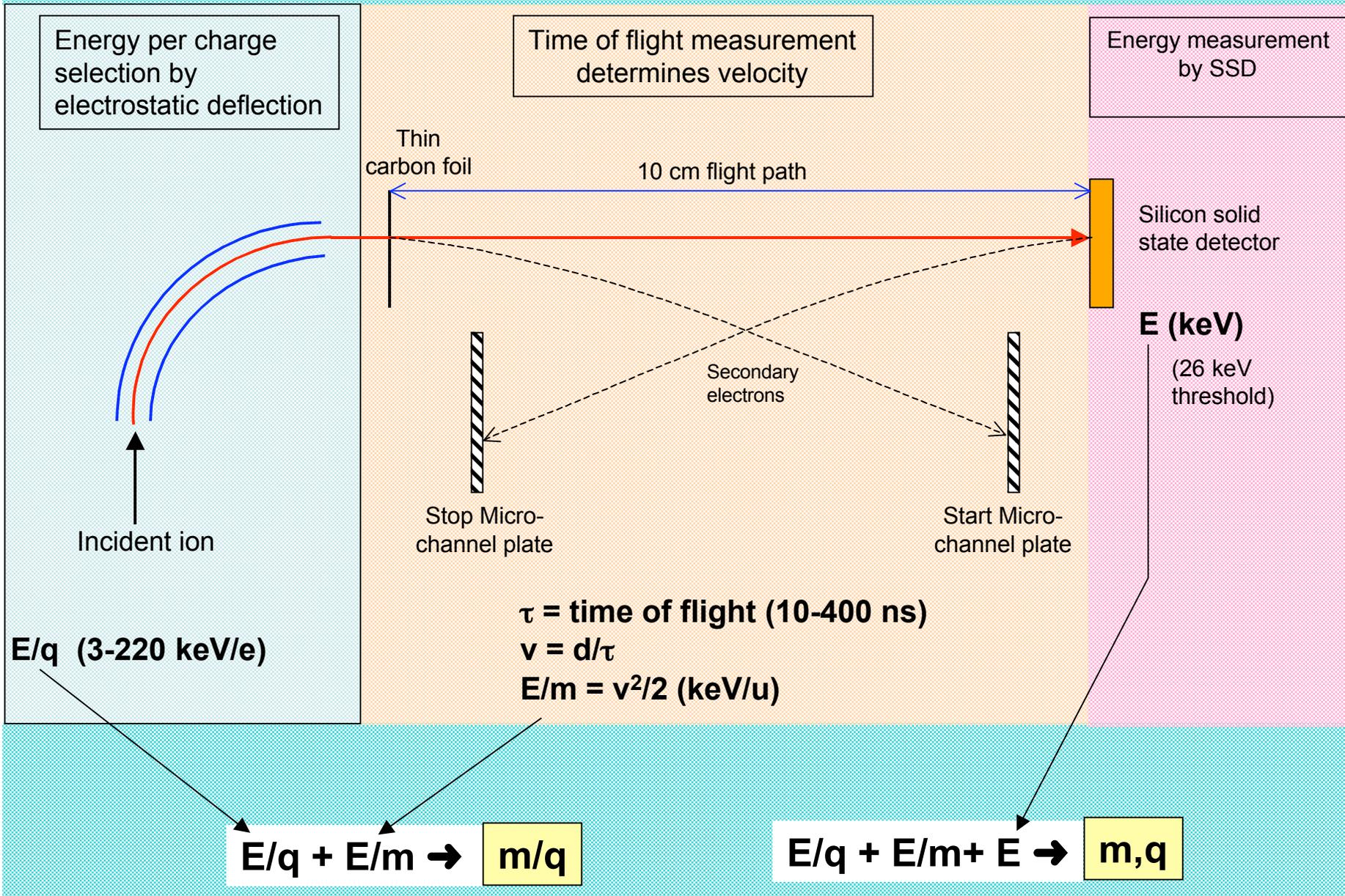


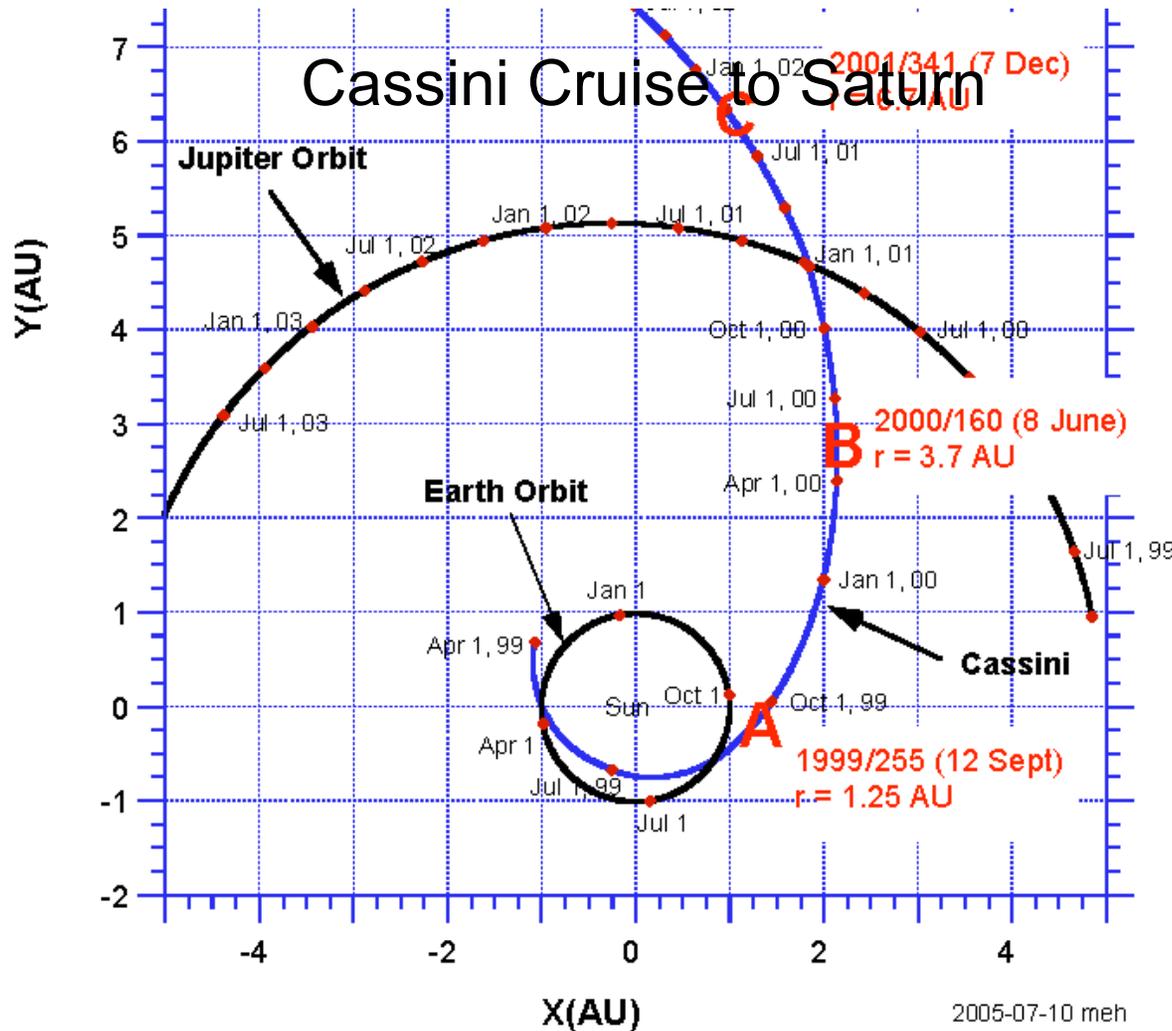
Suprathermal Ion Composition at Cassini From 1 to 9 AU

Matt Hill & Doug Hamilton
University of Maryland

Tom Krimigis & Don Mitchell
JHU Applied Physics Lab

CHEMS Principles of Operation



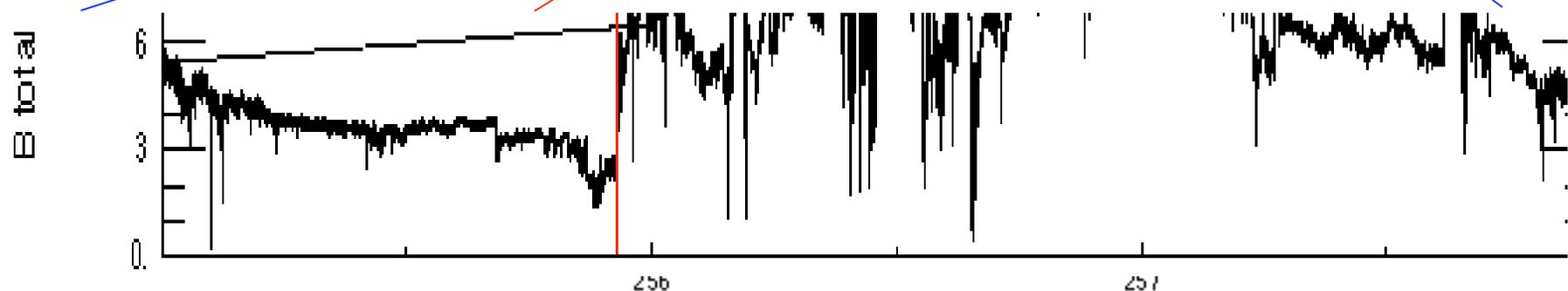
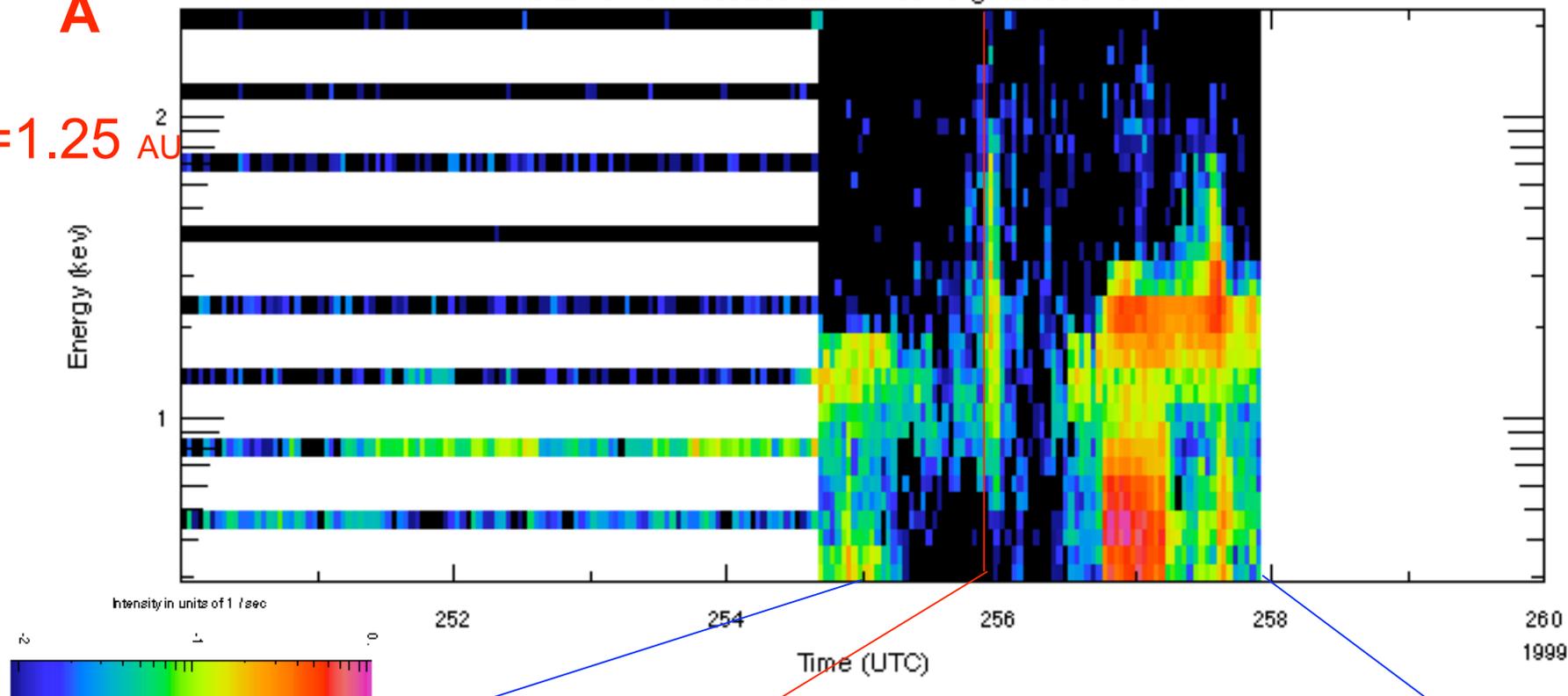


Define four
Shock events

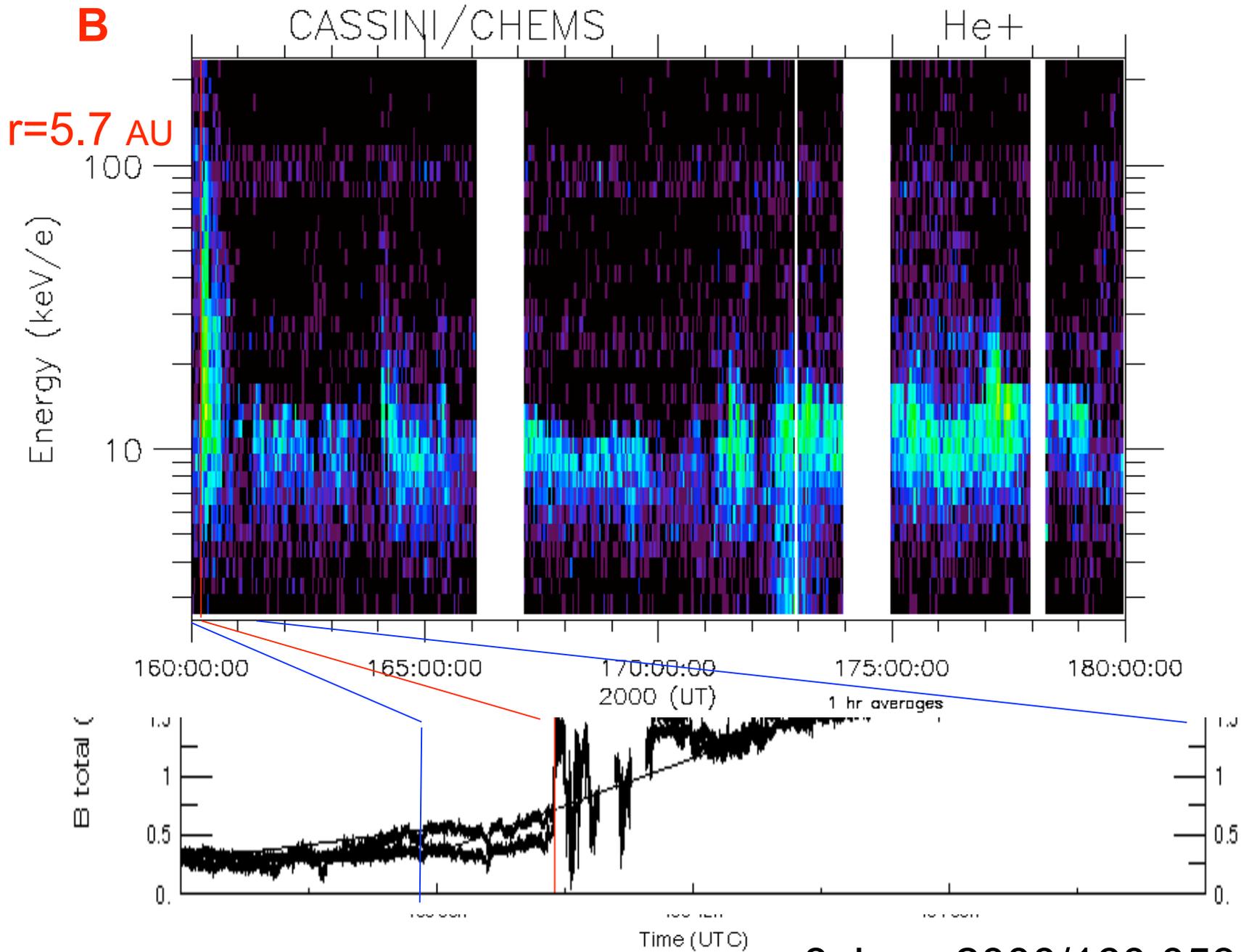
- A** 1999 Sep 12
- B** 2000 June 8
- C** 2001 Dec 7
- D** 2003 Nov 16

CHEMS He+ 1999/250-259 1 hour avg. 2005-07-06 meh

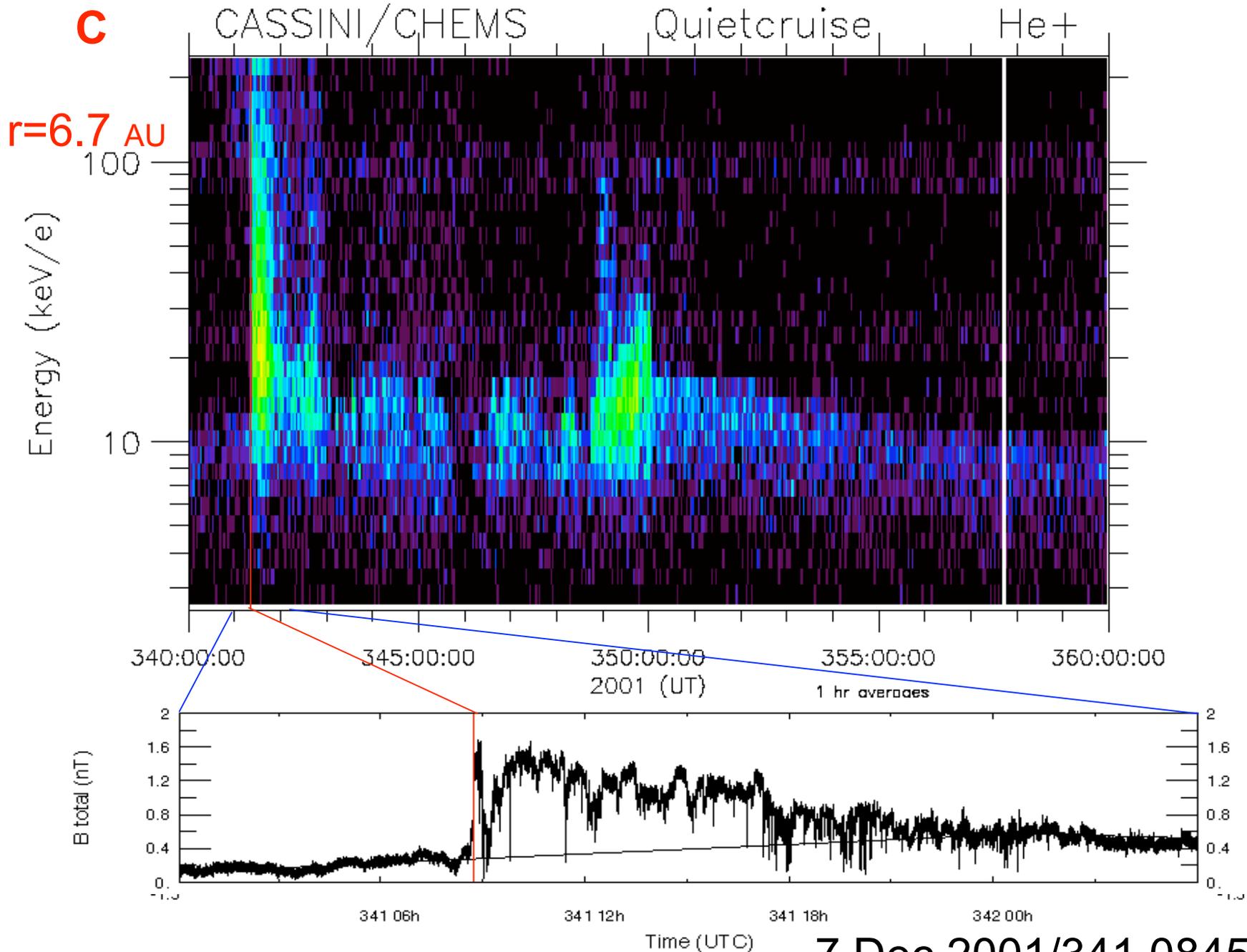
A
 $r=1.25$ AU



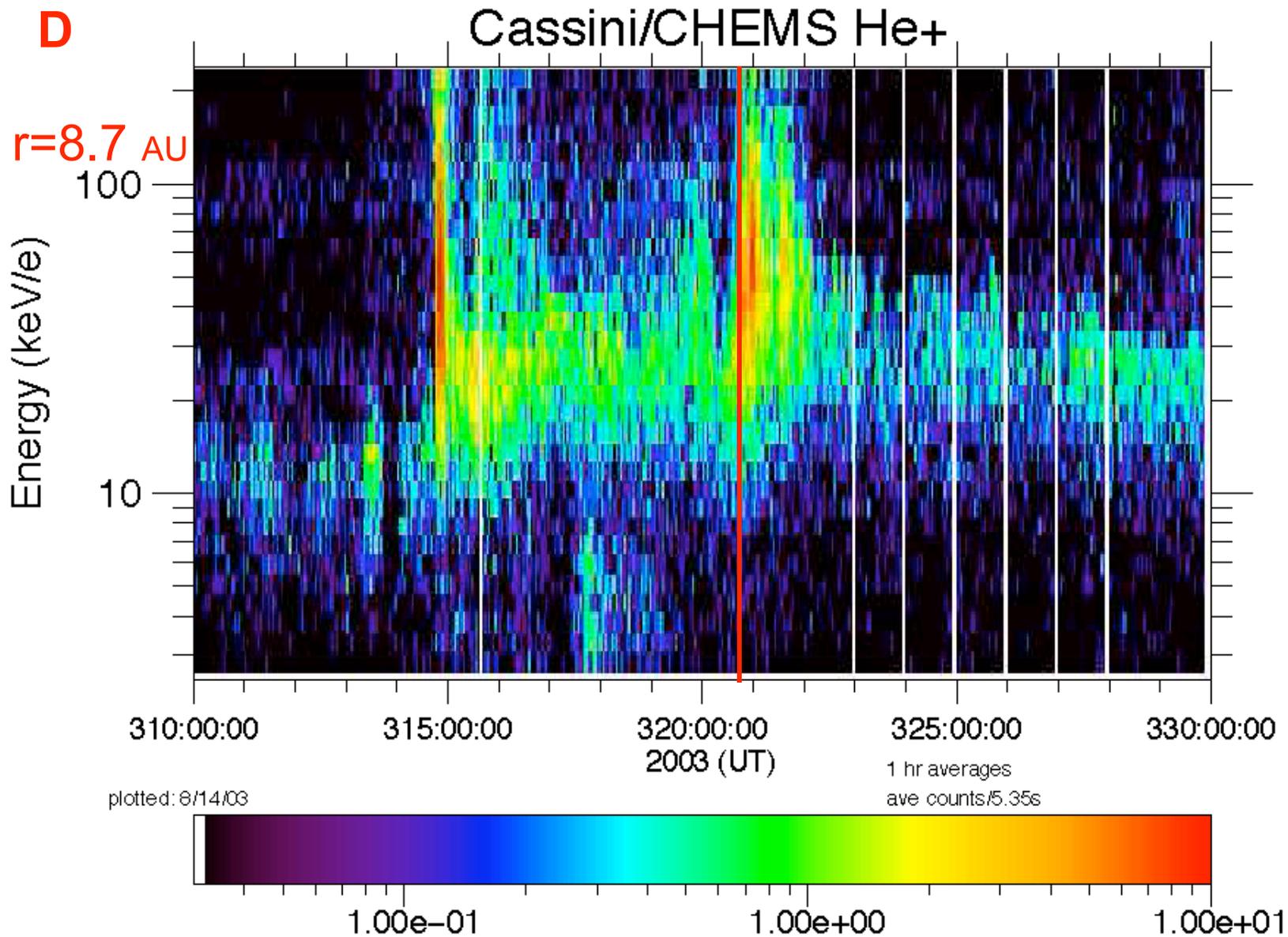
Time (UTC)
12 Sep 1999/255 2220UT



8 June 2000/160 0530UT

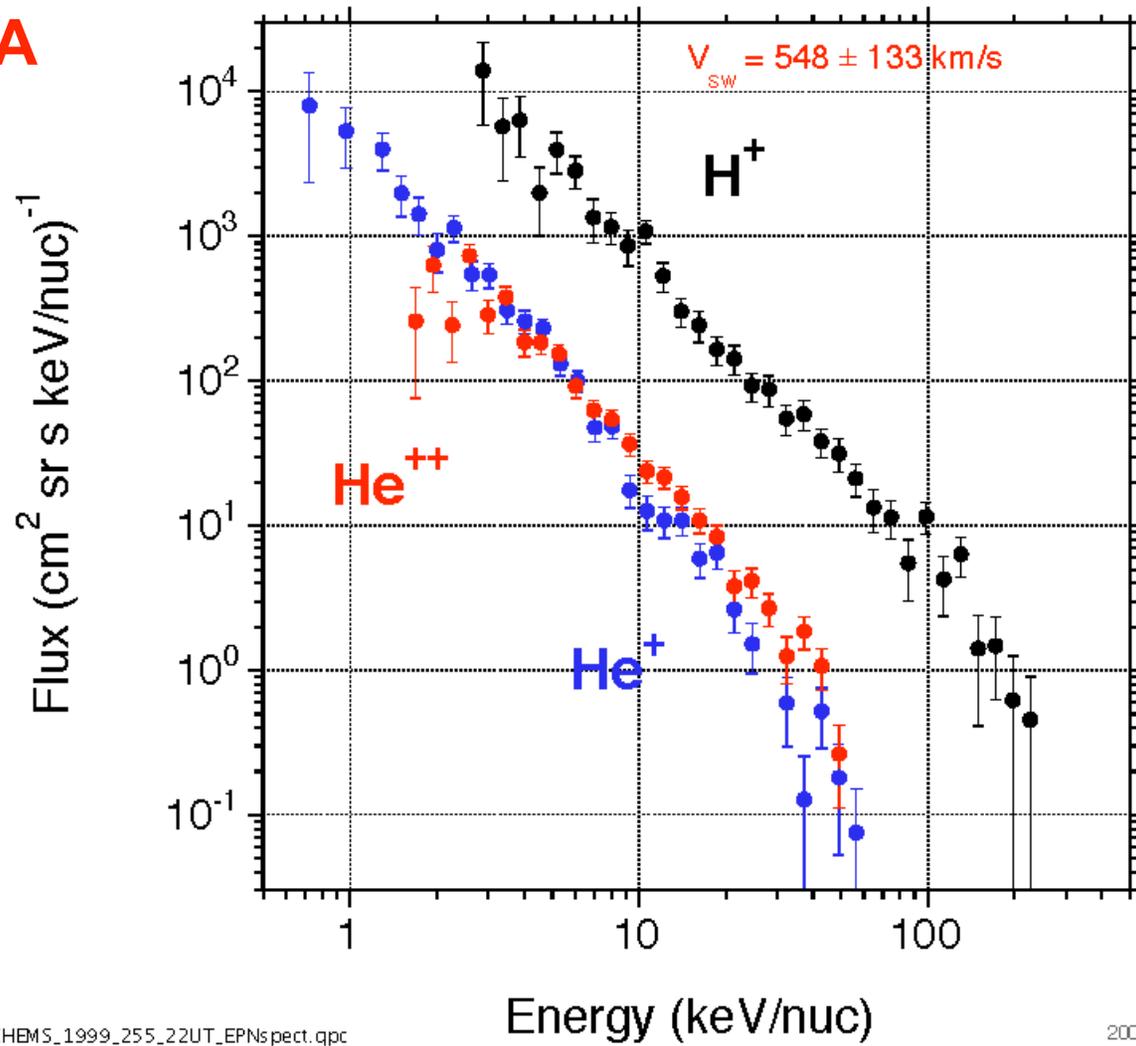


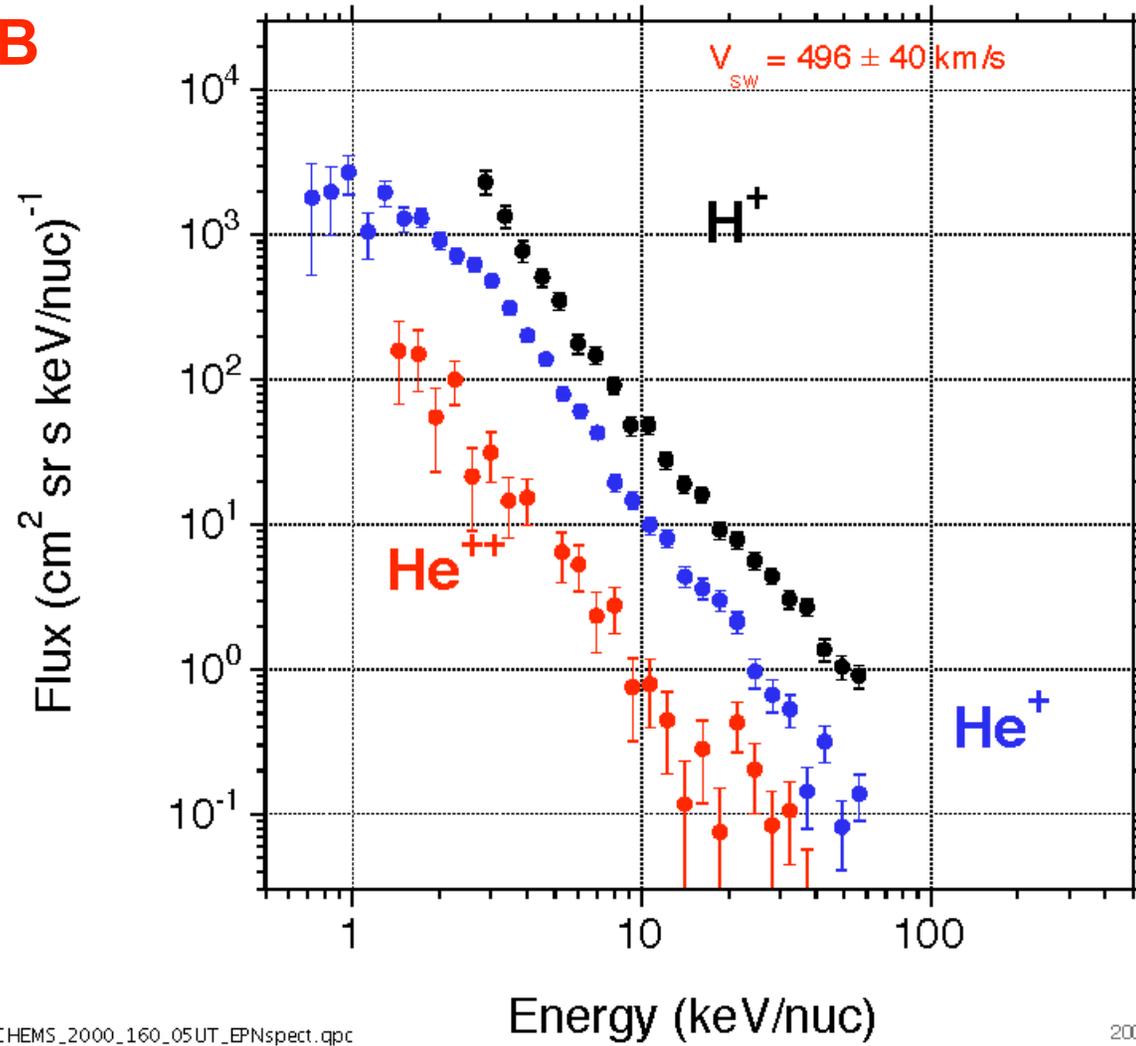
7 Dec 2001/341 0845UT



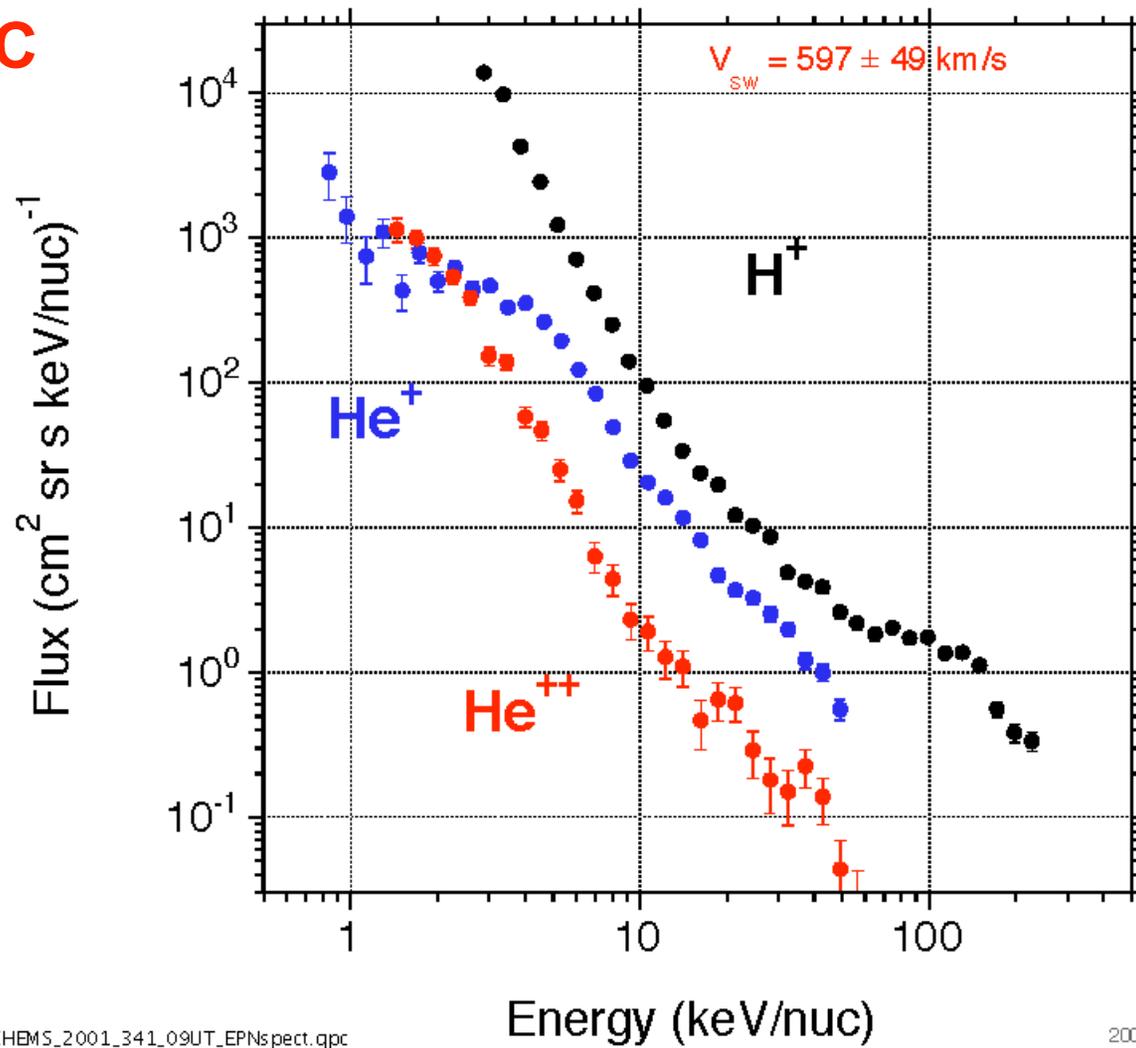
16 Nov 2003/320 1800UT

A

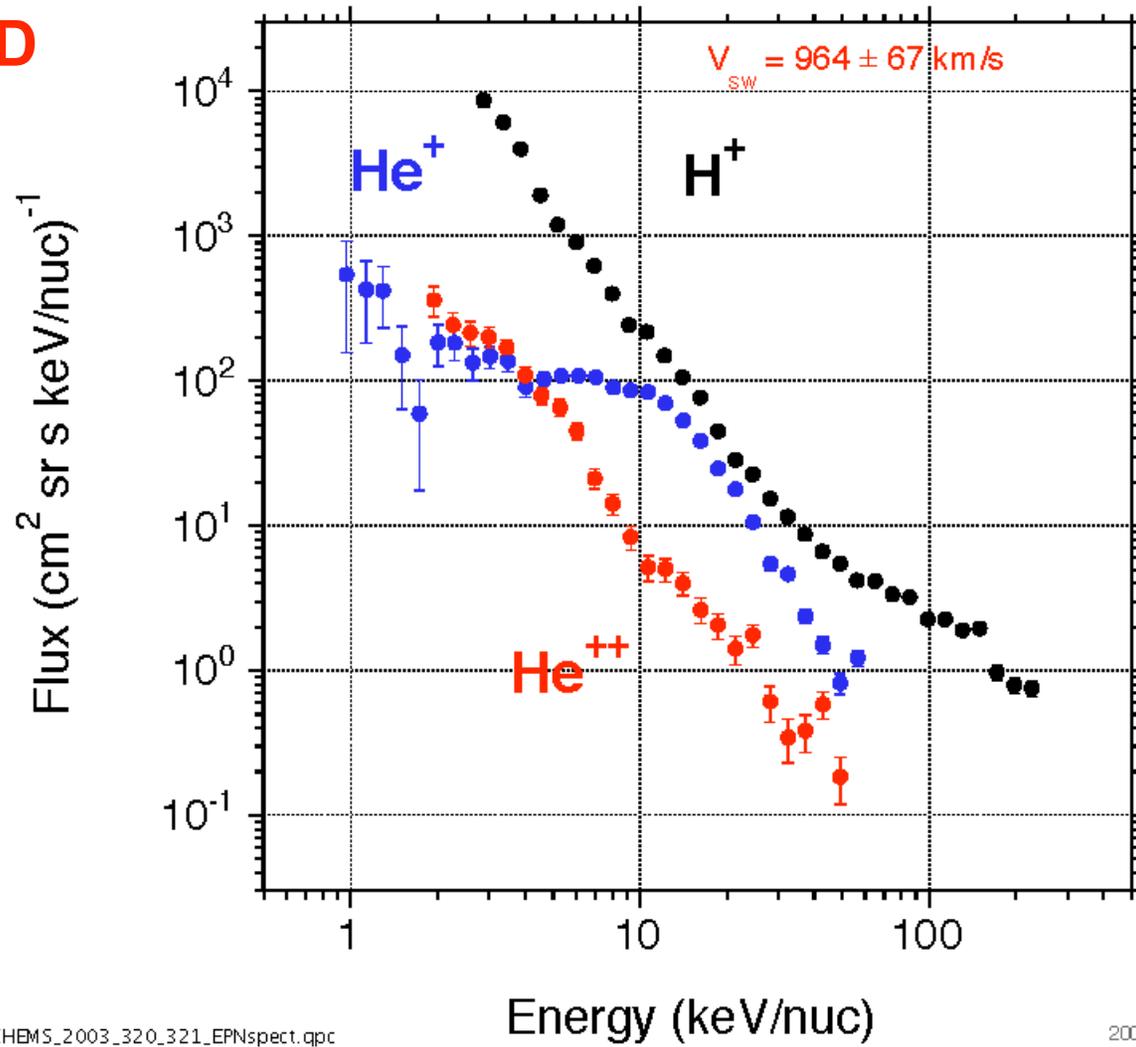


B

C



D



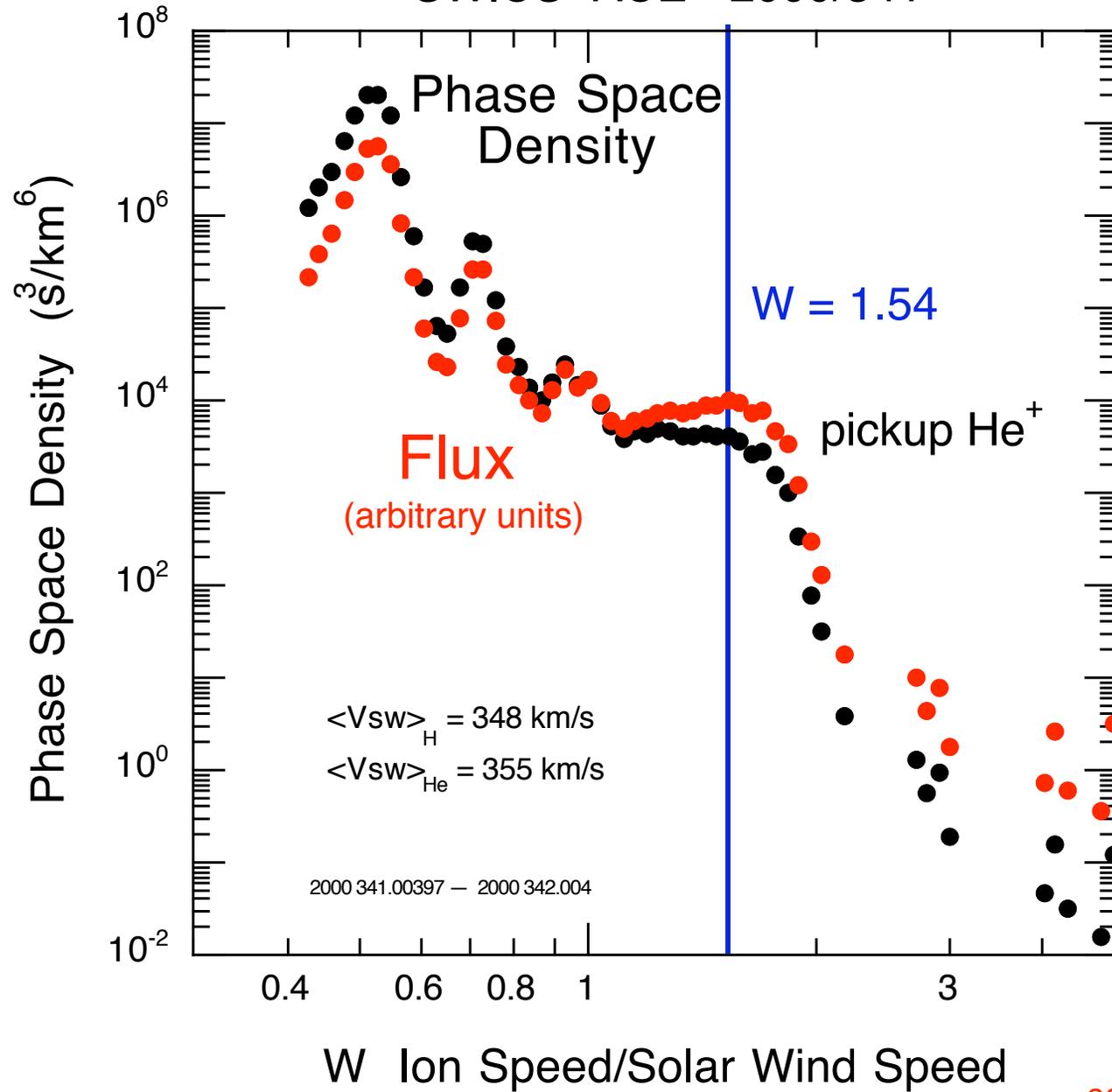
Suprathermal Abundances During 4 Shock Events

He ⁺ / He ⁺⁺	5 keV/nuc	10 keV/nuc	20 keV/nuc	40 keV/nuc	
1.3 AU 1999 548 km/s	1	.5	0.8	0.3	A
3.7 AU 2000 496 km/s	13	12	22	7	B
6.7 AU 2001 597 km/s	8	12	100	10	C
8.7 AU 2003 964 km/s	1.5	14	13	6	D

He ⁺⁺ / H ⁺	5 keV/nuc	10 keV/nuc	20 keV/nuc	40 keV/nuc	
1.3 AU 1999 548 km/s	5%	4%	4%	2%	A
3.7 AU 2000 496 km/s	2%	2%	1%	3%	B
6.7 AU 2001 597 km/s	2%	2%	3%	3%	C
8.7 AU 2003 964 km/s	5%	3%	5%	4%	D

He ⁺ / H ⁺	5 keV/nuc	10 keV/nuc	20 keV/nuc	40 keV/nuc	
1.3 AU 1999 548 km/s	5%	2%	3%	0.7%	A
3.7 AU 2000 496 km/s	25%	23%	30%	13%	B
6.7 AU 2001 597 km/s	16%	20%	26%	28%	C
8.7 AU 2003 964 km/s	8%	40%	62%	23%	D

SWICS ACE 2000/341



2005-04-15

Solar Wind Speed

Using the Pickup Ion Peak vs. Cutoff

cutoff

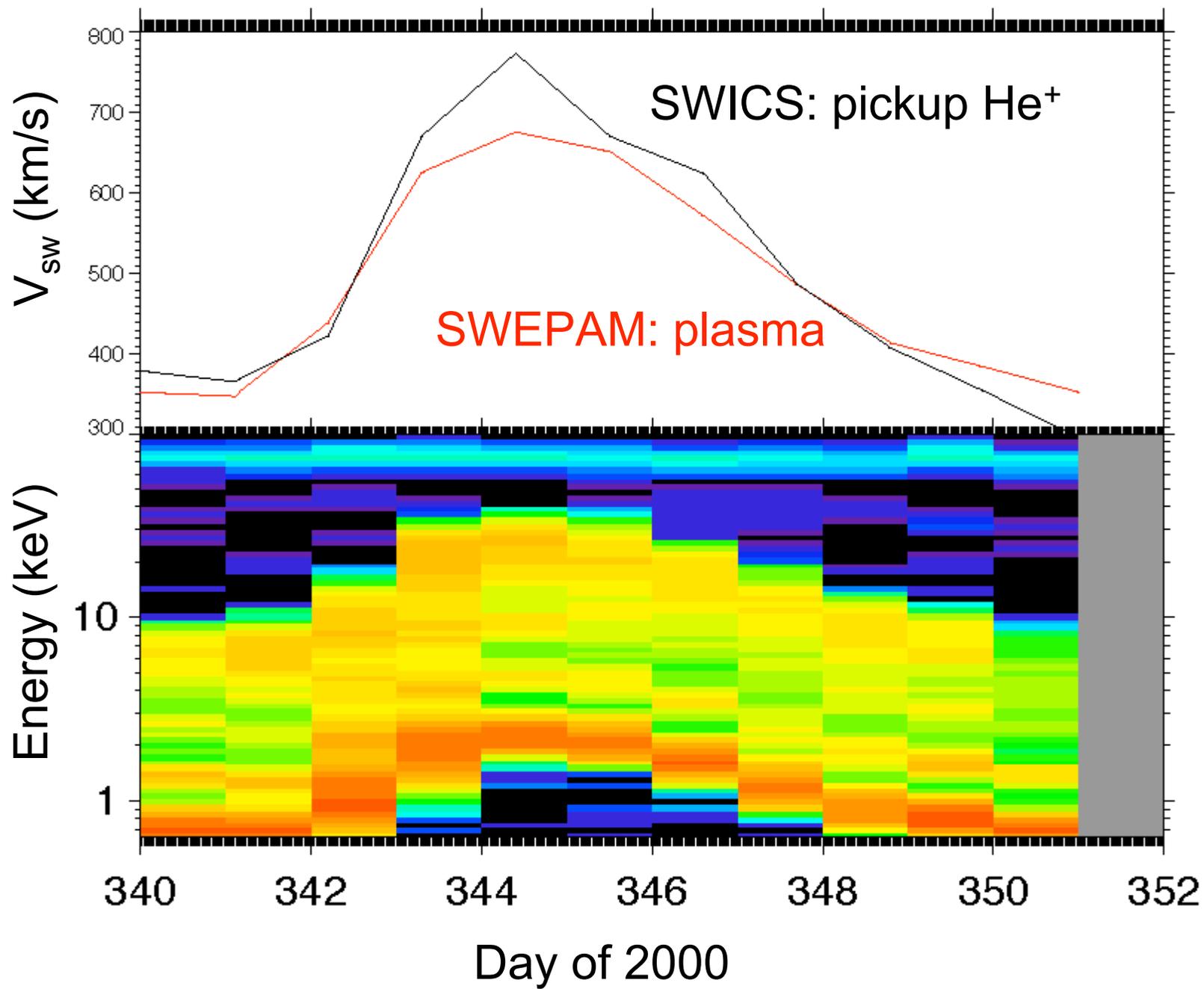
$$E_{cutoff} = \frac{1}{2} m (2V)^2 \quad V = \frac{1}{2} \sqrt{\frac{2E}{m}}$$

peak

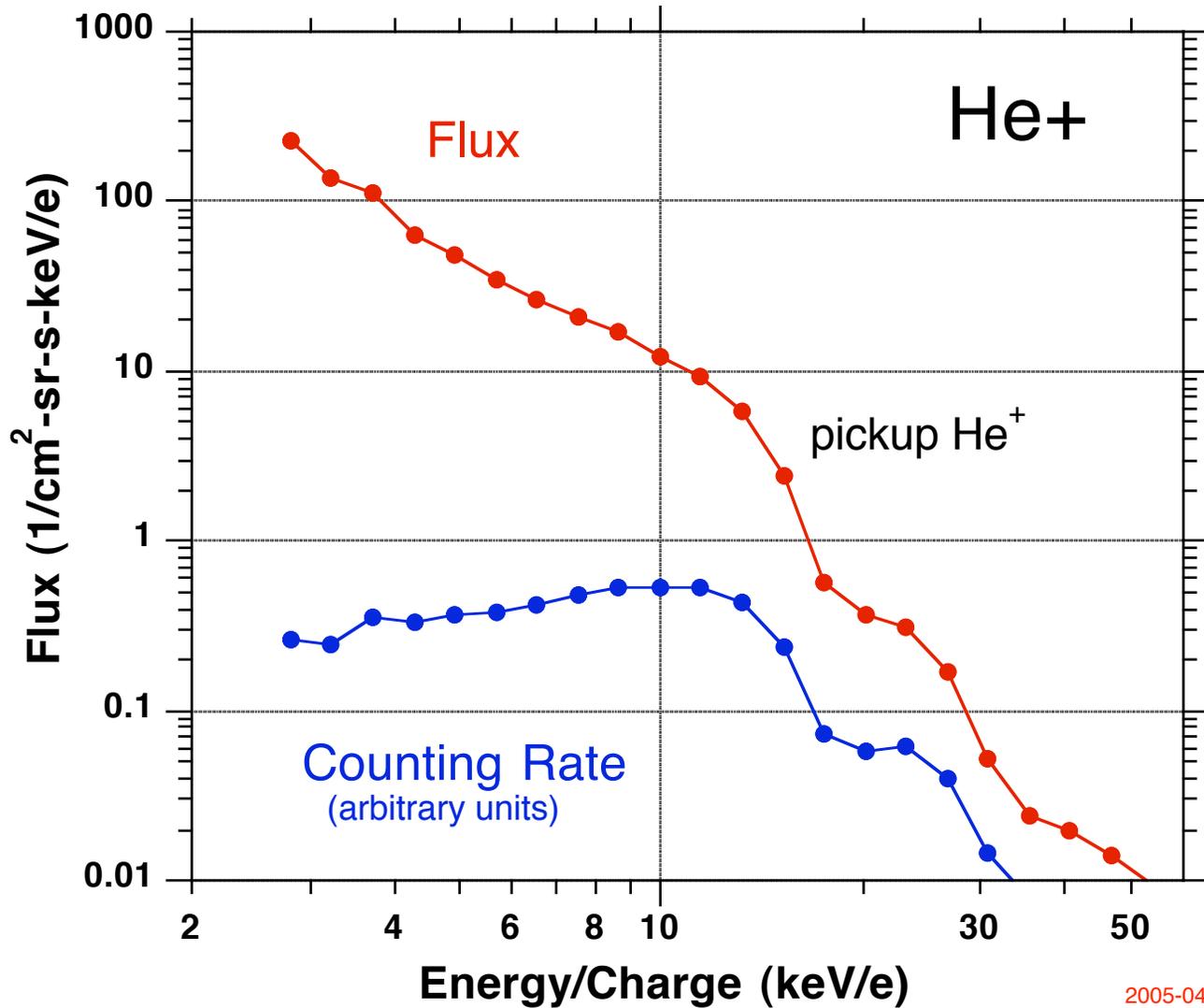
$$E_{peak} = \frac{1}{2} m (\alpha V)^2 \quad V = \frac{1}{\alpha} \sqrt{\frac{2E}{m}}$$

$$\alpha \approx 1.5$$

ACE SWICS & SWEPPAM



Cassini / CHEMS 2004/235-275

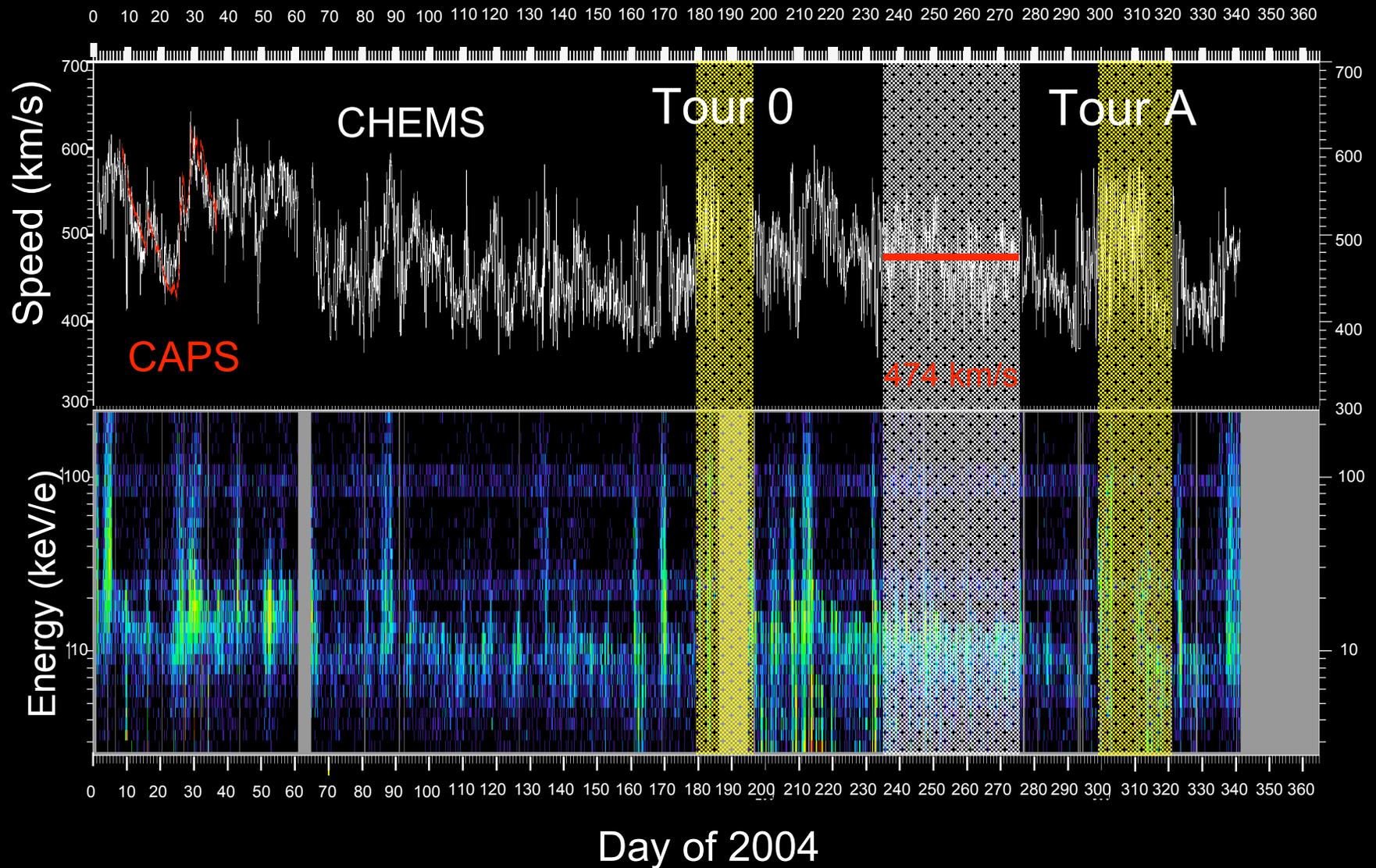


$$V_{sw} = 474 \pm 34 \text{ km/s}$$

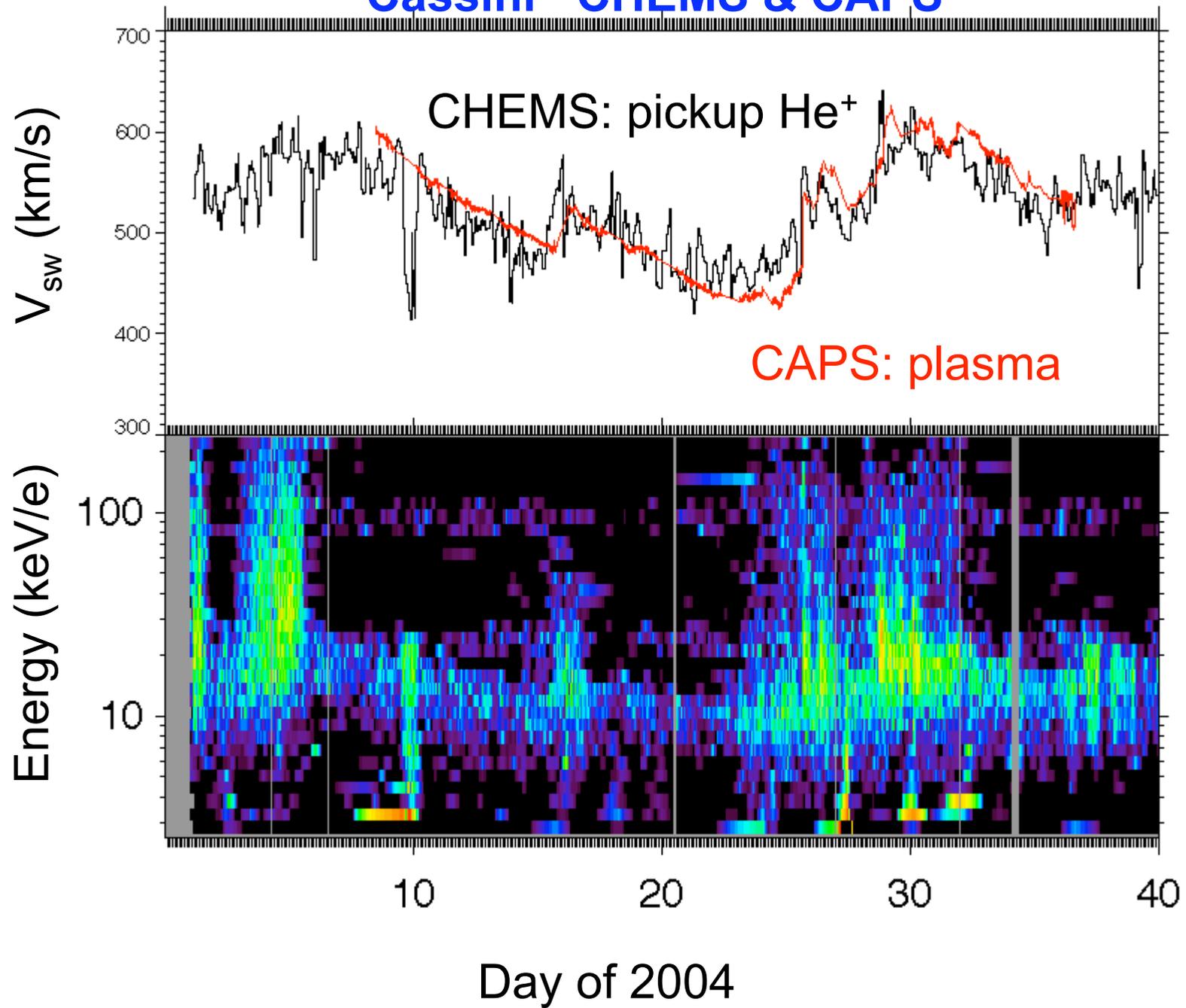
$$V_{sw} = 147 E_{peak}^{1/2}$$

Speed in km/s energy in keV/e

Solar Wind Speeds from CHEMS pickup He⁺ Spectra



Cassini CHEMS & CAPS

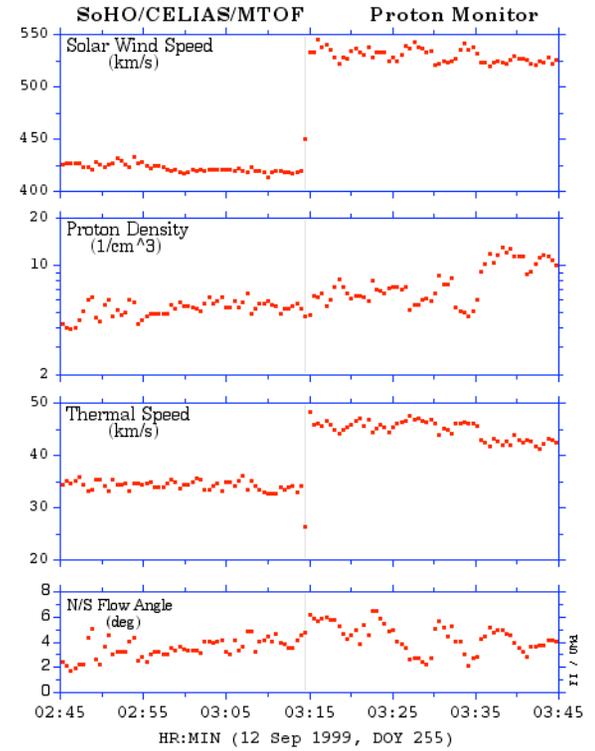
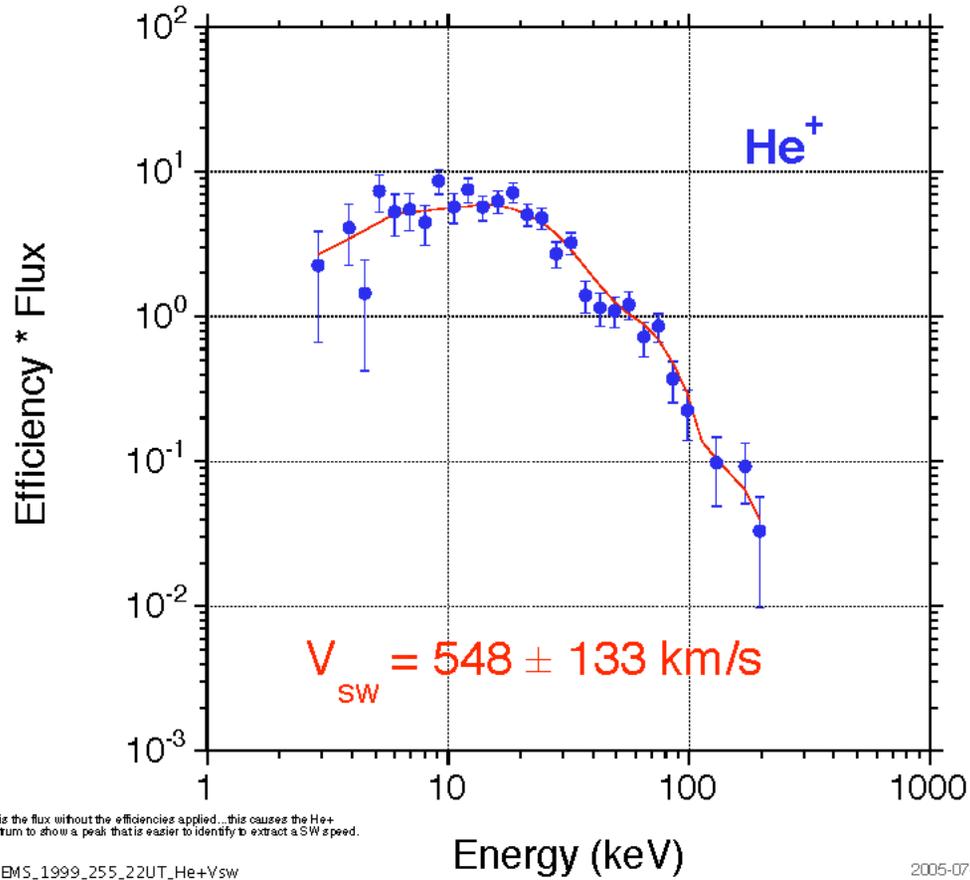


A

Cassin / MIMI / CHEMS

$r = 1.25 \text{ AU}$

1999/255 2200 UT - 1999/256 0000UT

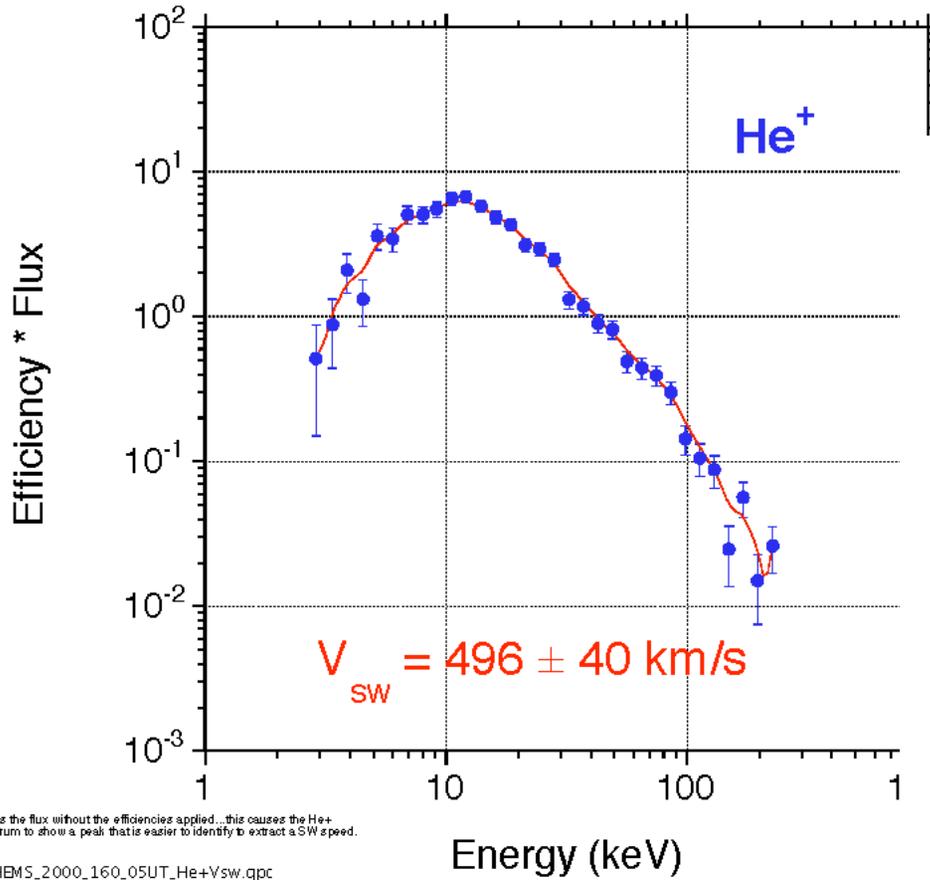


B

Cassin / MIMI / CHEMS

$r = 3.7 \text{ AU}$

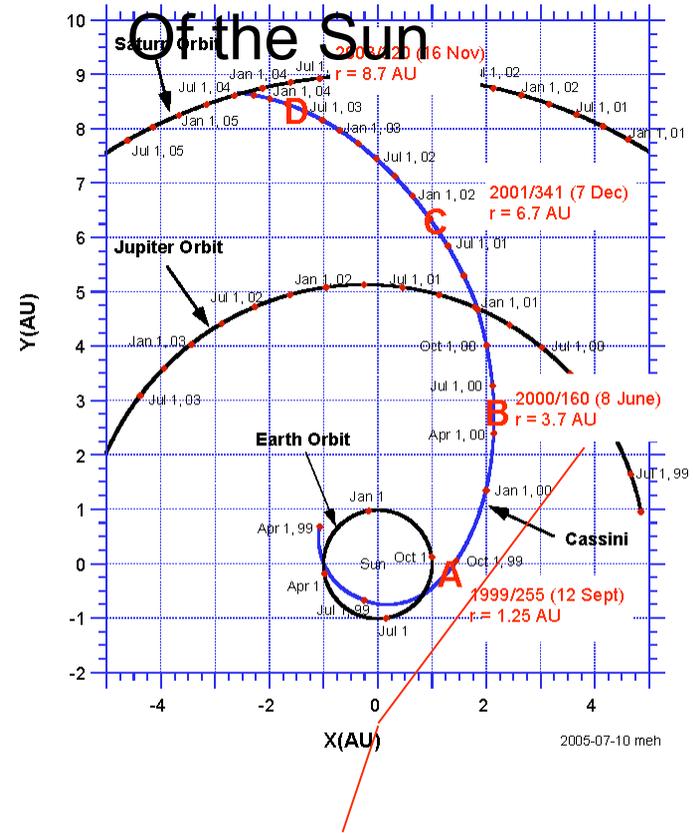
2000/160 1500 UT - 2000/160 1500UT



This is the flux without the efficiencies applied...this causes the He+ spectrum to show a peak that is easier to identify to extract a SW speed.

CHEMS_2000_160_05UT_He+Vsw.qpc

No obvious Earth Counterpart:
Eath & Cassini are
On opposite sides

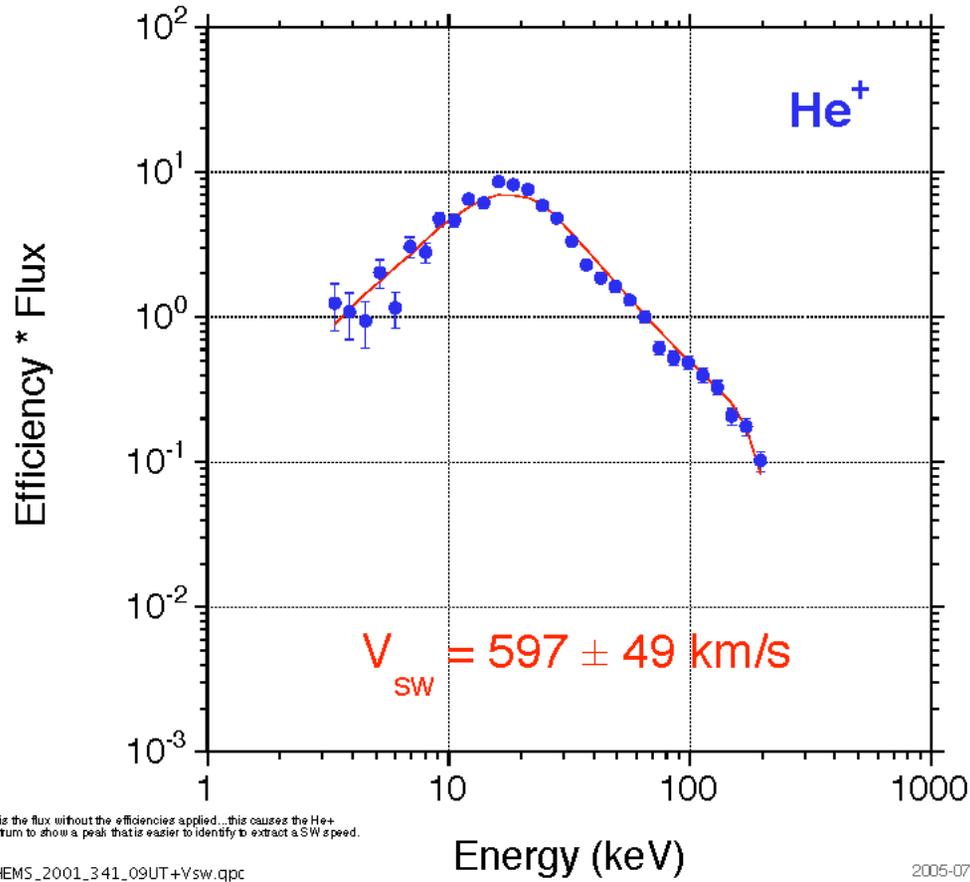


C

Cassin / MIMI / CHEMS

r = 6.7 AU

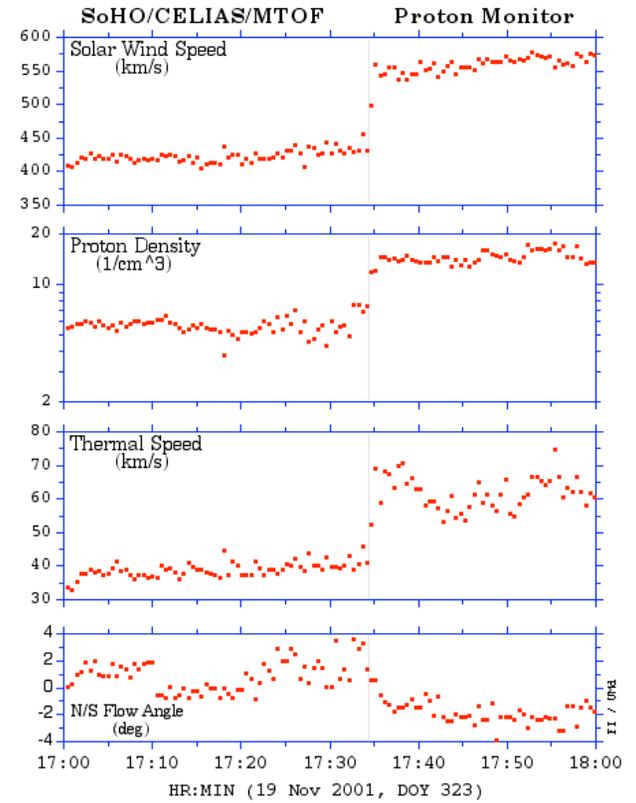
2001/341 0900 UT - 2001/341 2100UT



This is the flux without the efficiencies applied...this causes the He+ spectrum to show a peak that is easier to identify to extract a SW speed.

CHEMS_2001_341_09UT+Vsw.qpc

2005-07-10 meh

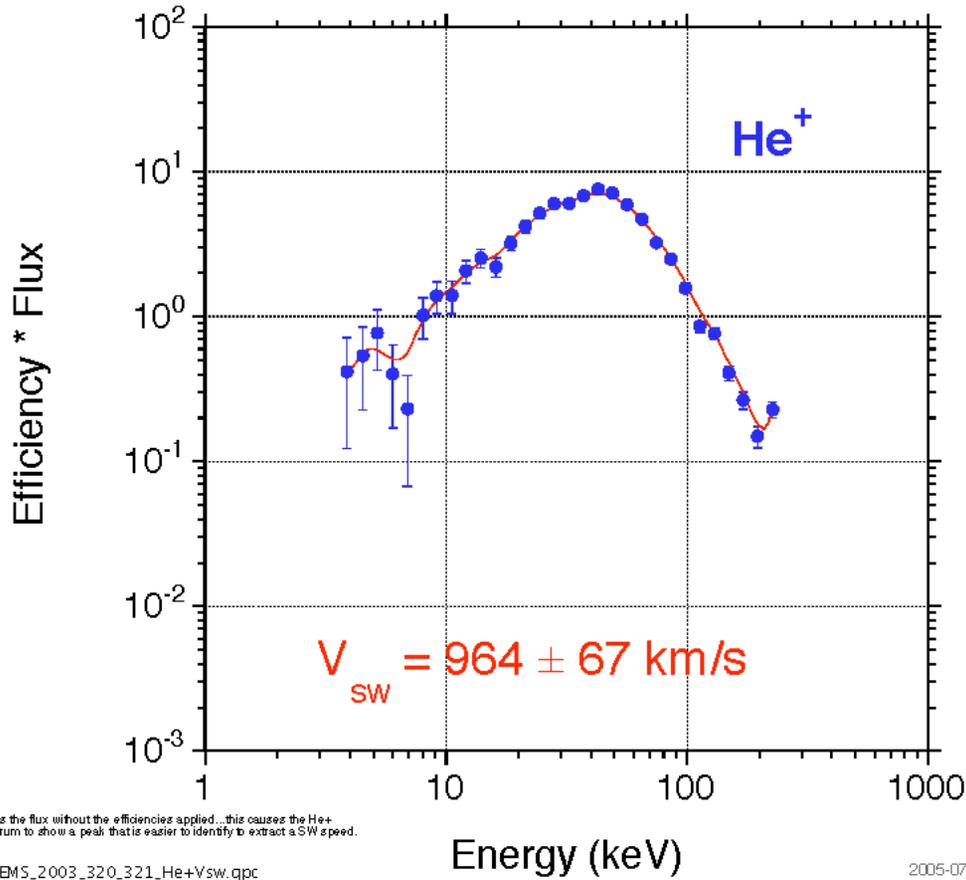


D

Cassin / MIMI / CHEMS

r = 8.7 AU

2003/320 1800 UT - 2003/321 0200UT



This is the flux without the efficiencies applied...this causes the He+ spectrum to show a peak that is easier to identify to extract a SW speed.

CHEMS_2003_320_321_He+Vsw.qpc

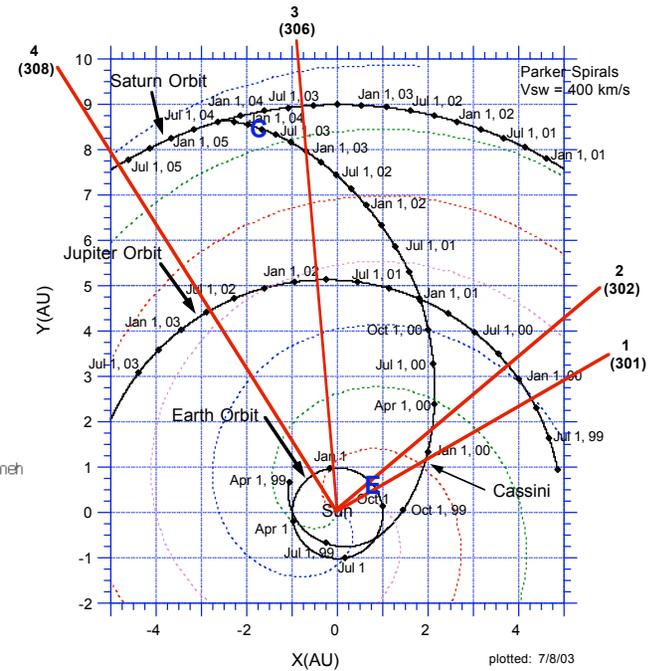
2005-07-10 meh

Nov 2, 2003/306 18 UT

Disturbance reaches Cassini

in 14.day at 1060 km/s

On 2003/320 22 UT



Summary

H⁺ and He⁺⁺ show only small relative compositional change

He⁺⁺/H⁺ ~ 2 - 4 % at all radii and SW speeds

Events A,B,C ~500-600 km/s wind

He⁺/He⁺⁺ & He⁺/H⁺ increases with radius > 20 keV/nuc

He⁺/He⁺⁺ ratio ranges from 0.3 to 100

He⁺/H⁺ ratio ranges 2% to 30%

Event D ~1000 km/s wind

High SW speed dominates He⁺ response

He⁺/H⁺ = 62% at 20 keV/nuc

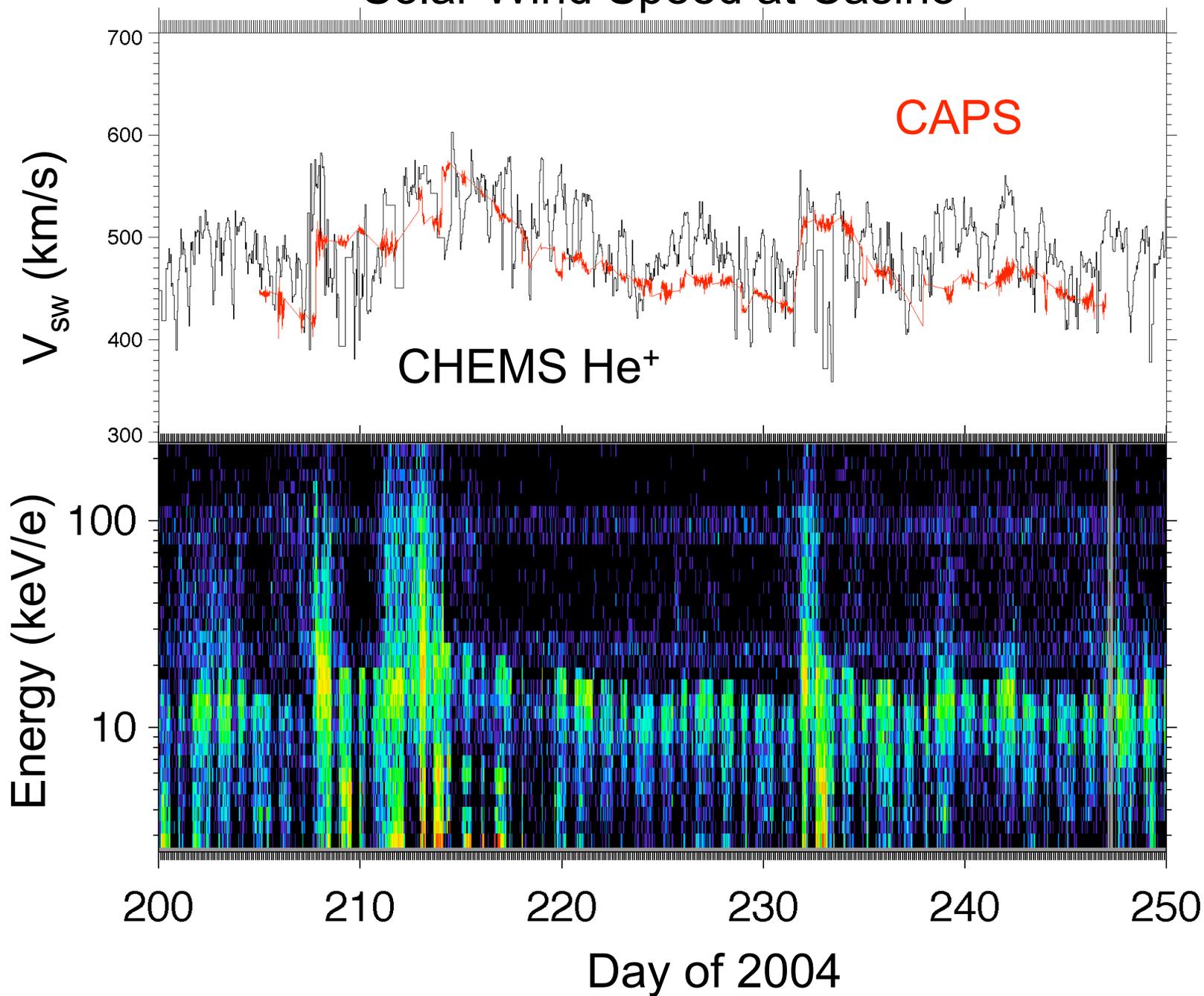
He⁺ mostly pickup ions, sensitive to solar wind speed

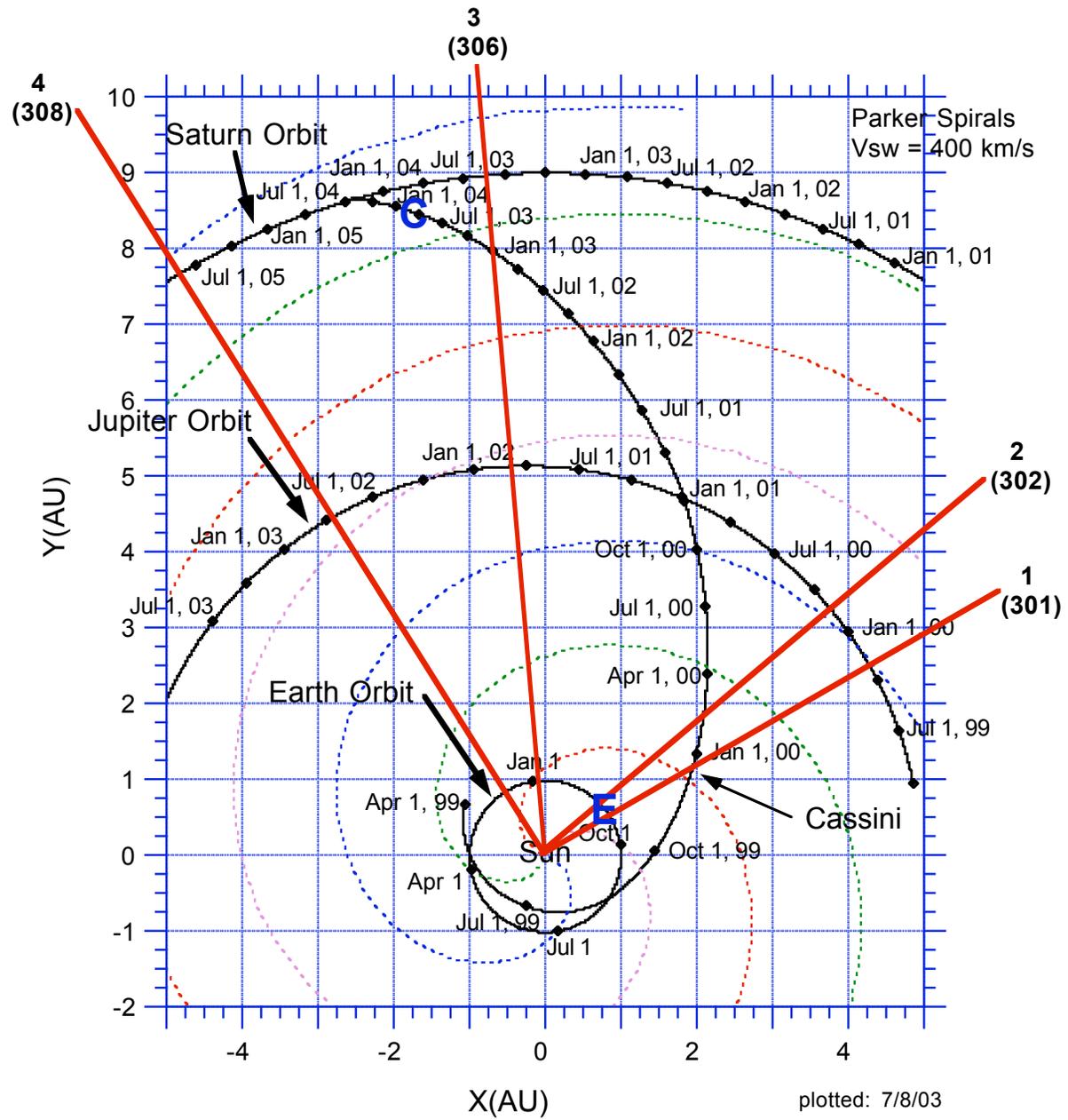
MIMI/CHEMS He⁺ can be used to determine SW speed

Method confirmed with ACE SWEPAM & SWICS data

Agreement with Cassini CHEMS and CAPS

Solar Wind Speed at Casino





U)

Delay Time

Nov 2, 2003/306 18 UT

Δt (days)

$\langle V \rangle$ (km)

Disturbance reaches Cassini

(Nov. 10)

13.3

1130

in 14.day at 1060 km/s

11.9

1270

8.1

1880

Reaches Cassini at

6.0

2500

2003/320 22 UT

14.2

1060

12.1

1250

(Nov. 16)

2003/320 2200 at CAS, travel time 14.2 d, $V_{trav} = 1060$ km/s

Nov 2 (306) 1739 UT

X8.3/2B

S14W56