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3D Velocity Distribution Functions of Pickup Ions with Ulysses/SWICS

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3 Dec 2021
AGU Fall Meeting 2021

Pickup Ions (PUIs)

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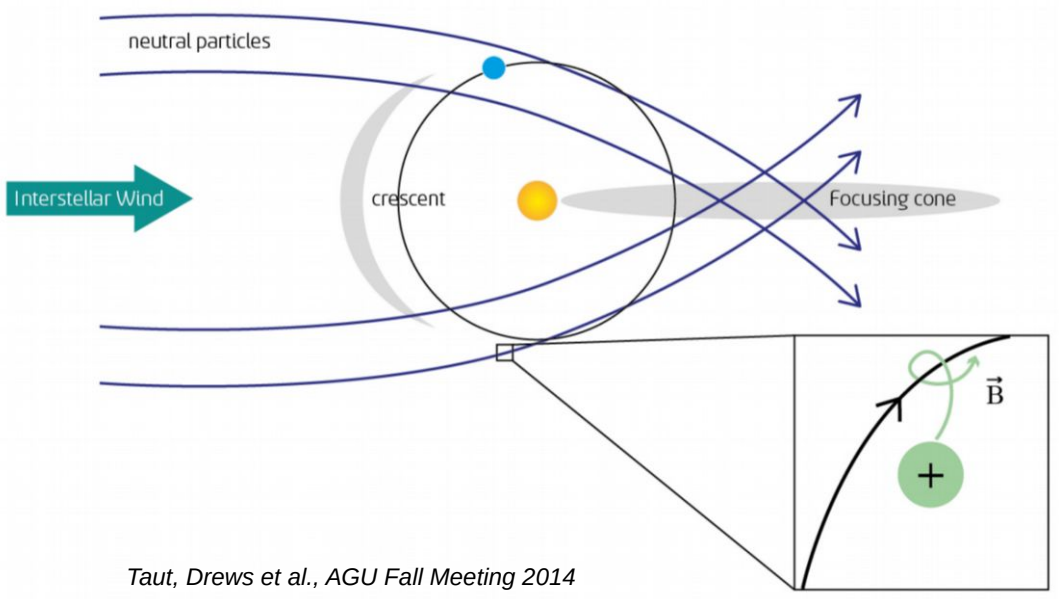
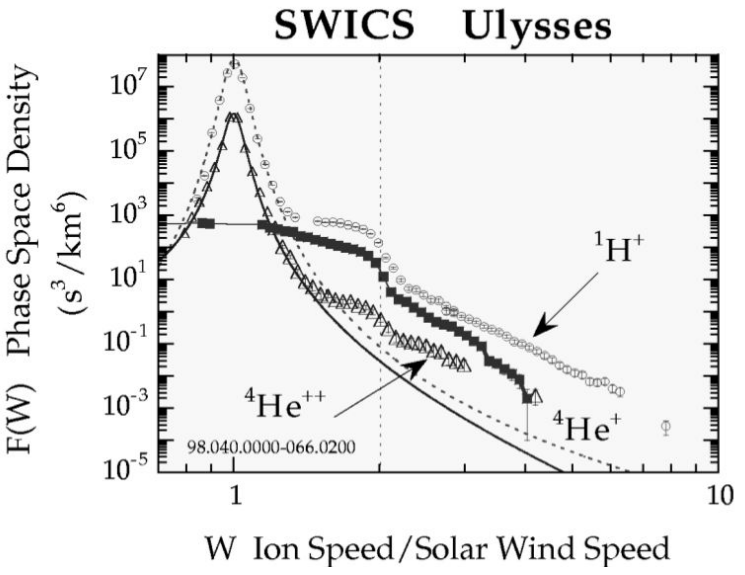


Taut, Drews et al., AGU Fall Meeting 2014



Gloeckler et al., 1999

$$W = \frac{v_{PUI}}{v_{SW}}$$

PUI Velocity Distribution Function

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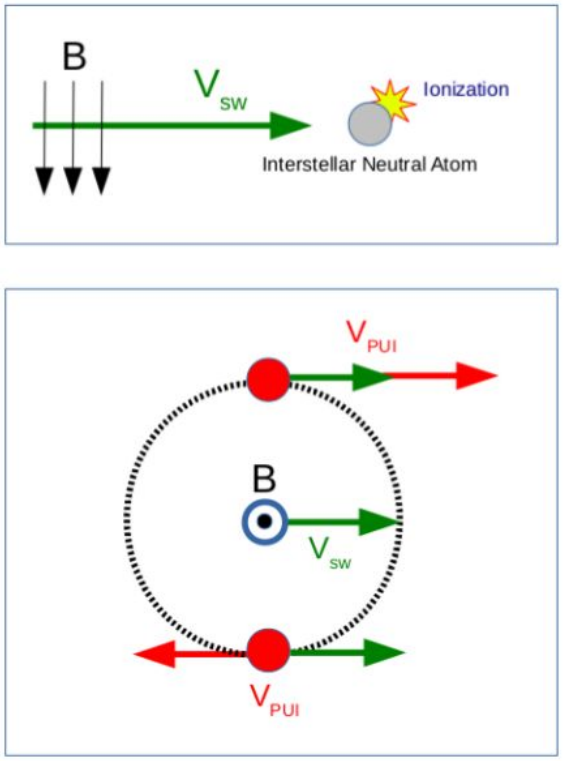
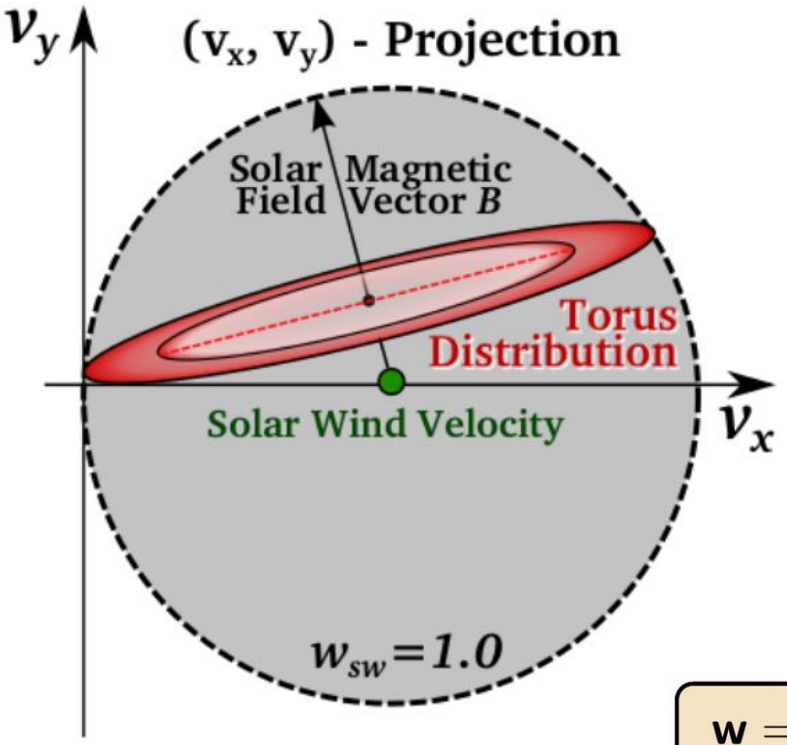


Taut, Drews et al., AGU Fall Meeting 2014



$$w = \frac{v_{PUI}}{v_{SW}}$$

Drews et al., 2016

Development of the VDF

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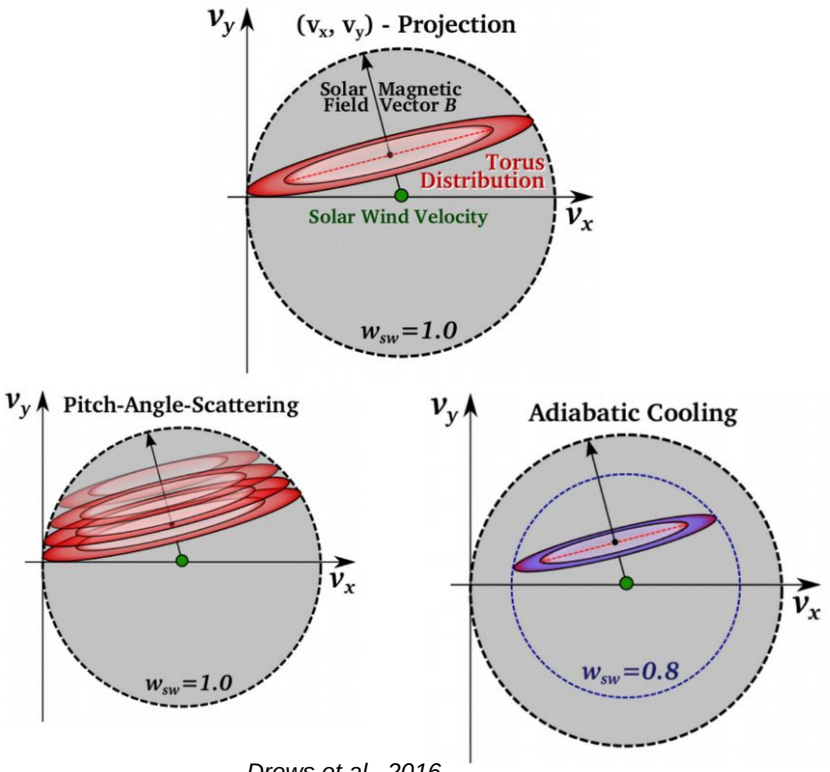
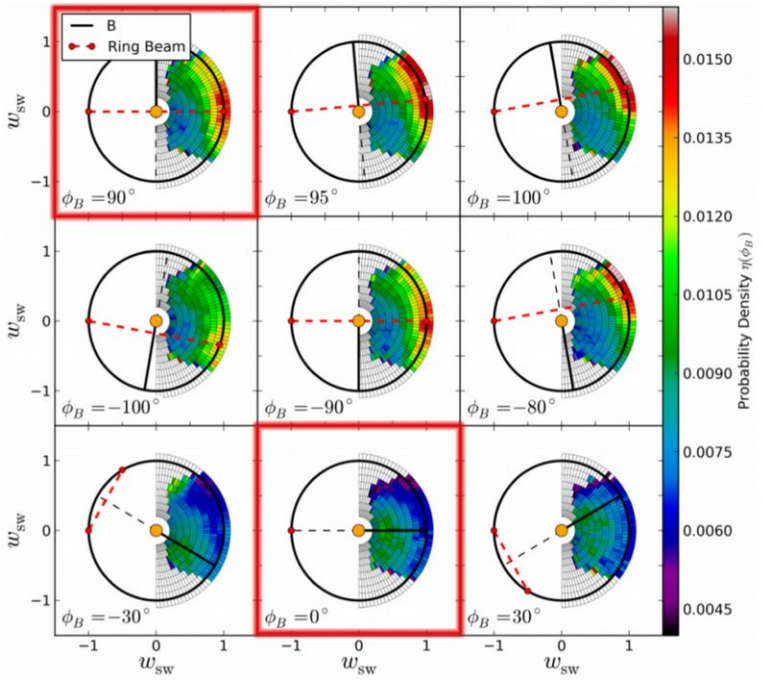
Theory - isotropization



Drews et al., 2016

Measurements:
STEREO/Plastic



Drews et al., 2015

3D observations

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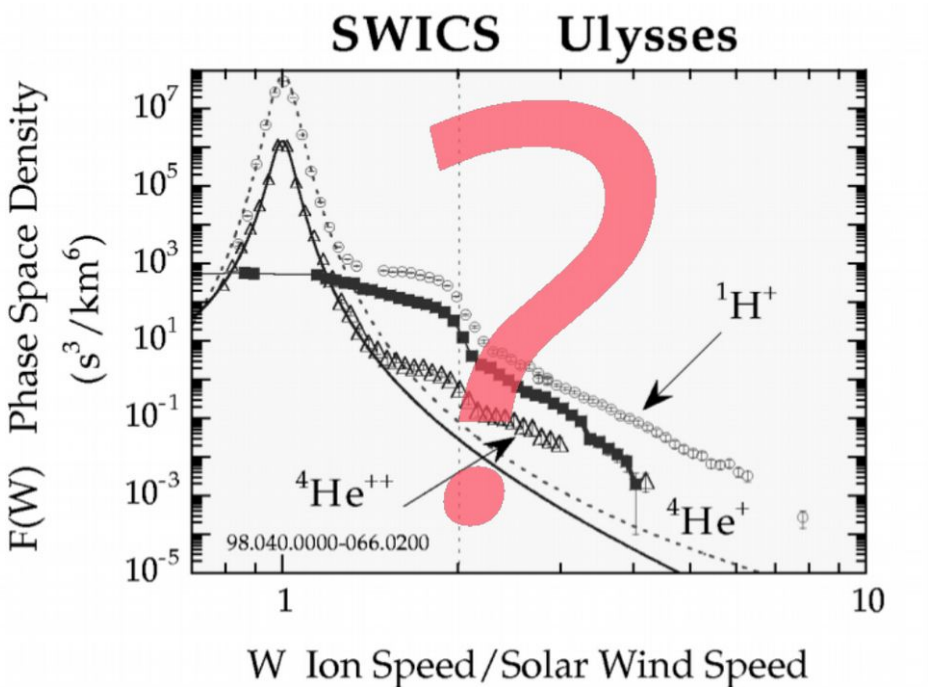
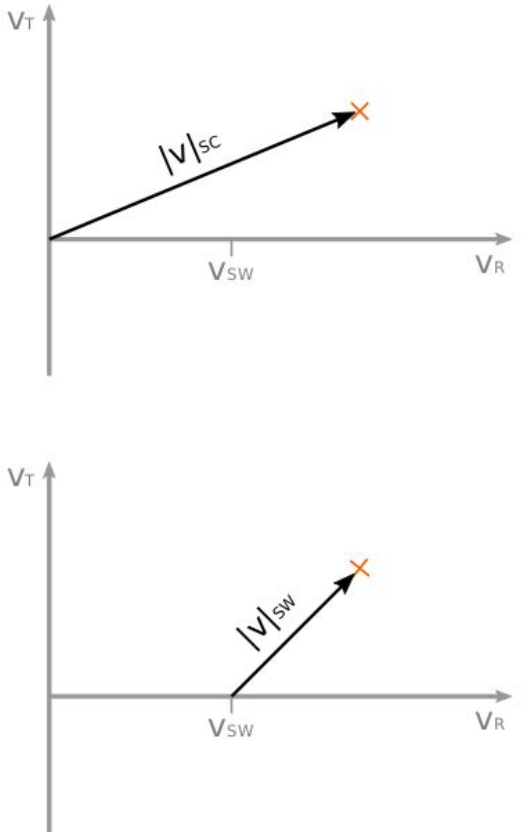


Gloeckler et al., 1999



Ulysses / SWICS

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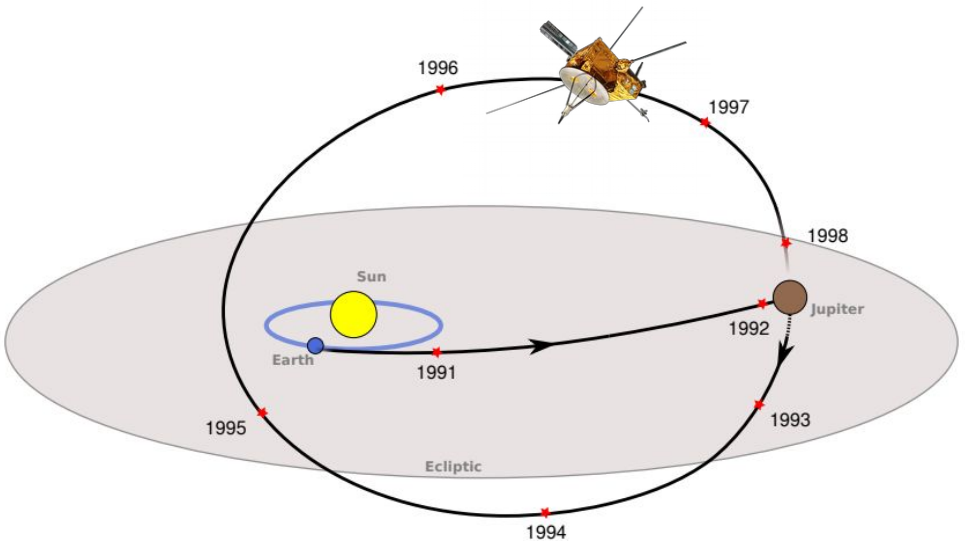
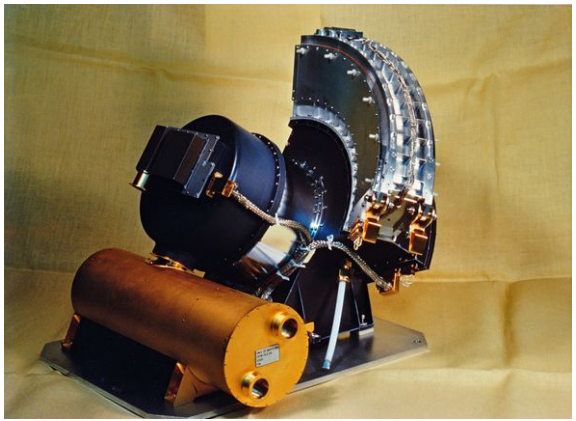


adapted from www.cosmos.esa.int, 2019



The **S**olar **W**ind **I**on **C**omposition **S**pectrometer

Gloeckler, Geiss et al., 1992

Time-Of-Flight Mass Spectrometer:
m, m/q, E

- Identification of He+
- |v| of the ion

Angular resolution of velocity

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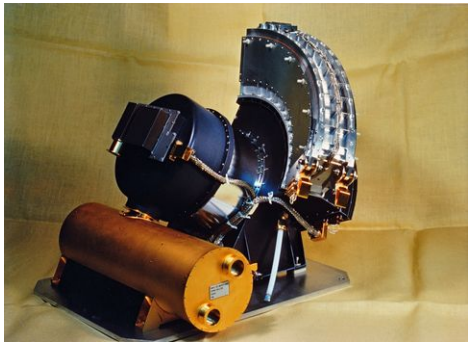

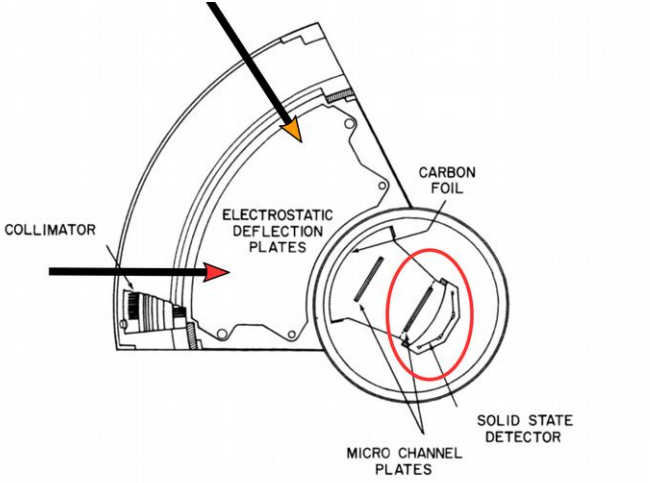

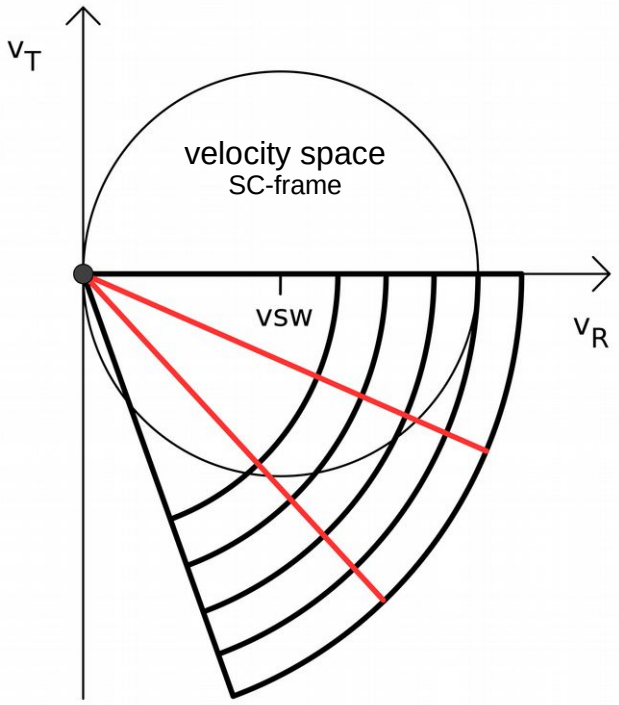

|v| measurement:
locate ion on **circular segment** centered around $\mathbf{v}_{sc} = 0$

SWICS: **3 detectors**
Rough distinction between angles of incidence

3rd dimension: spin of the SC
Divided into **8 sectors**

The Virtual Detector

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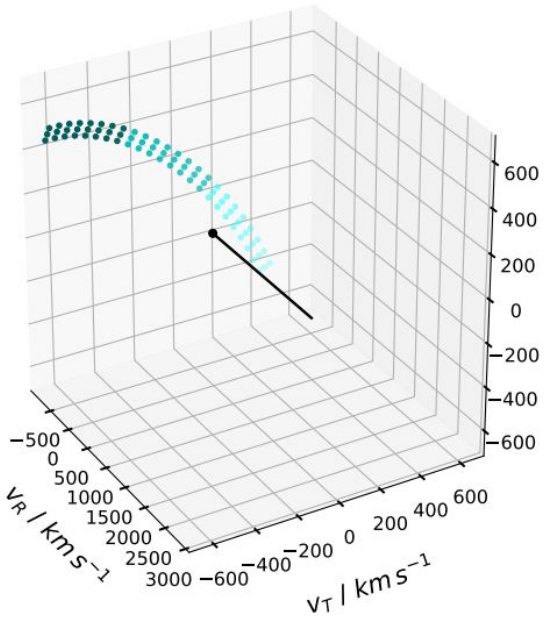
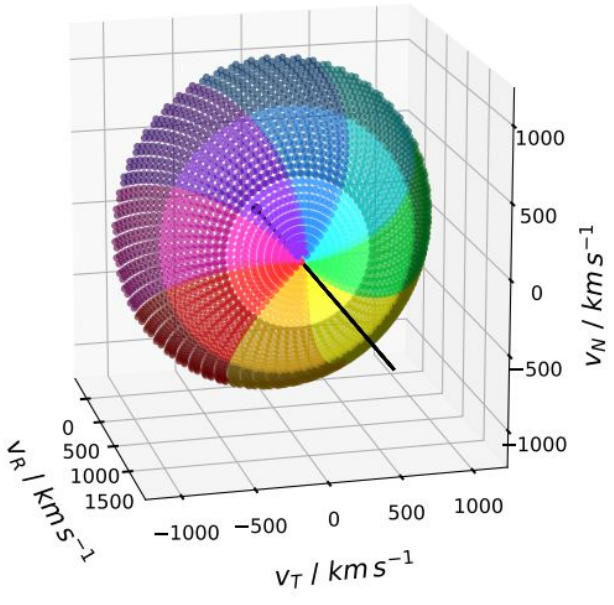
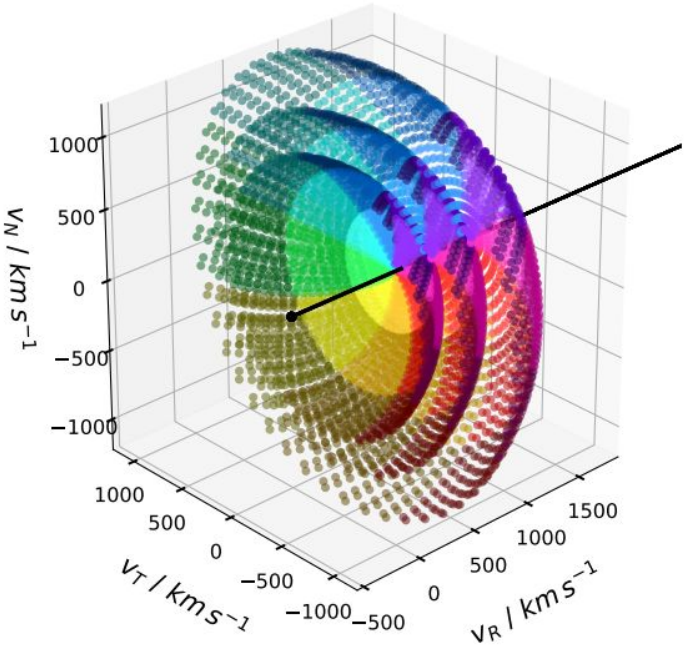


Unrotated collimator acceptance for one |v|



Collimator acceptance for one spacecraft spin for one |v|



Collimator acceptance for different |v|

Cut through 3D Spectrum

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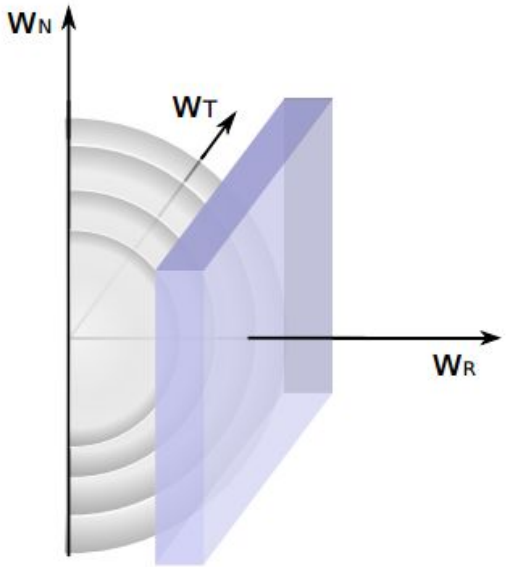
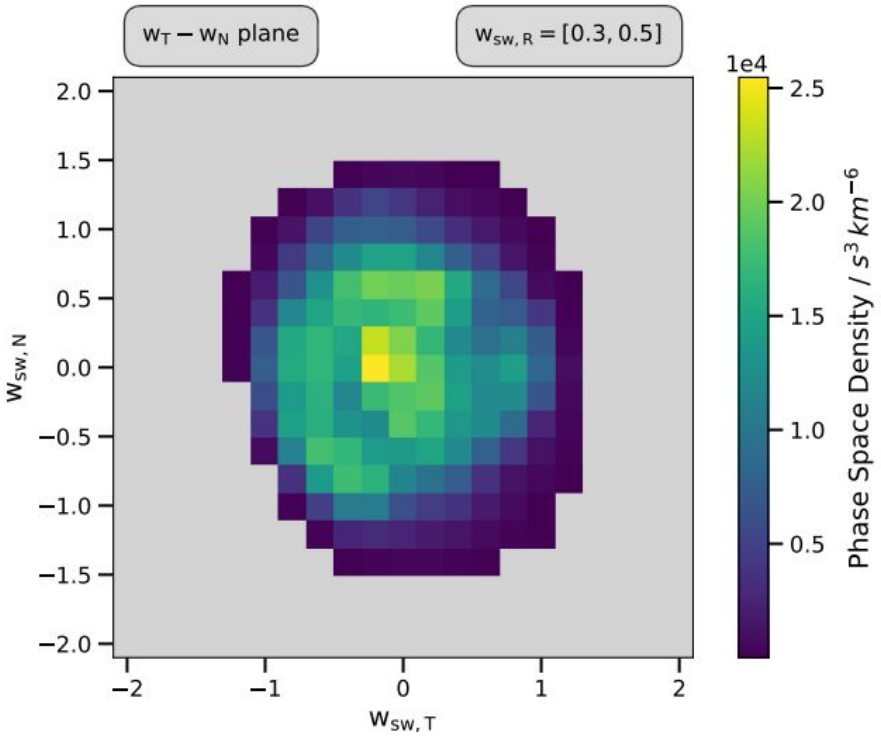


$$\mathbf{w} = \frac{\mathbf{v_{PUI}}}{\mathbf{v_{SW}}}$$



50 days in 1993
v_{sw}: 760 – 780 km/s

Conclusion & Outlook

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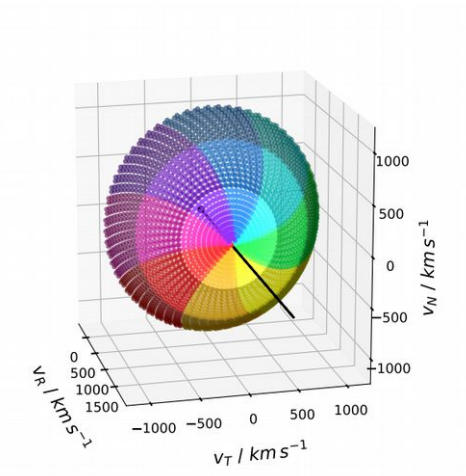
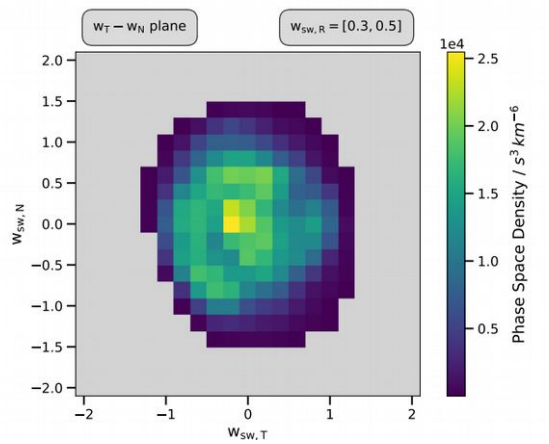
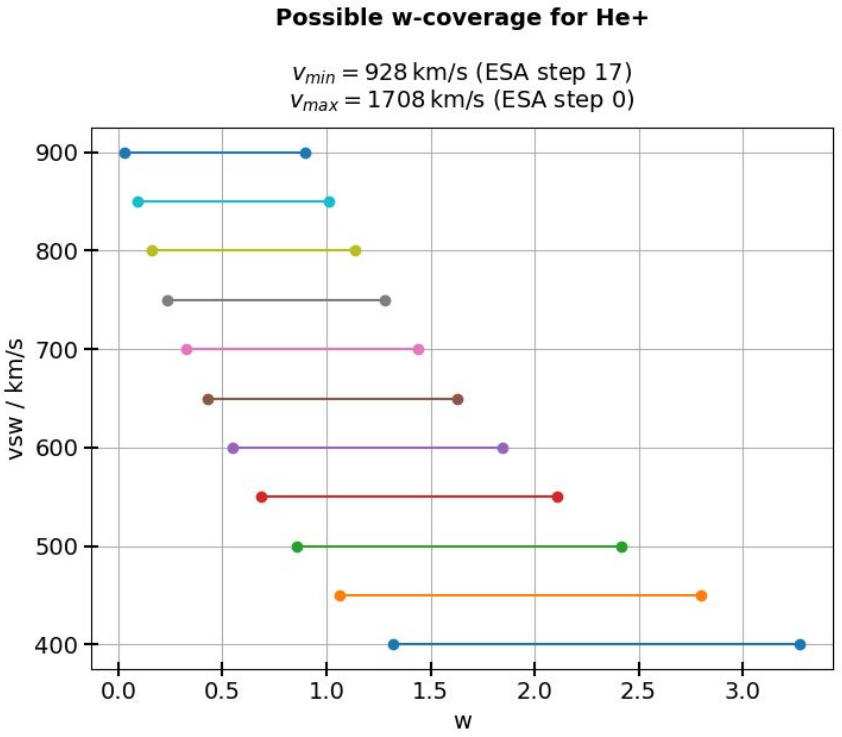
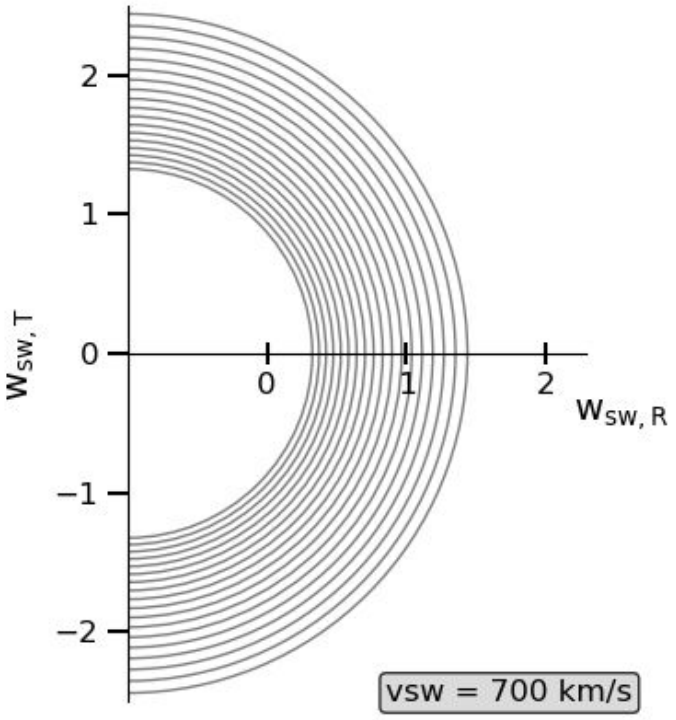
- Full information on velocity distributions only in 3D
- Construction of a **Virtual detector** for directional resolution of He+ PUIs with Ulysses/SWICS

➔ PUI distribution with the IMF






Possible w-coverage for He+
v_{min} = 928 km/s (ESA step 17)
v_{max} = 1708 km/s (ESA step 0)
vsw / km/s
900
800
700
600
500
400
0.0
0.5
1.0
1.5
2.0
2.5
3.0
w


$W_{SW,T}$
$W_{SW,R}$
2
1
0
−1
−2
0
1
2
vsw = 700 km/s