

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

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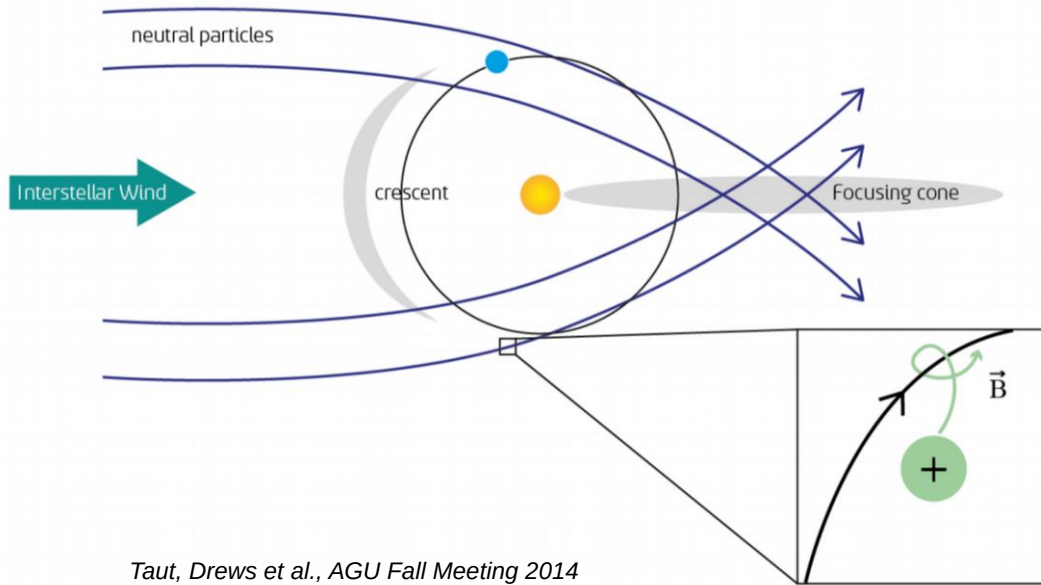
14 Dec 2021

AGU Fall Meeting 2021

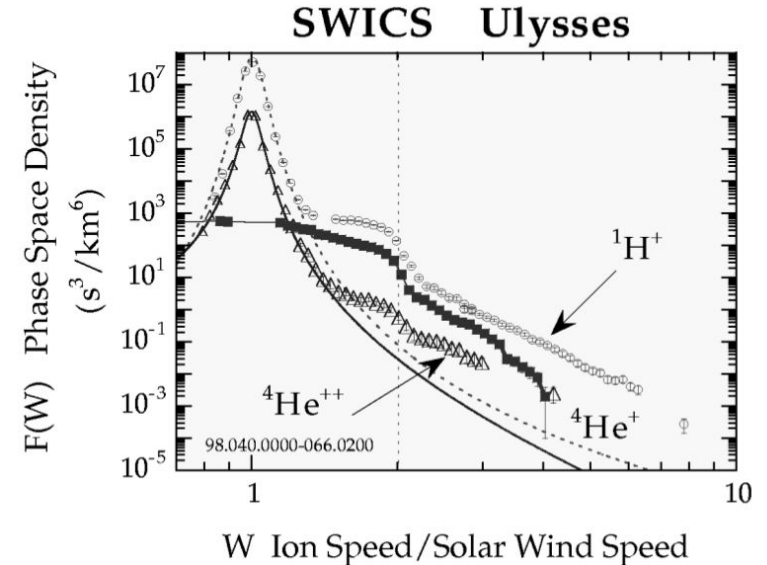
Session SH22A:

From the Sun to the Local Interstellar Medium II 09:45 - 11:00 CST

Pickup Ions (PUIs)



Taut, Drews et al., AGU Fall Meeting 2014

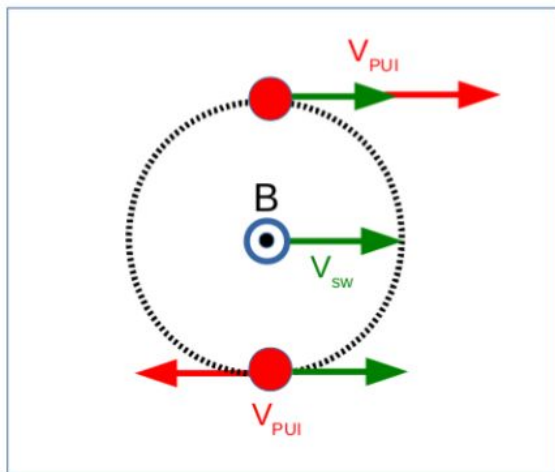
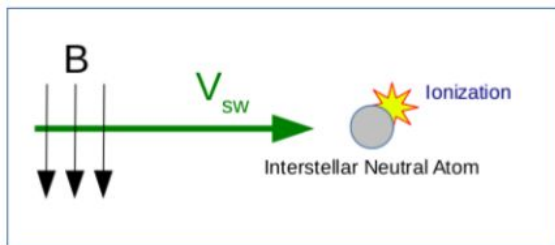


Gloeckler et al., 1999

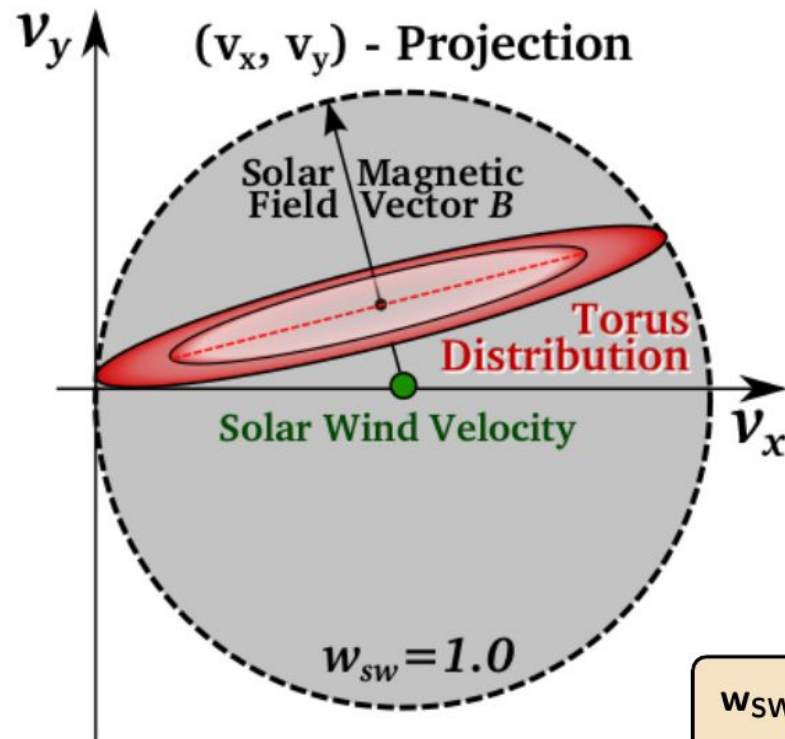
$$W = \frac{v_{PUI}}{v_{SW}}$$

v_{PUI} : PUI velocity
 v_{SW} : solar wind velocity

PUI Velocity Distribution Function (VDF)



Taut, Drews et al., AGU Fall Meeting 2014



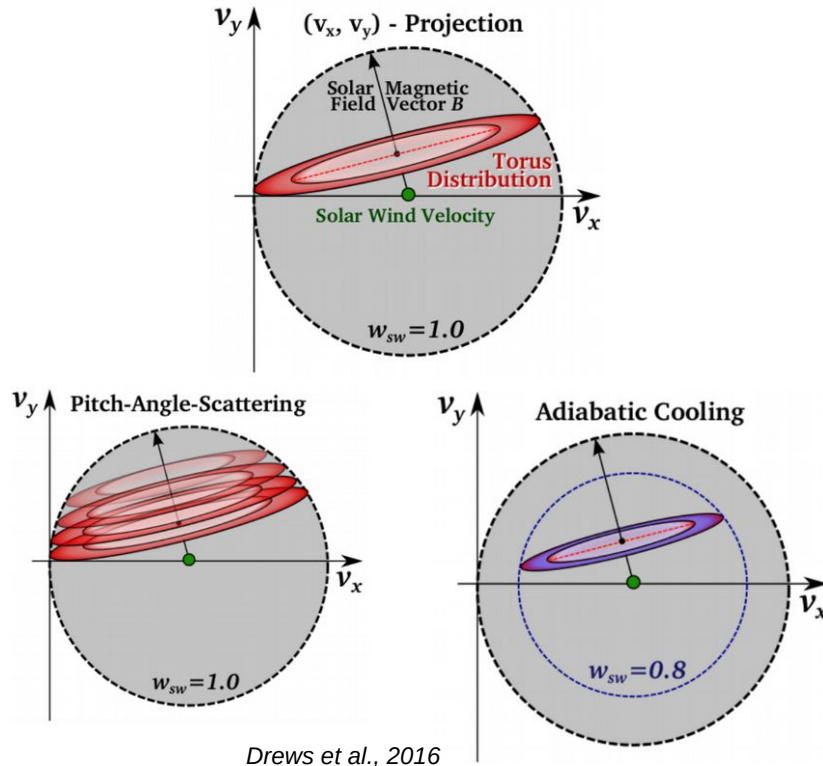
Drews et al., 2016

$$w_{SW} = \frac{v_{PUI} - v_{SW}}{v_{SW}}$$

v_{PUI} : PUI velocity
 v_{SW} : solar wind velocity

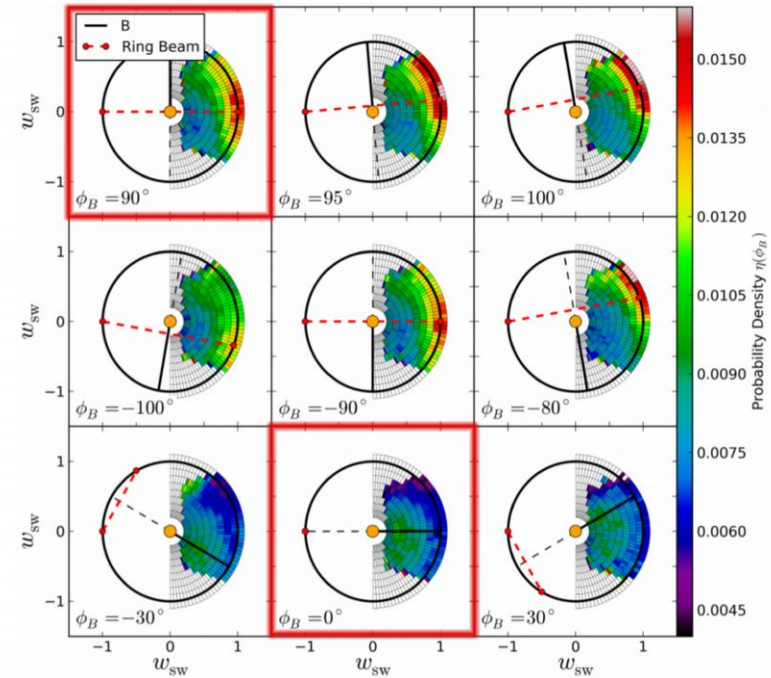
Development of the VDF

Theory - isotropization



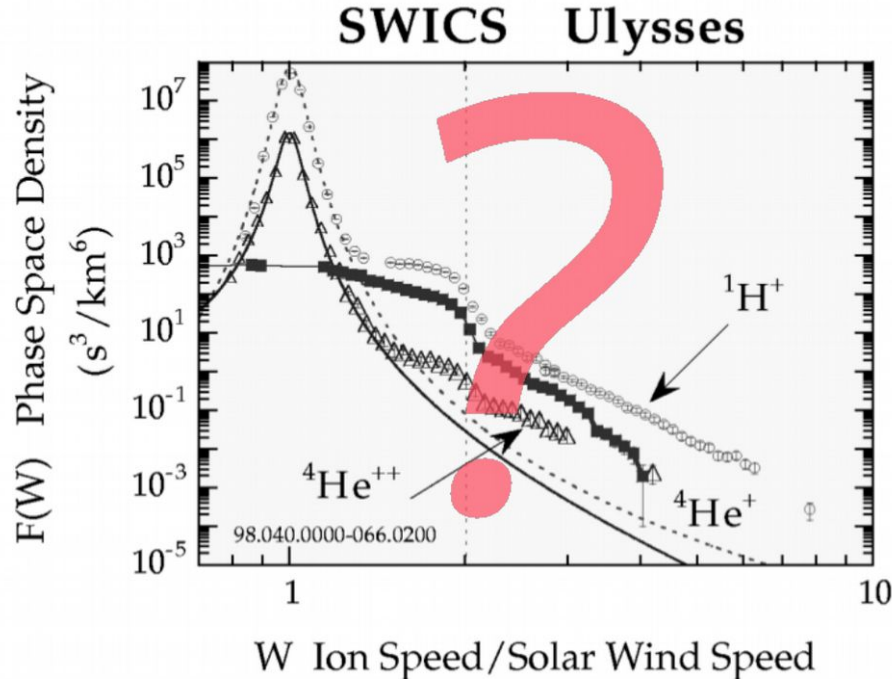
Measurements: STEREO/PLASTIC

He⁺ PUIs, $200 \text{ km/s} < v_{sw} < 500 \text{ km/s}$

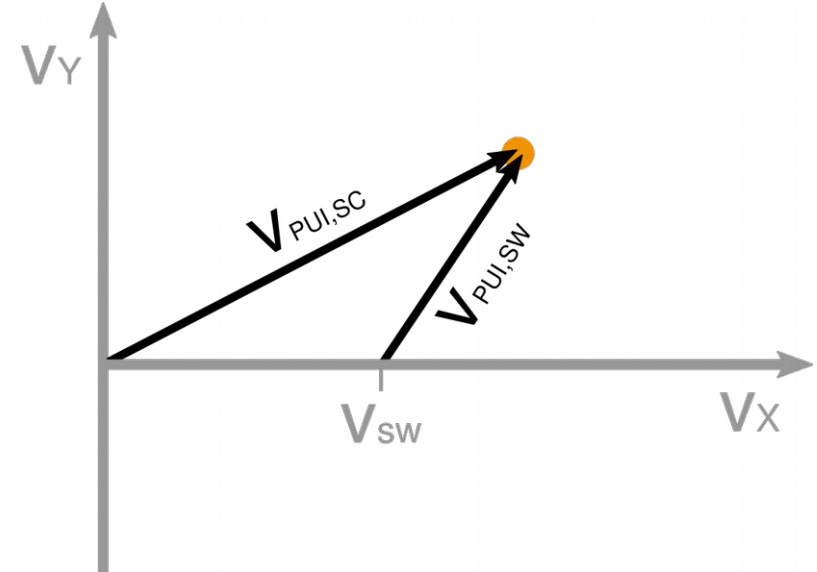


Drews et al., 2015

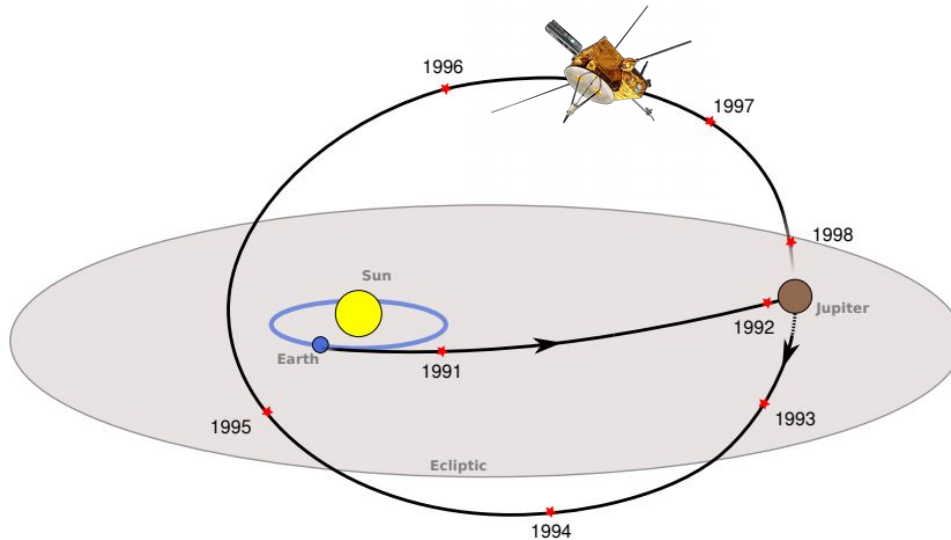
Why 3D Observations?



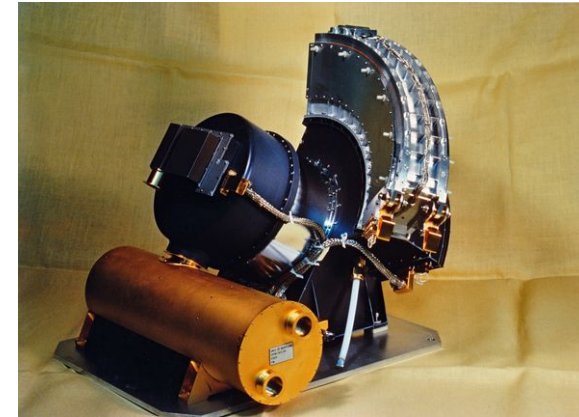
Gloeckler et al., 1999



Ulysses / SWICS



adapted from www.cosmos.esa.int, 2019



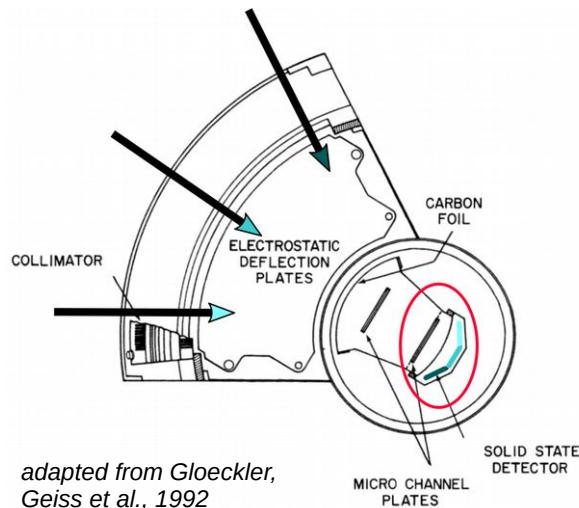
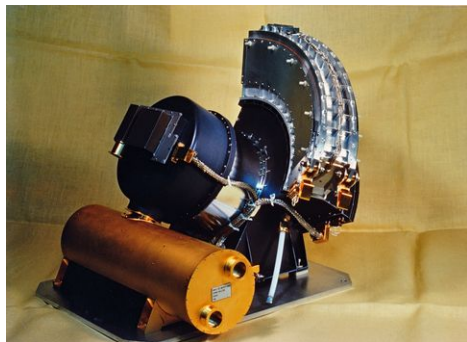
The **Solar Wind Ion Composition Spectrometer**

Gloeckler, Geiss et al., 1992

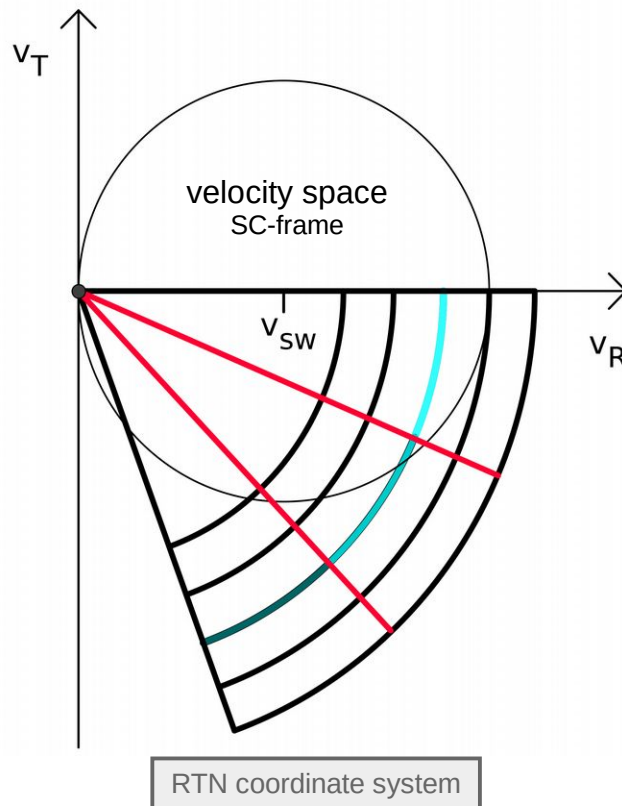
Time-Of-Flight Mass Spectrometer:
mass, mass-per-charge, energy

- Identification of He^+
- $|v_{\text{PU}}|$ of the ion


Angular Resolution of Velocity



adapted from Gloeckler,
Geiss et al., 1992

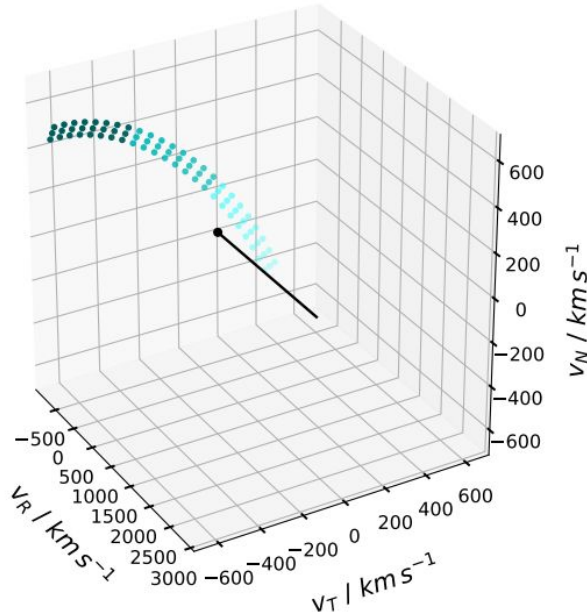


$|v|$ measurement:
Locate ion on **circular segment** centered around $v_{sc} = 0$

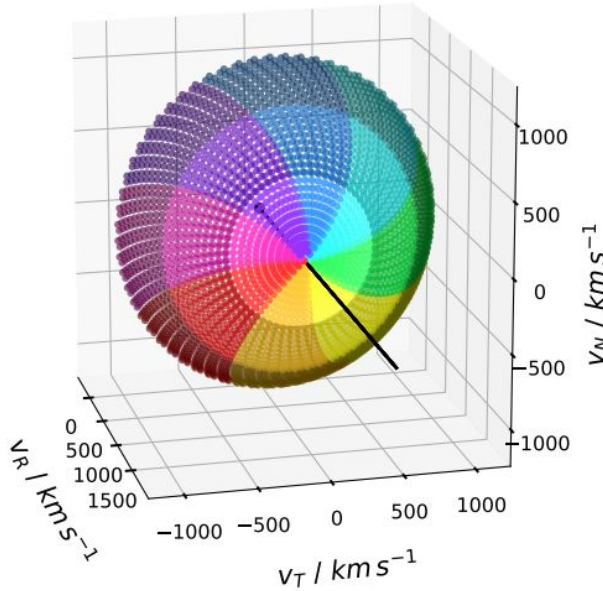
SWICS: **3 detectors** 
Rough distinction between angles of incidence

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

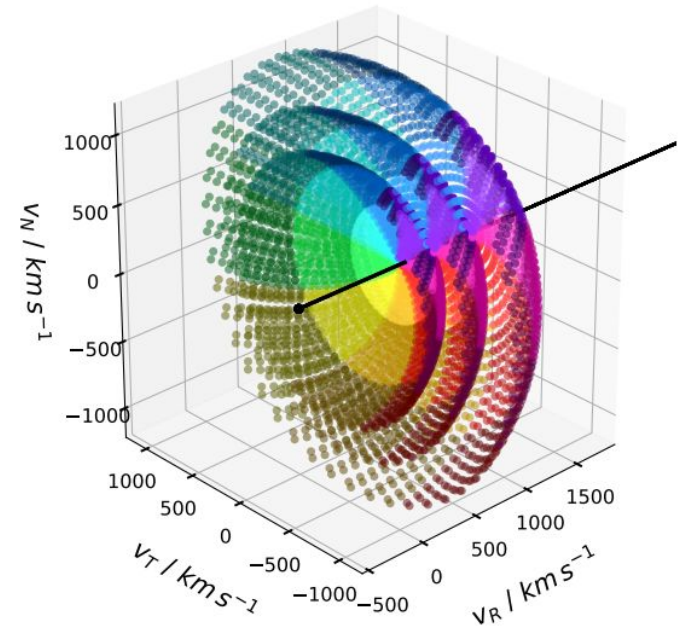
The Virtual Detector



Unrotated collimator acceptance
for one $|v_{PUI}|$

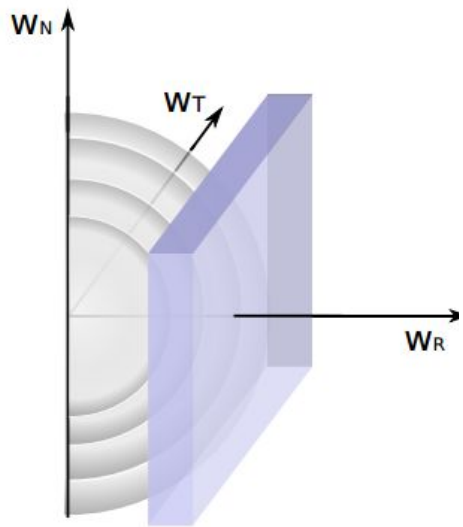


Collimator acceptance for
one spacecraft spin, for one $|v_{PUI}|$



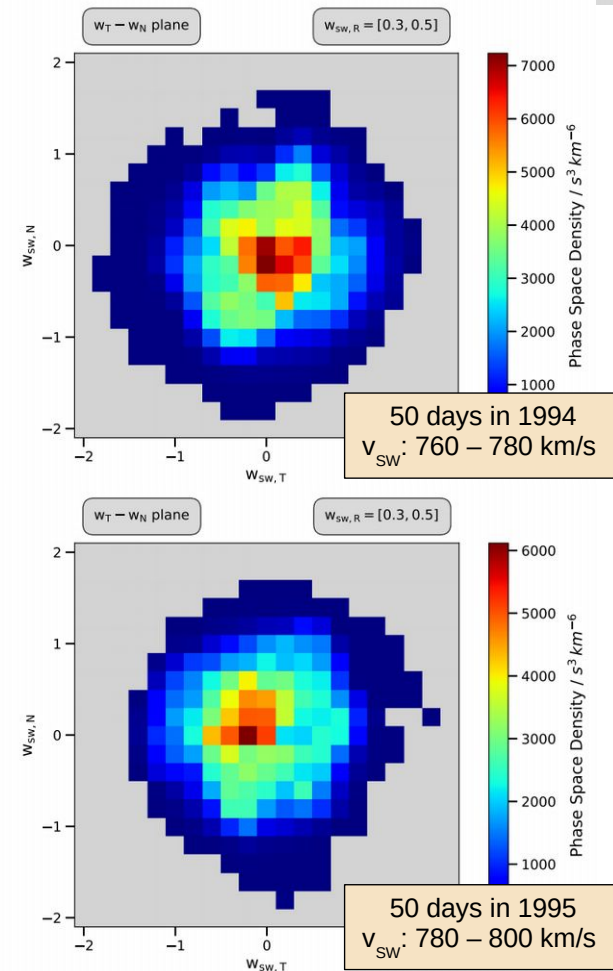
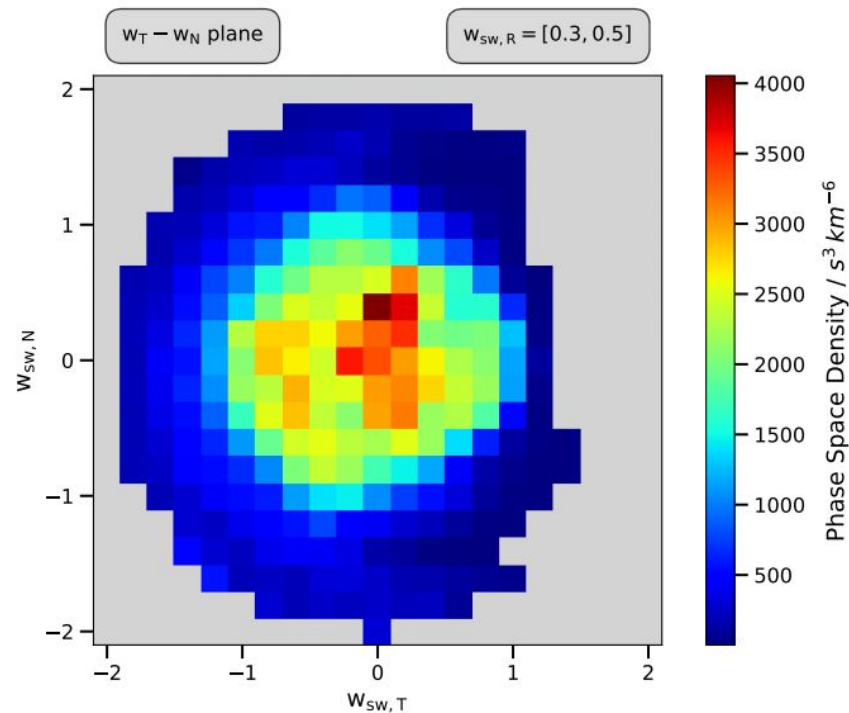
Collimator acceptance
for different $|v_{PUI}|$

Cut through 3D Distributions



$$\mathbf{w}_{SW} = \frac{\mathbf{v}_{PUI} - \mathbf{v}_{SW}}{v_{SW}}$$

v_{PUI} : PUI velocity
 v_{SW} : solar wind velocity



- Full information on velocity distributions only in 3D
- Construction of a **virtual detector** for directional resolution of He^+ PUIs with Ulysses/SWICS
- No clear anisotropic structures
-> more effective isotropization with fast solar wind and large solar distances?

→ PUI distribution with the IMF

