Viewing the S-Web from Within:
ADAPT-WSA Mapping onto WISPR Observations of the Inner Corona

June 29 – July 2, 2026
Madison, Wisconsin

Evangelos Paouris[1], Samantha Wallace[2], Angelos Vourlidas[1] and Charles Nick Arge[3]
1: Johns Hopkins University Applied Physics Laboratory, 2: Embry-Riddle Aeronautical University, 3: Goddard Space Flight Center NASA

Plain language abstract:

- We present a novel way to better associate models of the Sun's magnetic structure with images taken by WISPR on board Parker Solar Probe. This work adds ADAPT-WSA S-web information into the HELIOS 3D visualization tool. In simple terms, the S-web traces important magnetic boundaries in the corona, especially regions where open and closed magnetic fields meet. These boundaries may be connected to the release of specific solar-wind structures and small-scale activity.
- The key idea is to place these magnetic structures into a realistic 3D view that follows Parker Solar Probe as it moves around the Sun. HELIOS can then project the modeled heliospheric current sheet and S-web structures directly onto WISPR images. This helps researchers examine whether bright rays, folds, or changing coronal features seen by WISPR are related to modeled magnetic structures, or whether their appearance is affected by viewing geometry.
- The method can also be used to study small transient "blob" features by tracing possible release corridors from the corona into the heliosphere. Overall, the project connects three things that are often treated separately: magnetic maps of the low corona, white-light images from WISPR, and eventual in situ interpretation. The result is a flexible, reproducible tool for rapidly exploring events and improving the physical interpretation of PSP observations.

HELIOS 3D Visualization Tool

Helio-Environment Localization and Interpretation of OutflowS (HELIOS; Paouris et al., 2025) is an interactive 3D visualization tool designed to interpret complex white-light structures observed by Parker Solar Probe/WISPR, with broader applicability to other white-light imagers such as SoloHI/Solar Orbiter. By combining PSP's time-dependent orbital motion, the evolving WISPR field of view, and 3D reconstructions of coronal structures such as the heliospheric current sheet, coronal-hole boundaries, and CMEs, HELIOS provides the geometric context needed to distinguish projection effects from real plasma motion. The tool helps localize small transient blobs, coronal rays, and large-scale structures in 3D, enabling researchers to connect remote-sensing observations with the underlying magnetic environment and, ultimately, with in situ measurements.

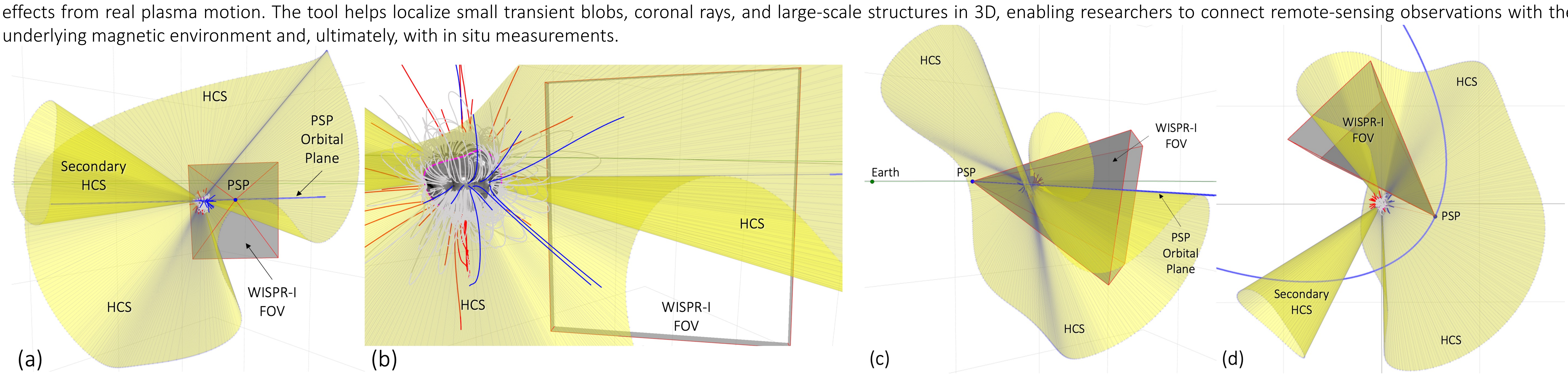

Figure 1: *HELIOS 3D output for 2024 December 24 at 16:00 UT shown from four perspectives. The views illustrate PSP's location and orbit, the WISPR-I field of view, and the 3D HCS reconstructed from PFSS-based linear extrapolations between 2.5 and 30 Rs. The HCS intersects the WISPR FOV and shows a folded structure near the center of the view, with some segments nearly aligned with the WISPR pointing direction. PFSS field lines and the ADAPT magnetogram mapped onto the solar surface provide additional magnetic context, while the side and top-down views show the geometry relative to PSP, Earth, and the Sun–Earth line.*

ADAPT-WSA and S-Web

The ADAPT-WSA framework provides a physics-based way to connect observed solar-wind structures back to their coronal source regions by combining time-dependent photospheric magnetic-field maps with coronal and solar-wind modeling. A key diagnostic from this framework is the separatrix web (*Antiochos et al. 2011; Linker et al. 2011*), or S-web: a complex network of separatrices and quasi-separatrix layers that traces where open and closed magnetic fields come into close contact. These high-connectivity-gradient regions are important because they identify likely sites of interchange reconnection, where plasma from closed coronal loops can be released into the solar wind and may form mesoscale structures such as blobs, rays, and compositionally distinct solar-wind streams.

Integrating the S-web into HELIOS would therefore add magnetic-connectivity context directly to the WISPR viewing geometry, helping link white-light structures to their possible coronal release corridors and eventual in situ signatures.

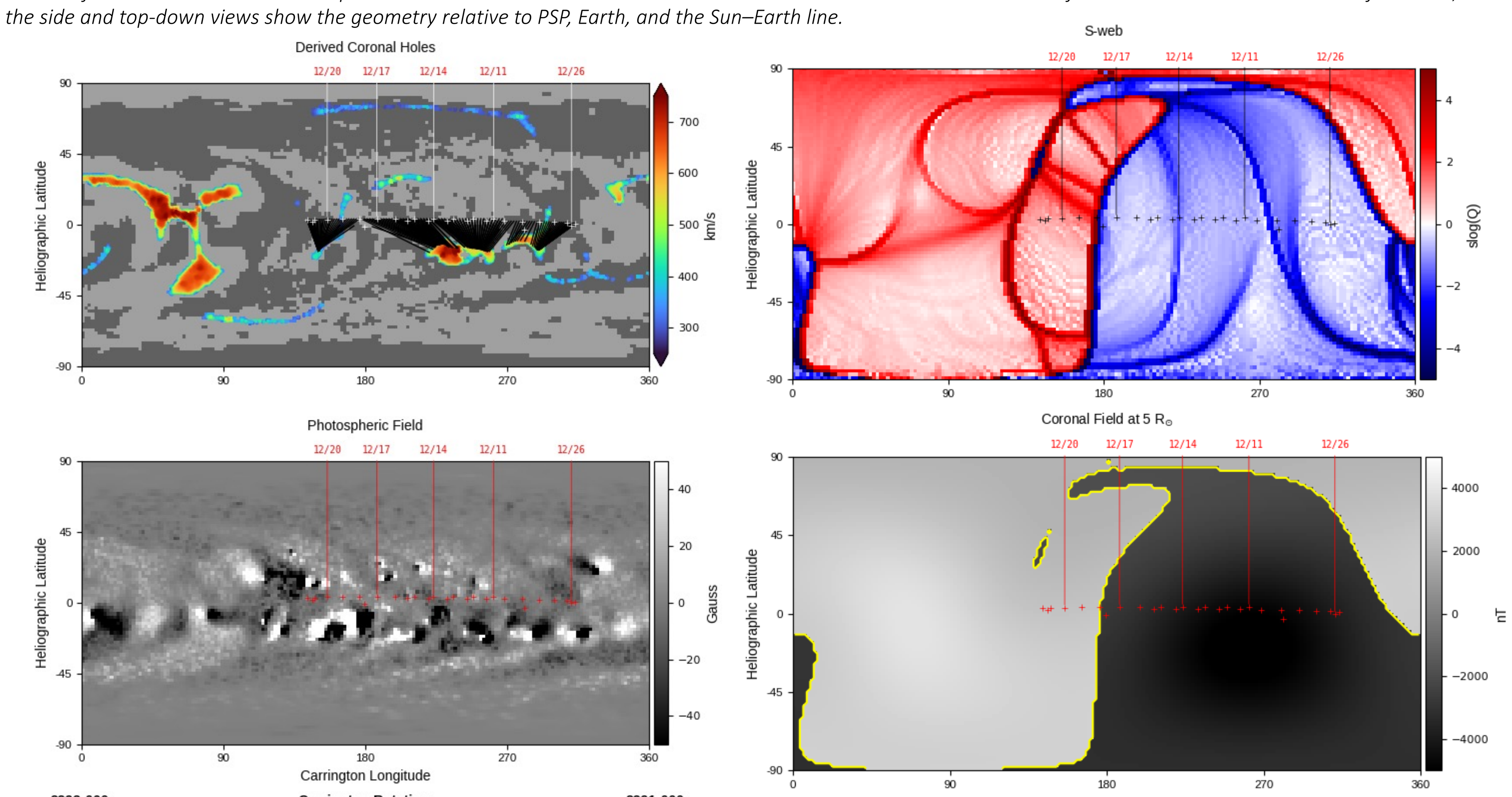

Figure 2: *ADAPT-WSA context maps for the selected PSP/WISPR interval. The panels show the model-derived coronal holes and solar-wind speed at 1 Rs, the signed squashing factor slog(Q) tracing the S-web topology, the ADAPT-GONG photospheric magnetic field, and the coronal magnetic field at 5 Rs with the HCS outlined in yellow. Red tick marks and date labels indicate the time-evolving PSP/subspacecraft mapping.*

S-Web in HELIOS 3D

Integrating the ADAPT-WSA S-web into HELIOS adds a new magnetic-topology layer to the existing 3D WISPR-viewing framework. This is important because the S-web traces high-Q separatrix and quasi-separatrix regions where open and closed magnetic fields are closely connected, making them likely pathways for interchange reconnection and the release of structured plasma into the solar wind. The novelty of this approach is that these magnetic release corridors can now be examined directly in the same 3D geometry used to interpret WISPR images, rather than only as model outputs on coronal maps. This provides a practical way to test whether rays, folds, blobs, and other small-scale white-light features are connected to specific topological structures in the corona. As an initial application, we mapped the five WISPR blobs recently analyzed with HELIOS by Paouris et al. (2025) and found that all of them are located very close to high-Q S-web regions, suggesting that the S-web may provide the missing magnetic context for their origin and evolution.

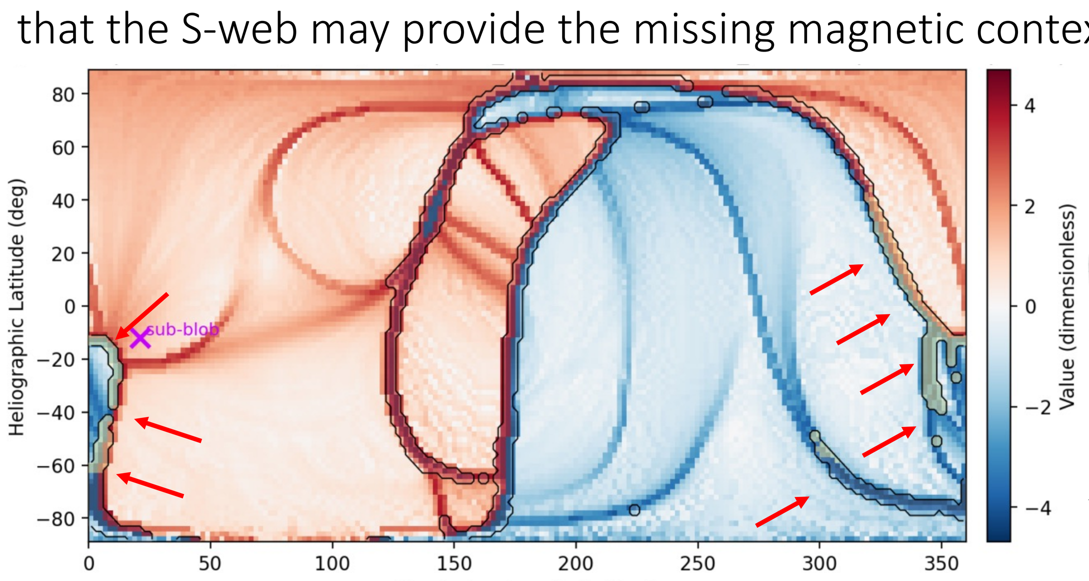

Figure 3: *Carrington map of the dimensionless signed squashing-factor distribution, slog(Q). Black contours highlight selected high-|slog(Q)| structures (|slog(Q)| > 4), tracing S-web connectivity regions, while the blue cross marks the projected location of the identified blob B3 near a candidate release corridor (see Paouris et al. 2025 for details). The red arrows indicate the portions of the S-web that intersect the WISPR-I FOV.*

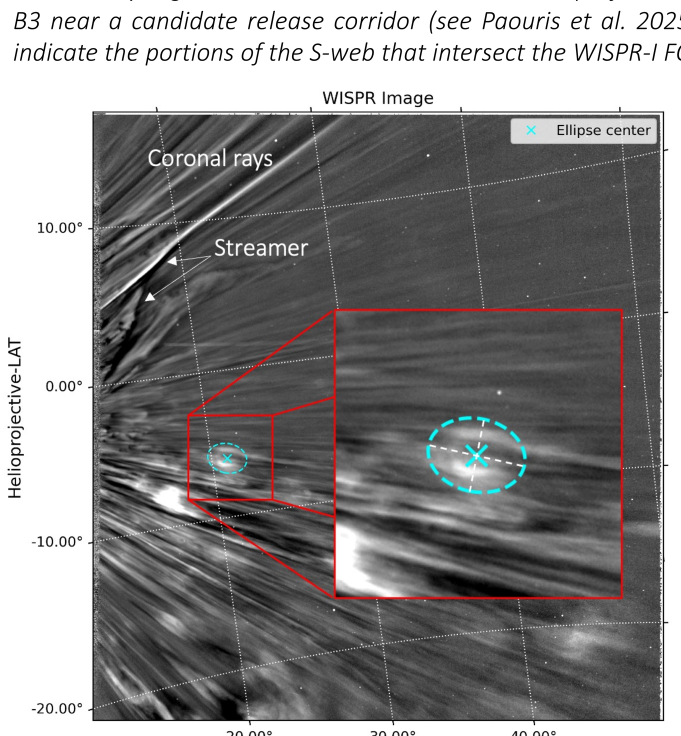

Figure 4: *WISPR LW image showing the tracked blob B3 and the fitted ellipse (inset), indicating the center, major axis, and minor axis. Blob B3 displays a central darker region and a characteristic morphological "c" shape typical of most blobs.*

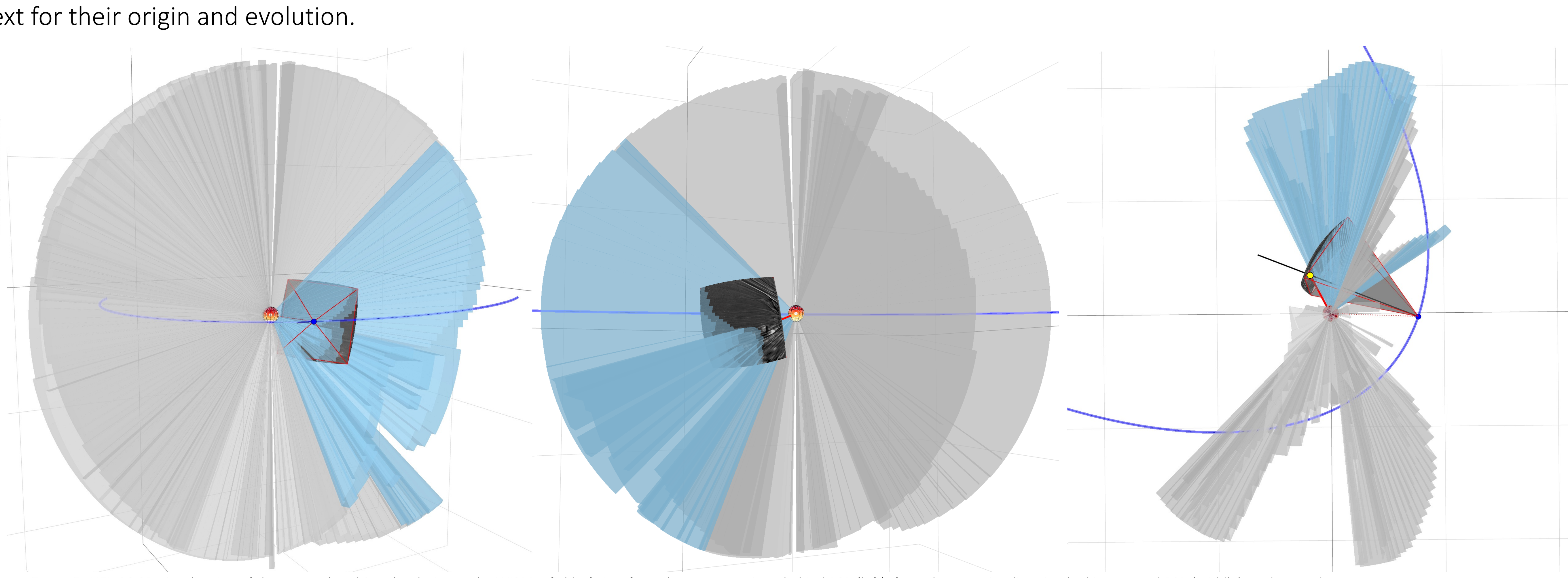

Figure 5: *HELIOS 3D visualization of the extrapolated S-web relative to the WISPR-I field of view from three perspectives: behind PSP (left), from the opposite direction looking toward PSP (middle), and a top-down view from solar north (right). Light-blue radial volumes mark S-web regions intersecting the WISPR-I FOV, while light-gray volumes indicate extrapolated S-web regions outside the FOV. The blob position, marked in yellow in the right panel, lies very close to the S-web, supporting a possible association with high-Q magnetic connectivity regions.*

By integrating the ADAPT-WSA S-web into HELIOS, we introduce a 3D framework that places WISPR white-light structures within the magnetic topology of the corona and inner heliosphere. This capability moves beyond visual comparison by identifying which high-Q S-web arcs intersect the evolving WISPR-I field of view and by placing observed rays and blobs in their 3D magnetic context. The examined blobs appear close to S-web regions, consistent with candidate release corridors where interchange reconnection is favored. This supports the *Paouris et al., 2025*, findings that all five blobs originated near HCS surfaces, and suggests that their HCS association may be part of the broader S-web topology. Thus, HELIOS + S-web provides a novel pathway for linking WISPR signatures to global magnetic structure.

HELIOS – Paouris et al., 2025

Acknowledgments: *EP acknowledges financial support from NASA LWS grant 80NSSC25K0130.*