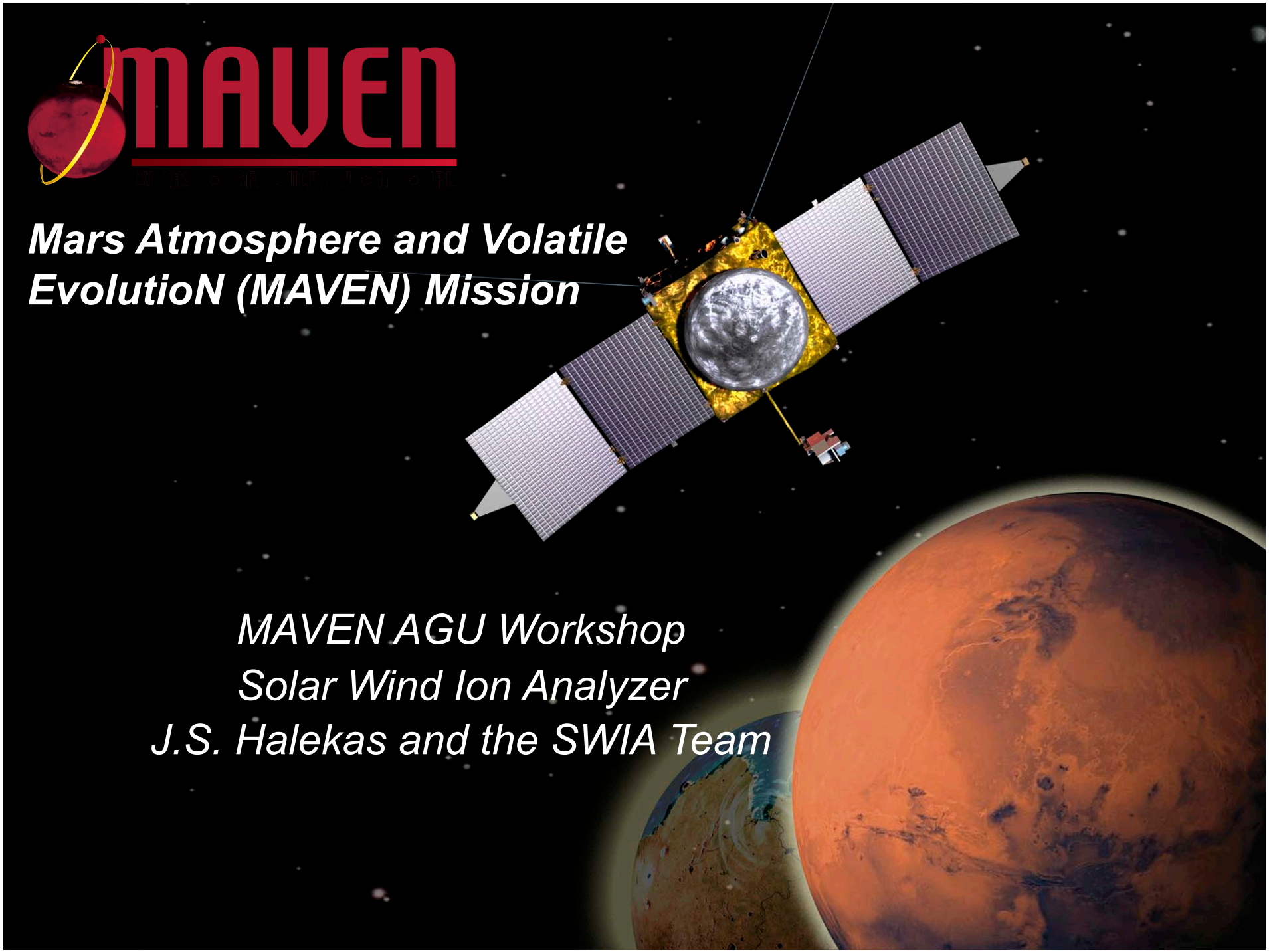
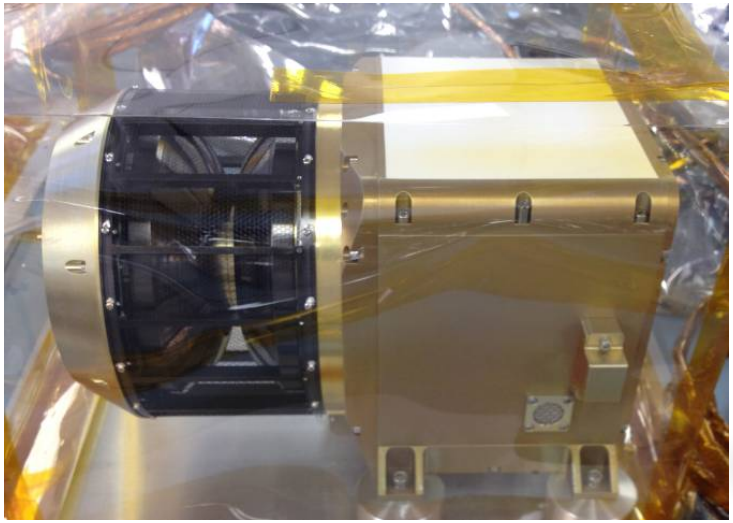
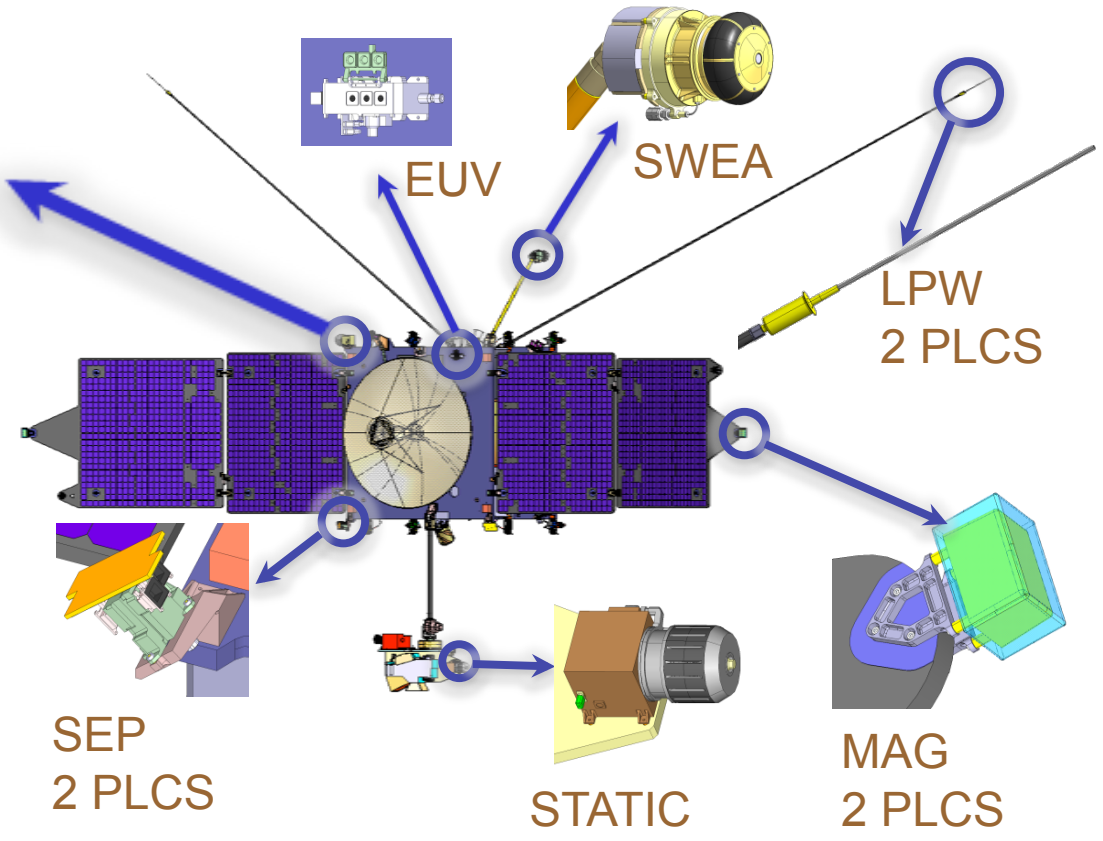

MAVEN
Mars Atmosphere and Volatile EvolutioN (MAVEN) Mission
MAVEN AGU Workshop
Solar Wind Ion Analyzer
J.S. Halekas and the SWIA Team

SWIA Family Portrait



SWIA



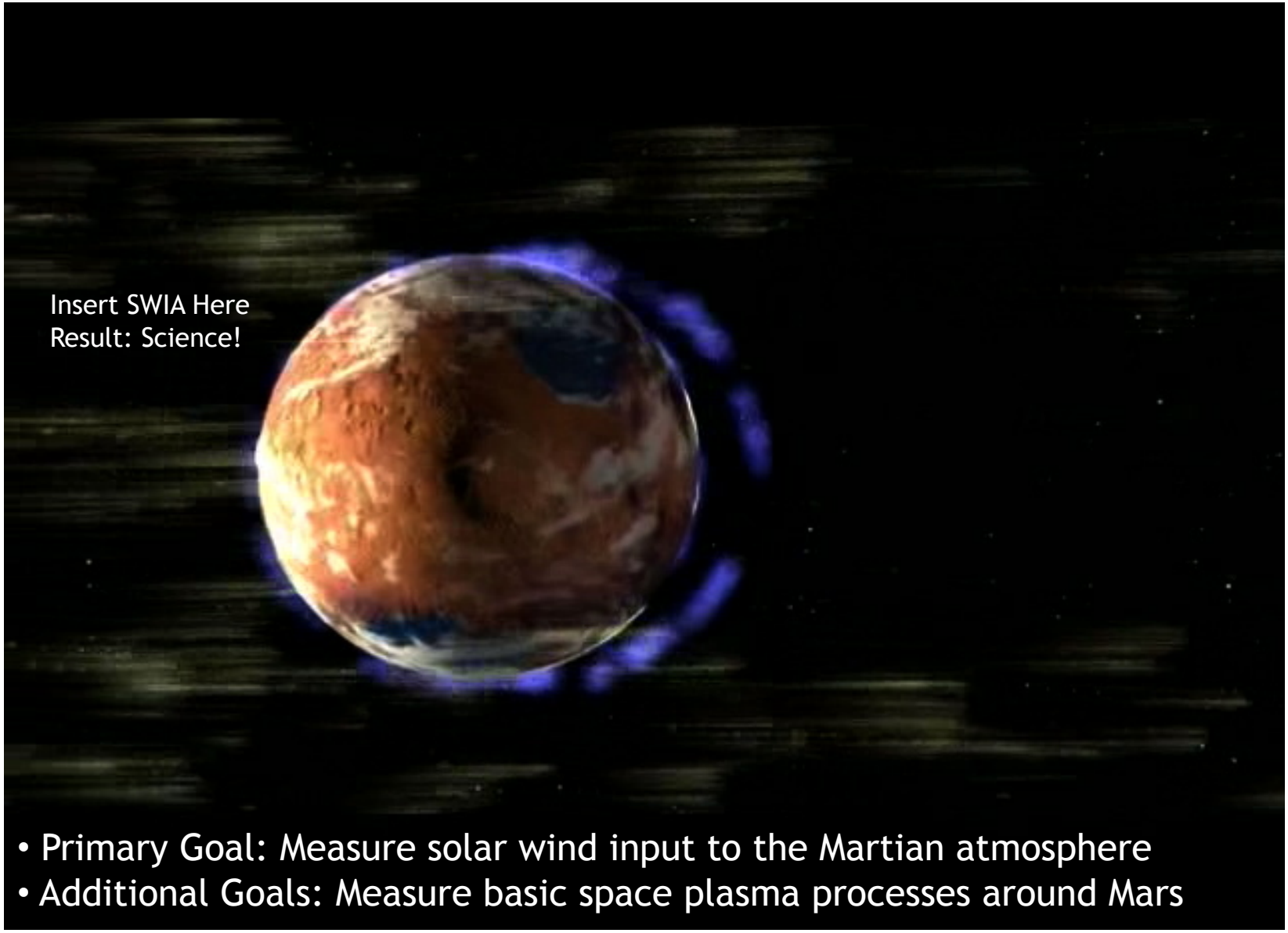
Delivered to LM last week (11/26)
Bench checkout nominal

Bolted on to spacecraft tomorrow (12/3)
S/C testing to follow

SWIA Level 1 Requirements

4.1.9: Solar Wind Ions	
Baseline: MAVEN shall determine density and velocity distributions of solar wind and magnetosheath protons (from 1000 km/s to 50 km/s). Better than 15% energy resolution; better than 30 degrees angular resolution.	**Rationale:** Solar-wind ion properties determine the solar-wind and magnetosheath properties near Mars and constrain the nature of the solar-wind interactions with the upper atmosphere, determine the ionization rates of neutrals from charge exchange, and determine the pickup acceleration of newly formed ions by the **v x B** electric field.

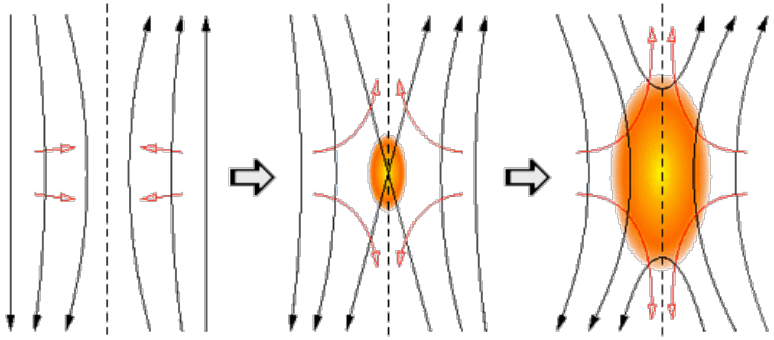
SWIA Science Goals

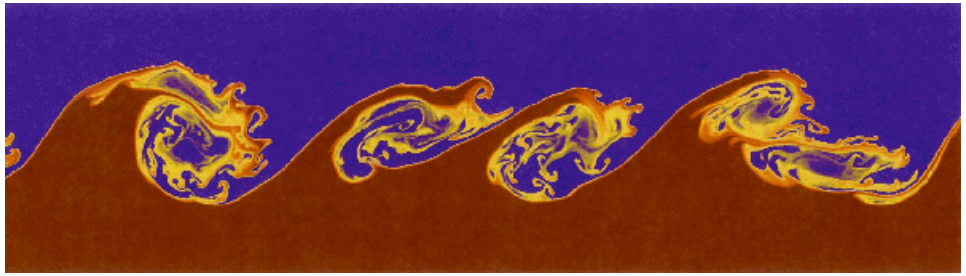


- Primary Goal: Measure solar wind input to the Martian atmosphere
- Additional Goals: Measure basic space plasma processes around Mars

SWIA Science Goals

- Non-thermal ion loss processes are key for MAVEN
  - Reconnection/Flux Ropes/Plasmoids
  - Bulk escape/plasma clouds
  - Polar wind
  - Auroral processes
  - Kelvin Helmholtz/boundary instabilities
  - Pickup escape

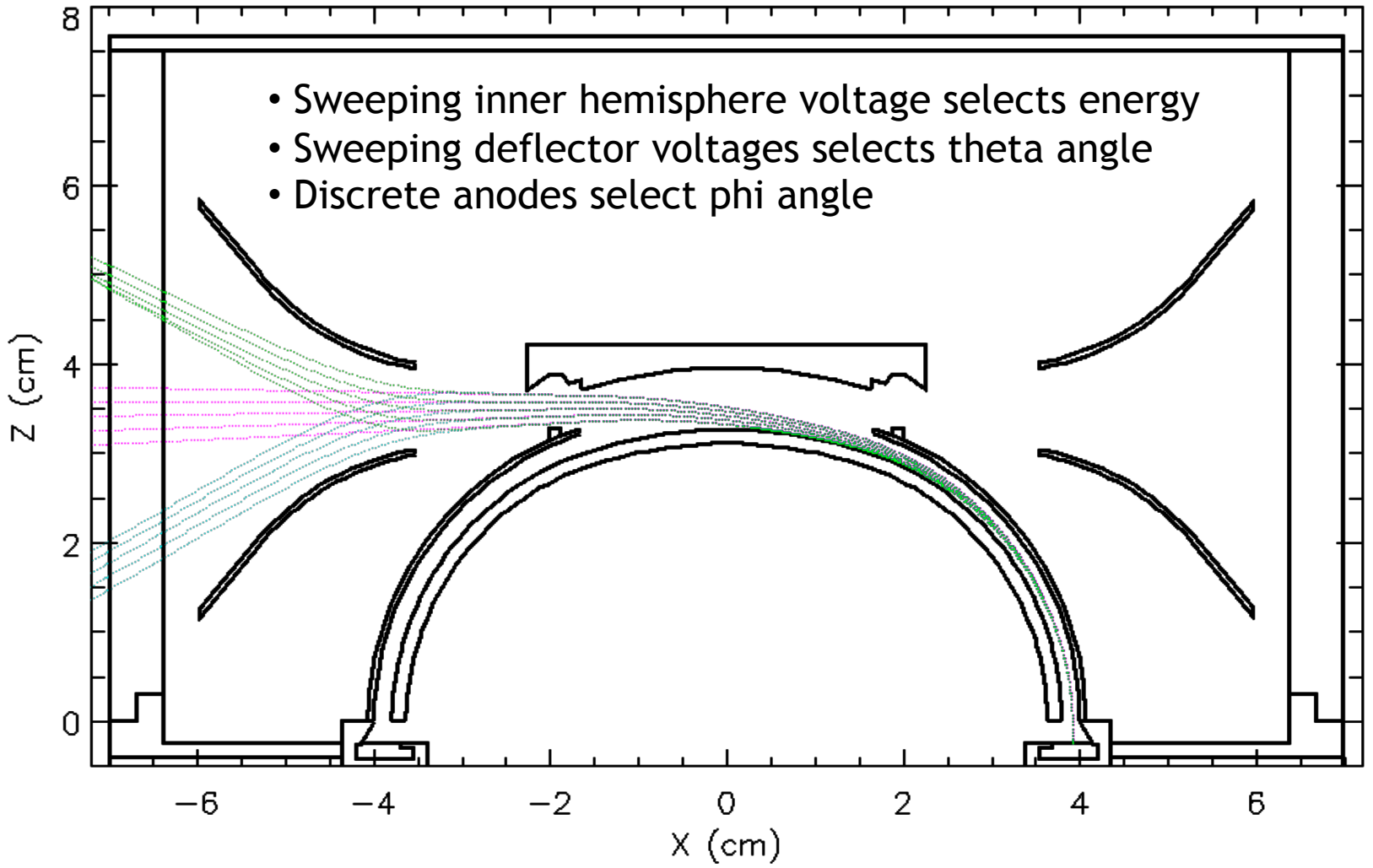




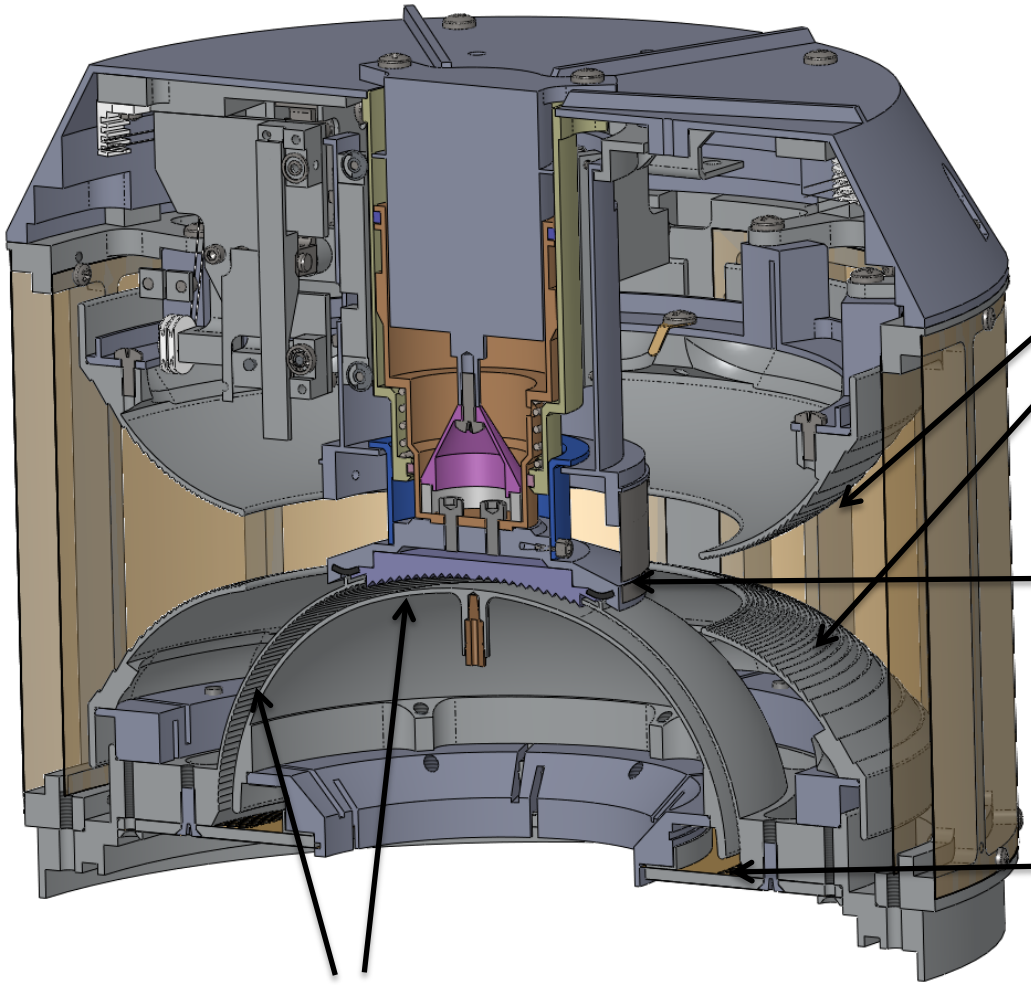
SWIA Measurement Capabilities

REQUIREMENT	SWIA Capability
PF72: SWIA shall measure energy fluxes from $1x10^{7}$ to $1x10^{10}$ eV/(cm^2 s sr eV) with no worse than 25% precision	SWIA will measure energy fluxes from $5x10^{4}$ to $7x10^{11}$ eV/(cm^2 s sr eV)
PF73: SWIA shall measure ion flow velocities from 50-1000 km/s	SWIA will measure from 5-25000 eV (flow velocities from 30-2000 km/s)
PF74: SWIA shall have energy resolution dE/E at least 15%	SWIA has energy resolution of 14.5% (13.5% with attenuator)
PF75: SWIA shall have angular resolution of at least 30° (10° in Sun direction)	SWIA has angular resolution of 22.5°, with 4.5° sectors in Sun direction
PF76: SWIA shall have time resolution of at least 1 minute or better	The basic SWIA measurement cadence is 4 seconds.
PF77: SWIA shall have a FOV of 180x40° or better	SWIA has a FOV of 360x90°

SWIA Optics


• Sweeping inner hemisphere voltage selects energy
• Sweeping deflector voltages selects theta angle
• Discrete anodes select phi angle
Z (cm)
X (cm)
8
6
4
2
0
−6
−4
−2
0
2
4
6

SWIA Optics Details



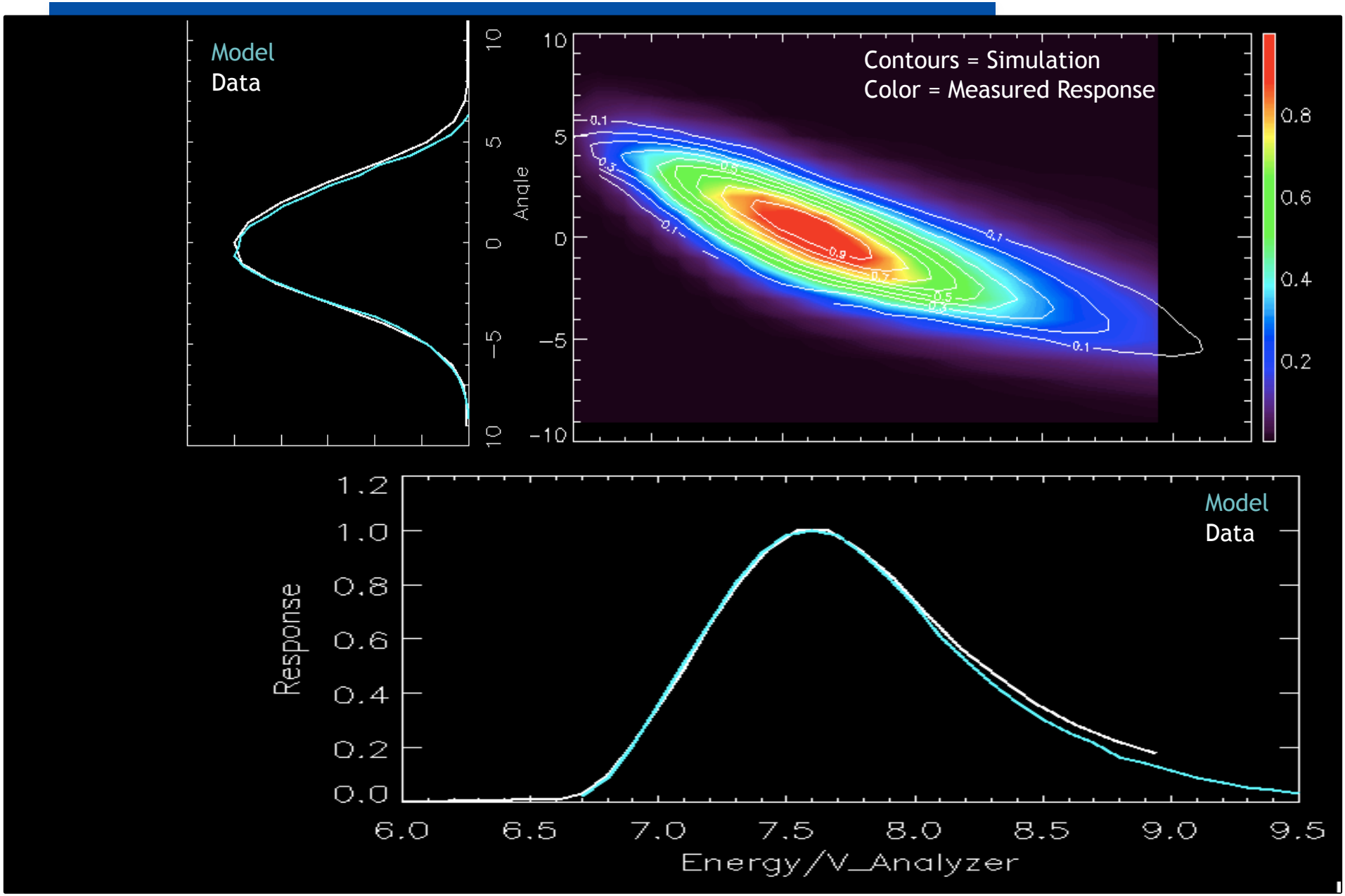
Deflector serrations prevent ions from scattering at a shallow enough angle to make it into the optics

Mechanical attenuator reduces sensitivity by factor of ~15

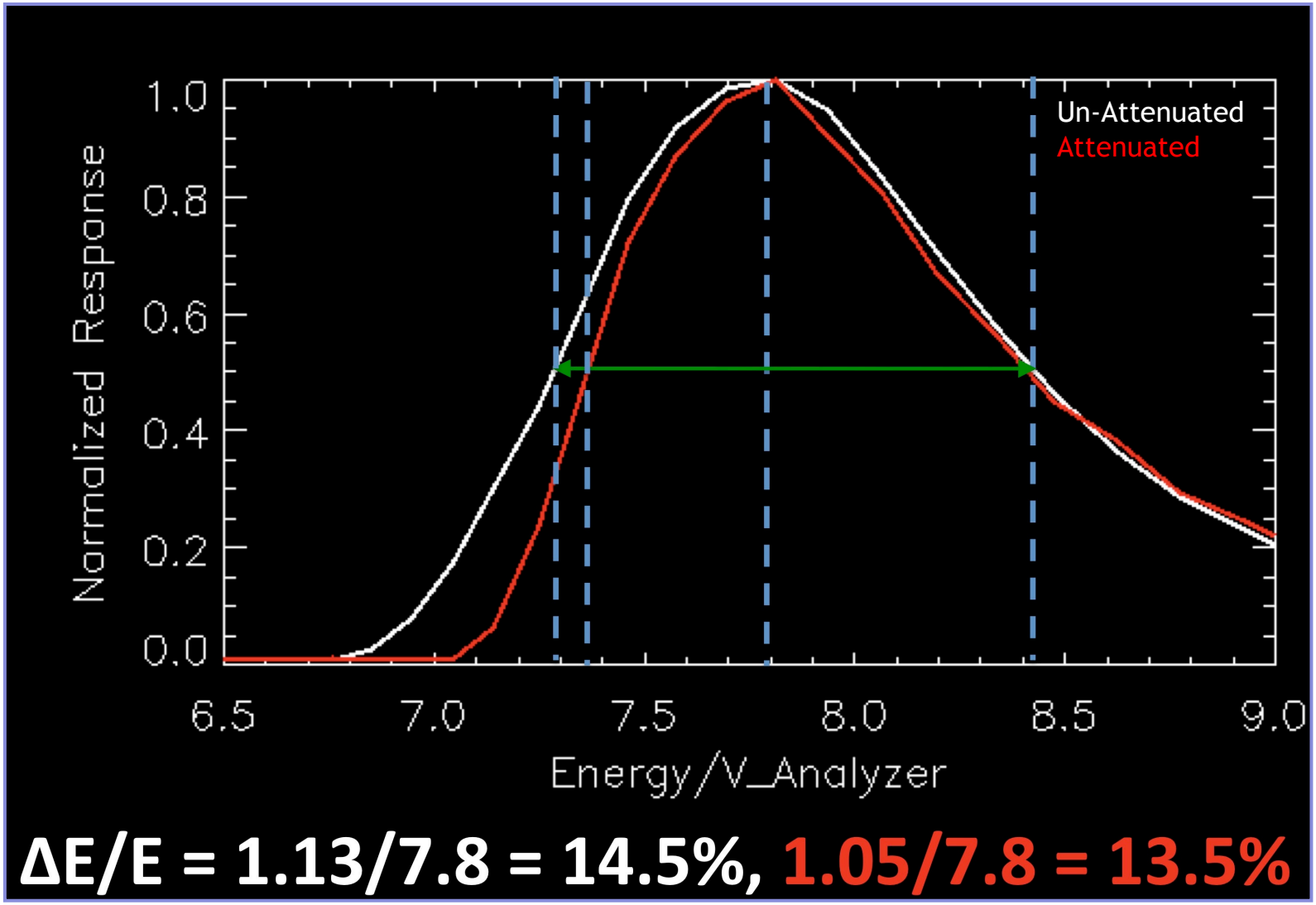
Double exit grids prevent field leakage and low-energy sensitivity change

Photons rejected by blackening (Ebanol-C) and scalloping inner surface of outer hemisphere and top cap

SWIA Calibration

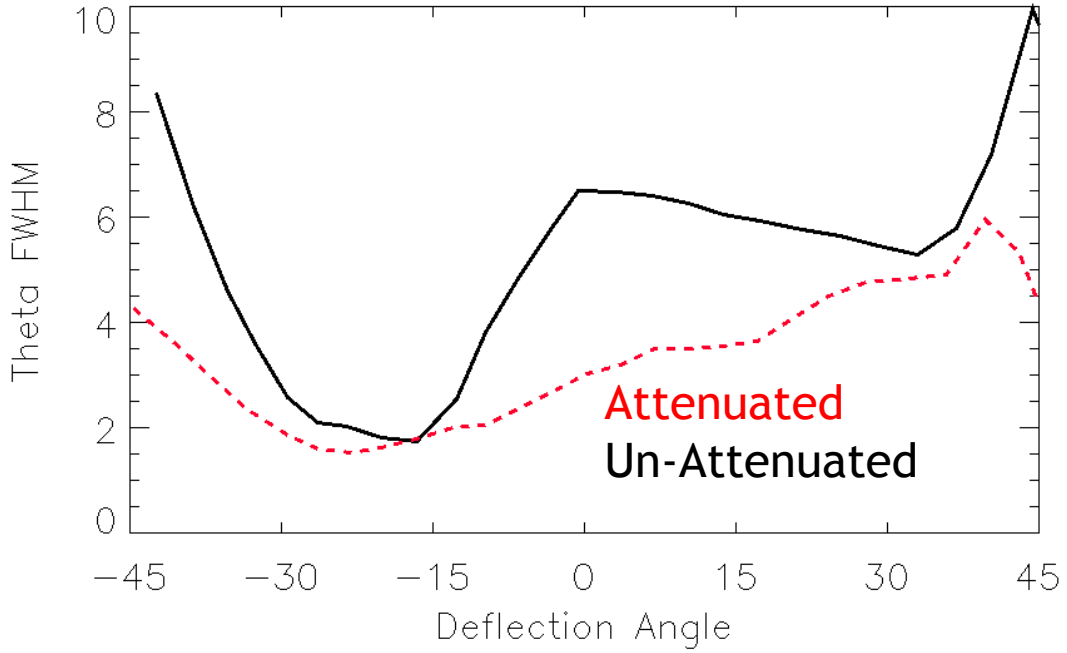


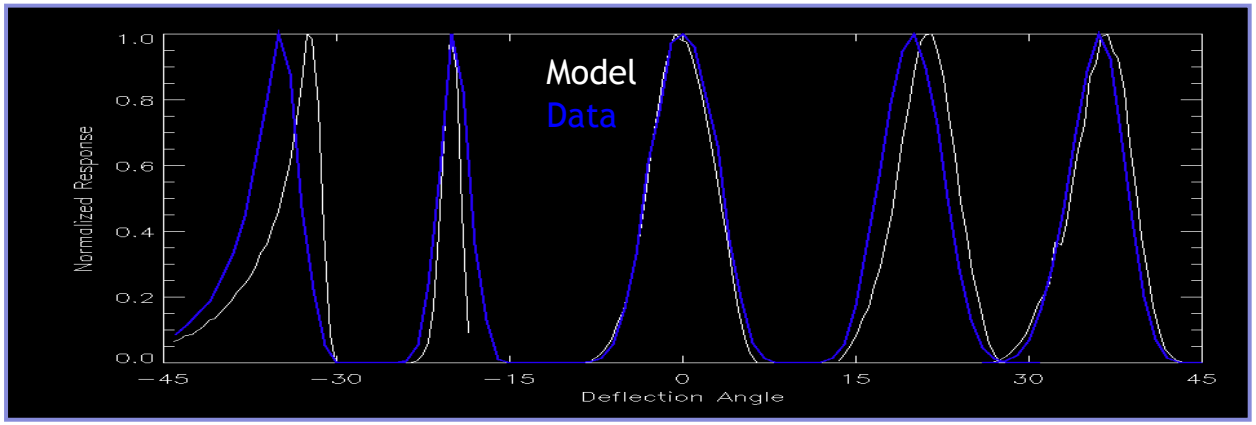
SWIA Energy Resolution

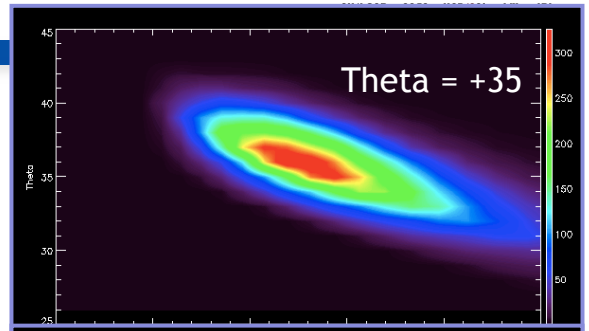


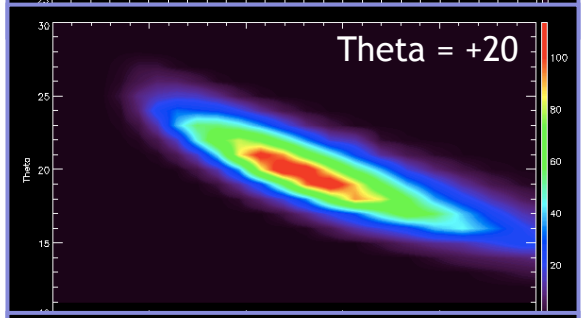
SWIA Theta Resolution/Coverage

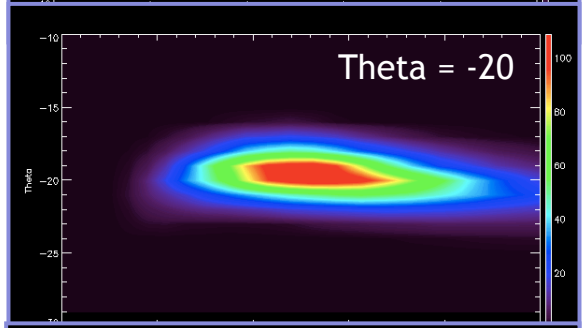
- Intrinsic theta resolution better than 10° for all deflections

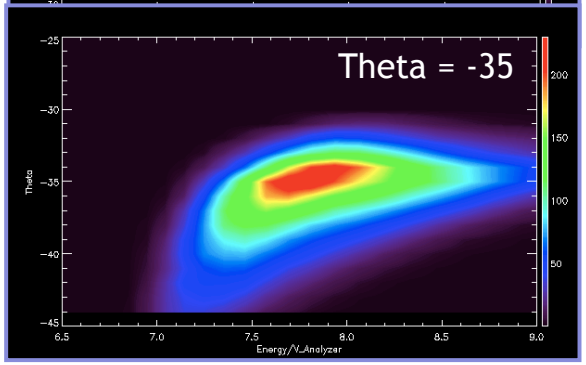








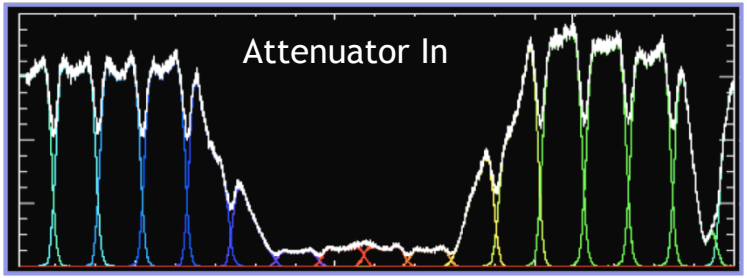


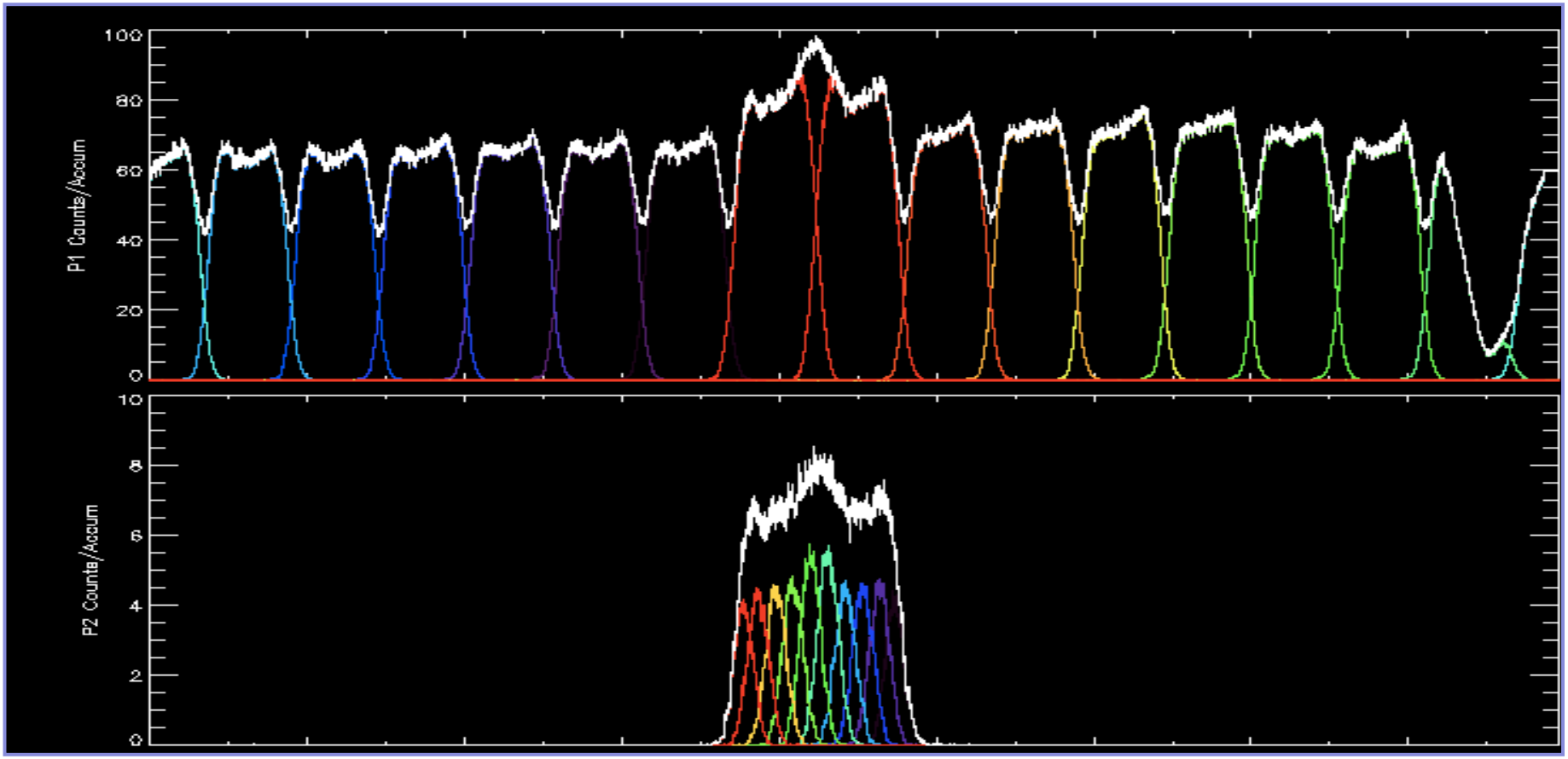


SWIA Phi Resolution/Coverage

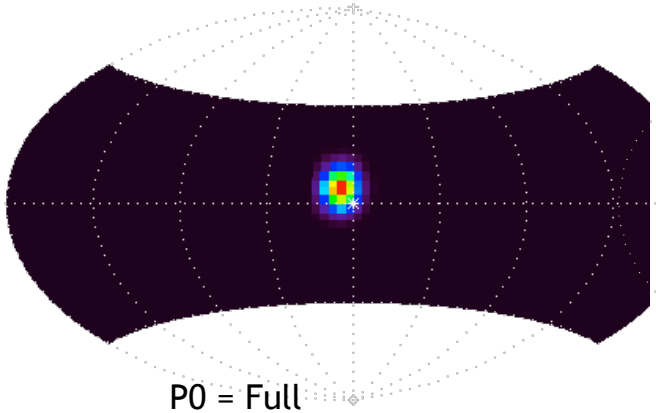
- Small dips in response due to ribs at exit of analyzer
  - No rib in in sun direction

- Fine anodes cover “Sweet Spot” in sun direction
- Attenuator allows measurement of intense fluxes without saturation





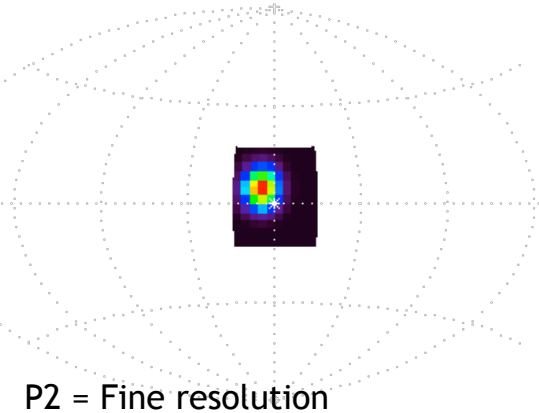
SWIA Basic Data Products



P0 = Full

Huge data volume

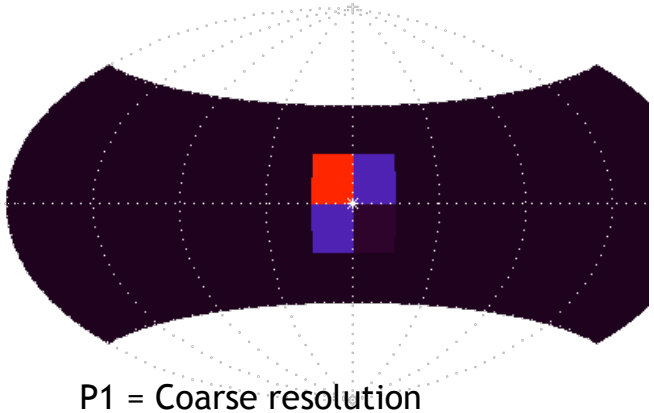
Mainly for calibration purposes



P2 = Fine resolution

48 energies X 10 phi X 12 theta
10% energy res,
4.5 degree angular res

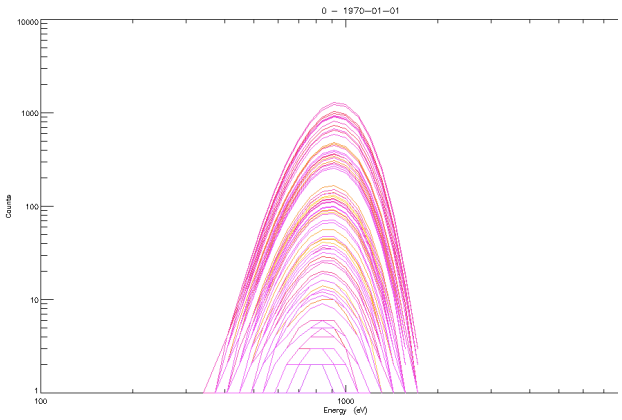
For solar wind measurements

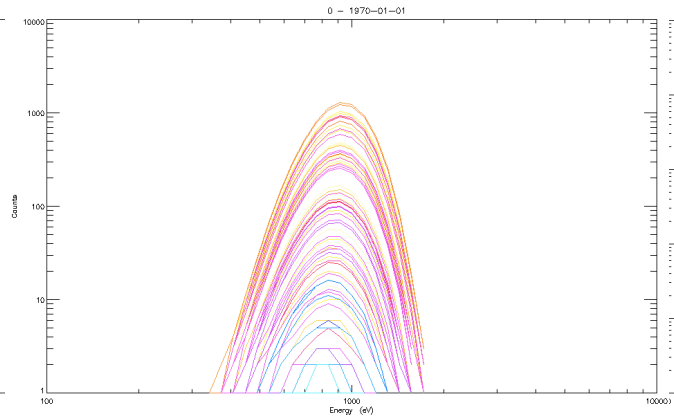


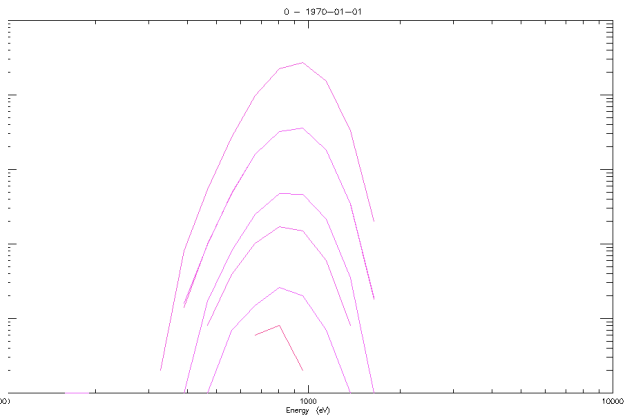
P1 = Coarse resolution

48 energies X 16 phi X 4 theta
20% energy res,
22.5 deg angular res

For magnetosheath/magnetosphere







SWIA Derived Data Products

- PFPDU packetizes P1 and P2 products, with configurable binning/sub-selection in both energy and angle
  - Can trade energy/angle resolution vs. time resolution
- PFDPU calculates partial moments (n,v,p,T,Q) onboard from either P1 or P2, depending on mode
  - Allows very high cadence measurement of basic plasma parameters
- PFDPU calculates average energy spectra onboard from P1
  - Very useful survey product

SWIA Telemetry

- PFDPU automatically switches SWIA telemetry mode based on how localized the distribution is in phase space

- **SW Mode**:
  - Fine 32E x 6φ x 8θ every 32 s [Covers Solar Wind Flows]
  - Coarse 24E x 16φ x 4θ every 128 s [Survey for Pickup Ions]
  - Energy Spectra every 8 s
  - P2 Moments every 4 s

- **Sheath Mode**:
  - Coarse 24E x 16ϕ x 4θ every 32 s for [Covers Sheath Flows]
  - Energy Spectra every 8 s
  - P1 Moments every 4 s

(*) Later in mission, better Earth-Mars geometries allow higher telemetry rates