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3D Visualization of MPDV Data

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Outline

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2. Major algorithm groups
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    2. In-line calculation of location, acceleration, displacement and uncertainty
    3. Grid interpolation
    4. Instantaneous surface modeling
    5. Instantaneous vector field modeling
3. Samples of 3D visualization
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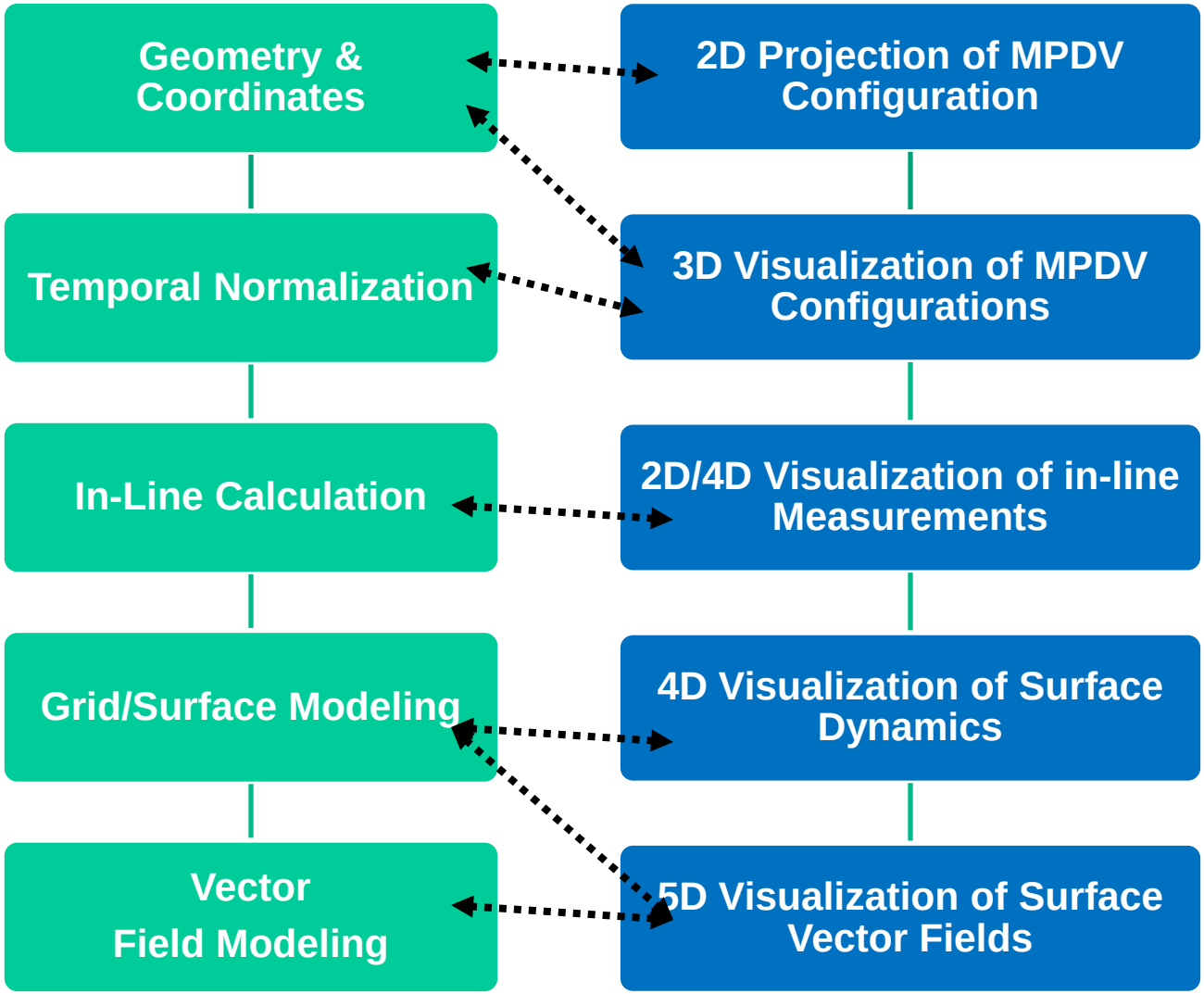
5. Summary

Objectives

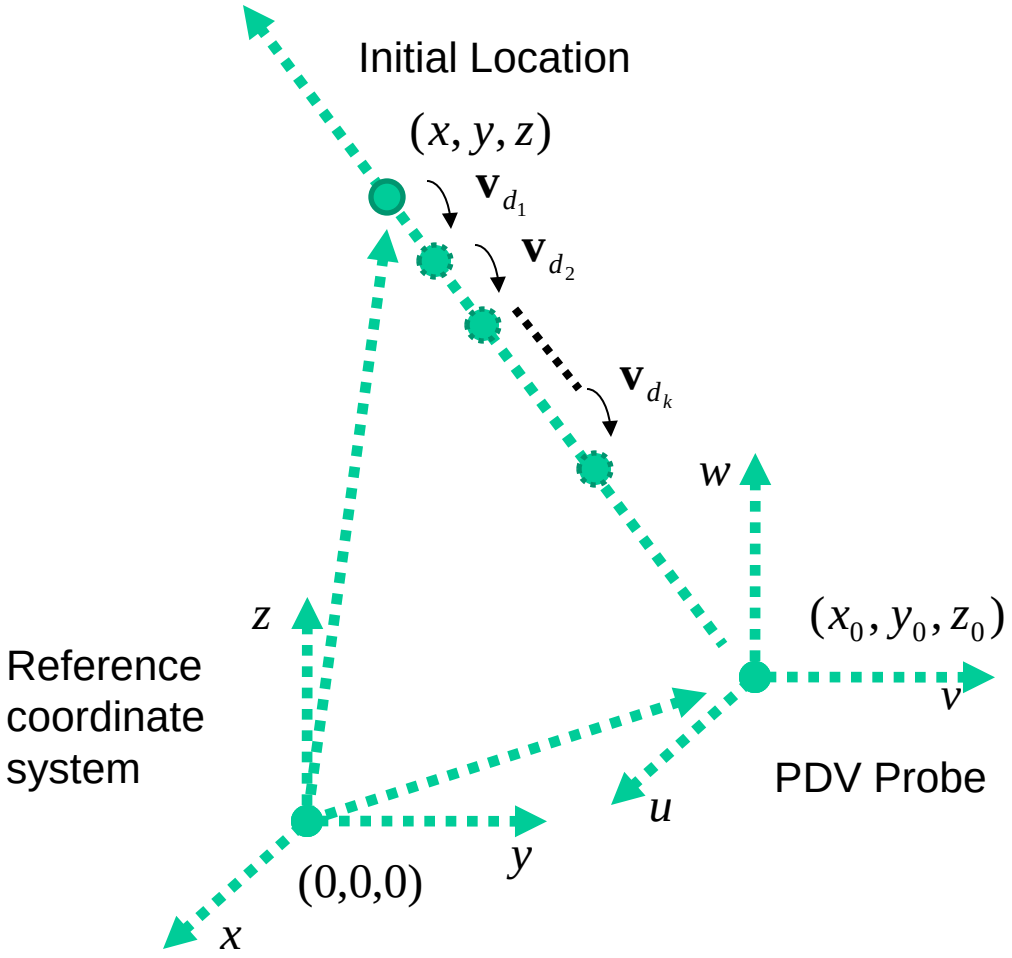
- When MPDV data of an object are acquired:
  - How to calculate and spatially interpolate other relevant quantities from the velocity data, such as accelerations, displacement?
  - How to calculate and visualize the coherent movement of the object (essentially displacement)?
  - How to calculate and visualize the dynamic fields of the velocity and its derived measurements, such as accelerations and uncertainties?

Major Algorithm Groups

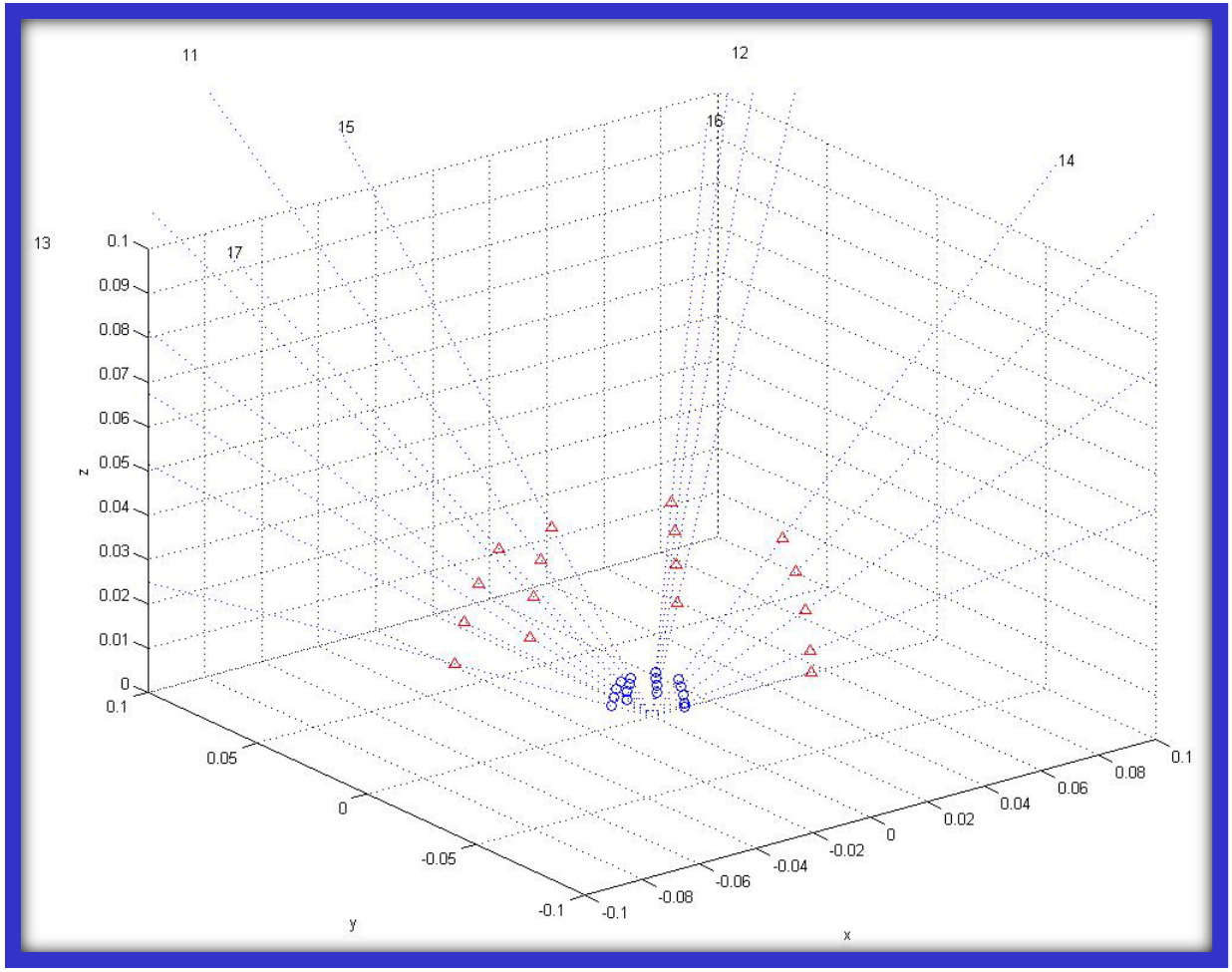


Single Probe PDV Time Series

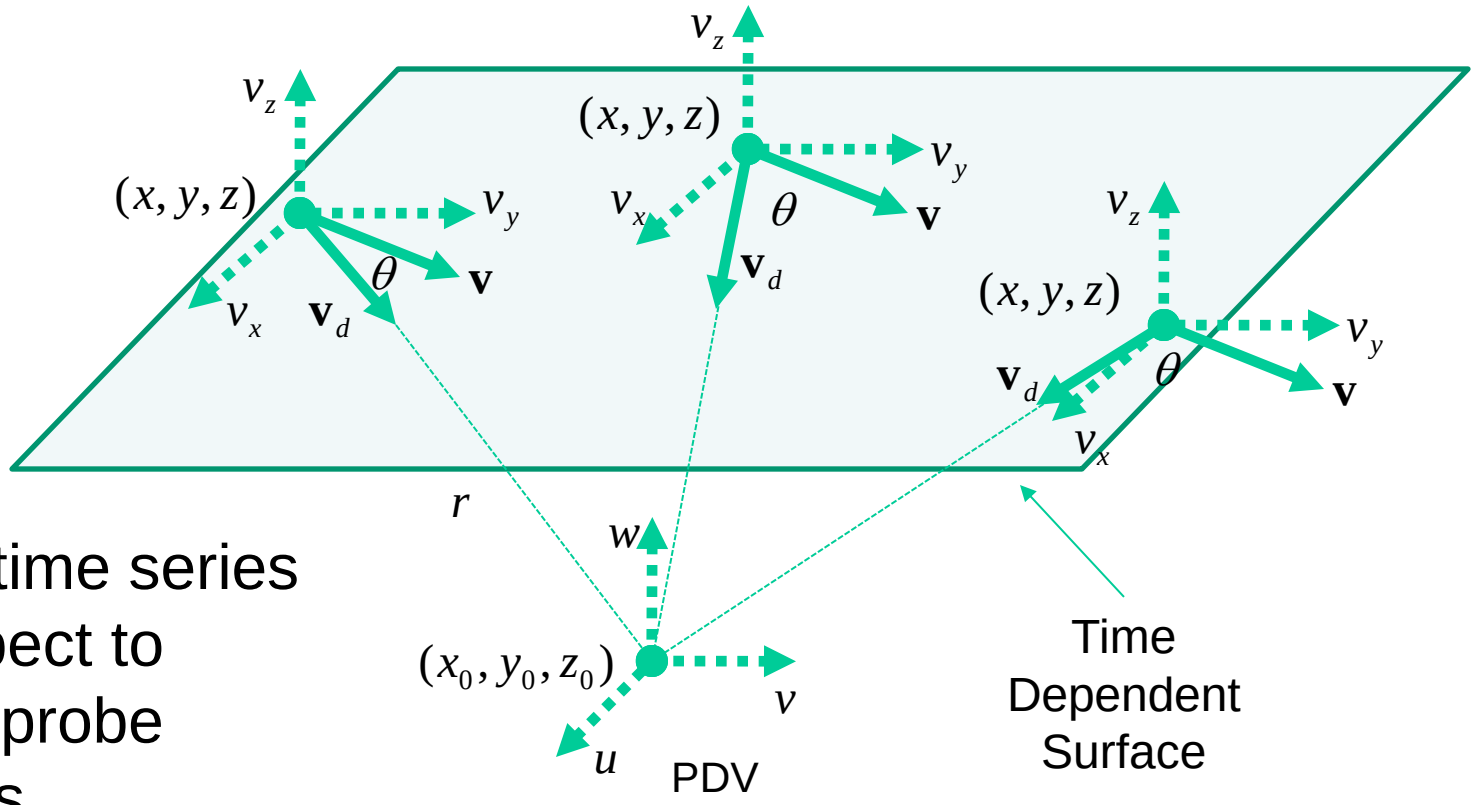
- In-line time series
- May have differences in beginning and ending times and sampling intervals.
- Many in-line quantities can be derived, such as acceleration, displacement, location ad uncertainty



Sample MPDV Line of Sight Plot



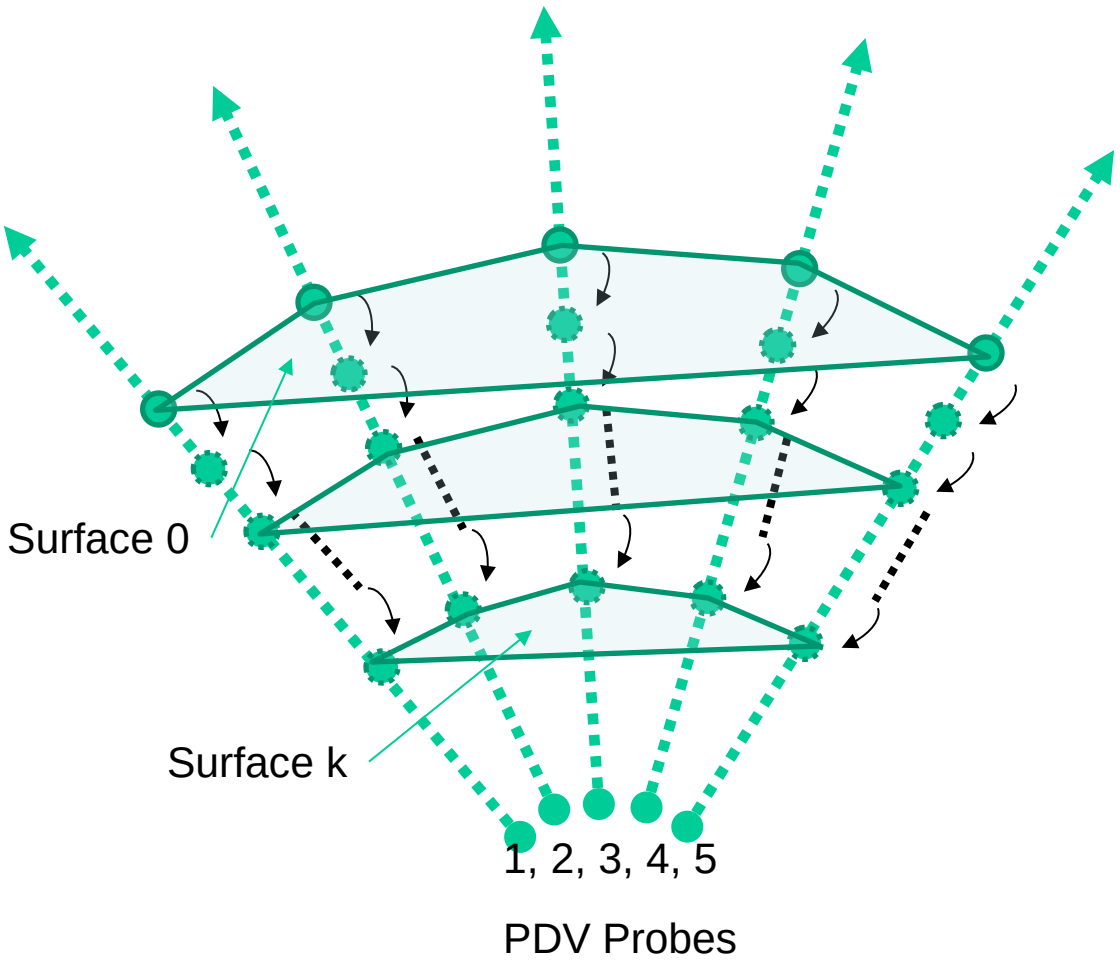
Multiple Probe PDV Data



Multiple time series with respect to different probe directions.

3D Visualization of MPDV Time Series

- Similar setup for the single time series from individual probes
- The MPDV time series need to be re-sampled in order to have the same time ticks
- Spatial interpolation is needed for visualizing surface movement

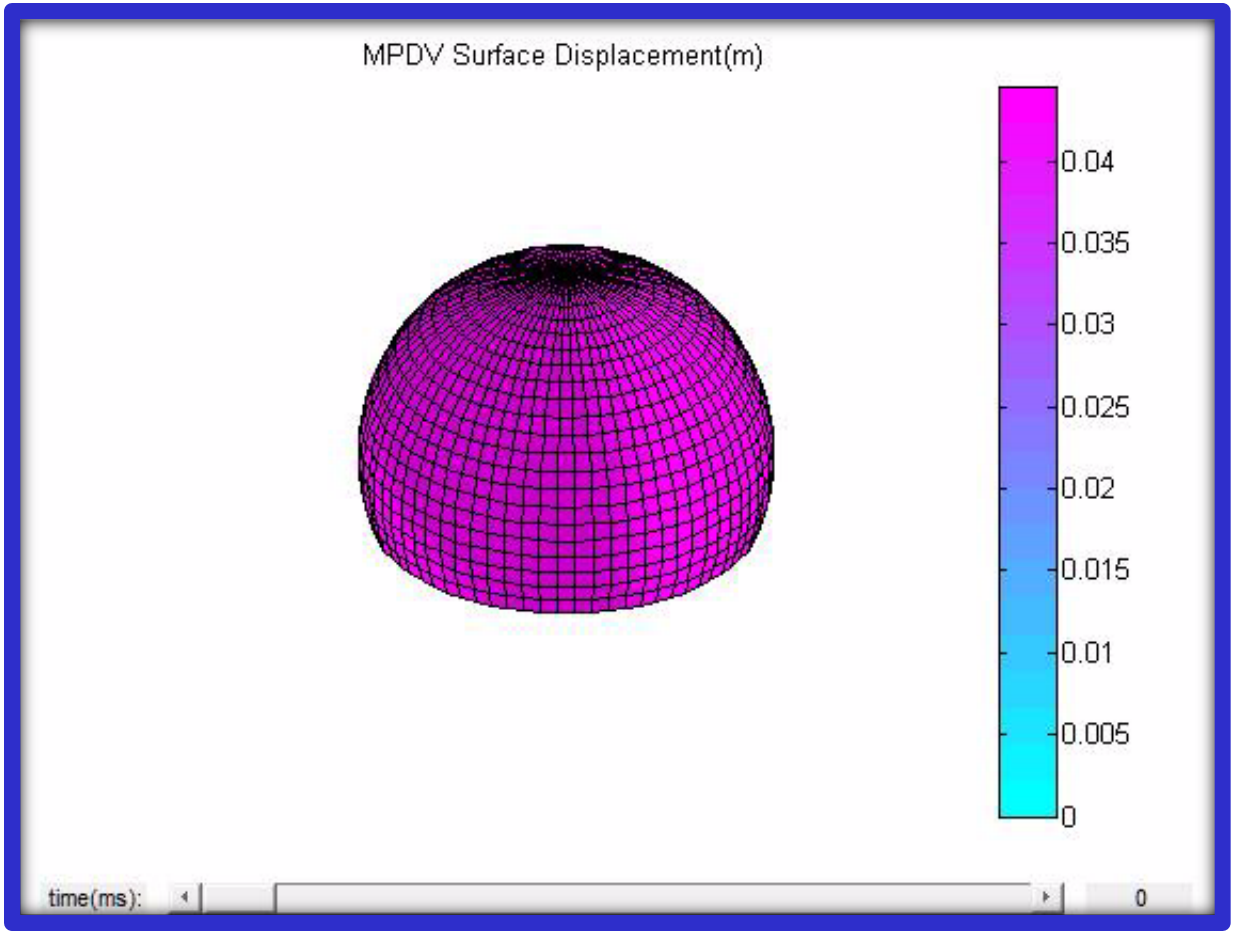


Key Steps for 3D Visualization

1) Resample and normalize the multiple PDV in-line velocity data series
2) Derive in-line surface location, displacement, acceleration, and uncertainty data
3) Construct instantaneous surface location (x, y, z) sampling data set with respect to a given time.
4) Interpolate a surface location function for the whole domain using the instantaneous surface sampling data
5) Plot the interpolated instantaneous surface location function obtained in Step 4.
6) Repeat Steps 3 to 5 for all sampling times in the normalized in-line surface location data (Dynamic View).
7) Other vector data can be overlaid on top of the instantaneous surface.

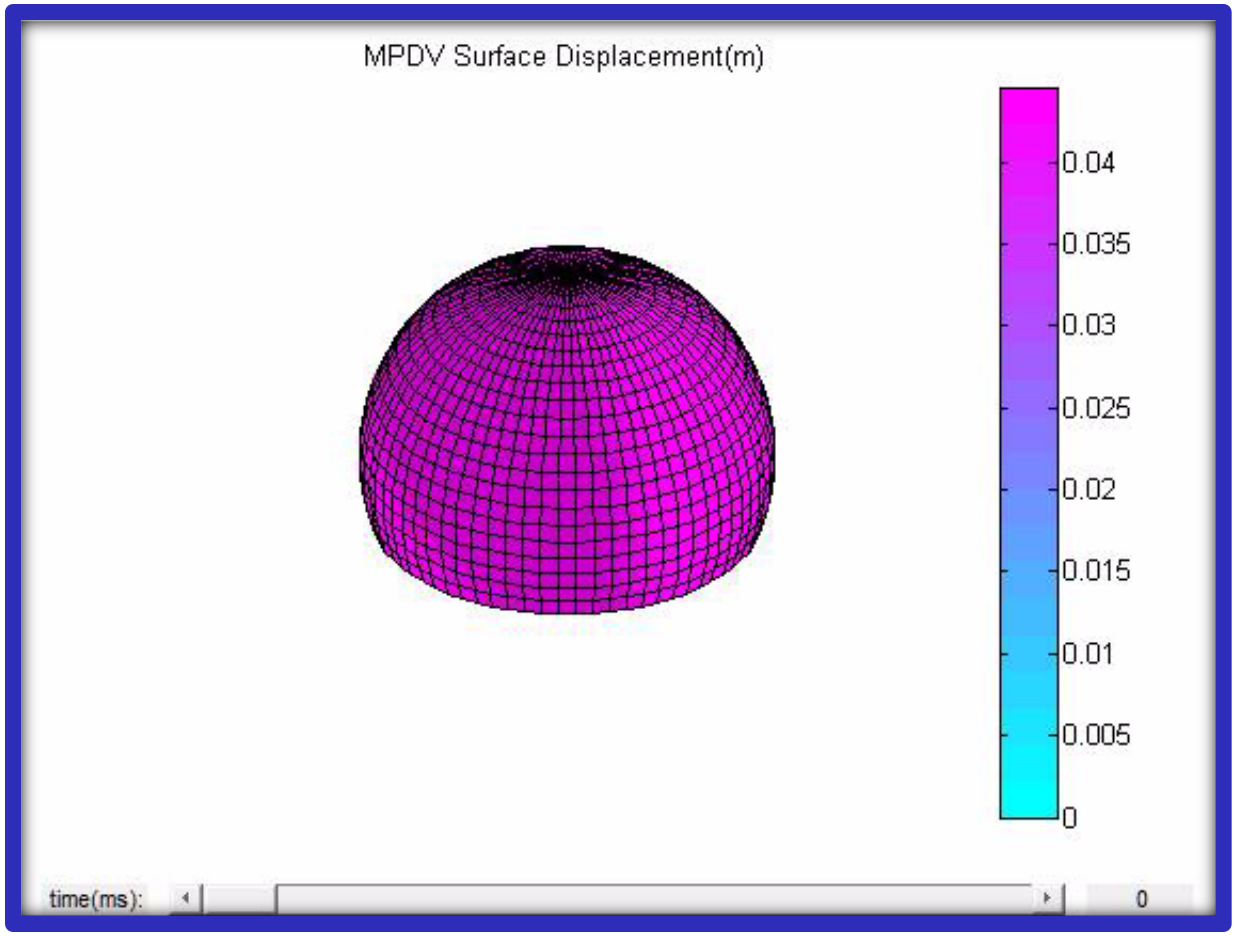
Surface Deformation– External View

- Surface deformation external view



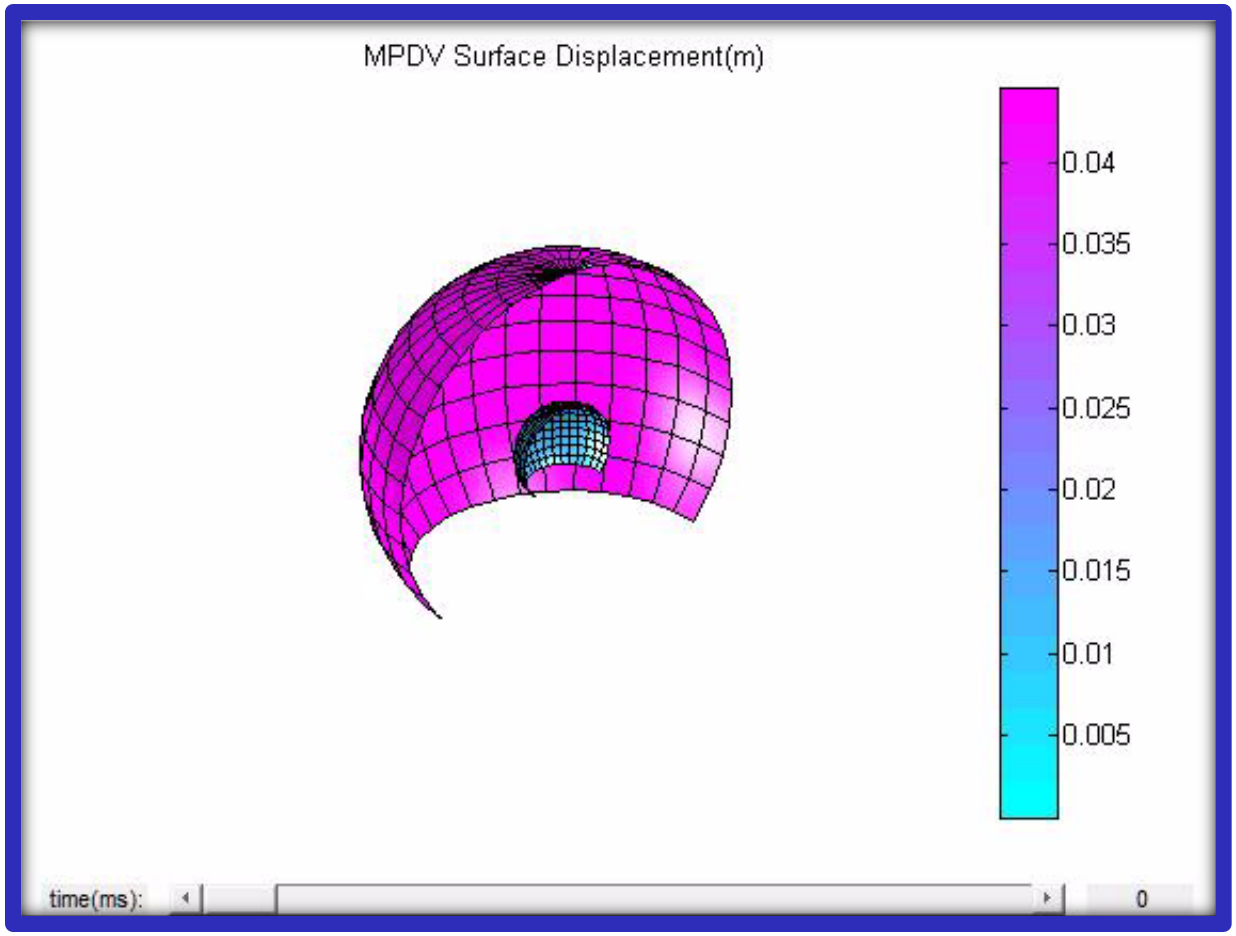
Surface Deformation– External View

- Surface deformation external view with PDV probe locations



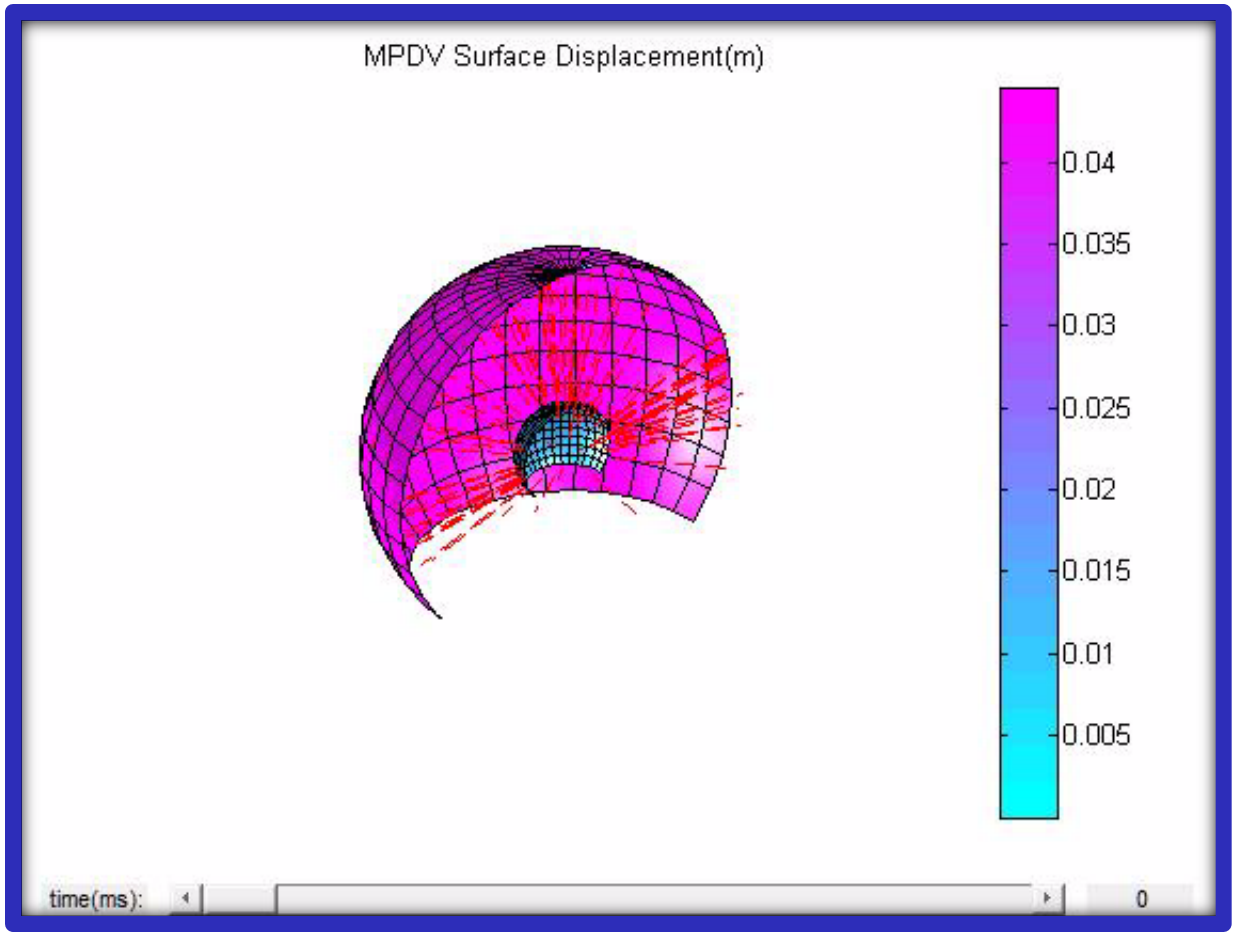
Surface Deformation- Cut View

- Surface deformation cut view



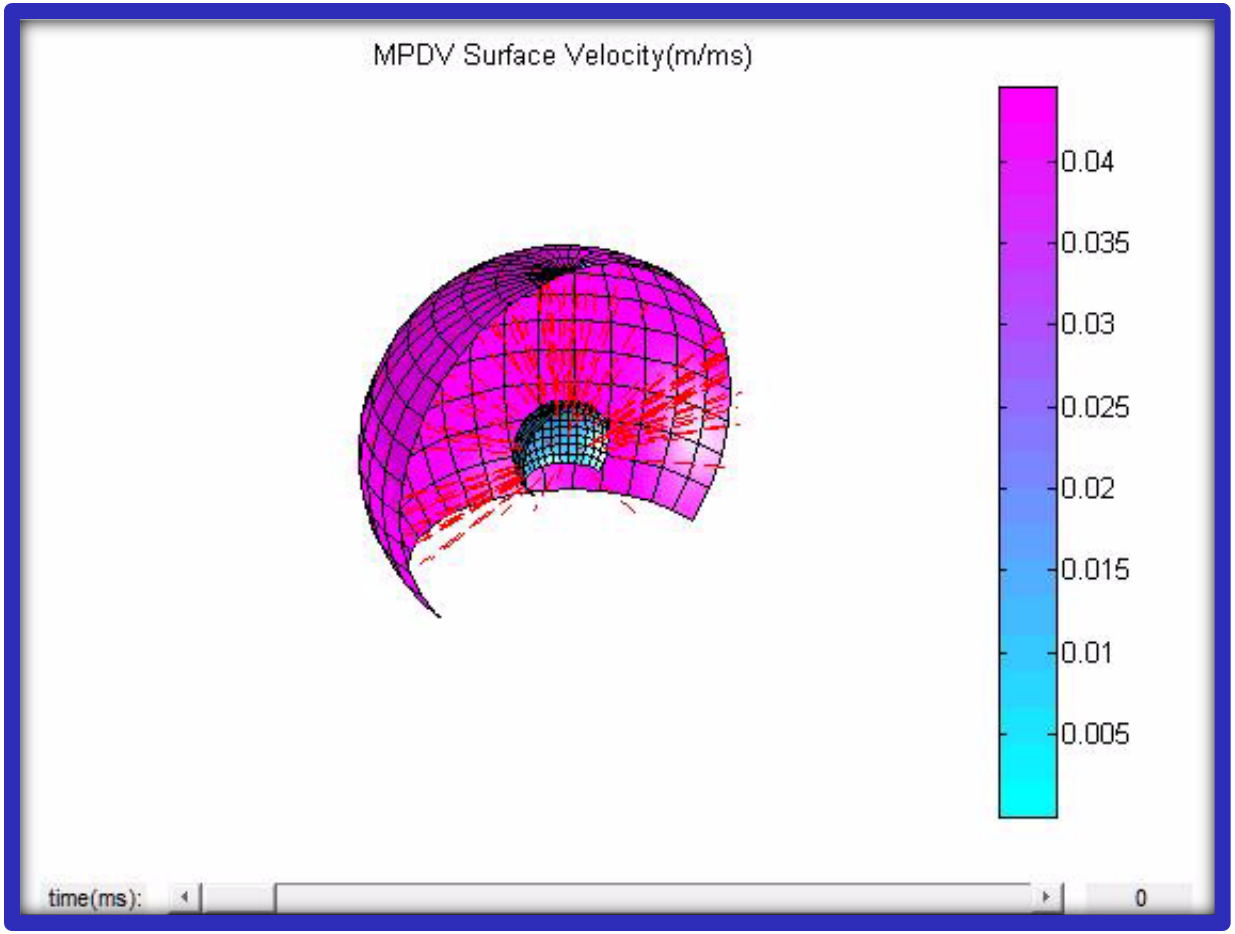
Surface Deformation- Cut View

- Surface deformation cut view with PDV probe locations



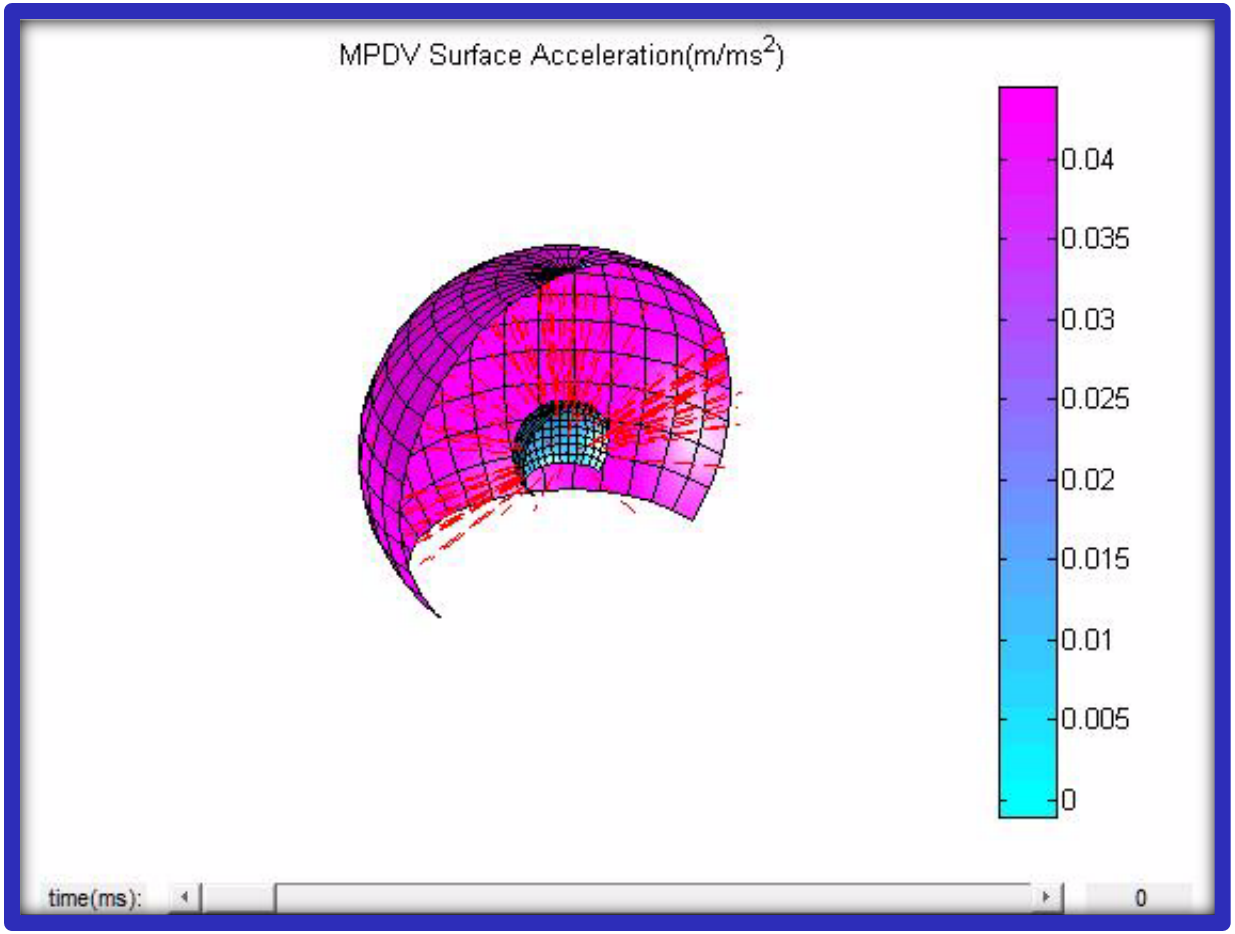
Surface Deformation-Velocity Field

- Surface deformation overlaid with velocity field and PDV probe locations



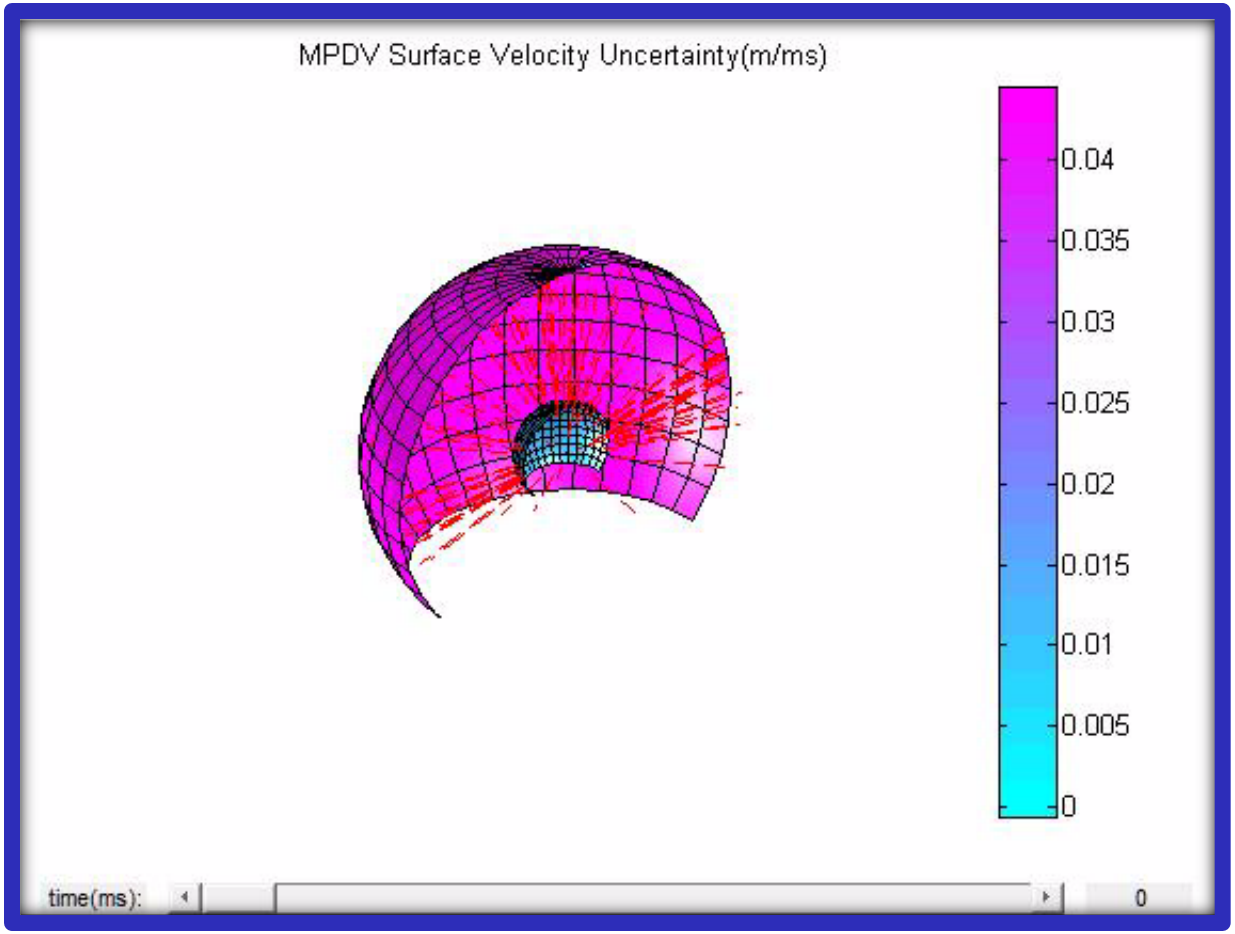
Surface Deformation- Acceleration Field

- Surface deformation overlaid with acceleration field and PDV probe locations



Surface Deformation- Uncertainty Field

- Surface deformation overlaid with uncertainty field and PDV probe locations



Summary

- We are now able to (with MPDV)
  - Derive and spatially interpolate velocity and other physical quantities of a deforming object
  - Visualize the dynamics of the deformation of the object
  - Visualize the velocity and other physical quantities defined on the deforming surface.
- Unresolved issues exist
  - PDV data calibrations
  - Uncertainty estimations
  - Grid calculation and interpolation
  - Physical measures, such as strain and stress
- Path forward
  - Refine and improve the algorithms
  - Expand physical quantity calculations
  - Explore PDV velocity calibrations