



***Solar Terrestrial Relations Observatory (STEREO)
Pre-Phase-A Requirements Review***



Orbit Determination

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Solar Terrestrial Relations Observatory (STEREO) Pre-Phase-A Requirements Review



Navigation Characteristics

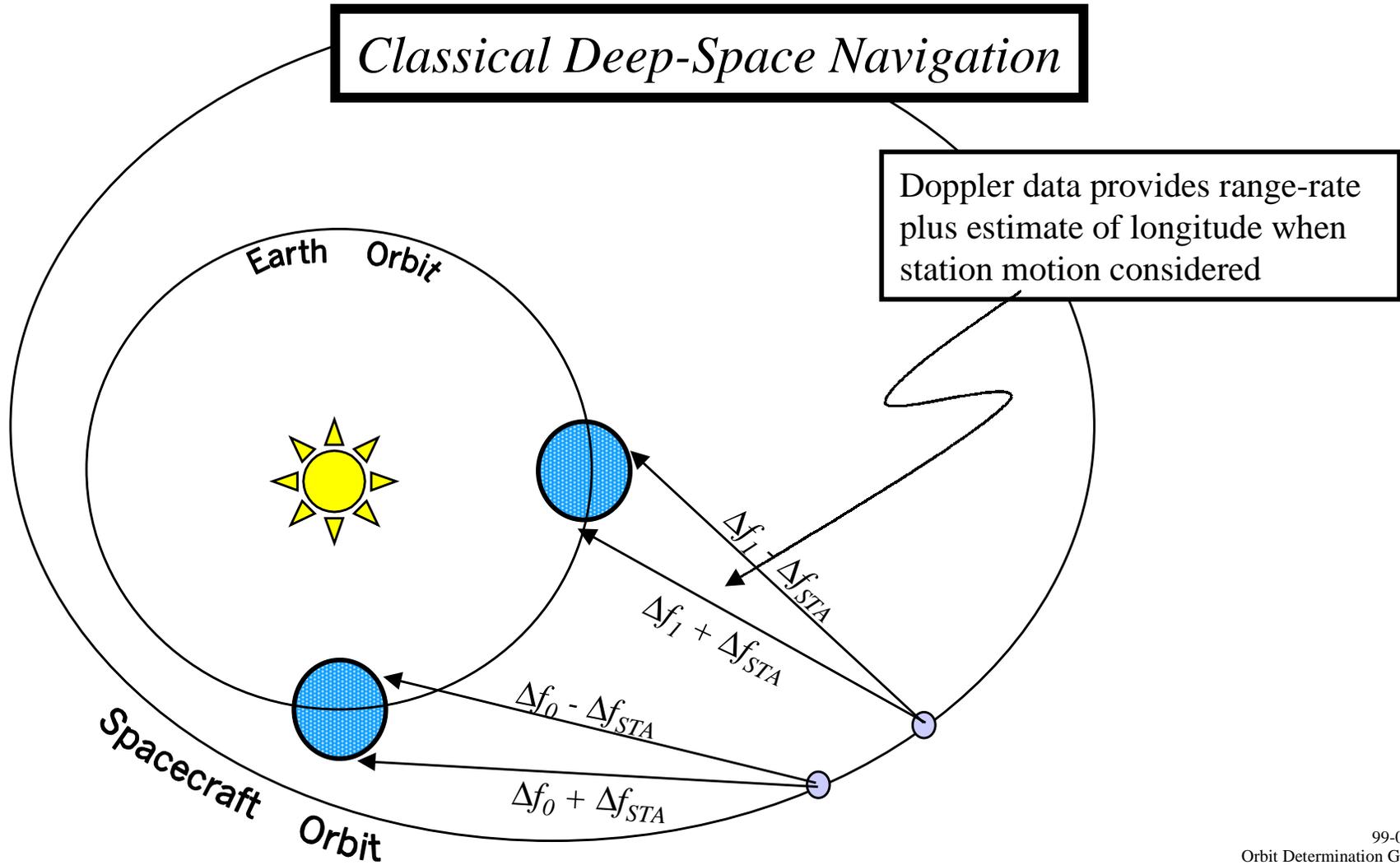
- Singular Doppler data provides range-rate (0-D solution)
- Station motion over one day provides 1-D solution (longitude)
- Add ranging to produce 2-D solution
- Add N/S stations or solar angles to get 3-D solutions
- Need change in Doppler data over time
 - STEREO in nearly identical Earth orbit
 - Fitting arcs very long (weeks or months)
 - Hi-fidelity radiation pressure model needed
 - Need dynamic cross-sectional area model
 - Need attitude information



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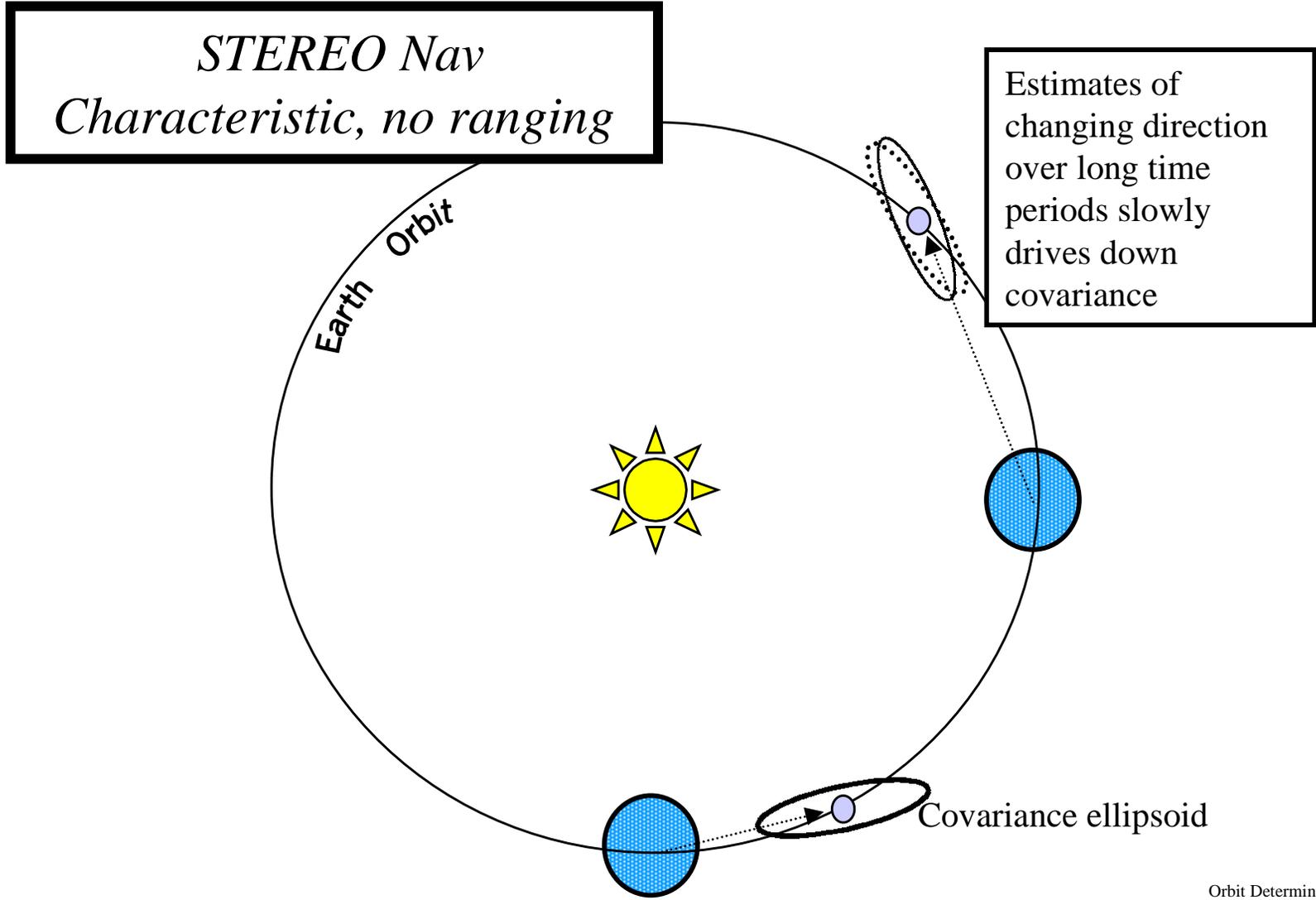


Classical Deep-Space Navigation



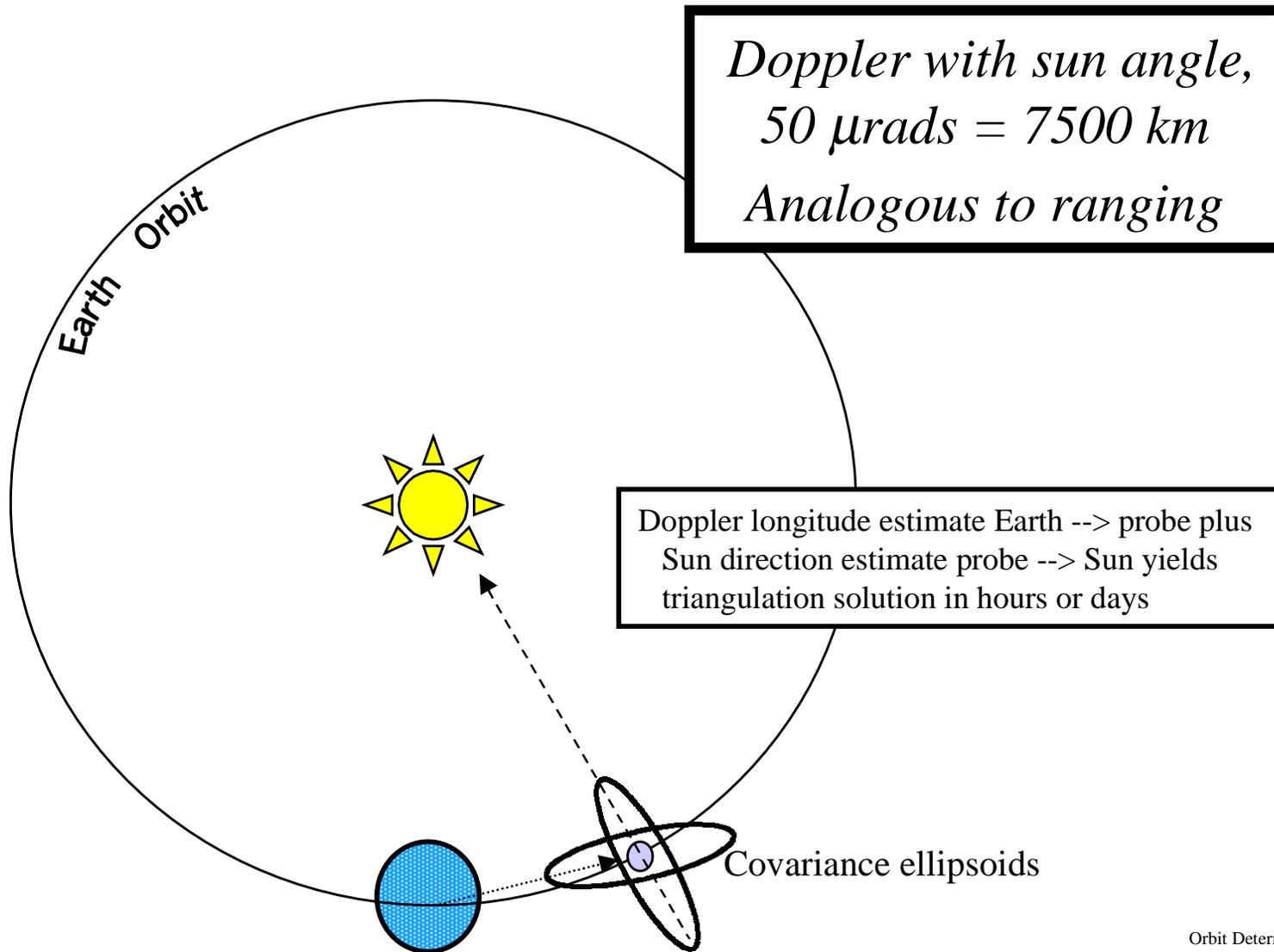


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Spacecraft Sun Angle Experimental Data

- Triangulation method determines Earth → probe range
- Convergence time drops from weeks/months to hours/day
- Minimizes need for hi-fidelity radiation pressure model
- Possibly good to 50 μ rads, would meet 7500 km requirement
- Inclusion in ground processing filter
- Needed for any onboard autonomous nav experiments



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Navigation Ground Software

- Acquire/[modify] existing systems
- Have narrowed candidates down to:
 - GTDS–Goddard Trajectory Determination System
 - OCEAN–Orbit Covariance Estimation and Analysis
- Currently determining capabilities of each
- TBD–ease of modifiability



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GTDS–Goddard Trajectory Determination System

- Old reliable, currently used on ~40 missions
- Vintage 1970's, batch, mainframe, Fortran, card punch format
- Installed and tested on JHU/APL Unix machines
- Source code, makefiles transmitted to JHU/APL, no known license problems
- Documentation delivered
- Ephemeris generator, orbit determination, test generation modules
- Hi-fidelity solar system and atmospheric models
- Determine modifiability



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OCEAN–Orbit/Covariance Estimation and Analysis

- Developed by Naval Research Lab (circa 1995, ongoing)
- Backup support for 12 operational LEO satellites (automated)
- Executable and documentation (no source) provided to support TIMED Guidance and Navigation System (GNS) validation
- Supported on DEC (VMS, Ultrix) and SGI (IRIX)
- Batch or filter based estimation (method is observation type dependent)
- Hi-fidelity solar system and atmospheric models
- Determine modifiability



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Conclusions

- Assume ‘one-way non-coherent’ Doppler
- Require Doppler data (range-rate) product
- Require RF ranging product (especially early in mission)
- Require solar angle (SCIP centroiding data) plus S/C attitude for alignment calculations and navigation option
- Require orbit determination software support
 - Baseline GTDS or OCEAN
 - Steep learning curve
 - Installation, testing, enhancements
 - Interface software development