New Astrometric Observations of Deimos with the SRC on Mars Express
Overview

- Deimos
- Mars Express Mission
- HRSC / SRC Camera
- Astrometric Observations
- Verification of Pointing
- Limb Measurements
- Results
Deimos

- Size and shape parameters (Source: WGCCRE2009):
  - Mean radius: $6.2 \pm 0.18$ km
  - Subplanetary equatorial radius: 7.8 km
  - Along orbit equatorial radius: 6.0 km
  - Polar radius: 5.1 km
  - RMS dev. From ellipsoid: 0.2 km

- Mean orbital elements referred to local Laplace plane (Source: MAR080):
  - Semi-major axis $a = 23458$ km
  - Eccentricity $e = 0.0002$
  - Argument of periapsis $\omega = 260.729^\circ$
  - Inclination $i = 1.788^\circ$
  - Longitude of ascending node $\Omega = 24.525^\circ$
  - Orbital period $P = 1.2624$ days
Mars Express

- ESA’s first mission to Mars
- Scientific payload: 7 instruments
  - HRSC, SRC
- Orbit insertion: 25 December 2003
- Highly elliptical orbit:
  - Periapsis: 258 km
  - Apoapsis: 11,560 km
- Polar orbit: Inclination 86.3°
- Orbital Period: 6 h 43 m
- Due to perturbation forces the orbit drifts slightly around Mars
HRSC/SRC Camera

- Framing camera
- To show details within HRSC scenes
- Optics
  - Maksutov-Cassegrain design
  - Focal length $f = 988.6$ mm
  - F-number $f/11$
- CCD detector
  - $1,024 \times 1,024$ CCD sensor
- Read-out-electronics

Credits: DLR

Credits: Oberst et al. 2008
Relative Astrometric Observations

- Given:
  - Spacecraft position
  - Spacecraft pointing
- Measured:
  - Deimos' center-of-figure
  - Background stars positions
- Desired:
  - Deimos' center-of-mass
- Assumption:
  - Deviations between COF and COM should be small.

Credits: cf. Kolyuka et al. 1990
Coverage of Deimos' orbit with SRC images
Verification of Pointing

- Given: Nominal pointing (CK kernels)
- Verification and improvement of pointing by measuring positions of background stars
- Pointing of camera
  - \( \omega \) rotation about x-axis
  - \( \phi \) rotation about y-axis
  - \( \kappa \) rotation about z-axis
- Required: Sample and line positions of at least two stars
- Generally: Measurement of the position of one background star
- Correct orientation of Deimos in the image => rotation about z-axis could be neglected
Comparison between the limbfit method based on an triaxial ellipsoid and a plate model
Limbfit workflow
Results and Outlook

Position of Deimos
- SRC image coordinates (sample, line)
- SRC camera coordinates \((X_C, Y_C, Z_C)\)
- S/C centered, inertial J2000, Equatorial coordinates

Position of MEX spacecraft
- Mars-centered, inertial J2000, Cartesian coordinates

Outlook
- Determine accuracies
- Comparison with existing orbit models

\[
\sigma = \sqrt{\sigma_a^2 + \sigma_b^2 + \left( \arctan \left( \frac{a}{r} \right) \right)^2}
\]

Credits: Oberst et al. 2006
References


Thank you for your attention.