



Leadership requires solutions

Services
Products
Experience



Our Services

services

Launcher Ascent

- Trajectory optimization
- Vehicle design optimization
- Multi-objective launcher family optimization
- Load case analysis for structural analysis
- Performance analysis and maps
- Launcher selection including kick-stage
- Launch window computation
- Guidance and navigation
- Control including flexible dynamics
- Injection accuracy analysis
- Launch risk and range safety assessment

Re-Entry

- Optimal re-entry trajectory and de-orbit manoeuvres
- Capsule and lifting body guidance
- Aero-assisted manoeuvres

Re-Entry Risk Assessment

- Destructive re-entry analysis including fragmentation, explosion, sheltering, melting and demise of fragments
- Casualty and fatality probability for on-ground population and aircraft passengers due to space debris
- Impact probability for ships and airplanes
- Maximum probable loss

Orbit Transfer

- Electric propulsion orbit raising
- Orbit transfer manoeuvres modelled as constrained optimal control problem
- Interplanetary and moon transfer with high and low thrust

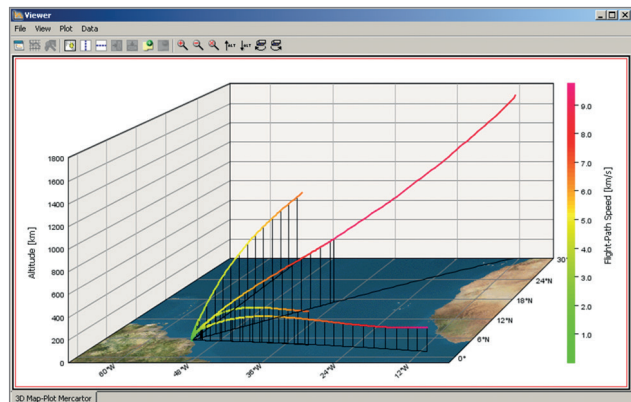
Orbital

- Optimal orbit manoeuvres for e.g. rendezvous and formation flying
- Multi-spacecraft mission analysis
- System concept analysis
- Communication analysis including inter-satellite link
- Navigation analysis, e.g. GPS signal during low-thrust transfer
- Multi-body simulation e.g. for robotic-arm, solar array or multi-payload deployment
- Coverage analysis and optimization

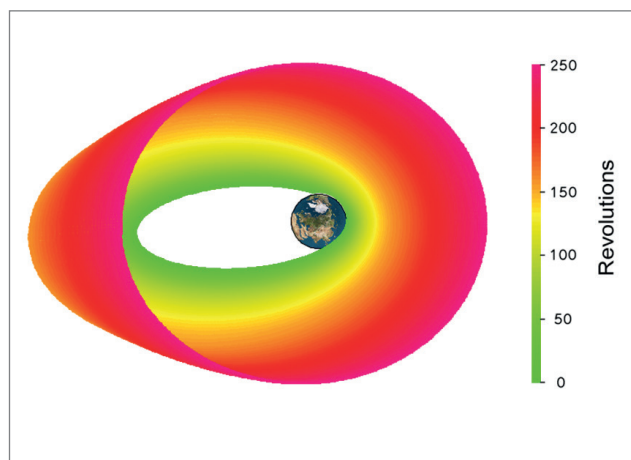
- Life time prediction
- Orbit determination
- Gravitational modelling of solar system bodies, e.g. irregular and binary asteroids
- Real-time emulation of raw camera and LIDAR data for rendezvous and landing
- Attitude and orbit control system design and analysis (AOCS)
- Pointing error breakdown and budgeting
- Magnetic field identification and cleanliness

Others

- Realistic animation of space missions
- Optimal trajectories of planes for observation of debris or laser communication links with satellites



Ascent trajectories of launcher family



Optimal low thrust transfer from GTO to GEO

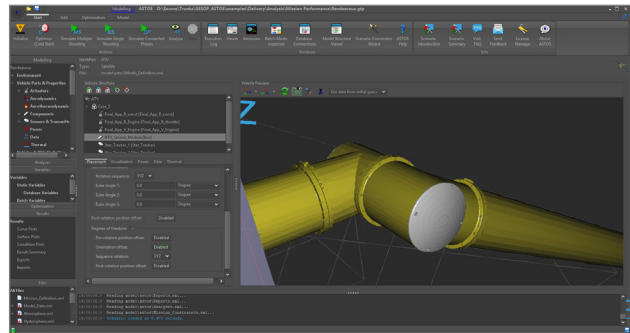
Our Products

products

We offer software products for design of space missions and software/hardware solutions for testing.

Multi-purpose design, analysis and verification software – ASTOS®

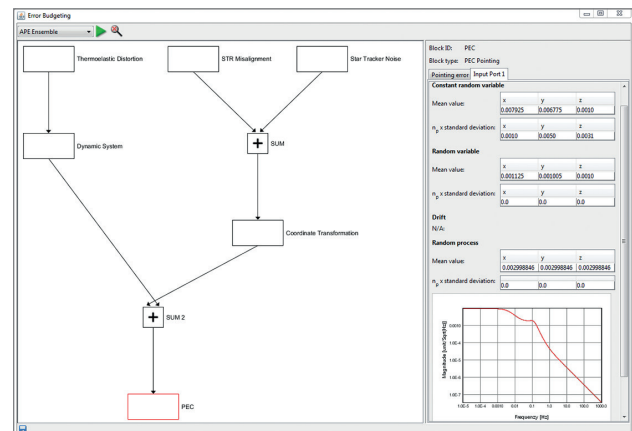
- Optimized multi-disciplinary vehicle design
- Mission feasibility & performance analysis
- Detailed mission analysis incl. life-time prediction
- Launch & re-entry risk assessment
- System concept analysis and verification
- Preliminary functional engineering simulation
- GNC design & validation
- Operations support



ASTOS 9 vehicle builder

Design & Analysis

- **LOTOS** – low thrust orbit transfer optimization
- **PEET** – pointing error engineering tool
- **GAMAG** – magneto-static field identification and compensation of spacecraft and its units
- **ODIN** – optimization of launch vehicle structures (licensed by MT Aerospace AG)
- **DCAP** – flexible multi-body simulation and contact dynamics analysis (licensed by Thales Alenia Space Italy S.p.A.)



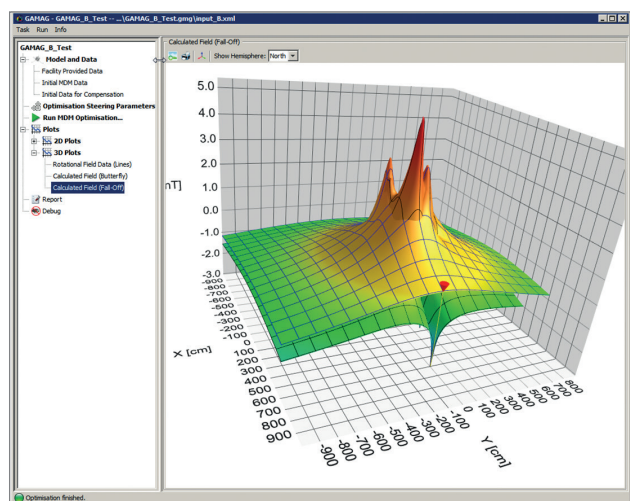
Pointing error budget with PEET

Control Optimisation

- **GESOP** – optimization software framework
- **SOS** – sparse optimization suite (licensed by AMA, Inc.)

Software and Hardware for Testing

- **Camera Simulator** – real-time emulation of raw camera and LIDAR data
- **Closed-Loop Simulation Testbench** – real-time environment and dynamics simulation for MIL/PIL/HIL
- **SCOE** – AOCs-SCOE based on ASTOS model library



Magnetic field identification with GAMAG

Our Experience

experience

Technology Development

The experience of Astos Solutions goes back to the late 80ties when the development of ASTOS was started under an ESA contract. In the past 15 years Astos Solutions has contributed to various technology development activities of ESA:

- Electric propulsion orbit raising and optimization tool
- Software for launch vehicle design optimization and trajectory optimization
- Launcher GNC simulation and sizing tool
- Optimal multi-payload deployment for Ariane 5 in sub-contract to Airbus DS (USACDF)
- Pointing error engineering tool PEET
- Station keeping with electric propulsion in GEO together with GMV
- Destructive re-entry of spacecraft in frame of ESA Space Situation Awareness program together with GMV
- Database for Near Earth Asteroids in frame of ESA Space Situation Awareness program together with Deimos
- Orbit propagator for asteroids
- Gravitational modelling of irregular solar system bodies
- Rapid assessment of design impact on debris generation
- European NLP solver WORHP
- Development of guidance algorithms for TAEM in subcontract to spin.works
- Support of ATV-JV re-entry for uncontrolled re-entry and post-processing of observation data
- Development of an AOCS-SCOPE for a German satellite
- Advanced modelling of launch vehicles in multibody software
- Destructive re-entry analysis and visual sensor simulation for the German Orbital Servicing mission in subcontract to Airbus DS and Kayser-Threde (DEOS Phase A/B)
- Optimal low thrust GTO-GEO transfer for orbital life extension studies such as coneXpress, CX, SMART-OLEV
- Selection of near Earth target asteroids and optimal low-thrust transfer in subcontract to Max-Planck Institute for Solar System Studies (ASTEX)
- Support of MAXUS-8 launch and computation of SHARK landing ellipse.
- Contribution to German orbital servicing mission DEOS
- Phase 0 study of nano launcher concept for DLR space administration
- Decay analysis for a drag sail deorbitation concept

Space Mission Studies

Astos Solutions has supported industry in a multitude of projects such as

- Mission and microwave link budget analysis of STE-QUEST, a cosmic vision study of ESA, in sub-contract to Airbus DS and TimeTech
- Launch vehicle design, performance and safety analysis in the frame of FLPP, NELS, VEGA, Hopper, Skylon, Heavy Lift Launch Vehicle, Shefex-II and other programmes in subcontract to Airbus DS, OHB System, MT Aerospace, Reaction Engines, ESA, DLR and others.

Research

In the frame of German and European research projects Astos Solutions has worked on

- Advanced transcription methods extending CAMTOS, BMWi
- Space robotics simulator, BMWi
- Future high-altitude high-speed transportation, FAST20XX, FP7
- High power electric propulsion: a roadmap for the future, HiPER, FP7
- Sensitivity Analysis for Deterministic Controller Design, SADC0, FP7

Our Company

company

Astos Solutions GmbH is an SME located in Stuttgart, Germany. Approximately 20 employees are working on software and hardware solutions for design and analysis of space missions and spacecraft. Astos Solutions performs engineering services, industrial research, distributes software products and supports education. The roots of Astos Solutions reach back to 1991 as a research team at the University of Stuttgart and later as a spin-off.