Small Innovative Launcher for Europe: Achievement of the H2020 project SMILE

Markus Kuhn, German Aerospace Center (DLR e.V.)
SMILE Project

- EU Horizon 2020 framework programme
- 14 partners from 8 European countries; coord. by NLR
- 4 M€ grant
- Jan 2016 – Dec 2018
- Activities:
  1. Business development
  2. Launcher & ground segment design
  3. Demonstration of critical technologies
Business Development

- Market assessment of satellites up to 500 kg from Euroconsult July 2017
  - Mega-constellations (OneWeb, SpaceX) distort picture
  - Small satellites (1-50 kg) are a multi-billion dollar market
  - Mainly in US
- Launch service
  - Both CubeSats and micro-satellites -> flexible deployer
  - Reliable launch rate -> efficient, parallelised organisation
  - Logistics -> easy transport of payload and stages
  - Price -> cost-effective launcher and launch site
Launcher Design

- Two concept configurations
  - 80 kg into 500 km SSO
  - Three-stage hybrid: high TRL, time-to-market
  - Three-stage liquid: more payload, recovery option

- Design drivers
  - Unitary stage diameter (production, manufacturing)
  - Length of hybrid stages driven by unitary motor (technology)
  - Length of stages limited by container length (logistics)
  - Pump-fed versus pressure-fed (costs vs. mass)
  - Maximum acceleration (‘smooth ride’)
  - Identical separation mechanisms (commonality)
  - Intelligence in upper stage (simplicity)
  - Margins for losses and uncertainties (realism)

Hybrid:
- 70 kg @ 600 km
- 80 kg @ 500 km

Liquid:
- 115 kg @ 600 km
- 130 kg @ 500 km

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 687242.
Critical Technologies

- **Propulsion**
  - Hybrid (Nammo)
    - $\text{H}_2\text{O}_2$ (87.5%) and HTPB
    - Low development and operational cost
  - Liquid (DLR, PLD Space)
    - LOX and kerosene (Jet A-1)
    - Ceramics & transpiration: reusability
    - First stage: aerospike
- **Avionics (NLR, TERMA)**
- **Automated Manufacturing (3D Systems, Airborne, NLR)**

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 687242.
Next Steps

• **Re-iterated Detailed Design:**
  • Aerodynamics (CFD analyses, also plume interaction)
  • Propulsion (liquid vs. hybrid engines)
  • Structures (CAD models)

• **Testing:** Liquid engine firing campaigns, Wind tunnel test campaign

• **Prototyping:**
  • Structures prototype
  • Payload deployer M3S prototype
  • Avionics experiment launch, hardware-in-the-loop demonstration

• **Business development plan:**
  • Technology roadmap

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 687242.
End With A

... thank you for your attention!

www.small-launcher.eu

Markus Kuhn, E: markus.kuhn@dlr.de, T: +49 (711) 6862 8408