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High Performance Space Structure Systems GmbH

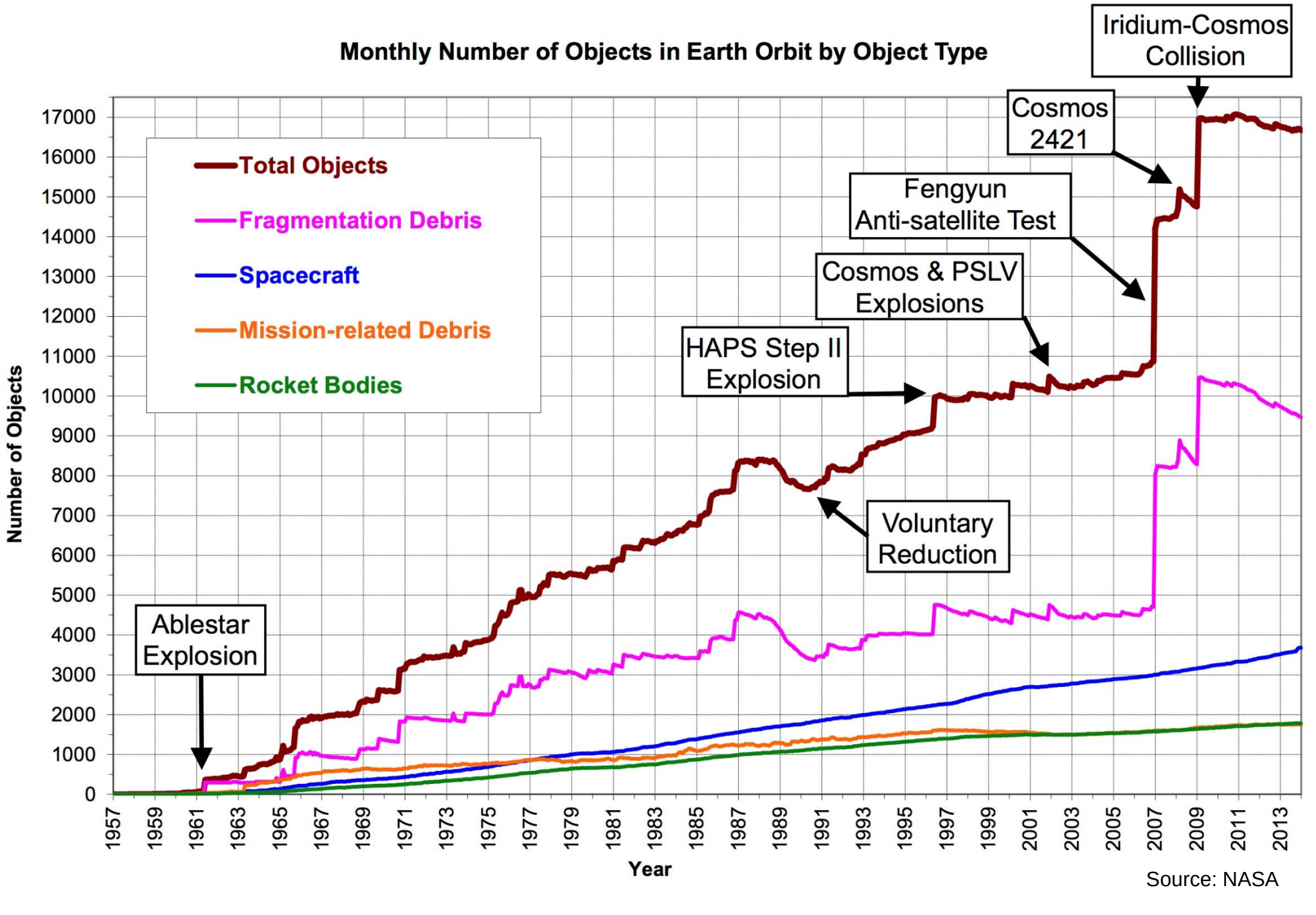
Deployables Cubed
„thinking outside the box“

The NABEO Dragsail: In Orbit-Demonstration Flight onboard Rocket Lab’s Electron Rocket #ItsBusinessTime

Dr. Thomas Sinn, Hugo Garcia-Hemme

2019 CubeSat Developers Workshop

San Luis Obispo, CA, USA| 23rd – 25th of April 2019


Monthly Number of Objects in Earth Orbit by Object Type
Iridium-Cosmos Collision
Cosmos 2421
Fengyun Anti-satellite Test
Cosmos & PSLV Explosions
HAPS Step II Explosion
Voluntary Reduction
Ablestar Explosion
Total Objects
Fragmentation Debris
Spacecraft
Mission-related Debris
Rocket Bodies
Number of Objects
Year
Source: NASA

ESA GSTP Activity ADEO (HPS prime)

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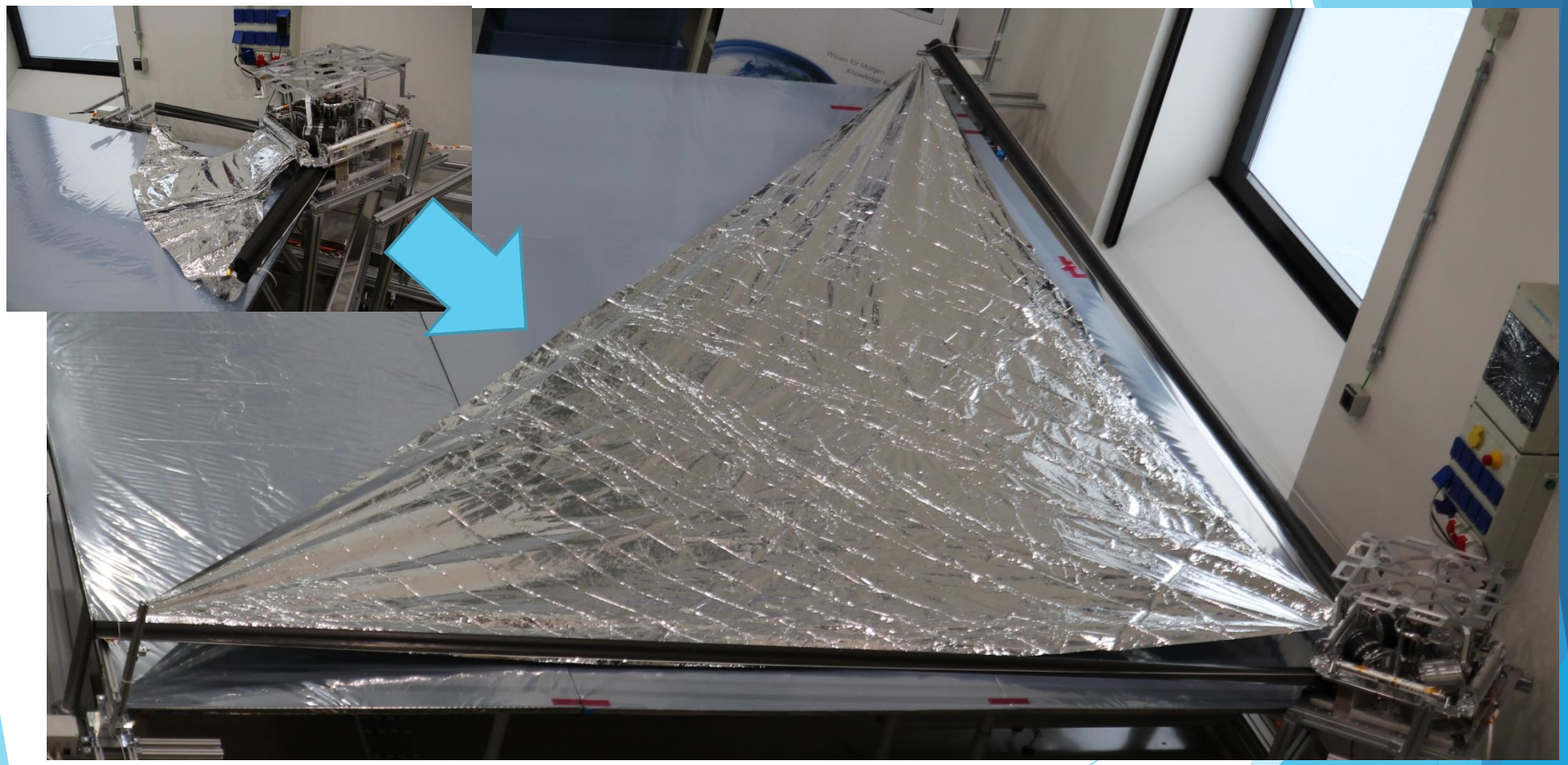

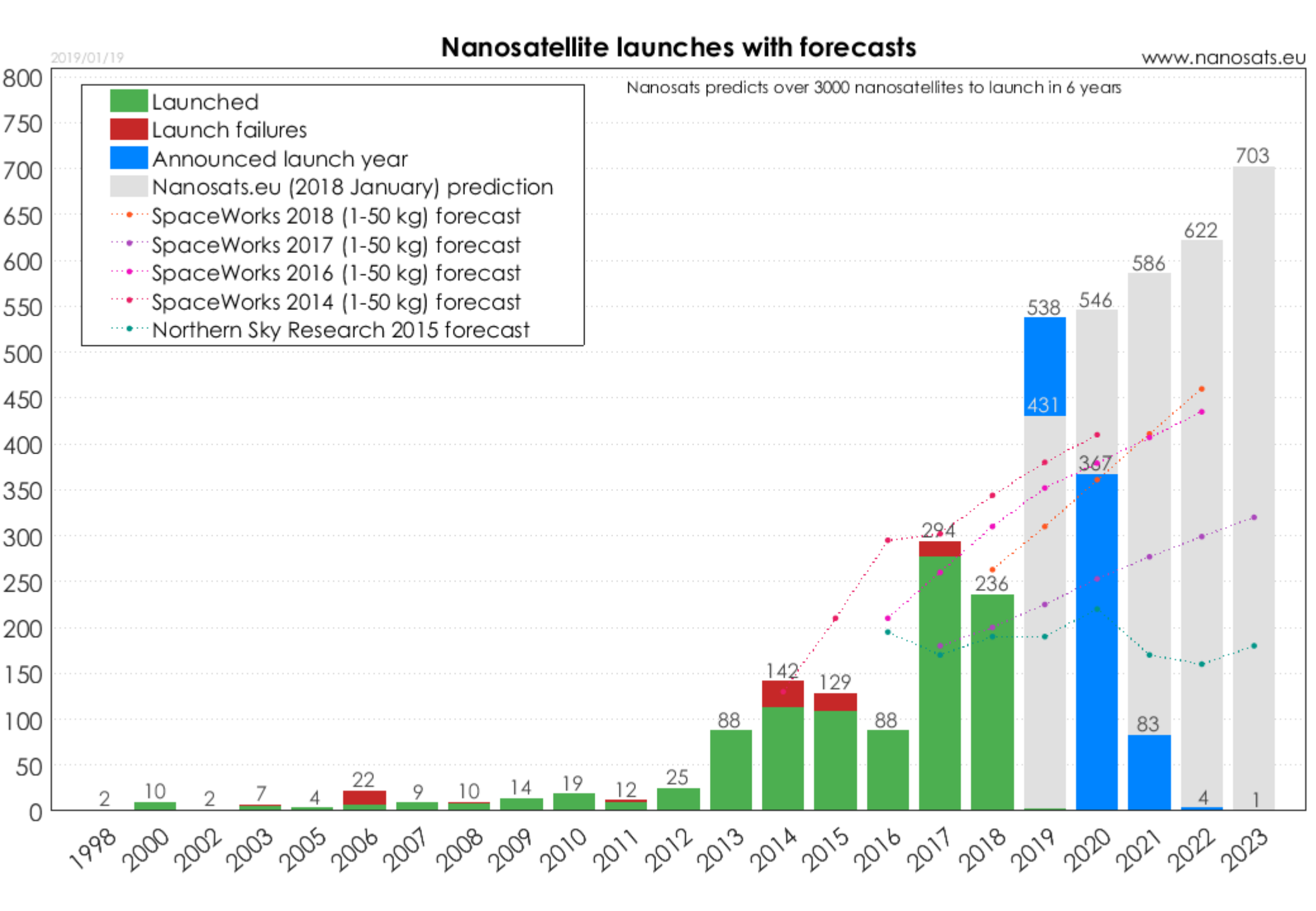
Nanosatellite launches with forecasts
2019/01/19
www.nanosats.eu
Nanosats predicts over 3000 nanosatellites to launch in 6 years
Launched
Launch failures
Announced launch year
Nanosats.eu (2018 January) prediction
SpaceWorks 2018 (1-50 kg) forecast
SpaceWorks 2017 (1-50 kg) forecast
SpaceWorks 2016 (1-50 kg) forecast
SpaceWorks 2014 (1-50 kg) forecast
Northern Sky Research 2015 forecast
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Fraunhofer EMI

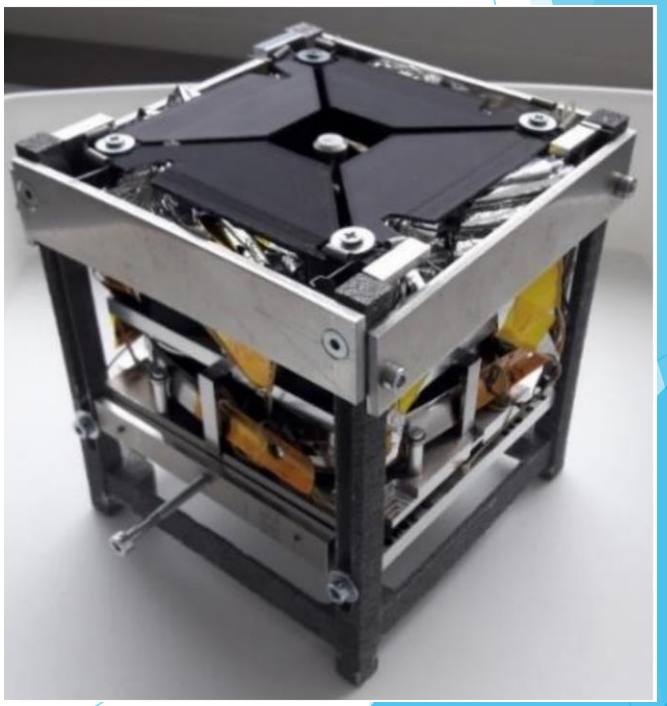
DLR

Technische Universität München

Cubesat Dragsail Development

- **Dragsail = passive solution:**
  - **using rest-atmosphere to decelerate**
  - **augmentation of drag-area by a deployed sail.**

- EDOS Development started in March 2017
  - Development partners:
    - HPS GmbH (DE)
    - Fraunhofer EMI (DE)
    - TUM (Technical University Munich) (DE)
    - DLR Bremen (DE)
  - Parameters:
    - Stored size <1U
    - Telescopic deployment (necessary for >3U nanosats)
    - Sail area as big as possible



The NABEO (ADEO-N) Project

Stakeholders:

- Dragsail development at HPS GmbH co-funded by Bavarian Ministry of Economics (DE)
- Hosted P/L program (by Ecliptic Enterprises)
- Launch Provider: Rocket Lab (USA/NZ)

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Bayerisches Staatsministerium für Wirtschaft und Medien, Energie und Technologie

ECLIPTIC

Programmatics:

- Offer for an IOV by Ecliptic/RocketLab: February 2018
- 1st launch attempt: 23rd of June 2018
- 2nd launch attempt: 27th of June 2018
- Launch on 11.11.2018

ROCKET·LAB

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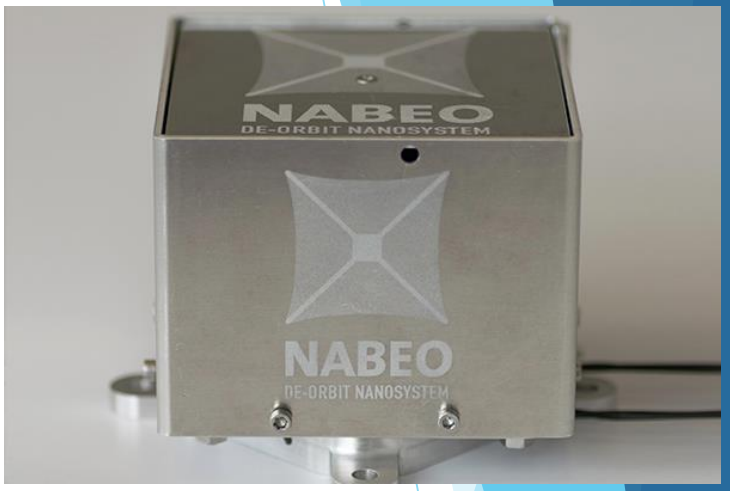
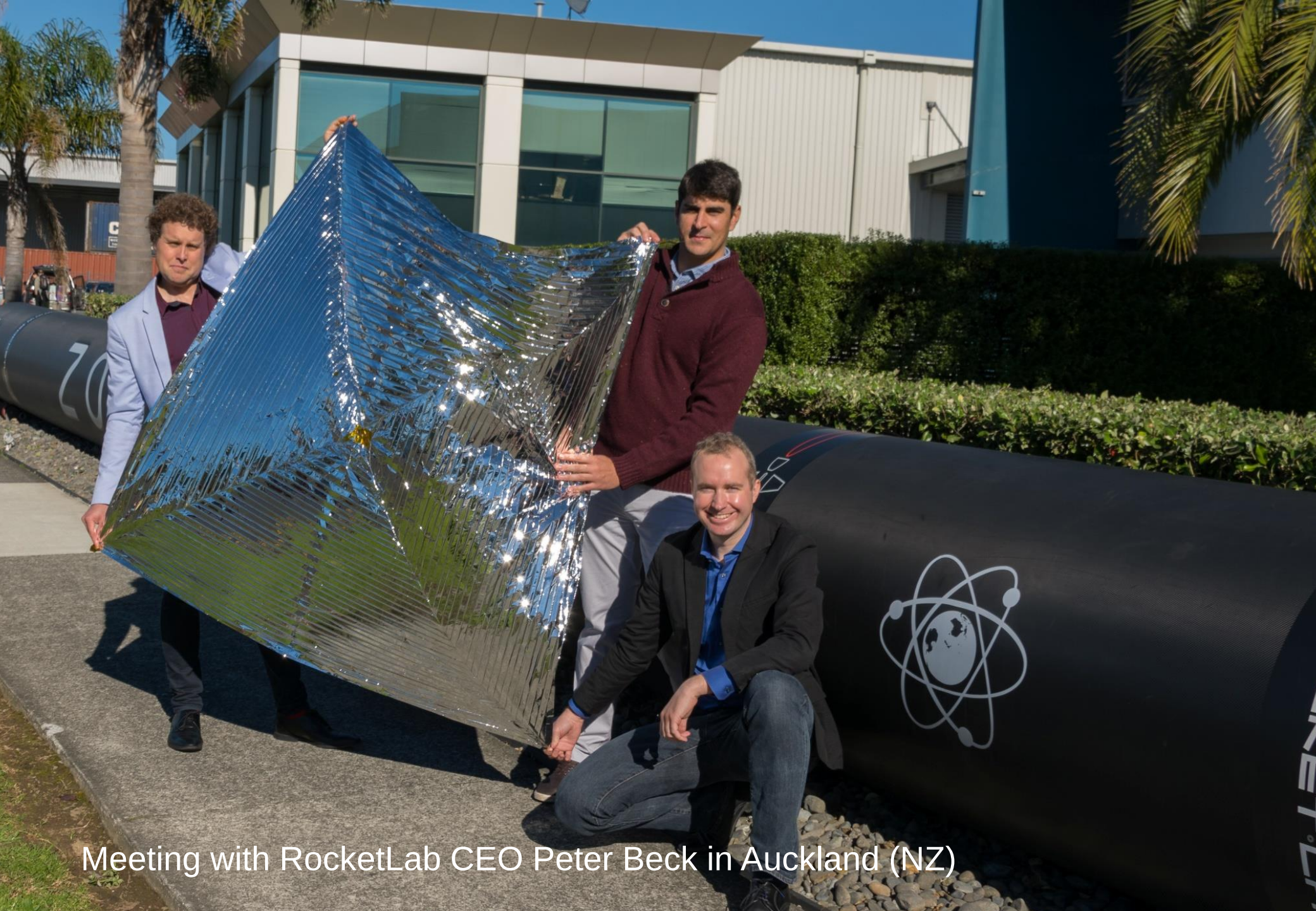
Summary of NABEO (ADEO-N):

- 2.5m^2 dragsail subsytsem deployed out of 1U cube
- 2 stage deployment through the top of the box
- Use of stored energy for deployment, no motors or electronic necessary
- Deployment triggert via single (short) signal
- Subsystem applicable to nanosatellites (cube sats) up to perigee of 750km and a mass of 1-100kg
- Designed, built and tested in February - May 2018
- Delivered to Rocket Lab (Auckland, New Zealand) on 28.05.2018





Meeting with RocketLab CEO Peter Beck in Auckland (NZ)

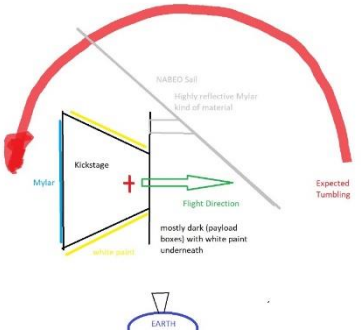

ROCKET LAB

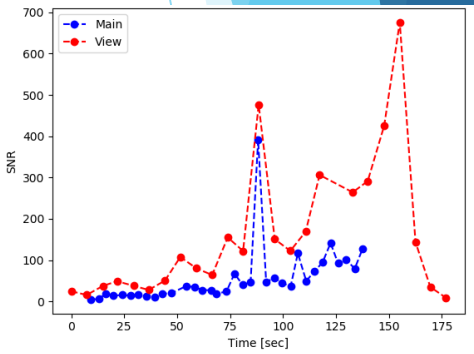
Picture source (Rocket Lab USA)

NABEO Flight Monitoring -> Confirmation of deployment / de-orbit

Optical Telescopes

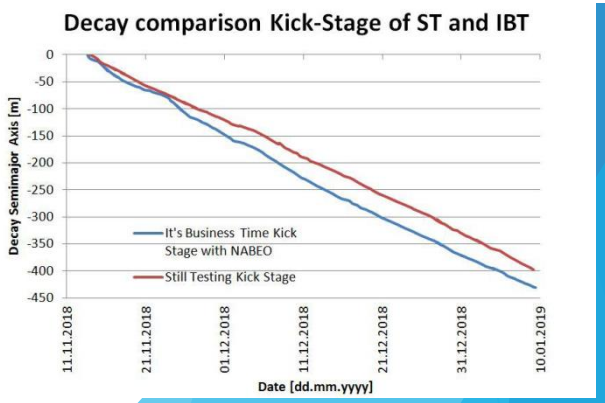
- Tracking via ongound telescopes from the Falcon Telescope Network with observations from Melbourne (Australia)
- **Observations of bright spots -> 1nd indication**
- **Observation of tumbling -> 2nd indication**





TLE data comparison

- Comparison of orbital parameters of „Still Testing“ Kickst (launched in January 2018) and „It‘s Business Time“ Kicks with NABEO (launched in November)
- Same time window, mass ST<IBT, orbit difference in November 3km (ST>IBT)
- **IBT kickstage de-orbit faster-> 3rd indication of fully functional NABEO dragsail**



Next Steps

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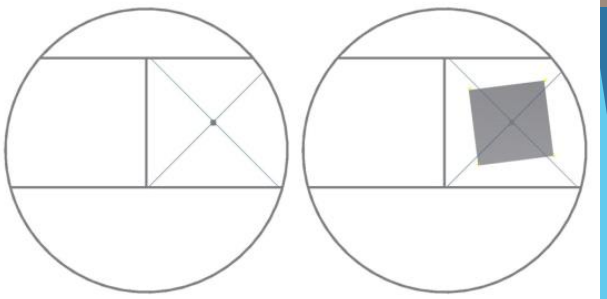
- 08/2019: ADEO-P Parabola flight with Novespace (co-funded by HPS/DLR)
- Fall/2019: Expected de-orbit of NABEO1 (launched on 11/11/2018)



Founding of @ Deployables Cubed

- Focus on release devices and deployables specifically designed for CubeSats
- 12/2019: full qualification of CubeSat release devices pin puller and release nut
- Already ongoing: Breadboarding of CubeSat deployables (boom, antennas/reflectors and de-orbit sail)

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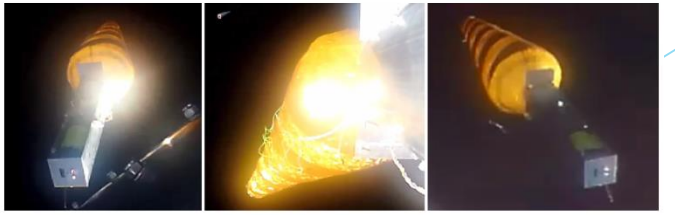
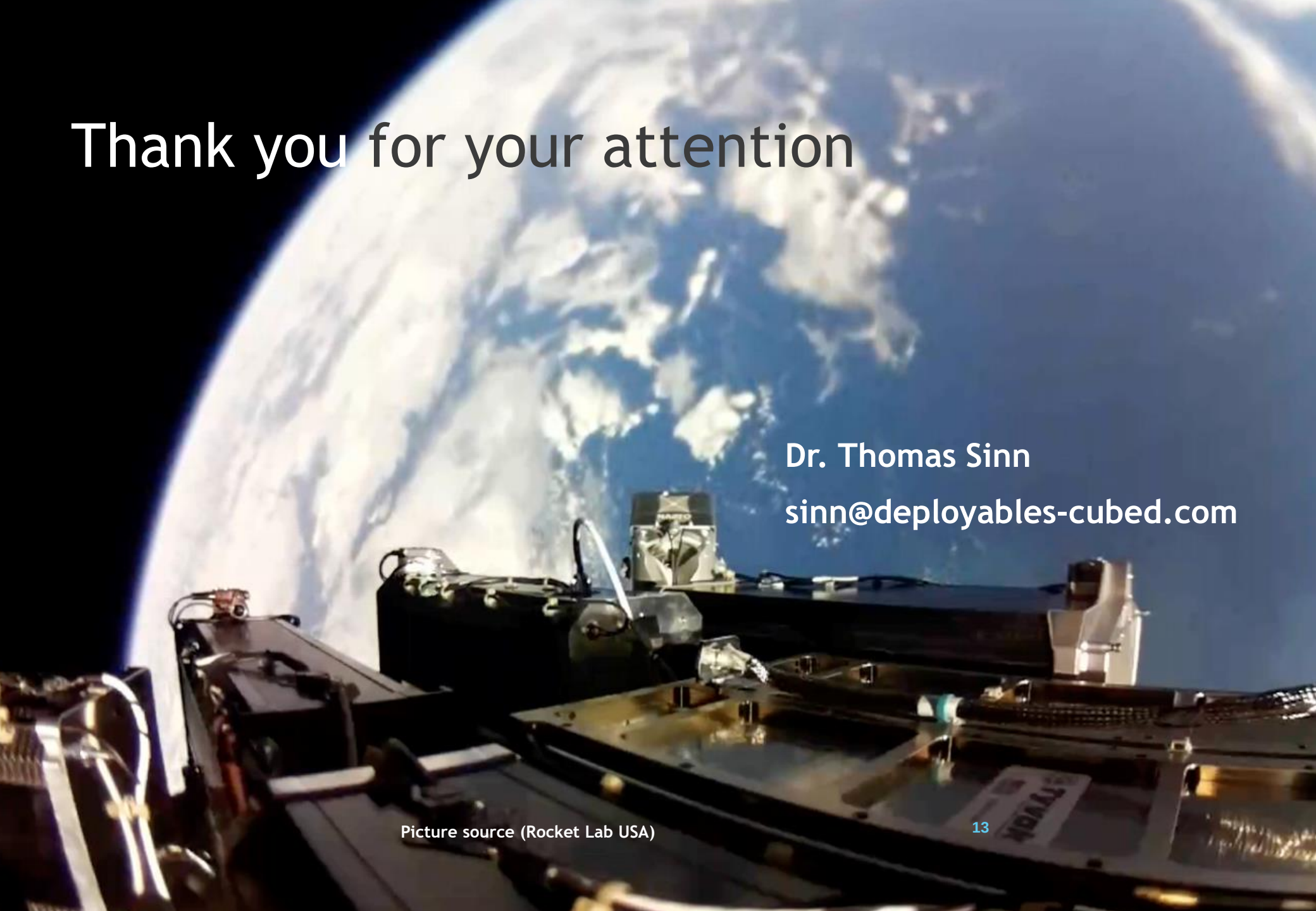


Thank you for your attention



Dr. Thomas Sinn

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Picture source (Rocket Lab USA)