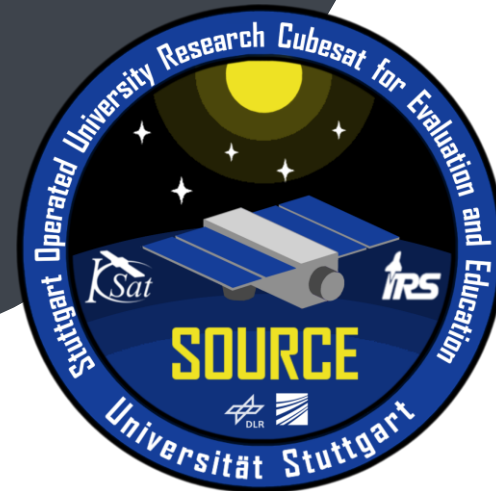


A CubeSat for demise investigation – SOURCE's approach for a better understanding of satellite re-entries

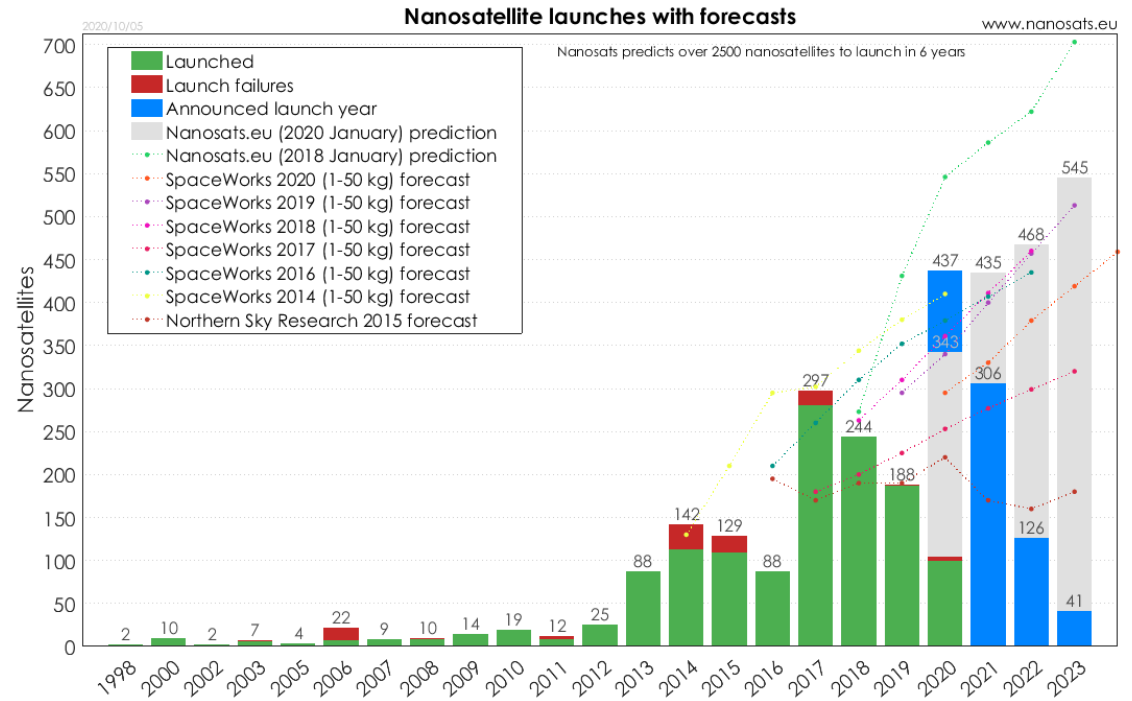
Daniel Galla
Sabine Klinkner
Georg Herdrich
Clemens Kaiser
Hendrik Kuhm
Hendrik Fischer



Future of Small Satellite Utilisation

Launch Forecast

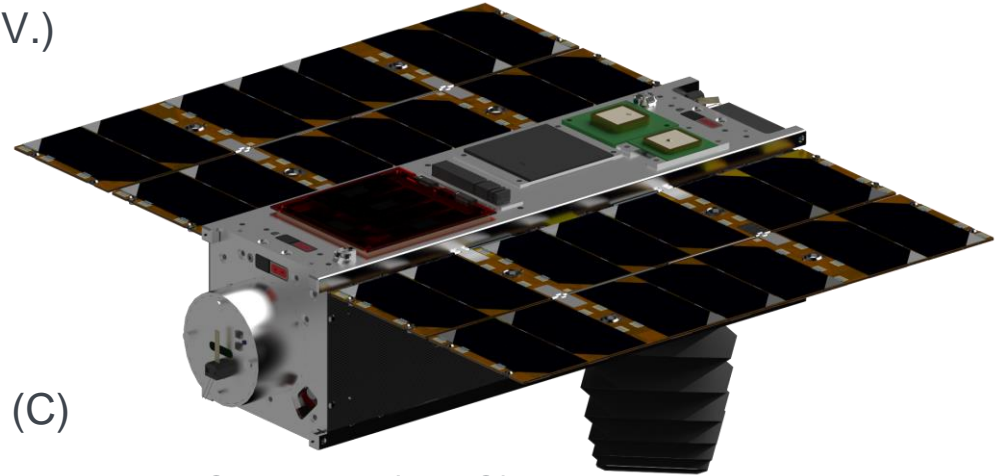
- Starlink:
 - 895 launched / 12.000 total
- Project Kuiper:
 - 3246 total
- OneWeb:
 - 74 launched / 650 total
- And many more:
Globalstar, Inmarsat, Iridium,
Disaster Monitoring Constellation,
RapidEye



SOURCE

Bus and Project Structure

- The Project is conducted by Institute of Space Systems (IRS) and Small Satellite Student Society at the University of Stuttgart (KSat e.V.)
- CubeSat properties:
 - 3U+, 36 x 10 x 10 cm³, 5 kg
 - Part of Fly Your Satellite (ESA)
 - Launch NET 2022 to SSO/ISS Orbit
- Current phase: End of detailed design phase (C)
- Part of the Integrated Research Platform for Affordable Satellites (IRAS)



SOURCE

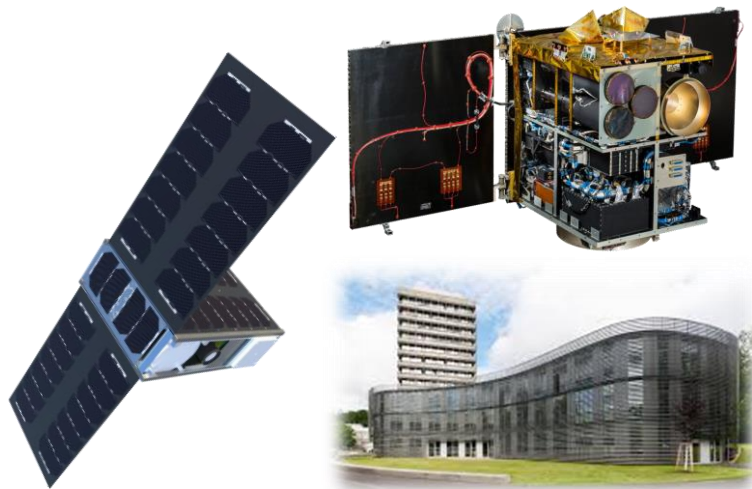
Project Partners



University of Stuttgart
Germany



Institute of Space Systems



University of Stuttgart



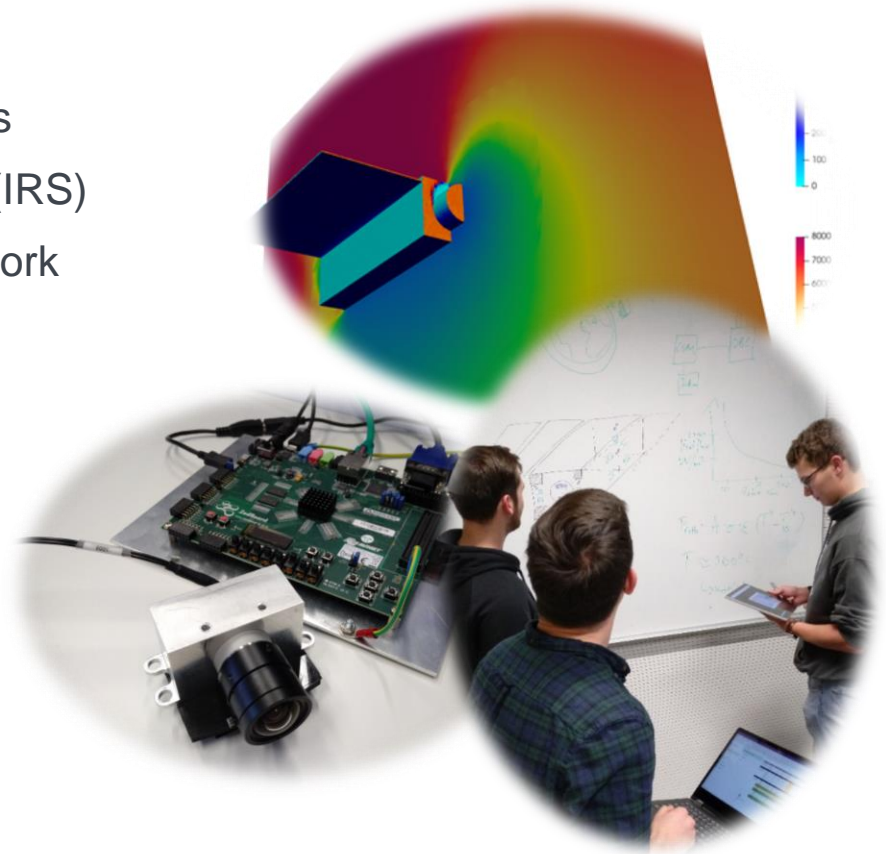
Small Satellite Student Society at the University
of Stuttgart



SOURCE

Mission Objectives

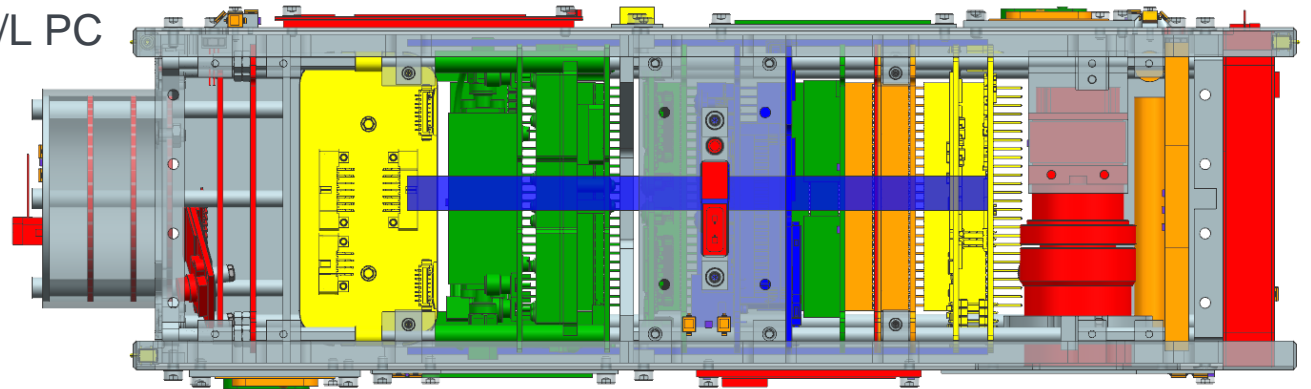
- Education of the next generation of space engineers
 - Student team (KSat e.V.) with Ph.D. supervisors (IRS)
 - Lecture, bachelor and master theses, volunteer work
 - > 80 active members, >200 in total
- Investigation of re-entry events for clean space
 - In-situ and optical measurements (Meteors)
 - Improvements for numerical tools (PICLas)
- Technology demonstration
 - Automotive parts in space
 - Integrated-circuit sandwich structures



SOURCE

Subsystem Overview

- **ACS:** Magnet torquers (3x), IMU (4x), sun sensors (20x) magnetometer (3x)
- **COM:** S-Band transceiver (1x Syrlinks), Iridium transceiver (2x), patch antennas (4x)
- **EPS:** Self-made PCDU, 77 Wh COTS battery, solar cells 2p7s x 4, several test strings
- **P/L:** MeSH Cam, heat flux and pressure sensors, FIPEX, IRAS Sandwich
- **TCS/Structure:** 3U+, deployable & body mounted solar panels, resistive heaters
- **OBC:** IOBC (ISIS), Zynq 7020 P/L PC



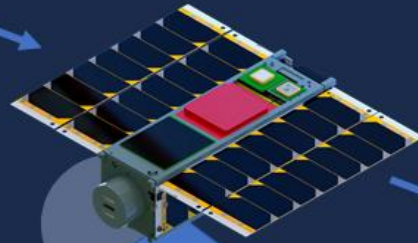
SOURCE

Mission Scenario

Deployment



Unfolding
solar panel
and baffle



200 km



Payload Operations:

- Meteor Observation
- Star- and horizon tracking
- Technology verification

S-Band Communication

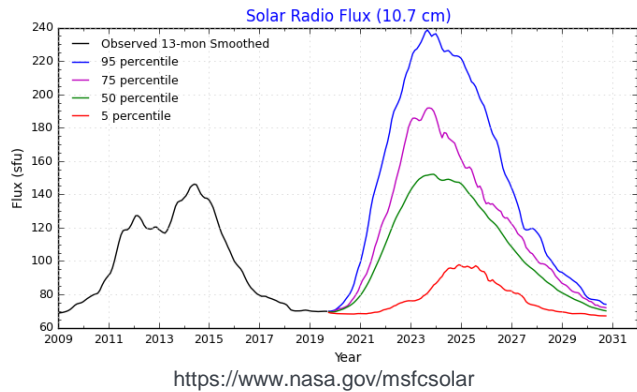
Payload Operations:
In situ demise measurements

Iridium Communication

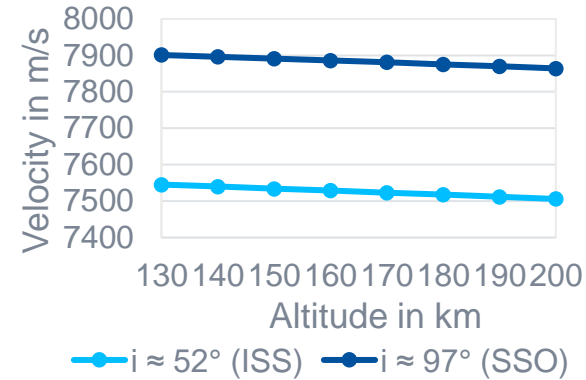
DSMC Simulations

Boundary Conditions

- Altitude range: 200 km – 130 km
- Extreme Scenarios
 - Highest/lowest atmospheric density



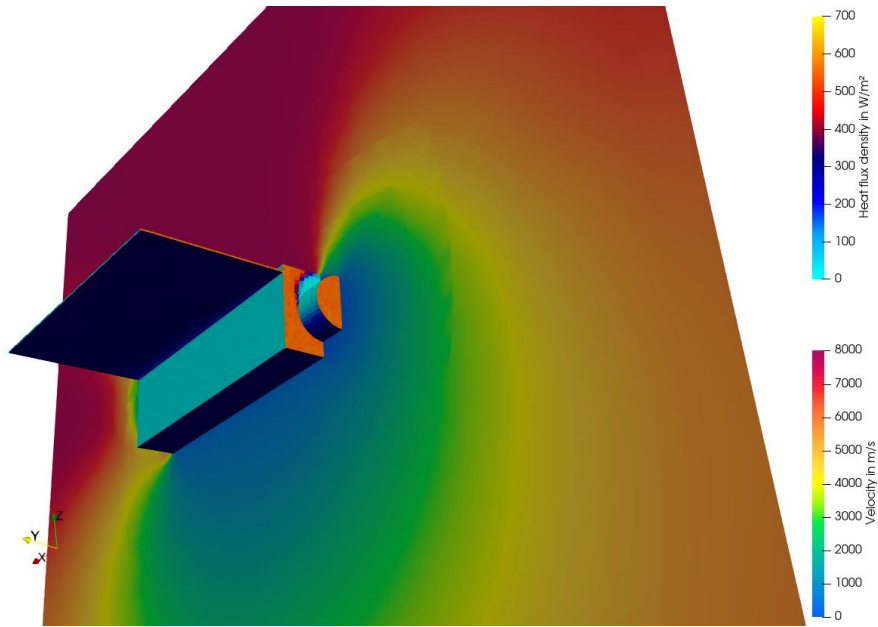
- Highest/lowest freestream velocity



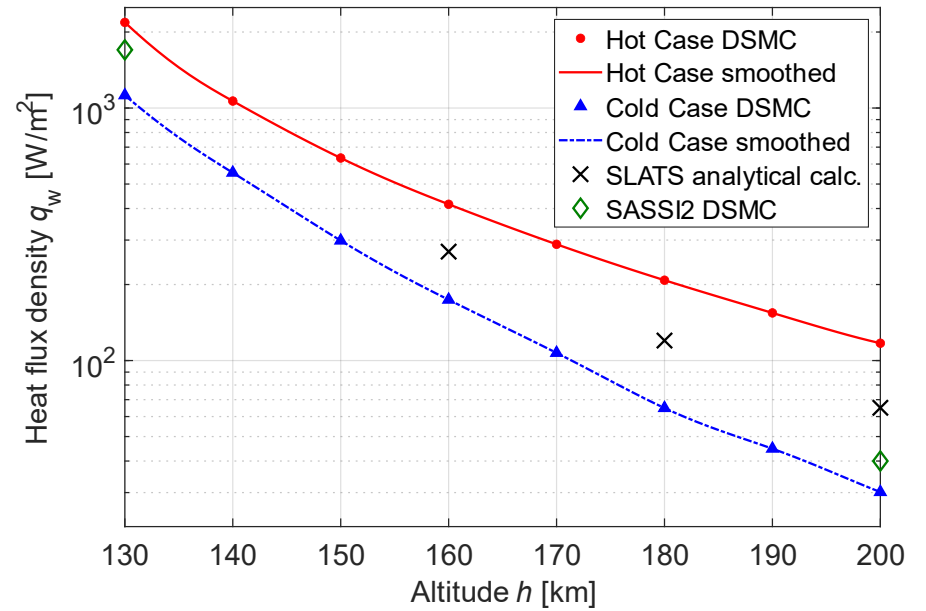
	COLD CASE	HOT CASE
Orbit inclination	52° (ISS)	97° (SSO 500 km)
Re-entry date	Jan 2022	Sep 2023

DSMC Simulations

Results – Heat Flux



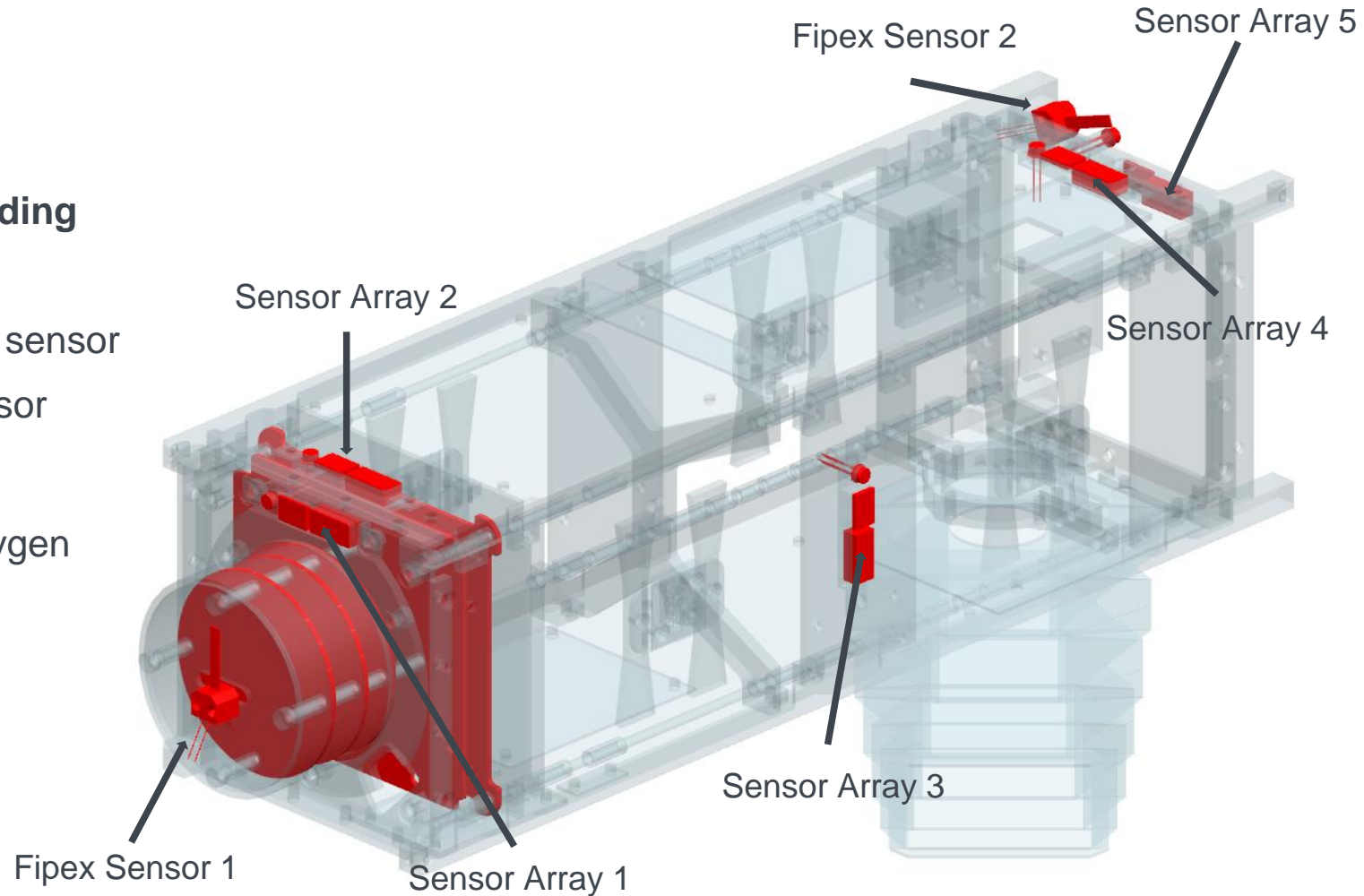
Peak heat flux density



SOURCE

Sensor Setup

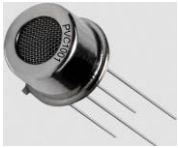
- **5 Sensor arrays, including**
 - Pressure sensor
 - Commercial heat flux sensor
 - In-house PHLUX sensor
- **2 FIPEX sensors**
 - Measuring atomic oxygen
- **17 sensors total**



SOURCE

Re-entry Sensors

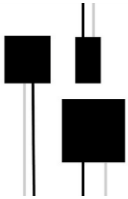
Posifa PVC 1000



- Pressure range:
- Resolution:
- Qualification testing

0.1 to 4000 Pa
~0.6 Pa

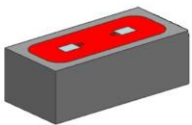
Wuntronic FM-120-K



- Heat flux range:
- Resolution:

-3300 to 6800 $\frac{W}{m^2}$
312.37 $\frac{mW}{m^2}$

IRS PHLUX

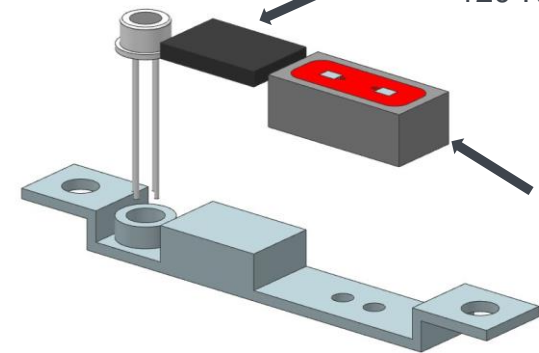


- 2 PT 1000 sensors
- Gold/Platinum coating
- Catalytic Effects

Pressure Sensor PVC
1000

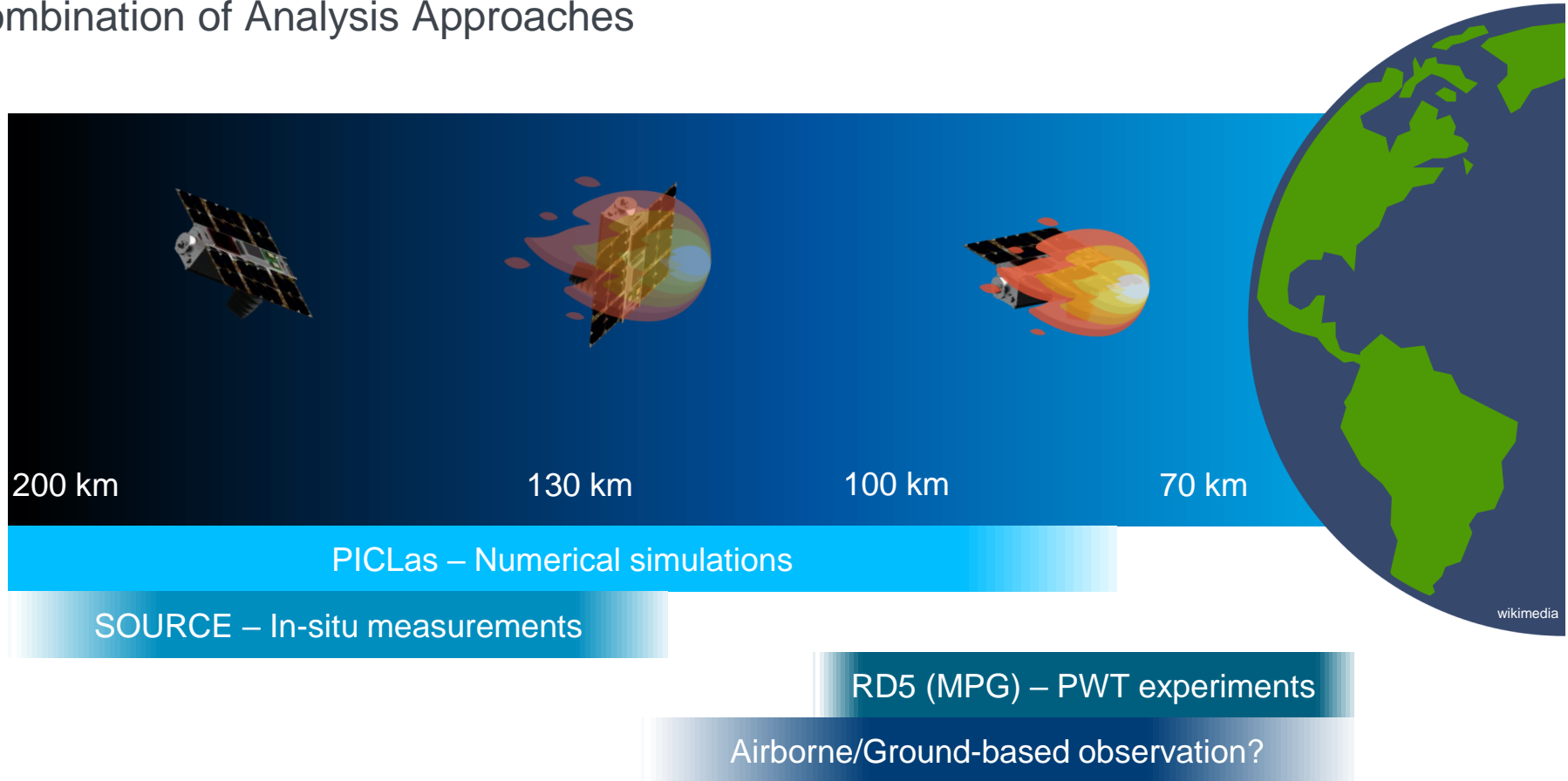
Wuntronic Heat Flux FM-
120-K

IRS PHLUX



Outlook

Combination of Analysis Approaches





Thank you very much!



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