Department of Aerospace and Geodesy
Technical University of Munich

IAPG
WARR
Satellite Technology

# DEDRA on-board MOVE-III: An in-situ detector to support space debris model validation

## MASTER Modelling Workshop 2021

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WARR
Wissenschaftliche
Arbeitsgemeinschaft für
Raketentechnik und Raumfahrt


# Presentation Outline

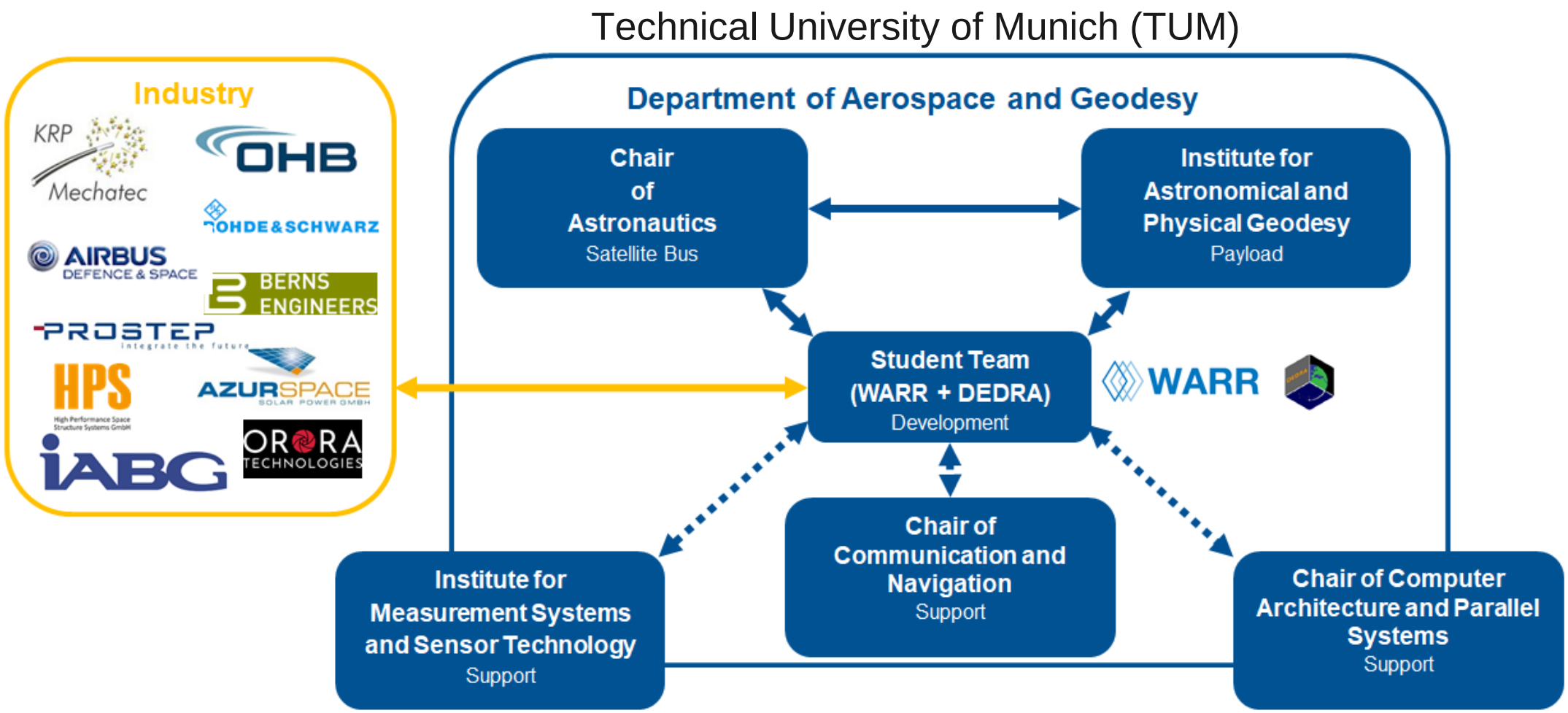
1. **Munich Orbital Verification Experiment (MOVE)**
   - Collaboration Framework
   - Background & Educational Aspects

2. **Mission Concept**
   - Mission Statement
   - Payload
   - Data Products

3. **Orbit and Simulations**
   - Orbit & Mission Parameters
   - MASTER Simulations

4. **Conclusion**

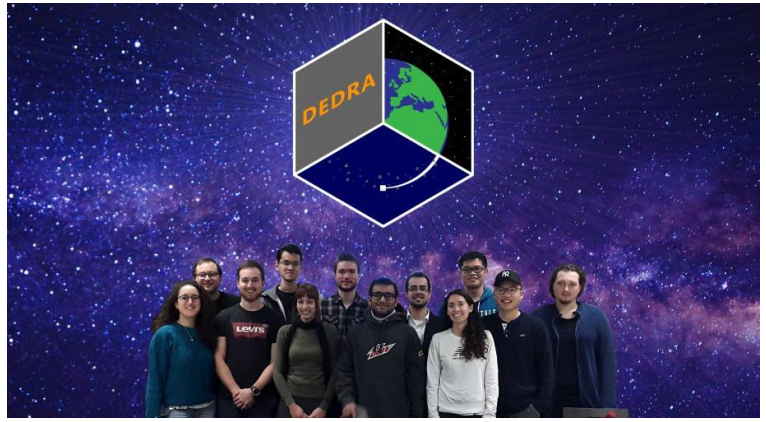
# MOVE-III – Collaboration Framework



# MOVE-III – Background & Educational Aspects

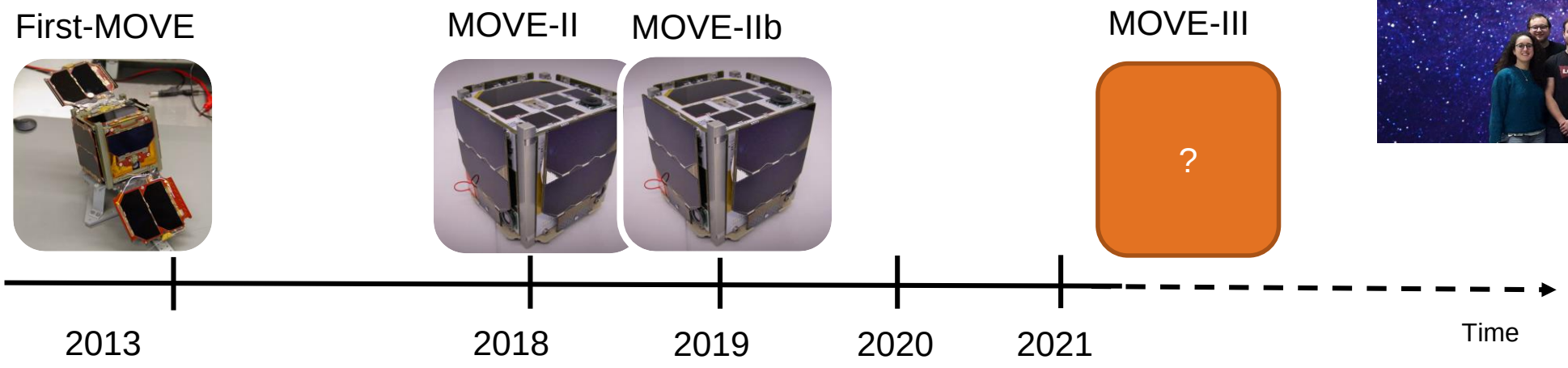
MOVE: Munich Orbital Verification Experiment

DEDRA: DEbris Density Retrieval & Analysis




**Student group** with main objective: the hands-on education of students in:

- ❑ spacecraft design
- ❑ qualification
- ❑ testing
- ❑ operation



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# Mission Statement

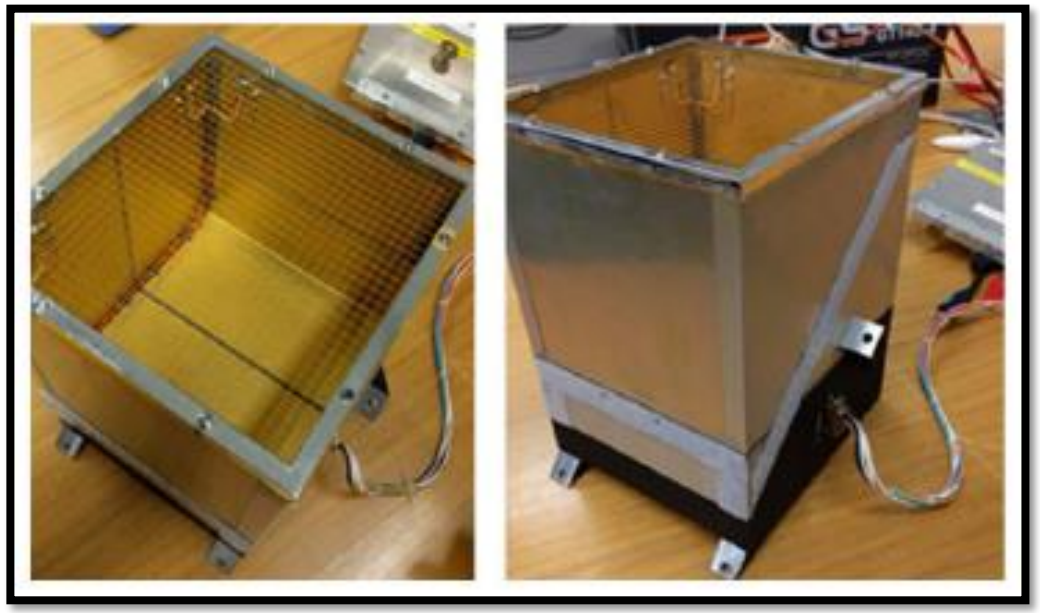

MOVE-III is the first cross-institutional project of the new Faculty of Aerospace and Geodesy at the Technical University of Munich.

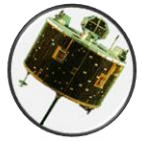
It shall conduct **in-situ measurements** of **submillimetre space debris** and **micrometeoroid** particles, making use of the Debris Density Retrieval and Analysis (DEDRA) sensor. The mission shall help to **validate** and **improve the space debris models** and contribute to the **characterization of the space environment** in **low earth orbit**.

Design, testing and operations shall be carried out as hands-on education for students of the Technical University of Munich under guidance and supervision from the Chair of Astronautics and the Institute for Astronomical and Physical Geodesy.

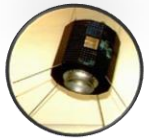
# Payload – DEDRA

## Heritage: Munich Dust Counter (MDC)





HITEN (MUSES-A) – 1990 to 1993



BREMSAT – 1994 to 1995

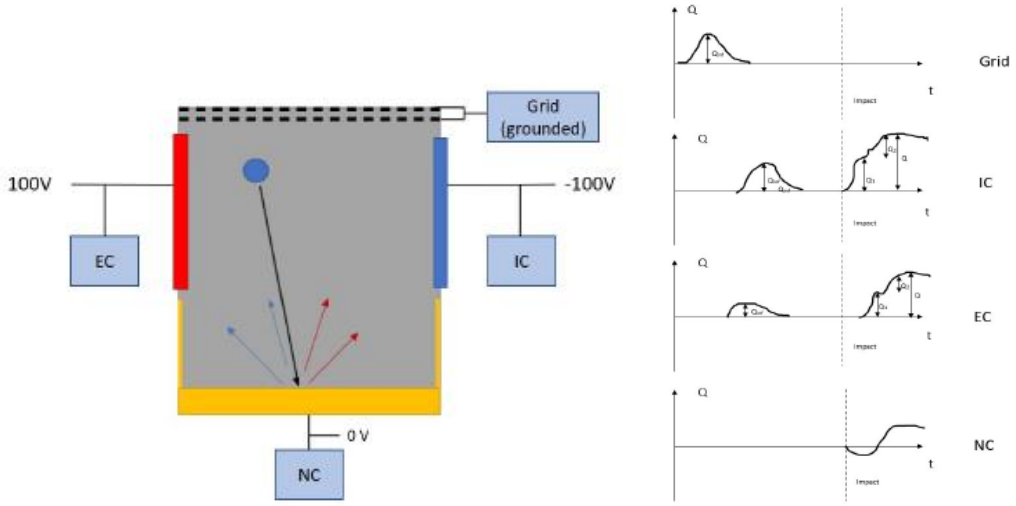
NOZOMI (PLANET-B) – 1998 to 2003

# Payload – DEDRA

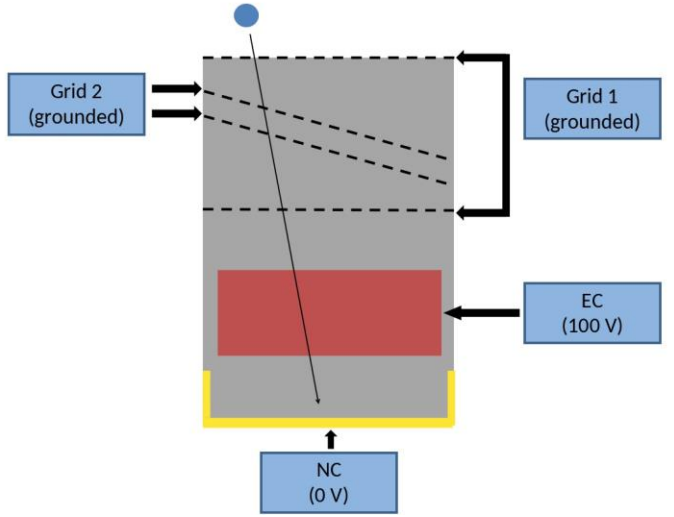
Measurement Principle & Sensor Design

- DEDRA is based on the MDC design and follows the same measurement principle
- All electronic components are being re-designed
- An advanced sensor design is proposed

## Baseline Design



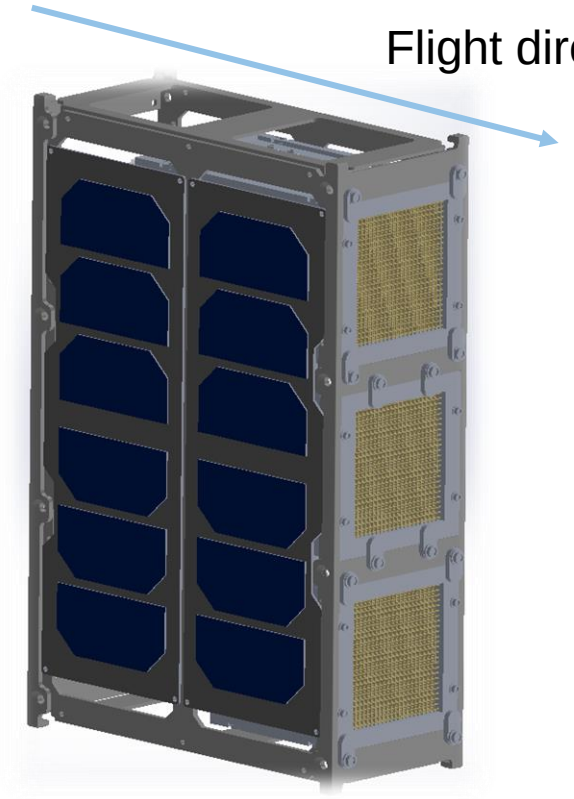

## Advanced Sensor Design

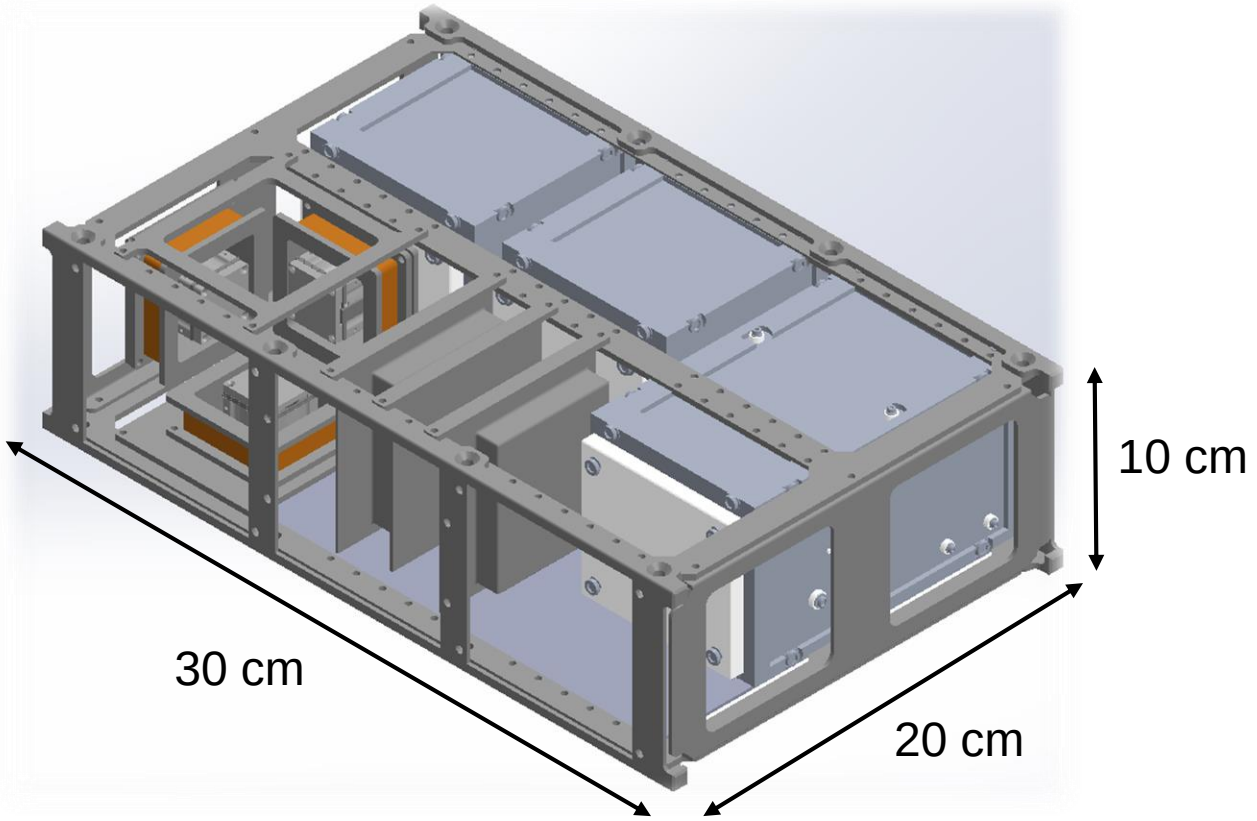



- Trackable mass range: $10^{-15}$ kg to $10^{-10}$ kg
- Velocity range: 7 $^{km}/_{s}$ to 30 $^{km}/_{s}$

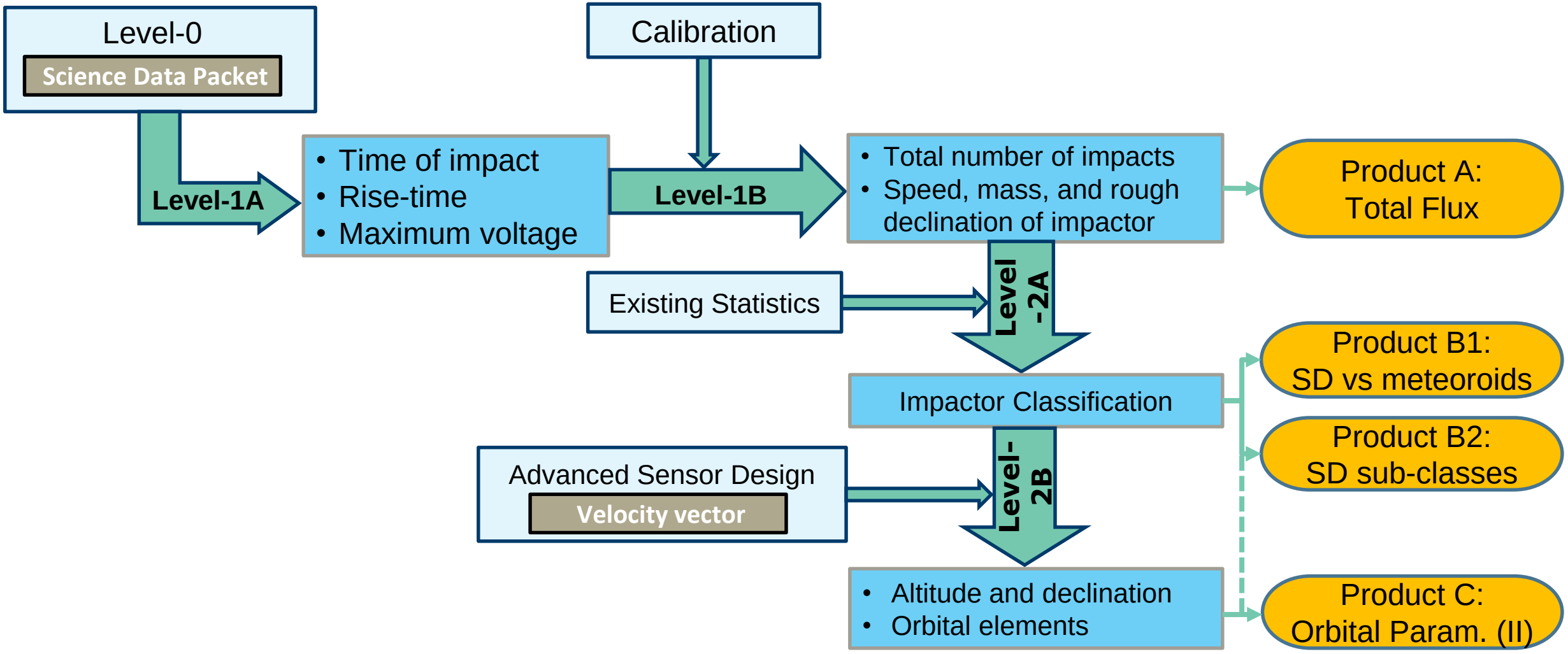
# Payload – DEDRA

## Mechanical Design & Sensor Configuration



# Data Products



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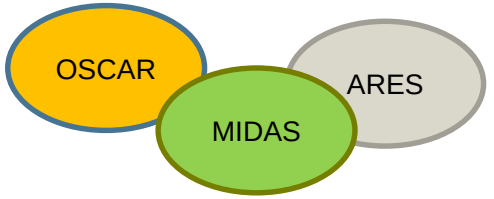
# Orbit & Mission Parameters

## Requirements

- Mission lifetime > 1 year
- Sun-synchronous orbit (~98°inclination)
- High small space debris and meteoroid flux
- Low flux of large objects
- Compliance with space debris mitigation guidelines (de-orbiting within 25 years)
- Low system complexity


Likely Orbit Range

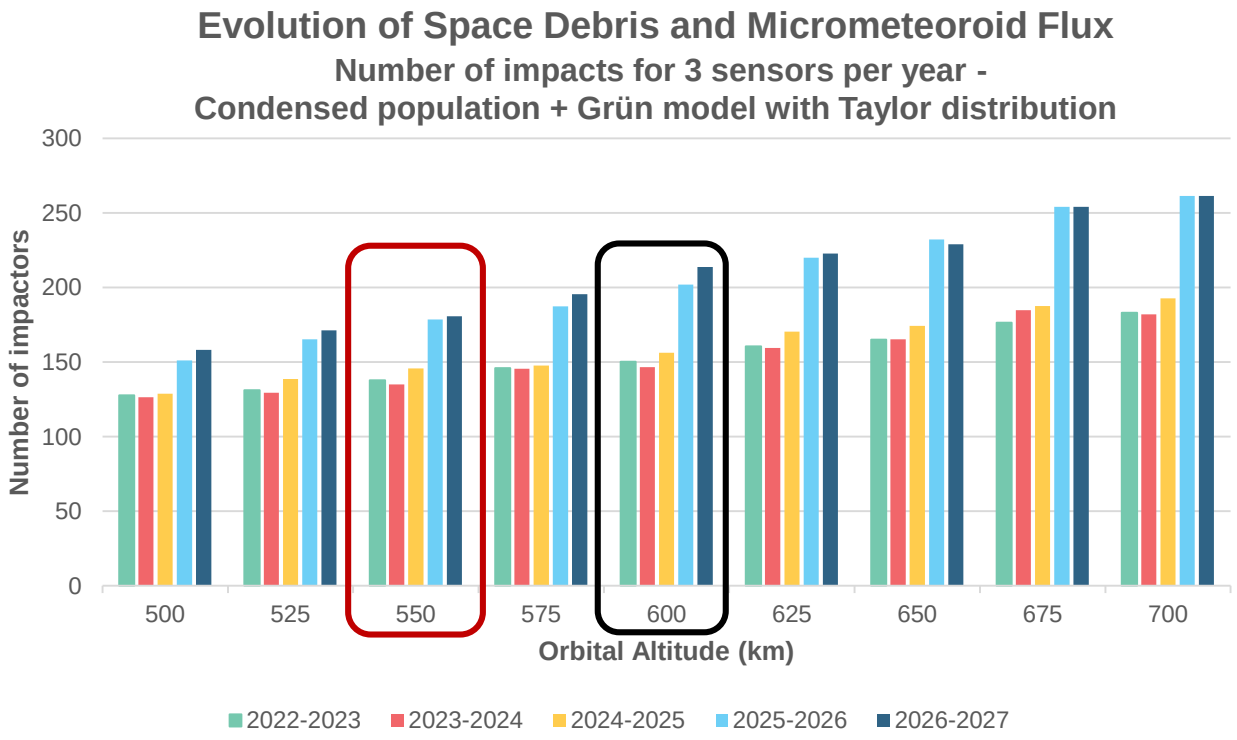
500 – 600 km

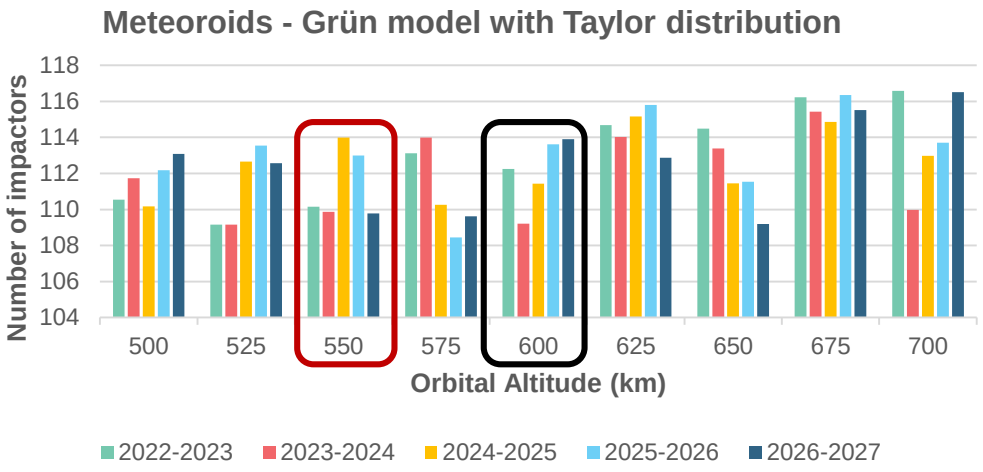


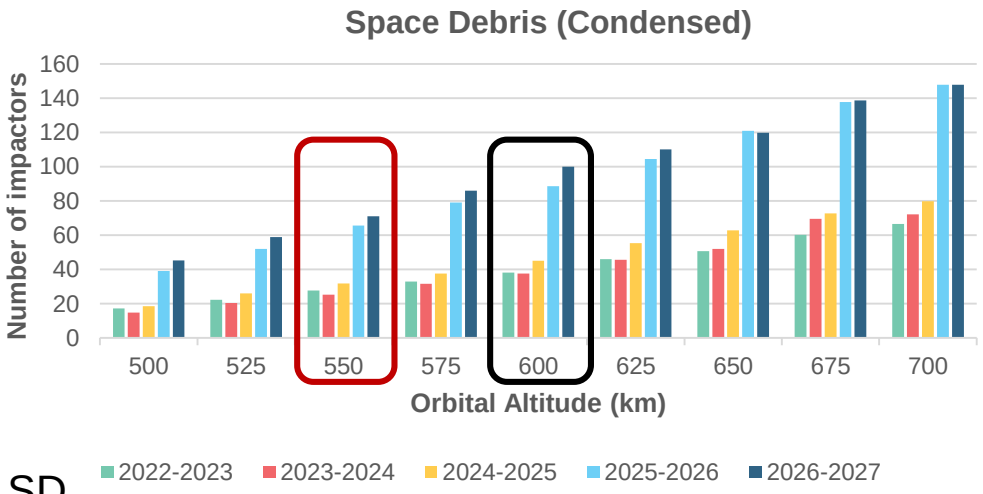


Total of 125-215 impacts/year, depending on orbit & simulation year

# MASTER-8 Simulations




- 550 km, 2024-2025:

146 impacts: 114 meteoroids, 32 SD

78% meteoroids, 22% SD

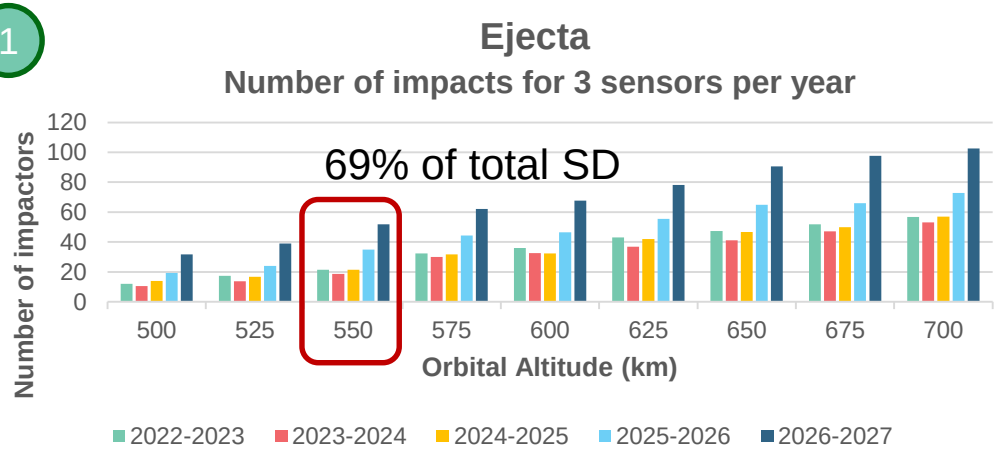
- 600 km, 2024-2025:

202 impacts - 114 meteoroids, 88 SD

56% meteoroids, 43% SD

# MASTER-8 Simulations

1

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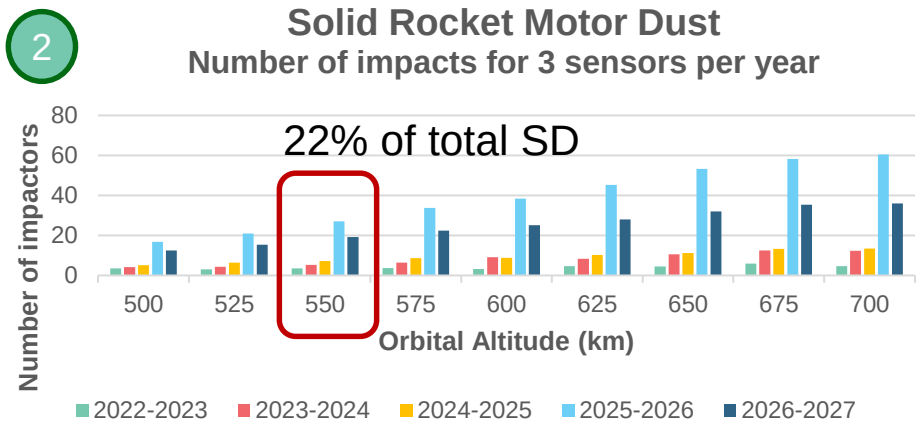


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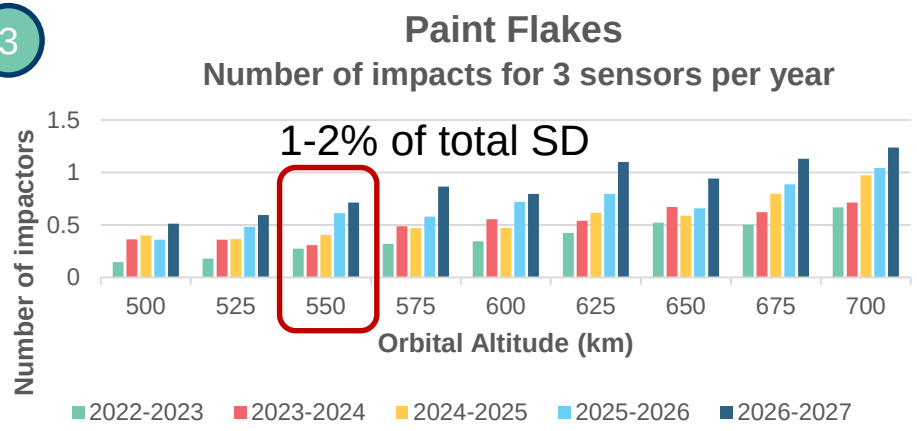


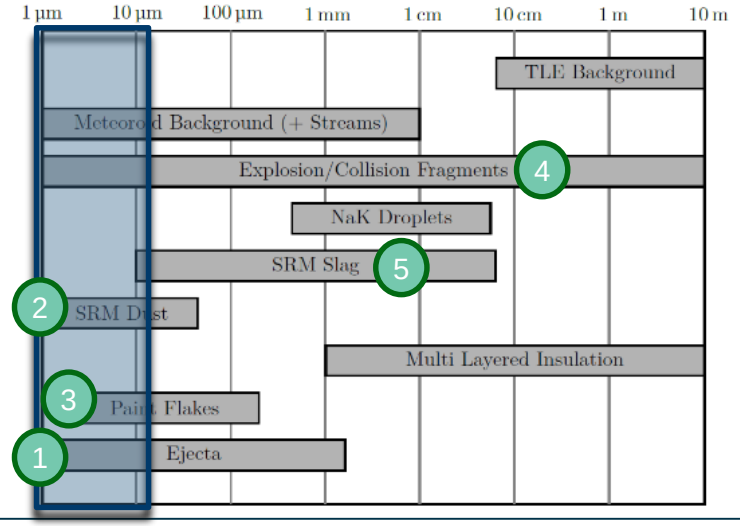

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# Conclusion

- MOVE-III is a **CubeSat** project of the Technical University of Munich
- MOVE-III aims at providing **in-situ measurements** of **submillimeter space debris** and **meteoroids**, in order to support and **validate** the **current space debris models**
- **DEDRA** is the **payload** of MOVE-III. It is a **plasma ionization sensor**, which can provide the **mass**, the **velocity** and potentially (with the advanced design) the **direction** of the incoming particles.
- **MASTER** predicts approximately **125-215 impacts within a year** (for altitudes between 500 km and 600 km and simulations years between 2023-2027) on the three DEDRA sensors.


# Sic itur ad astra