From Adventure to Business

Hansjörg Dittus
DESIS / MUSES TIMELINE

2014 / 2015
MUSES / DESIS
Start Mission

7. June 2017
MUSES installation on ISS

29. June 2018
DEISIS launch from Cape Canaveral to ISS via SpaceX Falcon

27.-28.08 2018
Installation of DESIS in MUSES. Start Commissioning Phase

23 October 2019
@ IAC Washington
Start operationell Phase (official announcement)

29.09.–01.10.2021
1st DESIS User Workshop (online)

We are here
2021
2022
2023
2024

Design, Development, Implementation, Test
Commissioning
Operations

Nomine End

© Gravity
Data Access

Commercial data: Teledyne Brown Engineering, Scientific / Humanitarian data: DLR
**DESIS Instrument**

- Hyperspectral instrument consisting of a Three-Mirror-Anastigmat (TMA) telescope combined with an Offner-type spectrometer

<table>
<thead>
<tr>
<th>Mission Instrument</th>
<th>MUSES/DESIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target lifetime</td>
<td>2018-2023</td>
</tr>
<tr>
<td>Off-nadir tilting</td>
<td>-45° (backboard) to +5° (starboard), -40° to +40° (by MUSES and DESIS)</td>
</tr>
<tr>
<td>Spectral range</td>
<td>400 nm to 1000 nm</td>
</tr>
<tr>
<td>Spectral Sampling (res., acc., bands)</td>
<td>2.55 nm, 0.5 nm, 235 bands. Binning: 118, 79, 60 bands</td>
</tr>
<tr>
<td>Spectral response</td>
<td>Gaussian shape, 3.5 nm FWHM</td>
</tr>
<tr>
<td>Software Binning (sampling distance, number bands)</td>
<td>Binning 2 (5.1 nm, 118 bands)</td>
</tr>
<tr>
<td></td>
<td>Binning 3 (7.6 nm, 79 bands)</td>
</tr>
<tr>
<td></td>
<td>Binning 4 (10.1 nm, 60 bands)</td>
</tr>
<tr>
<td>Radiometry (res., acc.)</td>
<td>13 bits, ~10%</td>
</tr>
<tr>
<td>Spatial (res., swath)</td>
<td>30 m, 30 km (@ 400 km)</td>
</tr>
<tr>
<td>SNR (signal-to-noise)</td>
<td>195 (w/o bin.) / 386 (4 bin.) @ 550 nm</td>
</tr>
<tr>
<td>Instrument (mass)</td>
<td>93 kg</td>
</tr>
<tr>
<td>Capacity (km, storage)</td>
<td>2360 km per day, 225 GBit</td>
</tr>
</tbody>
</table>

**FEE:** Front End Electronic  
**FPA:** Focal Plane Array  
**TMA:** Three Mirror Anastigmat  
**POI:** Pointing Unit
Huntsville, Alabama
03.09.2018  34°47´27.6´´N 87°08´38.8´´W

Example
Data Evaluation
One week after DESIS Installation
Vegetation

Huntsville, Alabama

03.09.2018  34°47´27.6´´N 87°08´38.8´´W

Vegetation

Forest

Wheeler Reservoir

Soil

City Huntsville

Athens

Agriculture fields

River Tennessee
Huntsville, Alabama

03.09.2018  34° 47' 27.6" N 87° 08' 38.8" W

Suspended Matter
Colored dissolved organic matter (CDOM)

Huntsville, Alabama
03.09.2018  34° 47′ 27.6″ N 87° 08′ 38.8″ W
Example: Rare Earth Elements (REE) @ Mt. Pass mine (USA / California)

*Gregg Swayze from USGS Spec Lab*

“So this may be the first demonstration of REE detection from space but may also have high enough resolution and SNR to allow differentiation of individual REE minerals”

Element: Neodym (Nd); Class: Lanthanoide
Usage: Magnets, Laser, Glas,…
DESIS Data Products

**Archive**
- L1A Raw Data (prepared for selection & ordering & processing)

**Analysis Ready Data**
- L1B Top-Of-Atmosphere (TOA) Radiance
- L1C Geocoded & Orthorectified
- L2A Bottom-of-Atmosphere (BOA) Reflectance

- Land Mask
- Water Mask
- Cloud Mask
- Cloud Shadow over land
- Haze over land
- Haze over water
- AOT Map
- WV Map

DESIS L2A

[Map Illustration]
Spectral calibration after smile correction is typically better than ~0.5 nm.

**DESIS Data Products - Quality**

Absolute radiometric calibration is well within ~5% at the Top-of-Atmosphere (TOA) radiance and TOA reflectance level when validated against RadCalNet.

Geometric accuracy with respect to Landsat-8 reference is ~20 m (< 1 pixel) linear RMSE.

Agreement of Bottom-of-Atmosphere (BOA) reflectance within ~5% to RadCalNet, Sentinel-2 and field campaign data from Pinnacles site (Australia).

**Analysis Ready Data**

- L1B Top-Of-Atmosphere (TOA) Radiance
- L1C Geocoded & Orthorectified
- L2A Bottom-of-Atmosphere (BOA) Reflectance

Spectral calibration after smile correction is typically better than ~0.5 nm.
Status of Data Acquisitions (July 2021)

World
~60,000 scenes processed (archive)
<35% of the land surface of the Earth
~29 TB data in the archive

Note: DESIS is not a mapping mission

~14600 scenes USA

~1620 scenes Germany
What are the current scientific applications of DESIS?

Currently ~50 international teams are using DLR’s science access to DESIS data (plus additional commercial customers of TBE)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Number of proposals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Thematic Exploitation &amp; Material Composition</td>
<td>2</td>
</tr>
<tr>
<td>Landcover &amp; vegetation</td>
<td>5</td>
</tr>
<tr>
<td>Water Resources</td>
<td>7</td>
</tr>
<tr>
<td>Ocean Applications</td>
<td>4</td>
</tr>
<tr>
<td>Coastal Applications</td>
<td>5</td>
</tr>
<tr>
<td>Calibration</td>
<td>1</td>
</tr>
<tr>
<td>Natural Resources</td>
<td>8</td>
</tr>
<tr>
<td>Geology</td>
<td>3</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>2</td>
</tr>
<tr>
<td>Others (e.g. methods development, data fusion)</td>
<td>4</td>
</tr>
</tbody>
</table>

- DLR is responsible for the scientific data distribution
- Tasking new data is based on a proposal process
- Data available for scientists worldwide

~16 proposals (40%) are related to water applications

*Spectral range 400 – 1000 nm*