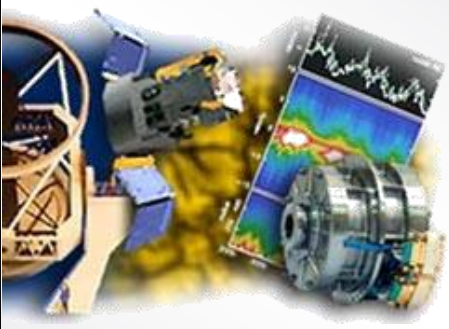
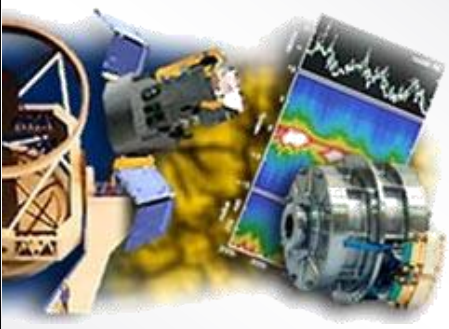


INSTITUTO DE ASTROFÍSICA DE CANARIAS

Simulating the wavefront measurement in Free Space Optical Communications

And the use of Laser Guide Stars for FSOC

Noelia Martínez
Instituto de Astrofísica de Canarias



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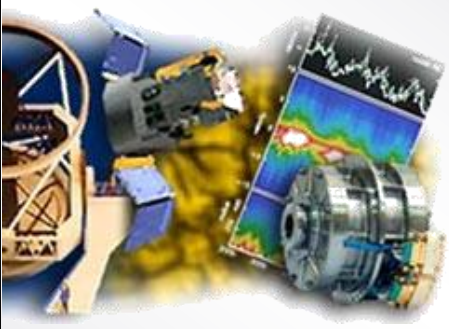

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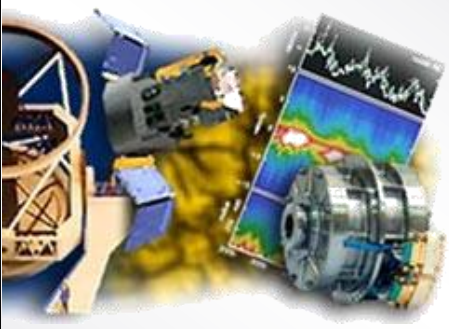
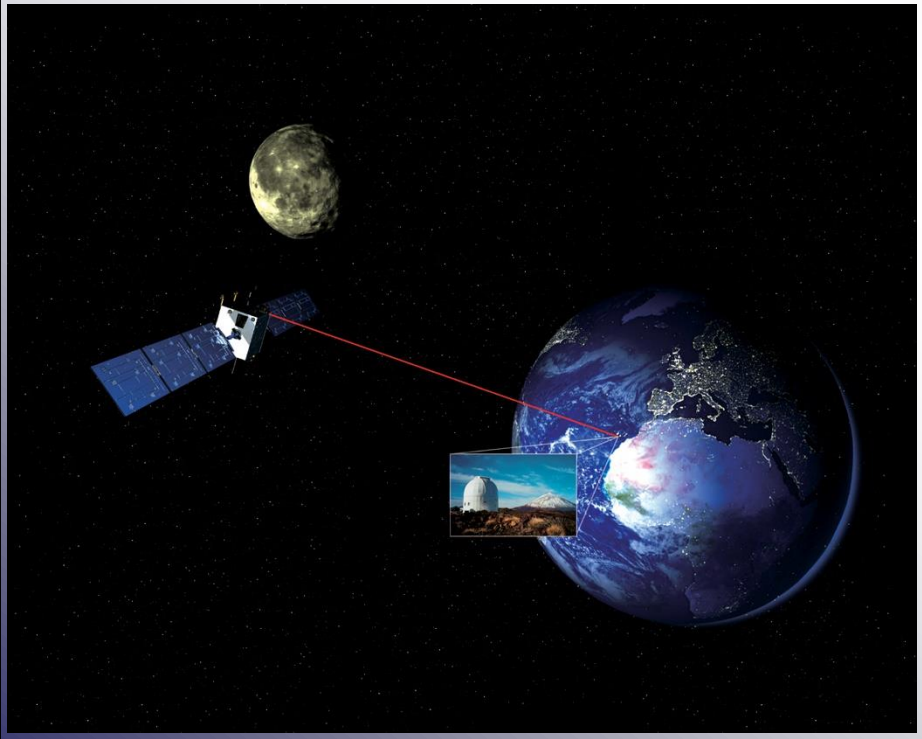


1. FSOC in turbulence medium

Free Space Optical Communications (FSOC)

Ground – Satellite
Satellite – Ground

Satellite - Satellite



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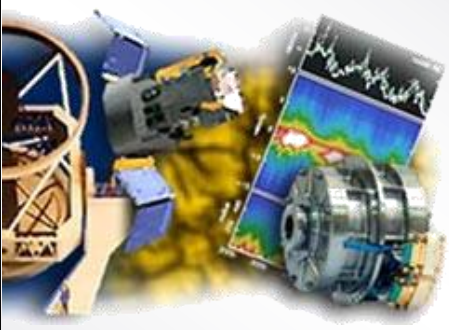

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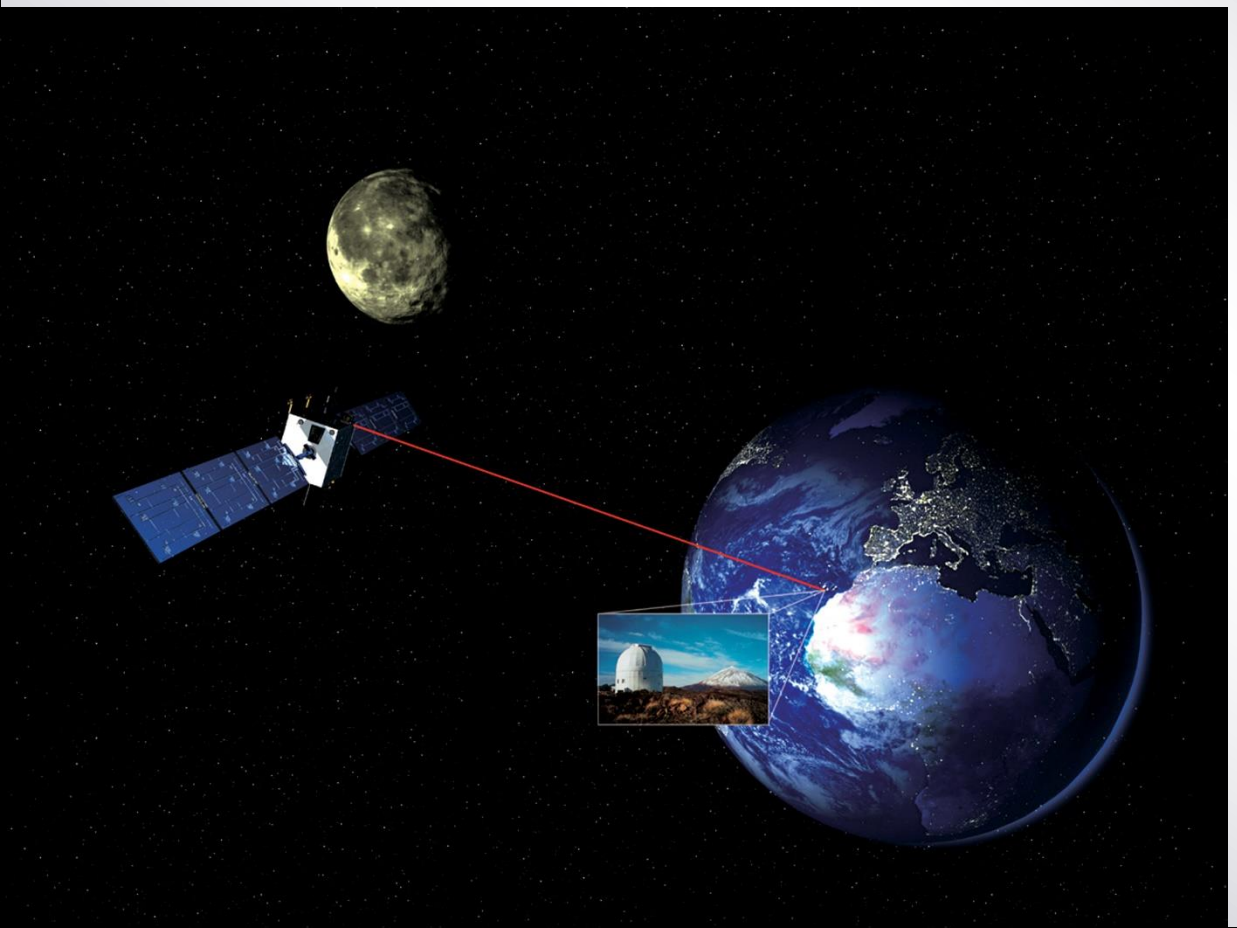
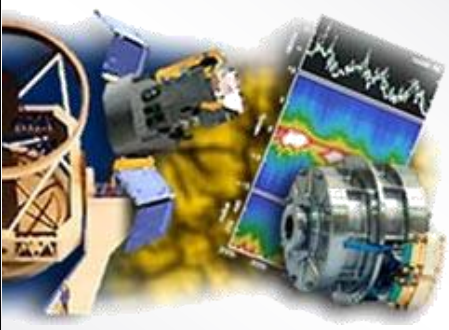


Toyoshima et al, 2011



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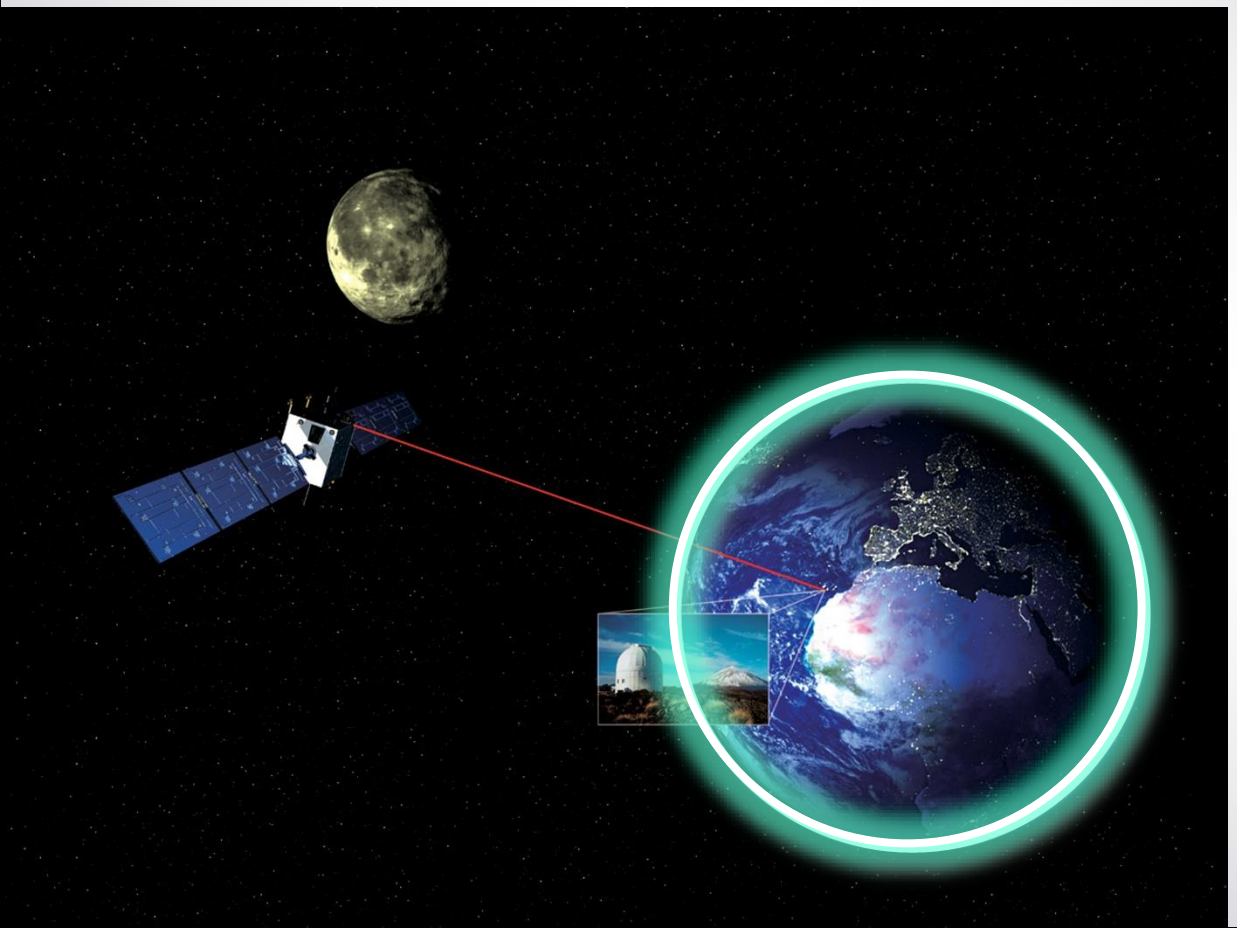

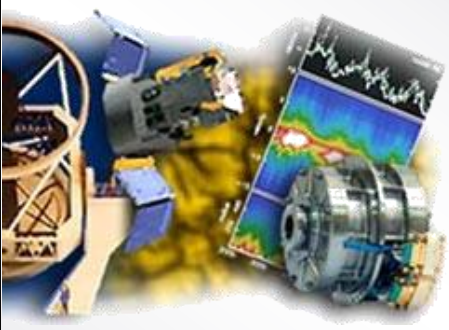

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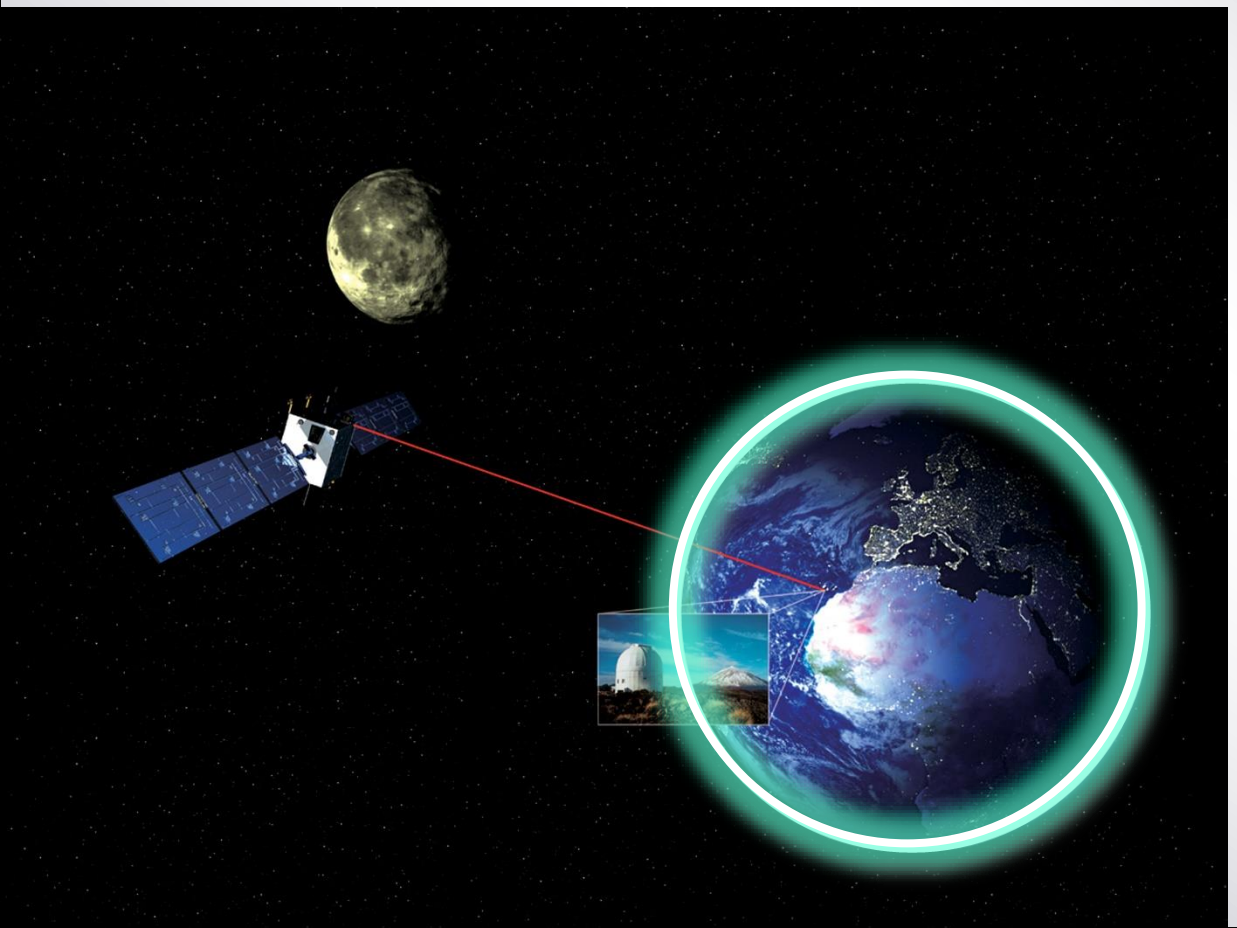
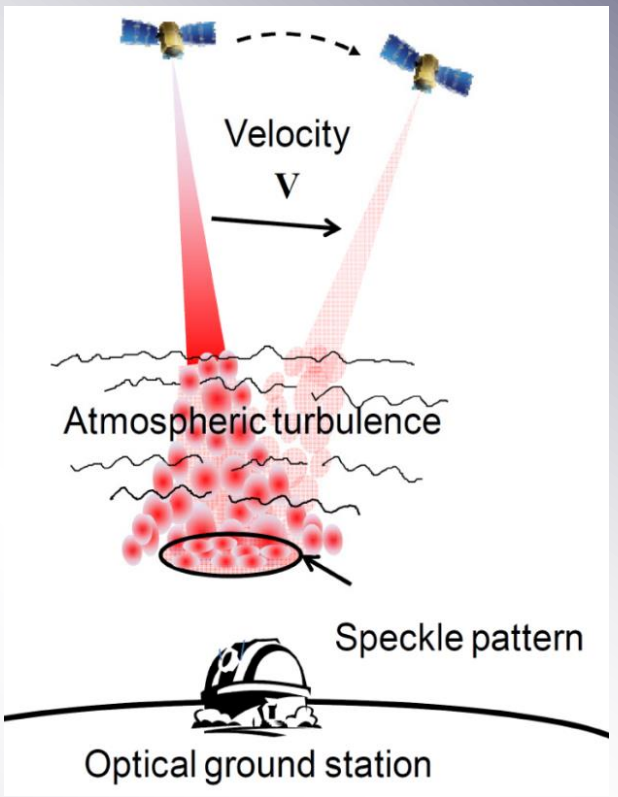
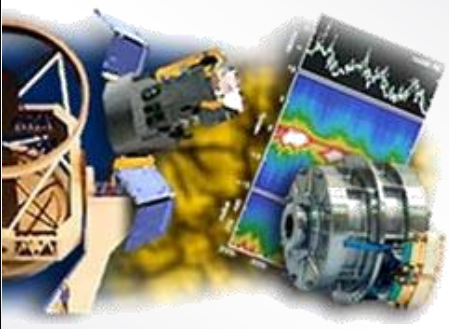




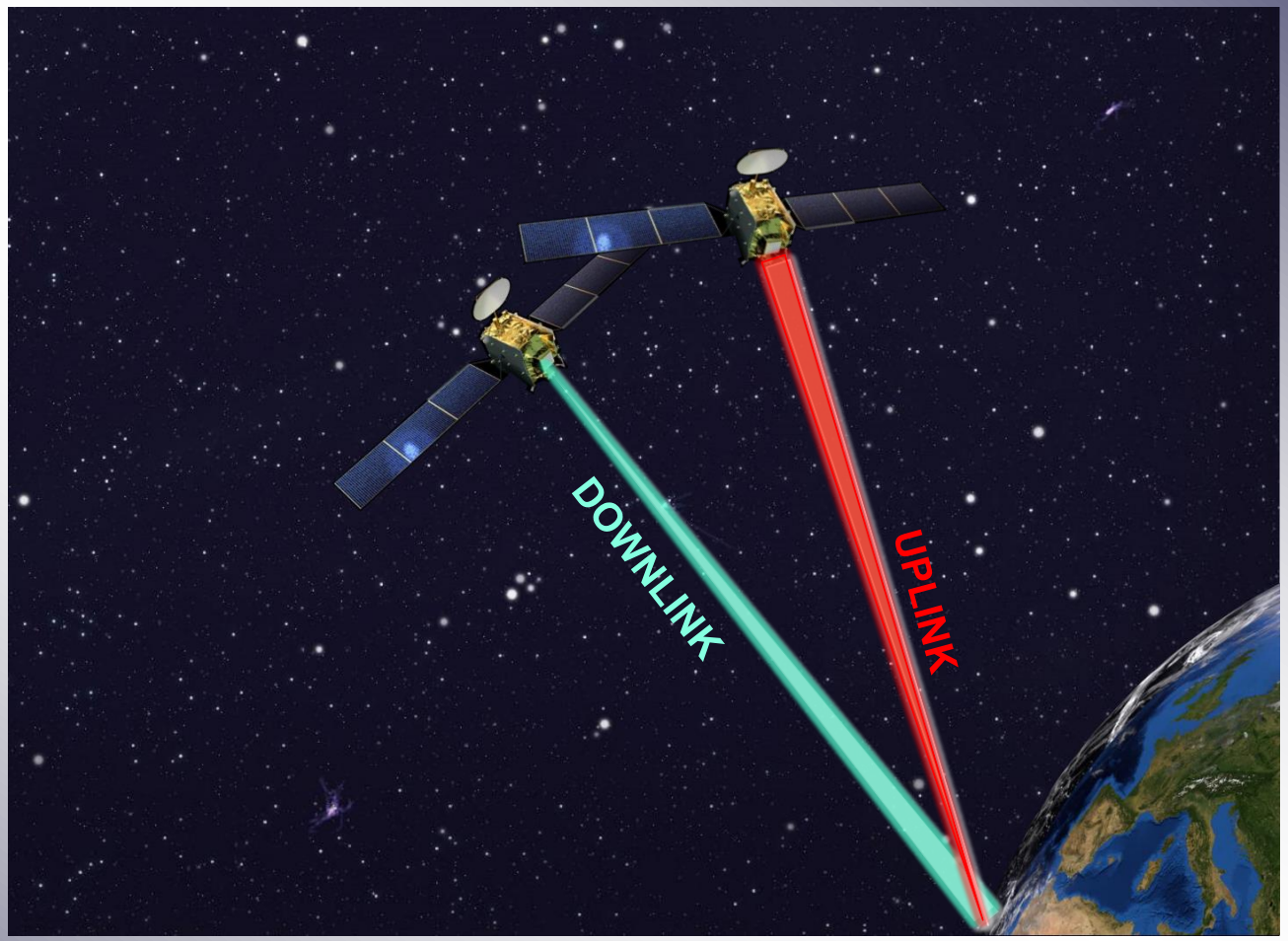
Toyoshima et al, 2011



1. FSOC in turbulence medium

Atmospheric turbulence effects on optical links:

- **Downlink effects:**
  - **Beam broadening**
  - **Scintillation**
- **Uplink effects:**
  - **Beam wander**
  - **Fluctuations in the angle-of-arrival**



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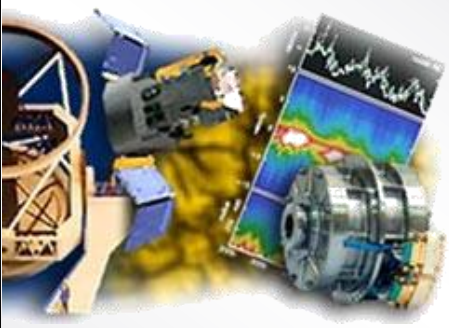
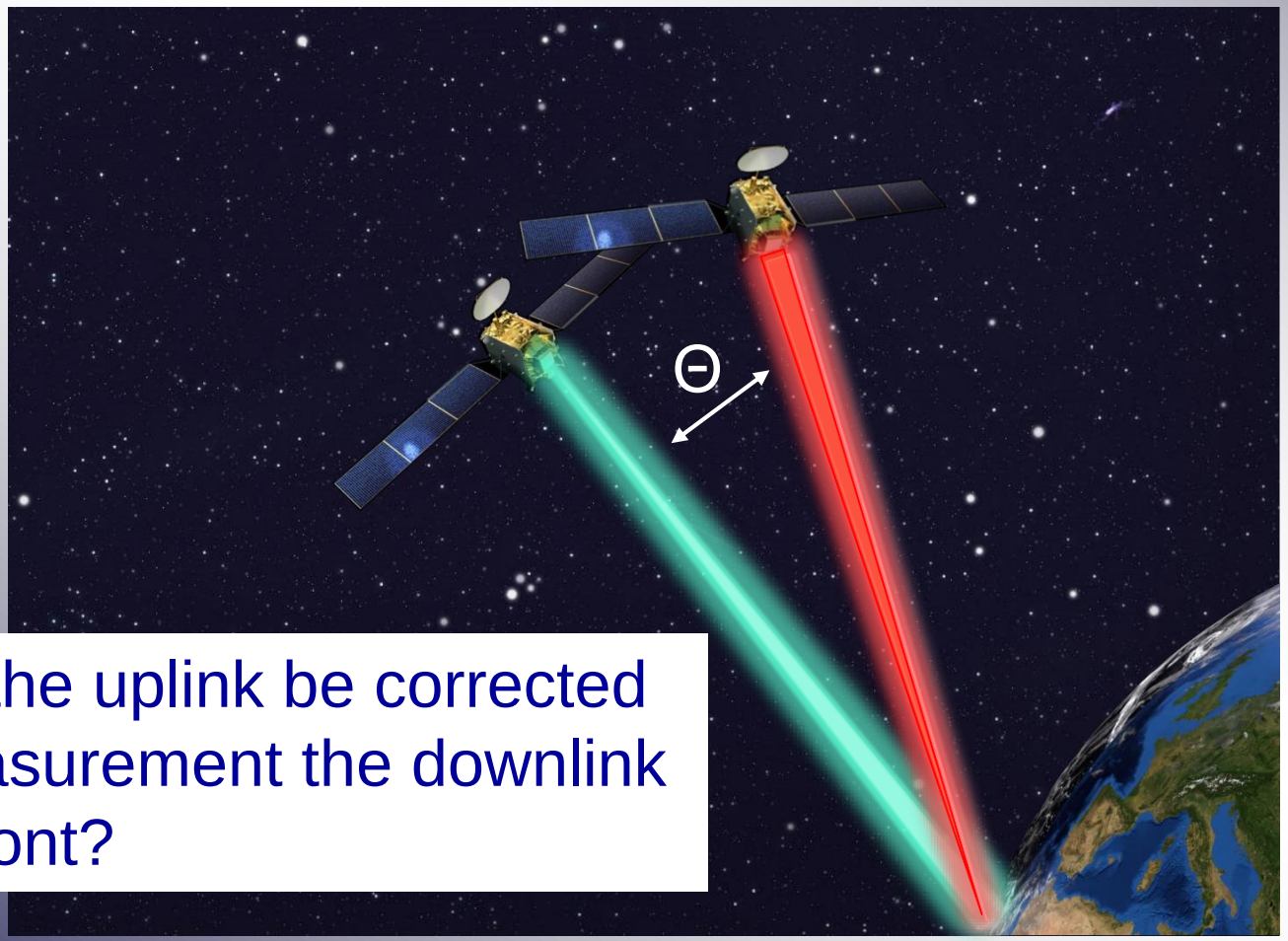
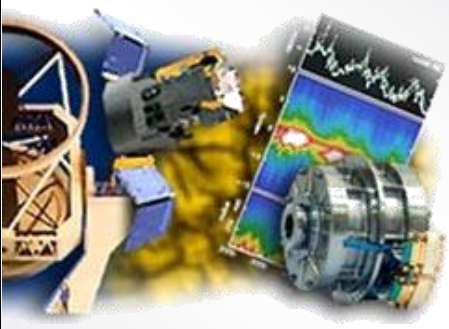


1. FSOC in turbulence medium

Measuring atmospheric turbulence on optical links



Could the uplink be corrected by measurement the downlink wavefront?



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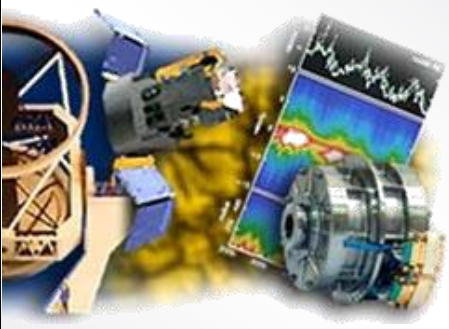


2. Simulations description

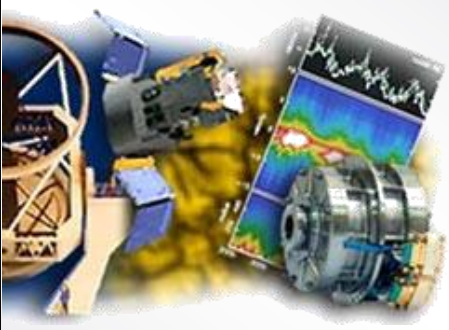
Object- Oriented Matlab Adaptive Optics Toolbox (OOMAO) Conan and Correia, 2014

Analysing the isoplanatic patch

1. Case study definition
2. Real available data
3. Simulation workflow

Closing the AO loop

1. Case study definition
2. Real available data
3. Simulation workflow



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Analysing the isoplanatic patch

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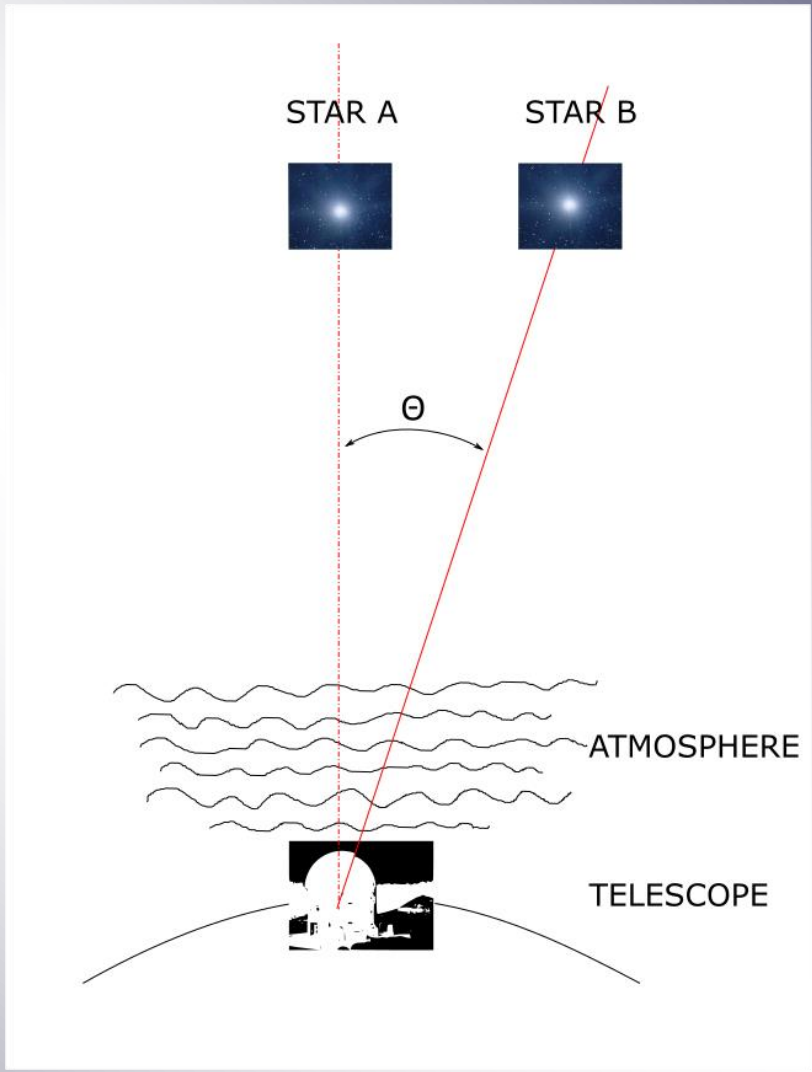

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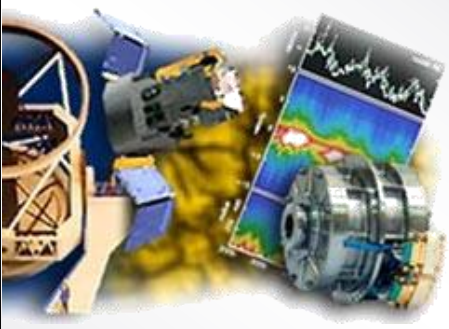


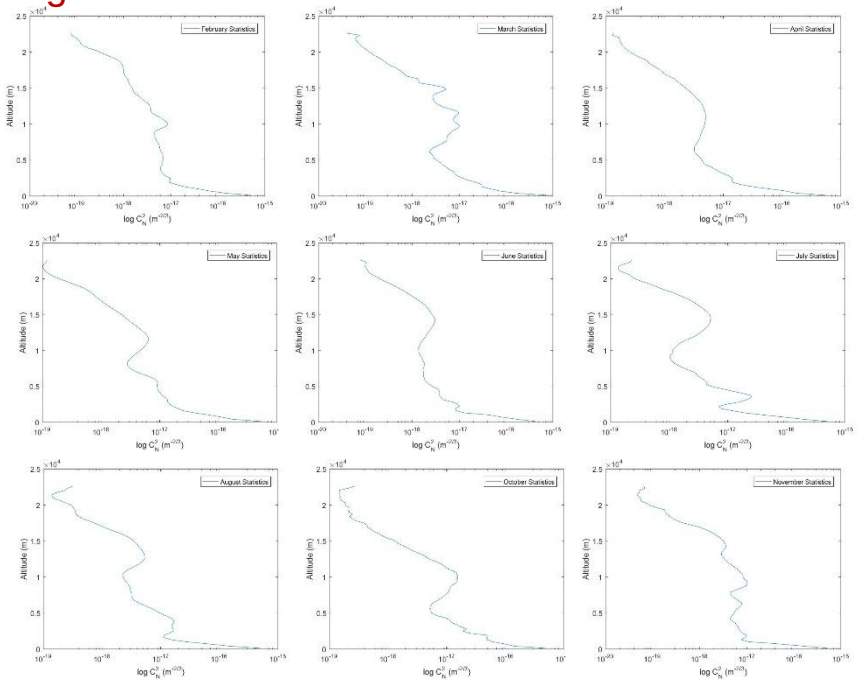
2. Simulations description

Analysing the isoplanatic patch

1. Case study definition
2. **Real available data**
3. Simulation workflow

Observatorio del Teide – Atmospheric Profiles –

Night data



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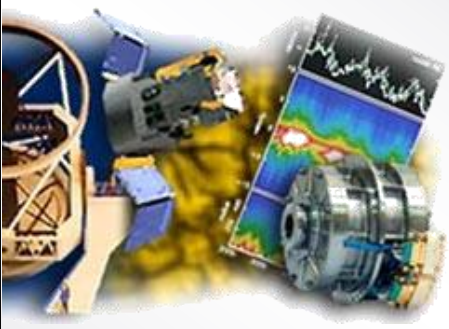

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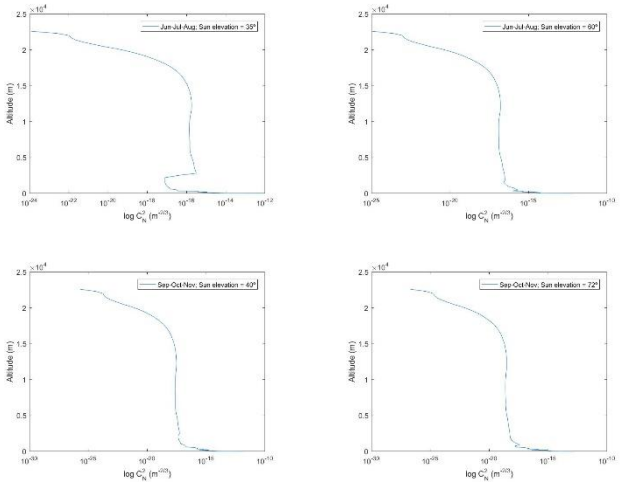
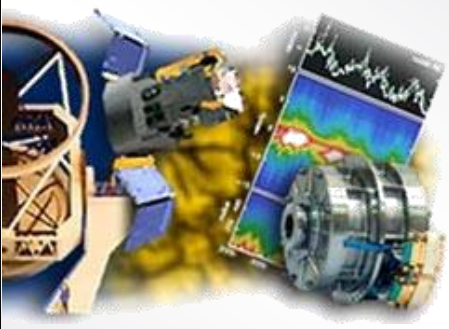
Observatorio del Teide – Atmospheric Profiles –

Day data





2. Simulations description

Analysing the isoplanatic patch

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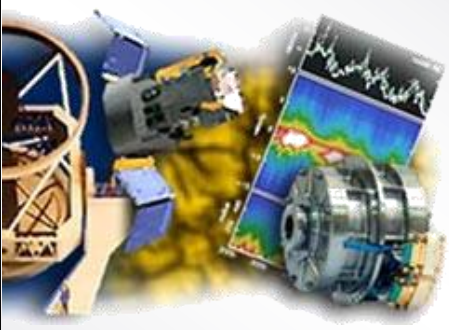
3. Simulation workflow

Optical Ground Station
– Optical Parameters –

Telescope diameter = 1m
Central obstruction = 20%

Laser Wavelength = 1200 nm



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Analysing the isoplanatic patch

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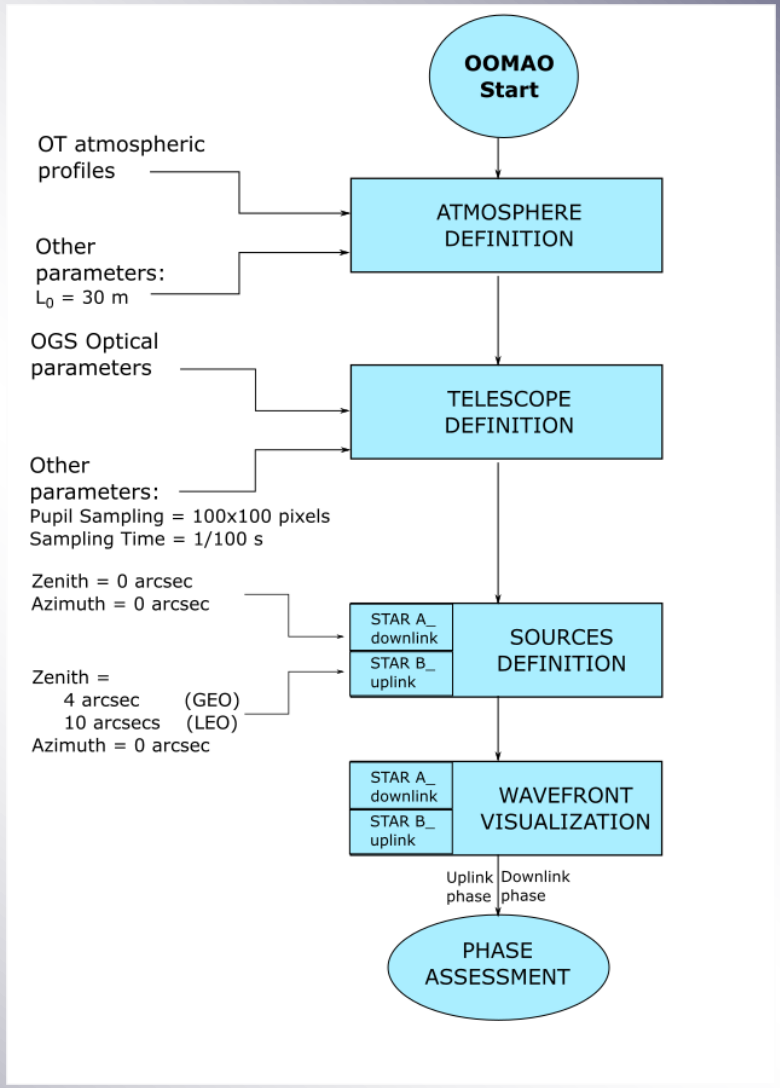

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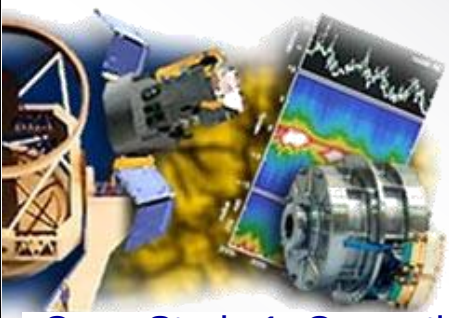
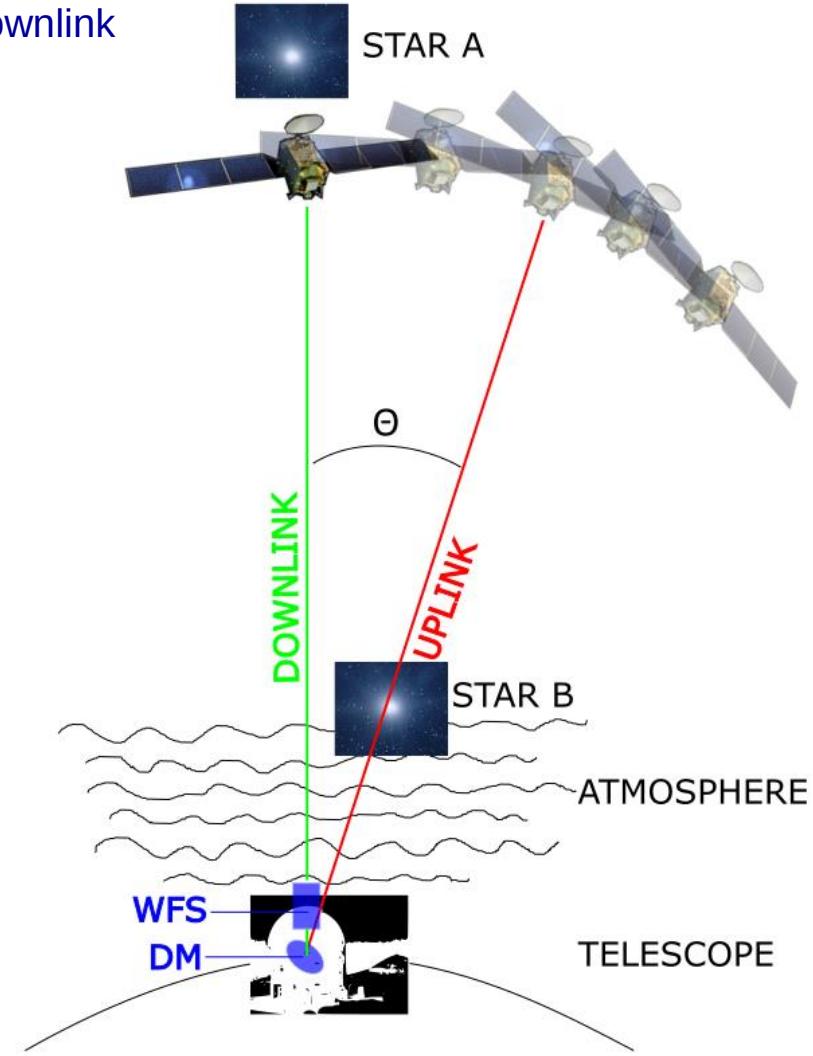


2. Simulations description

Case Study 1: Correcting the uplink with the downlink



Closing the AO loop

1. **Case study definition**
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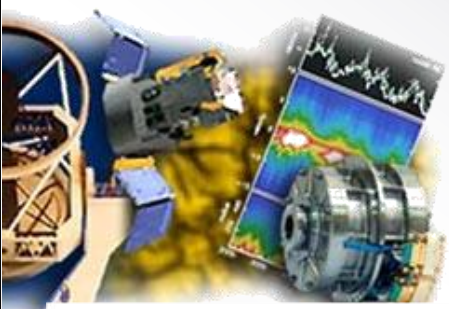
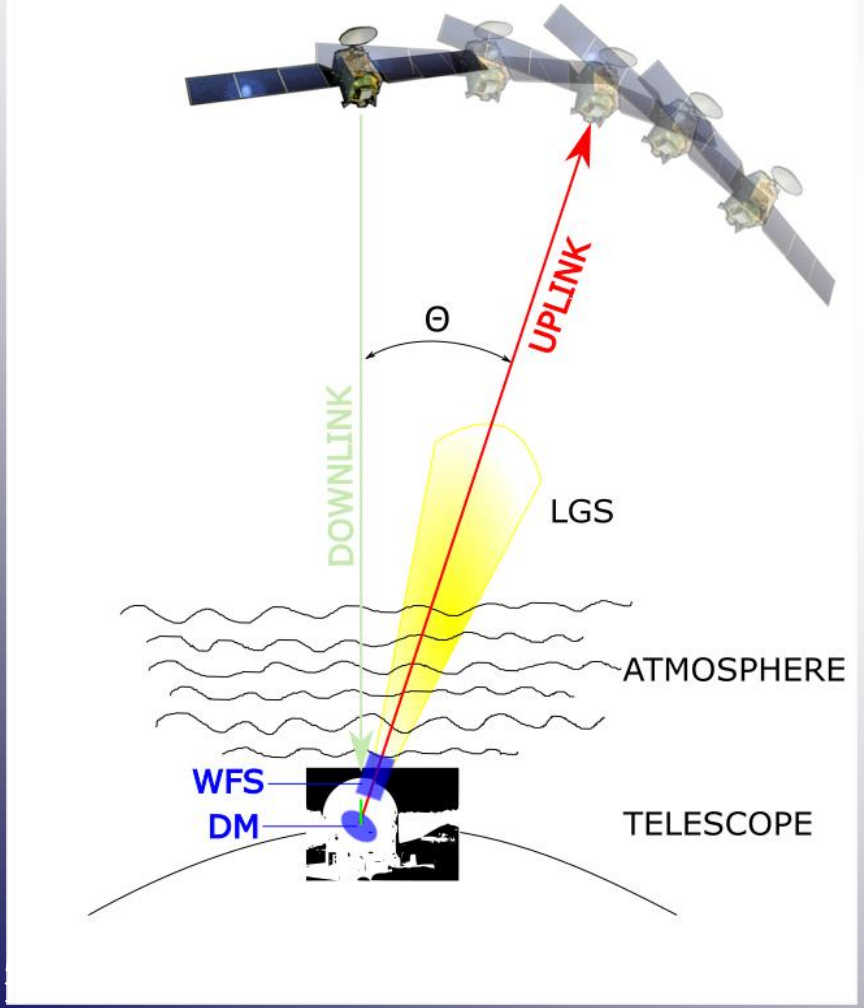
3. Simulation workflow



2. Simulations description

Case Study 2: Correcting the uplink with a Laser Guide Star



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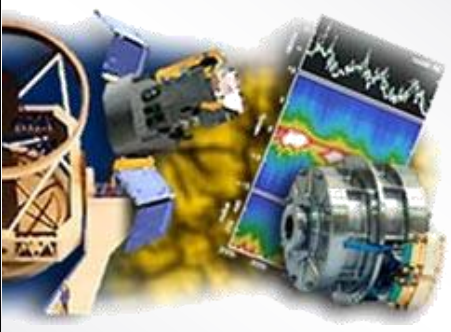
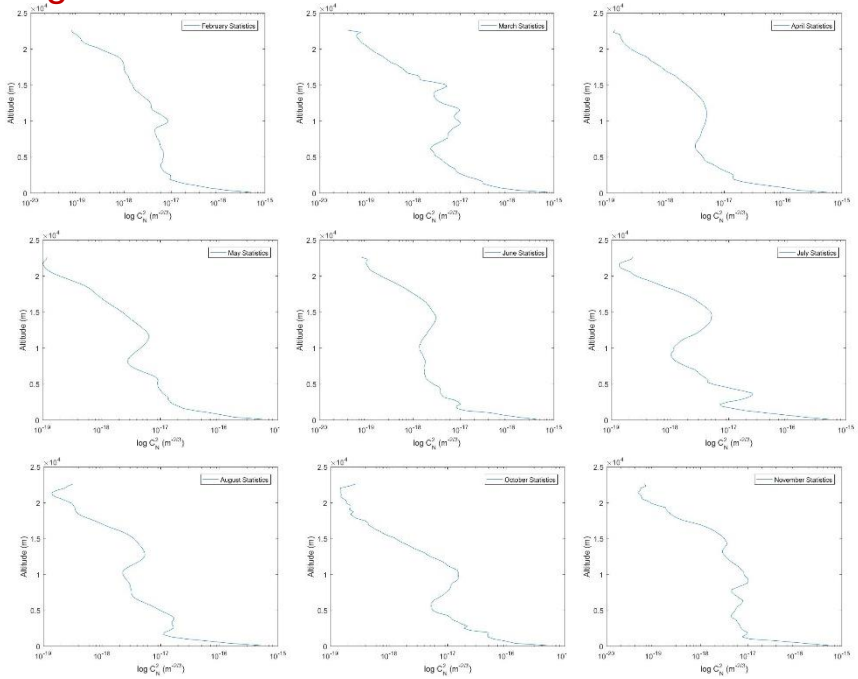


2. Simulations description

Observatorio del Teide – Atmospheric Profiles –

Night data



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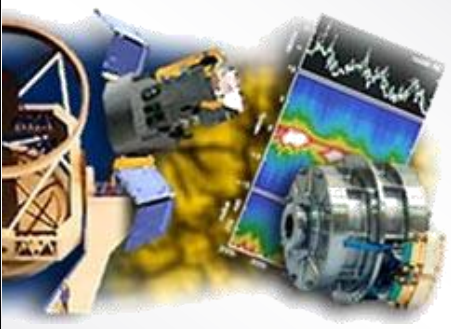

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Observatorio del Teide – Atmospheric Profiles –

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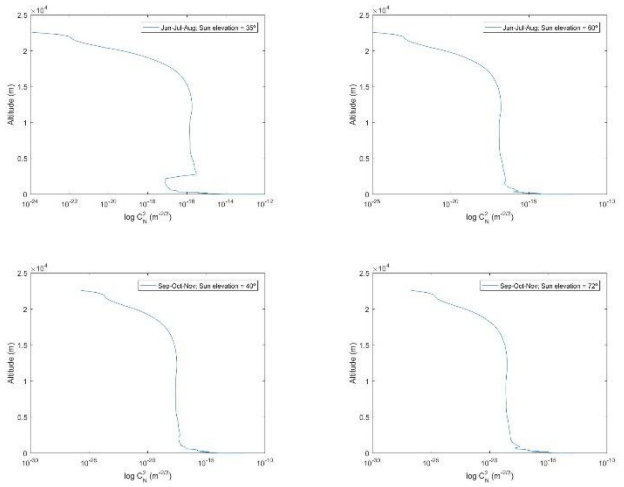

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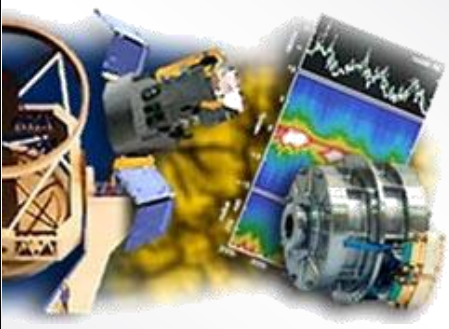

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3. Simulation workflow

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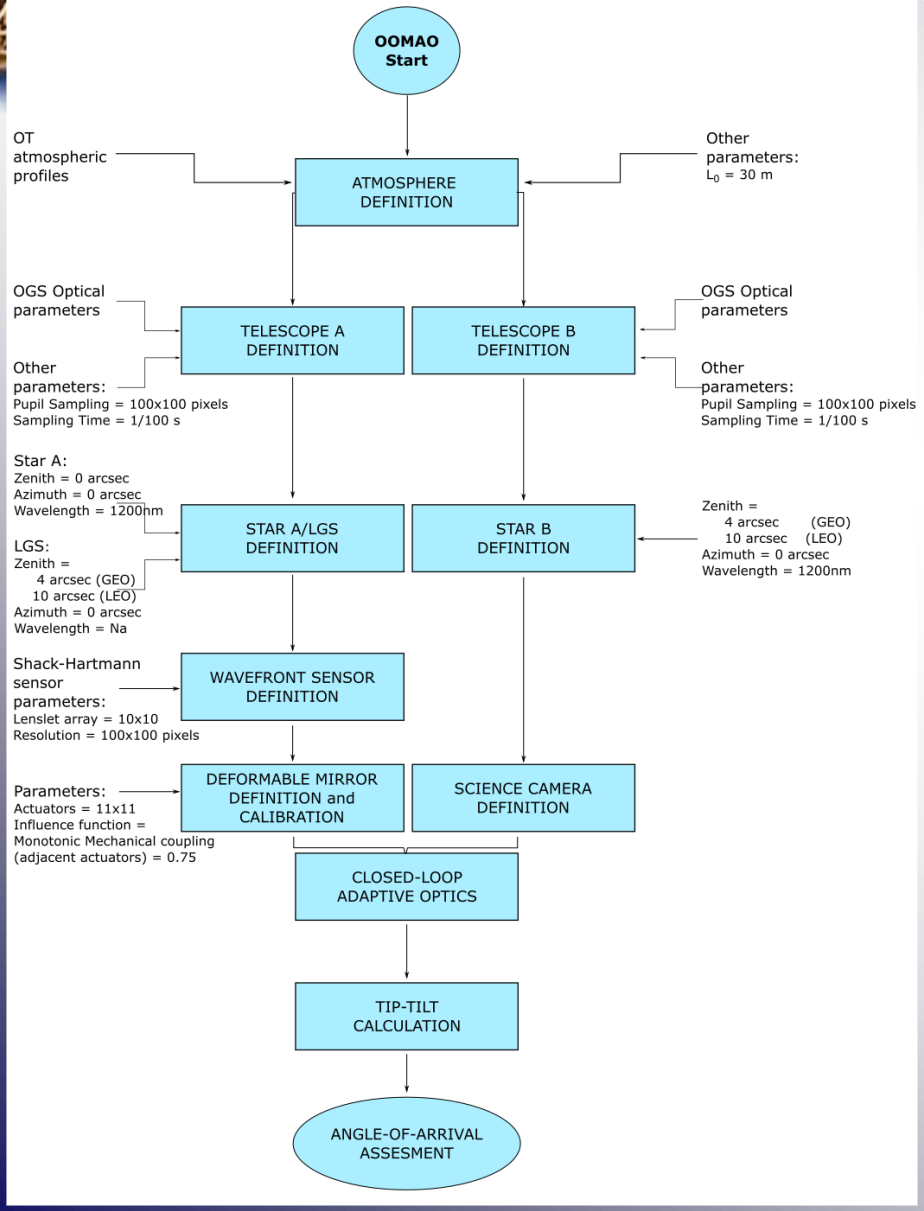

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2. Real available data
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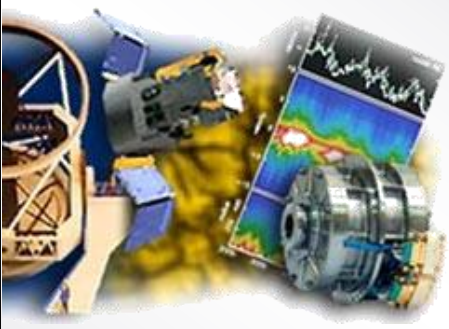

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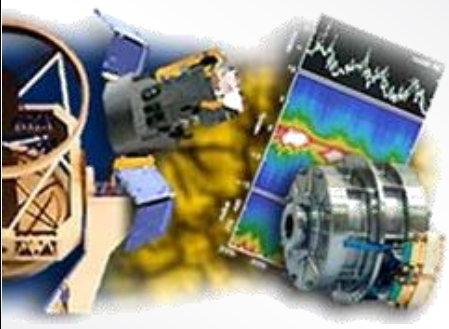


3. Simulations results

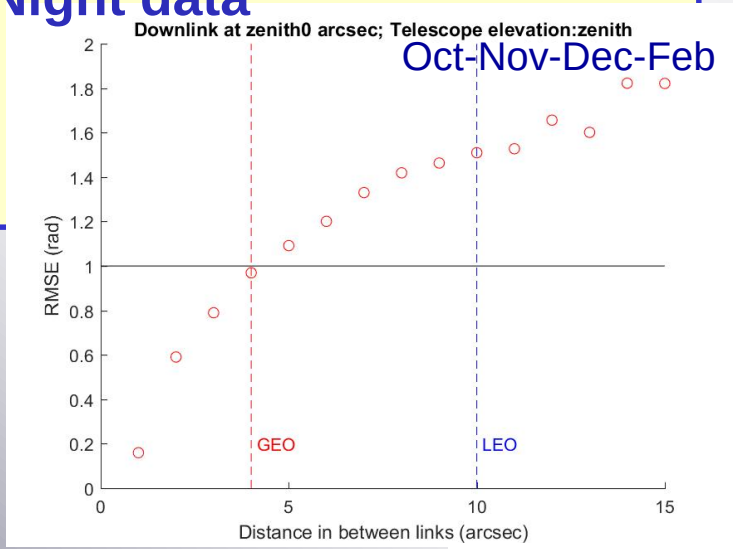
Analysing the isoplanatic patch

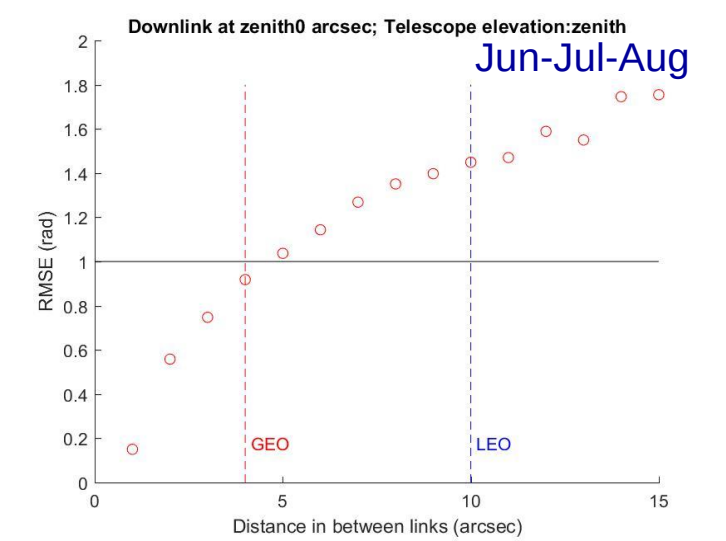
Closing the AO loop

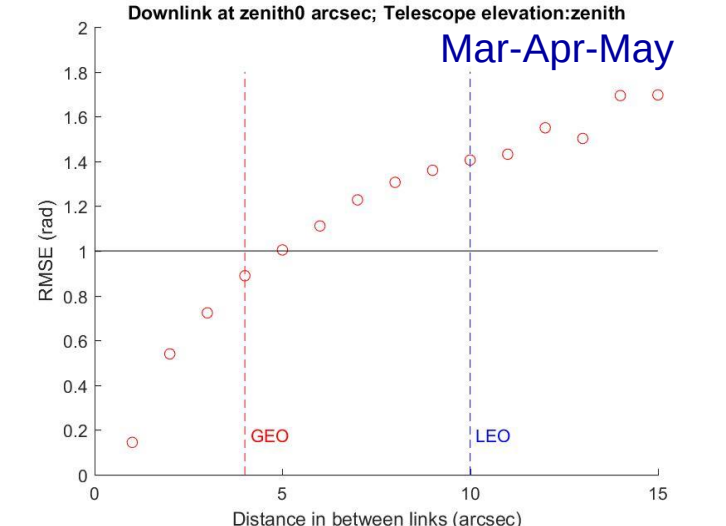
3. Simulations results

Analysing the isoplanatic patch

Night data







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Instituto de Astrofísica de Canarias

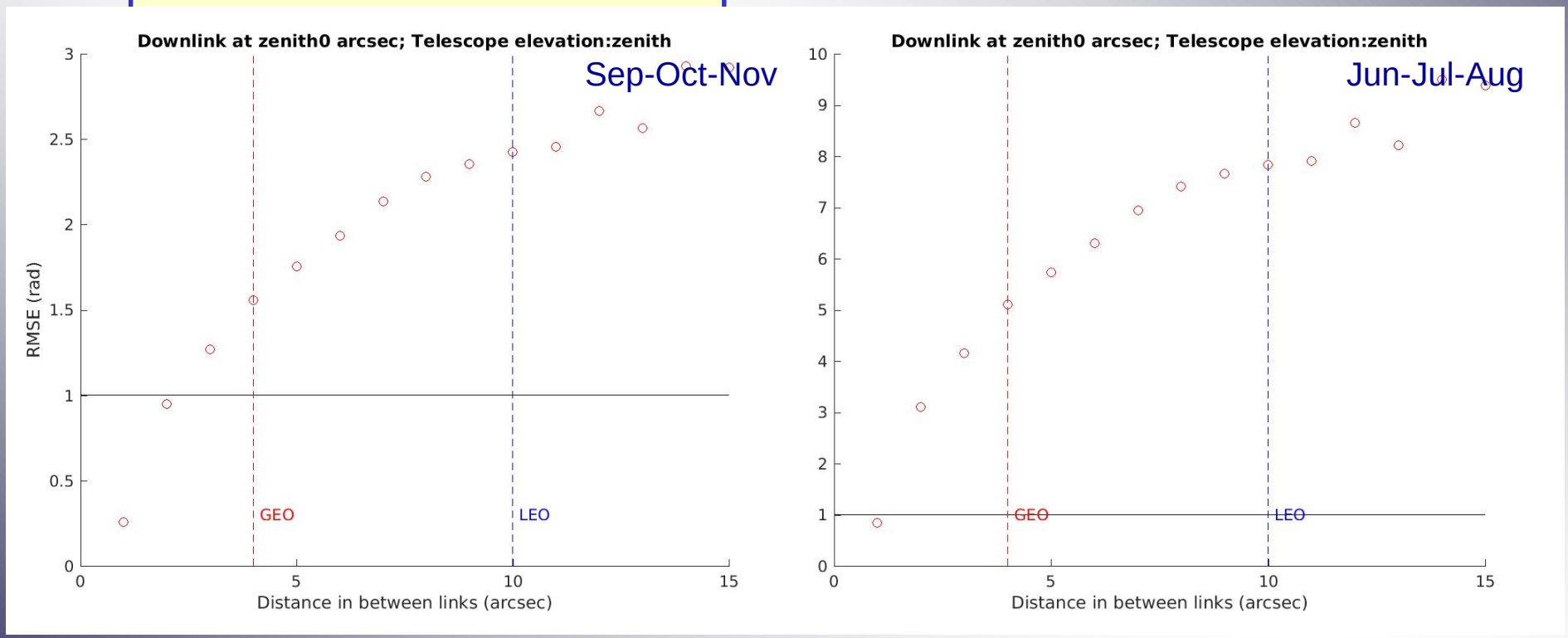
3. Simulations results

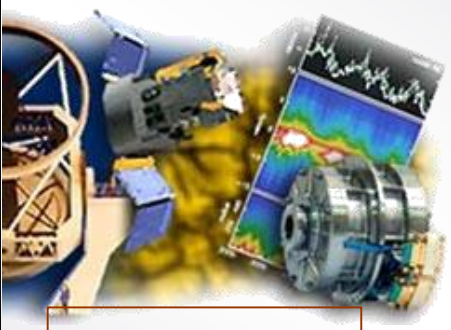
Simulations
n description

Future
work

Analysing the isoplanatic patch

Day data





3. Simulations results

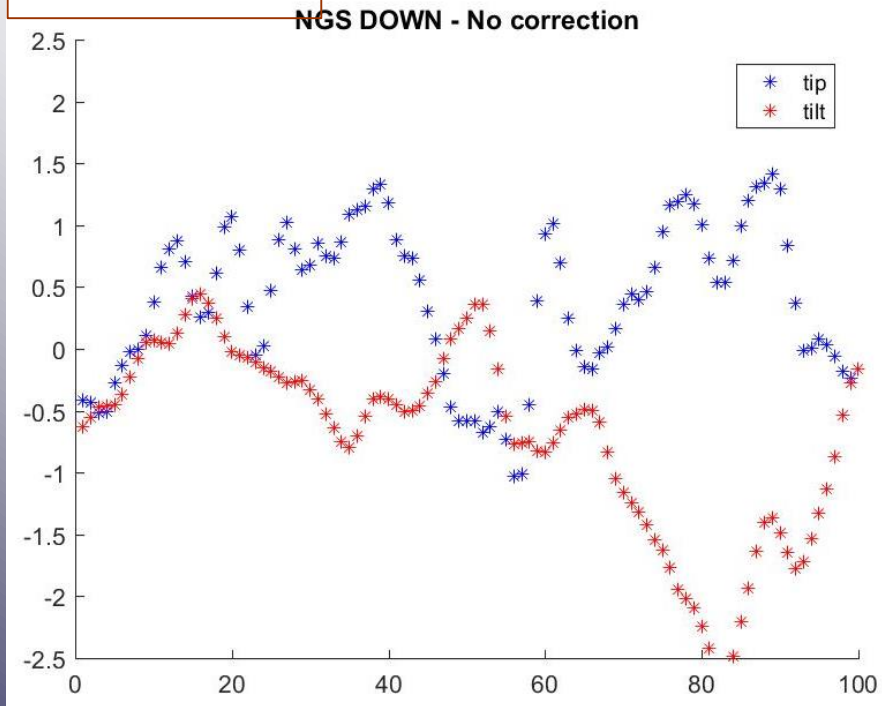
FSOC in turbulence medium

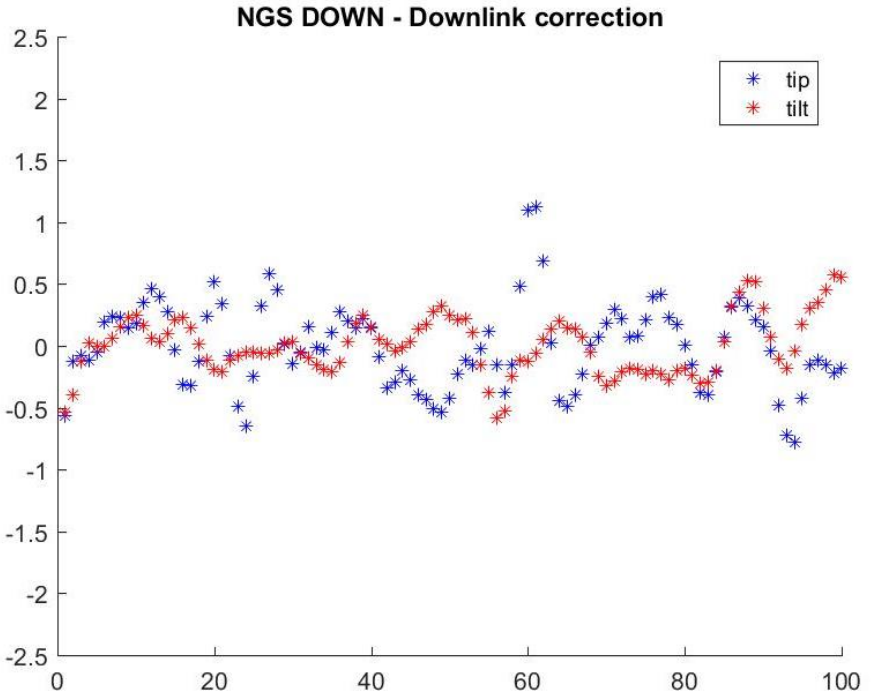
Simula descri

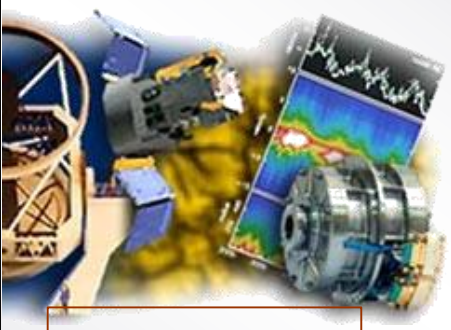
Closing the AO loop

Case Study 1: Correcting the uplink with the downlink

TIP-TILT ANALYSIS







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FSOC in turbulence medium

Simula descri

Closing the AO loop

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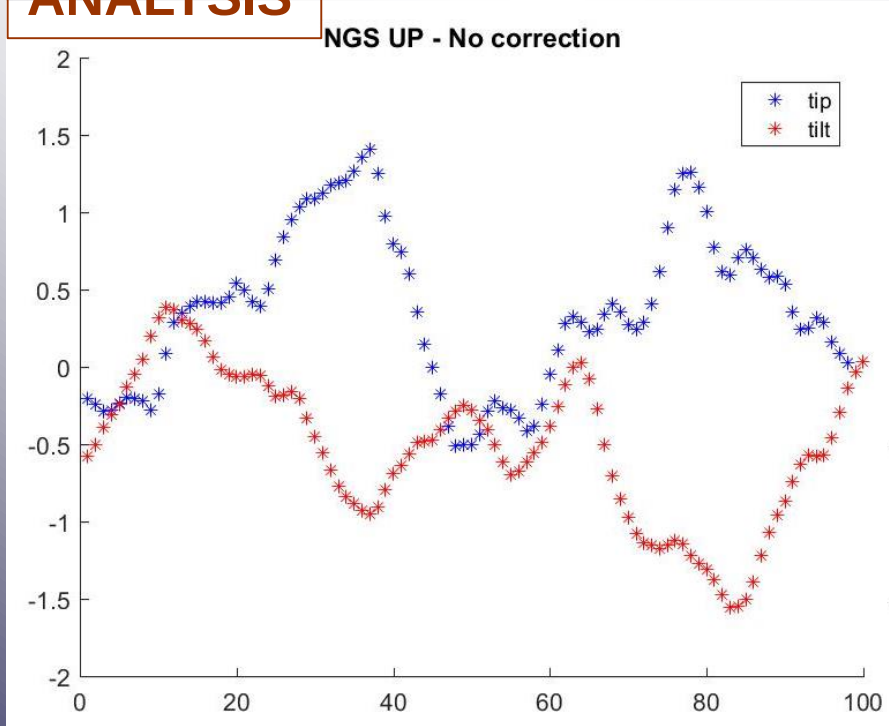
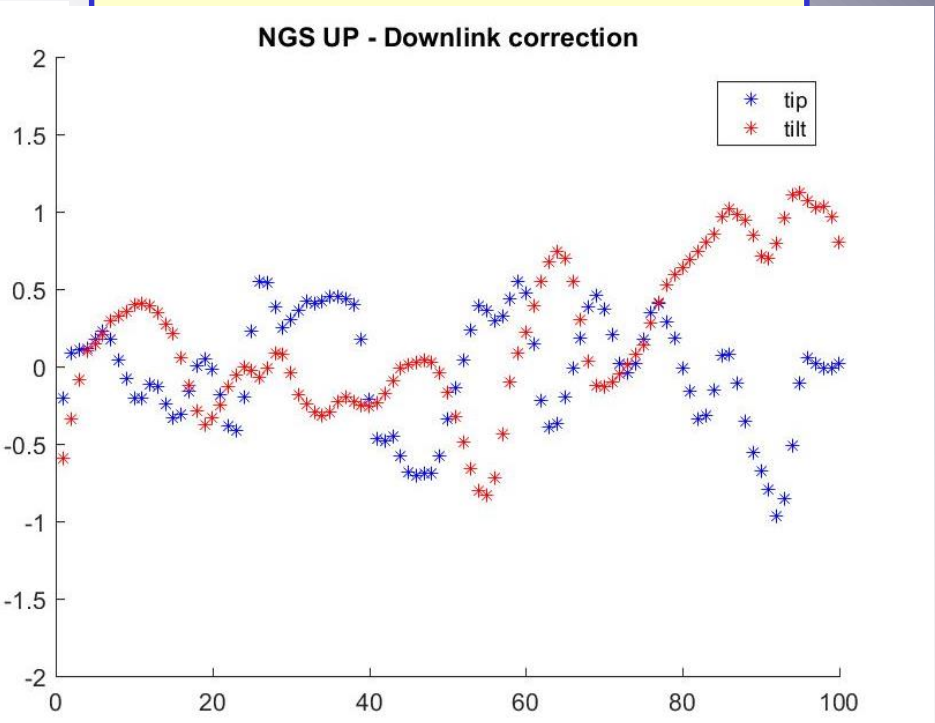
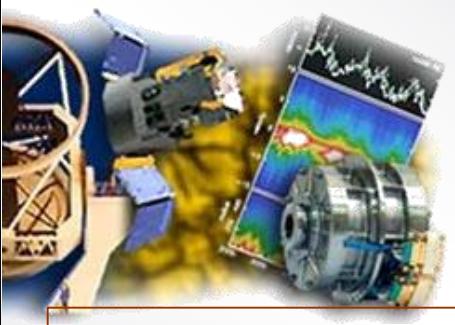




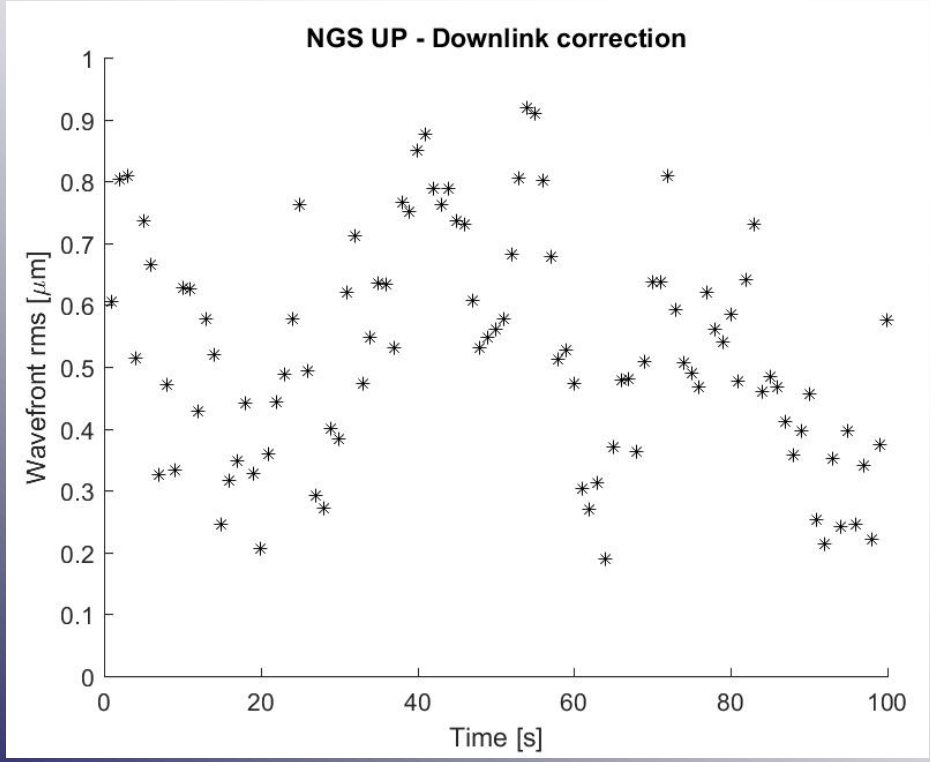


3. Simulations results

FSOC in turbulence medium

Simula descri

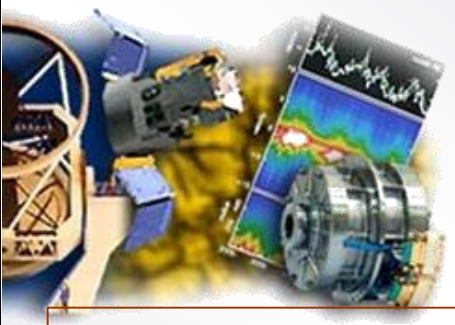
PHASE VARIANCE ANALYSIS



Closing the AO loop

Case Study 1: Correcting the uplink with the downlink

Case Study 2: Correcting the uplink with a Laser Guide Star



3. Simulations results

FSOC in turbulence medium

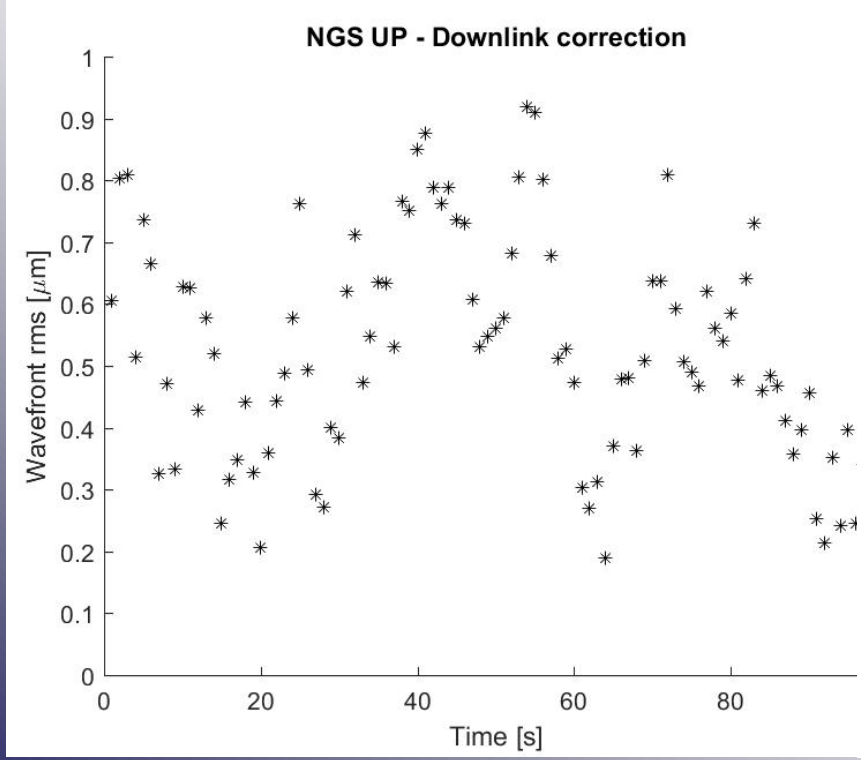
Simula descri

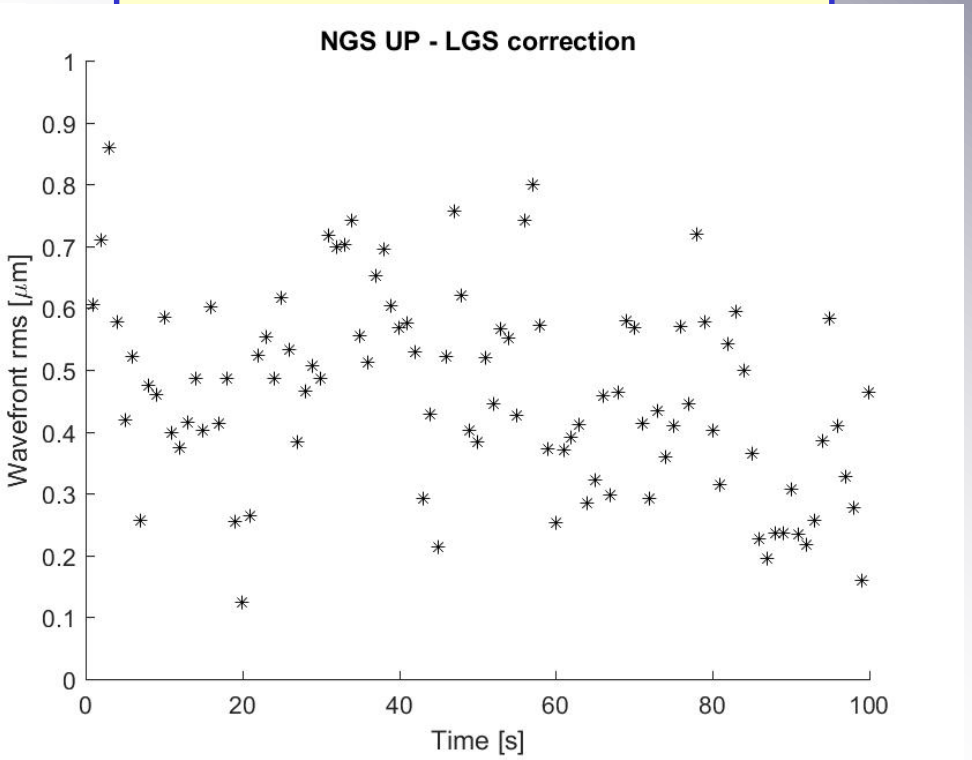
PHASE VARIANCE ANALYSIS

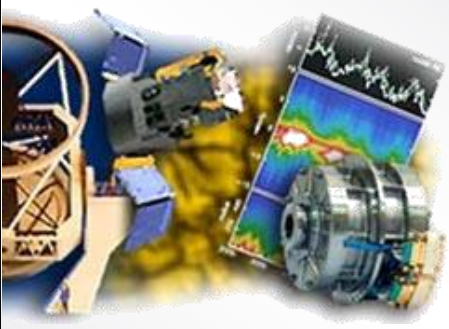
Closing the AO loop

Case Study 1: Correcting the uplink with the downlink

Case Study 2: Correcting the uplink with a Laser Guide Star







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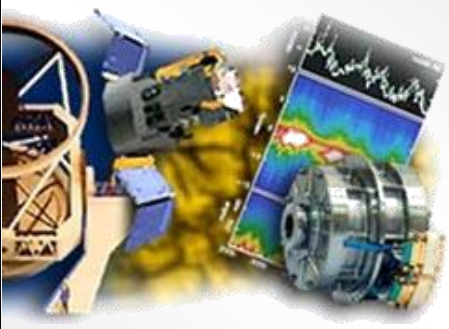
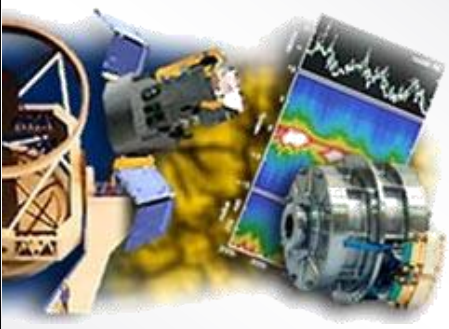


4. Future work

- Ongoing activity within the Technology Research Programme (TRP) with the European Space Agency.
- Further simulations regarding phase variance at the uplink.
- Lab testing and telescope testing.
- IACTEC – microsatellites programme.



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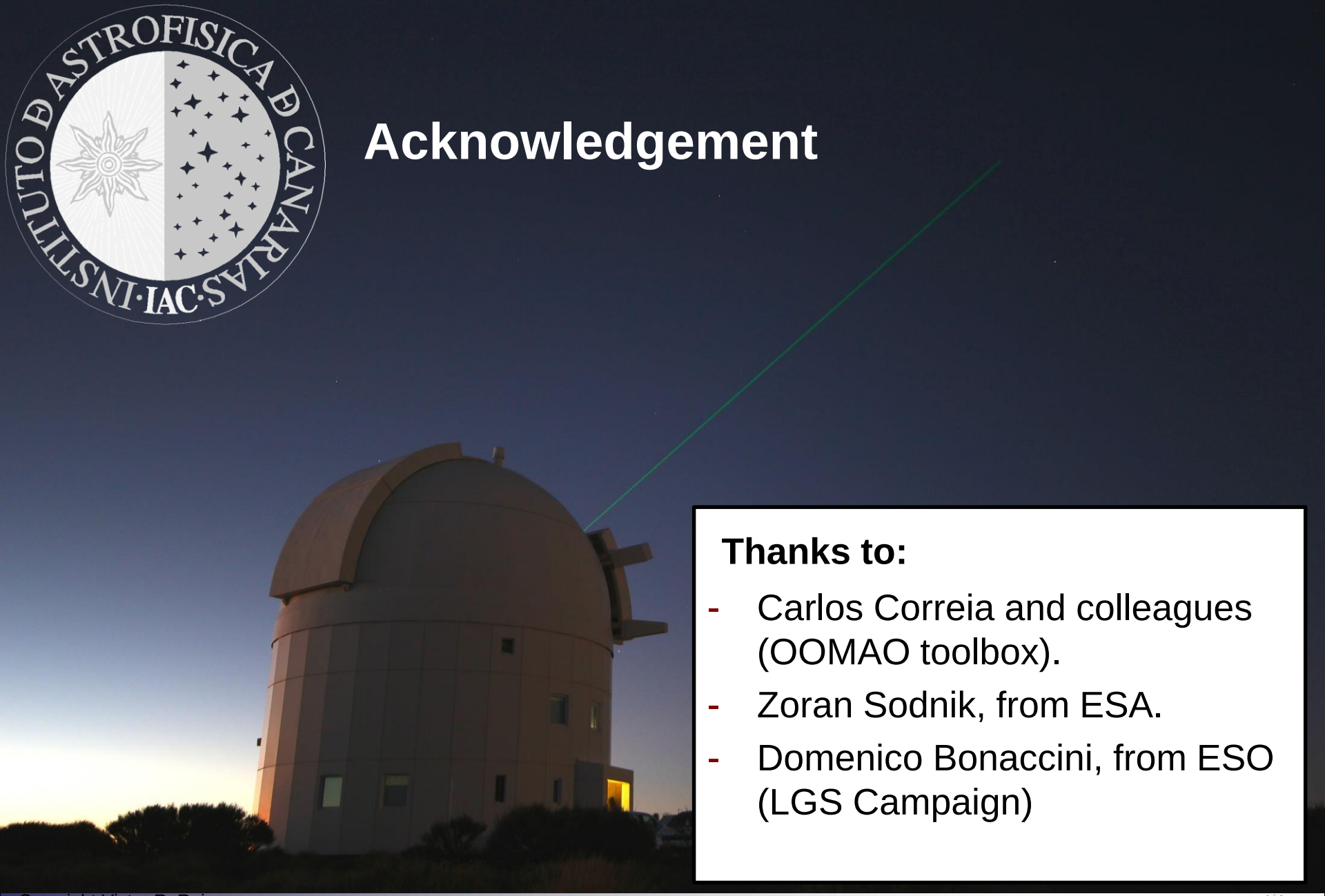
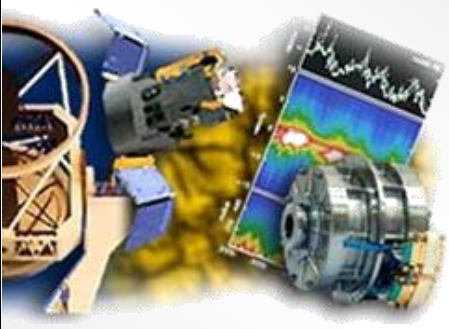
Acknowledgement



Thanks to:

- Carlos Correia and colleagues (OOMAO toolbox).
- Zoran Sodnik, from ESA.
- Domenico Bonaccini, from ESO (LGS Campaign)



INSTITUTO DE ASTROFÍSICA DE CANARIAS

Simulating the wavefront measurement in Free Space Optical Communications

And the use of Laser Guide Stars for FSOC

Noelia Martínez
Instituto de Astrofísica de Canarias