Calibration and Optimization of complex Adaptive Optics systems for Extremely Large Telescopes

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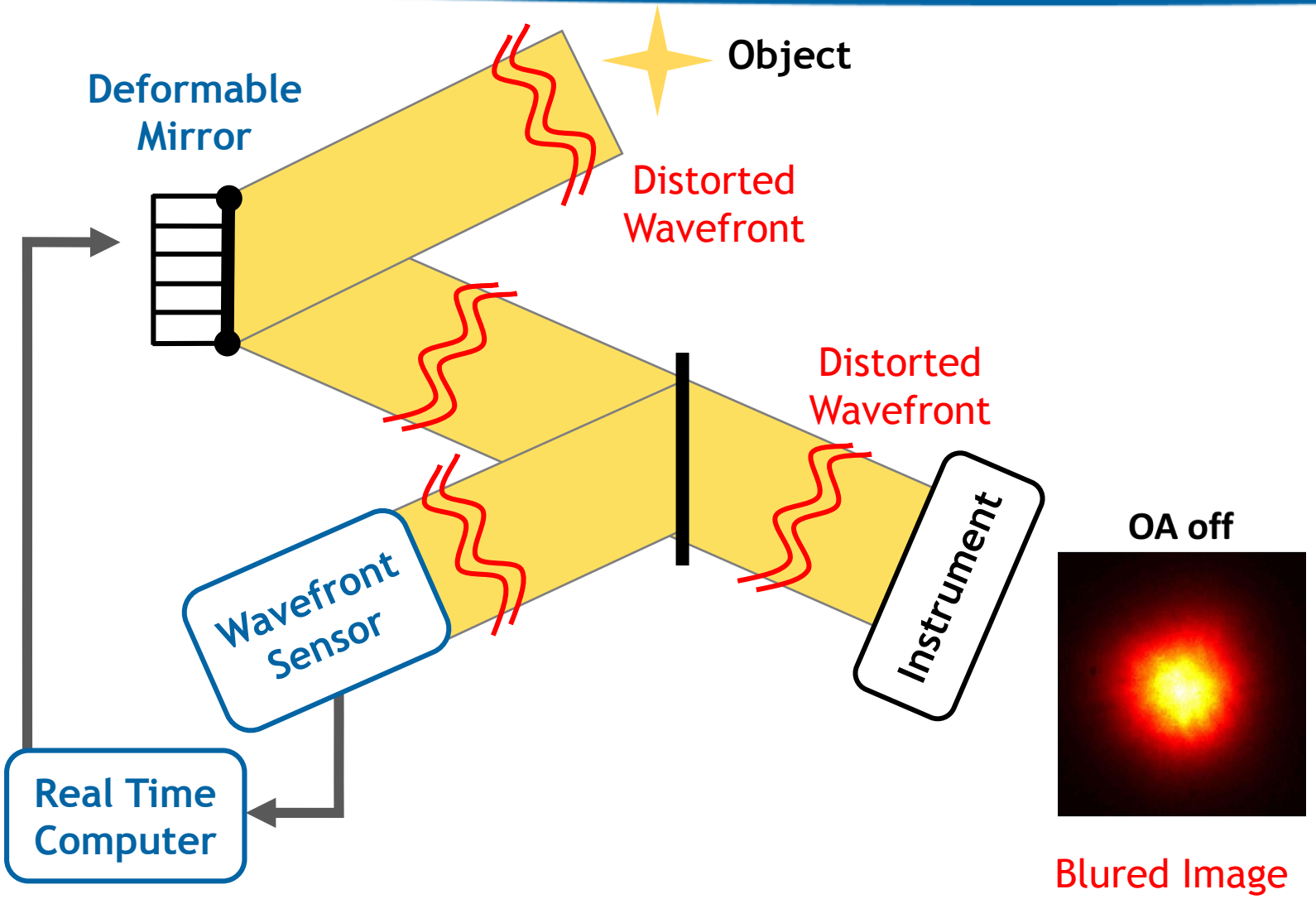
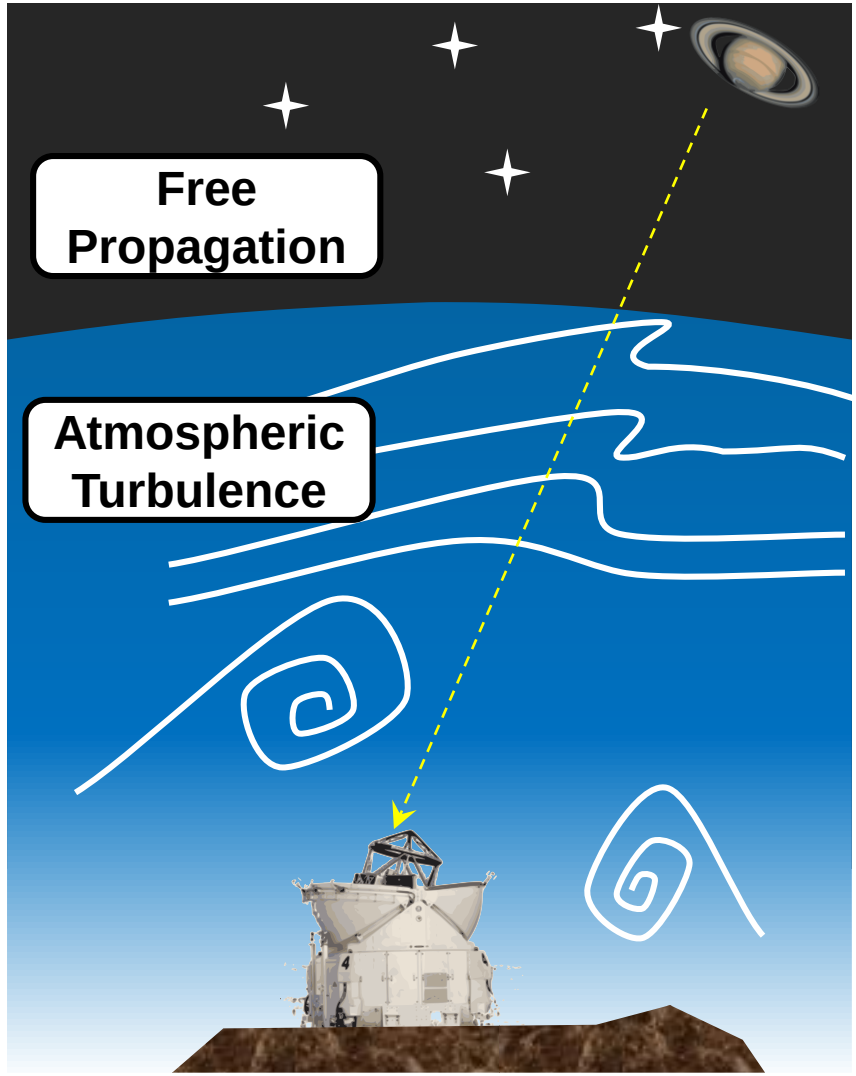
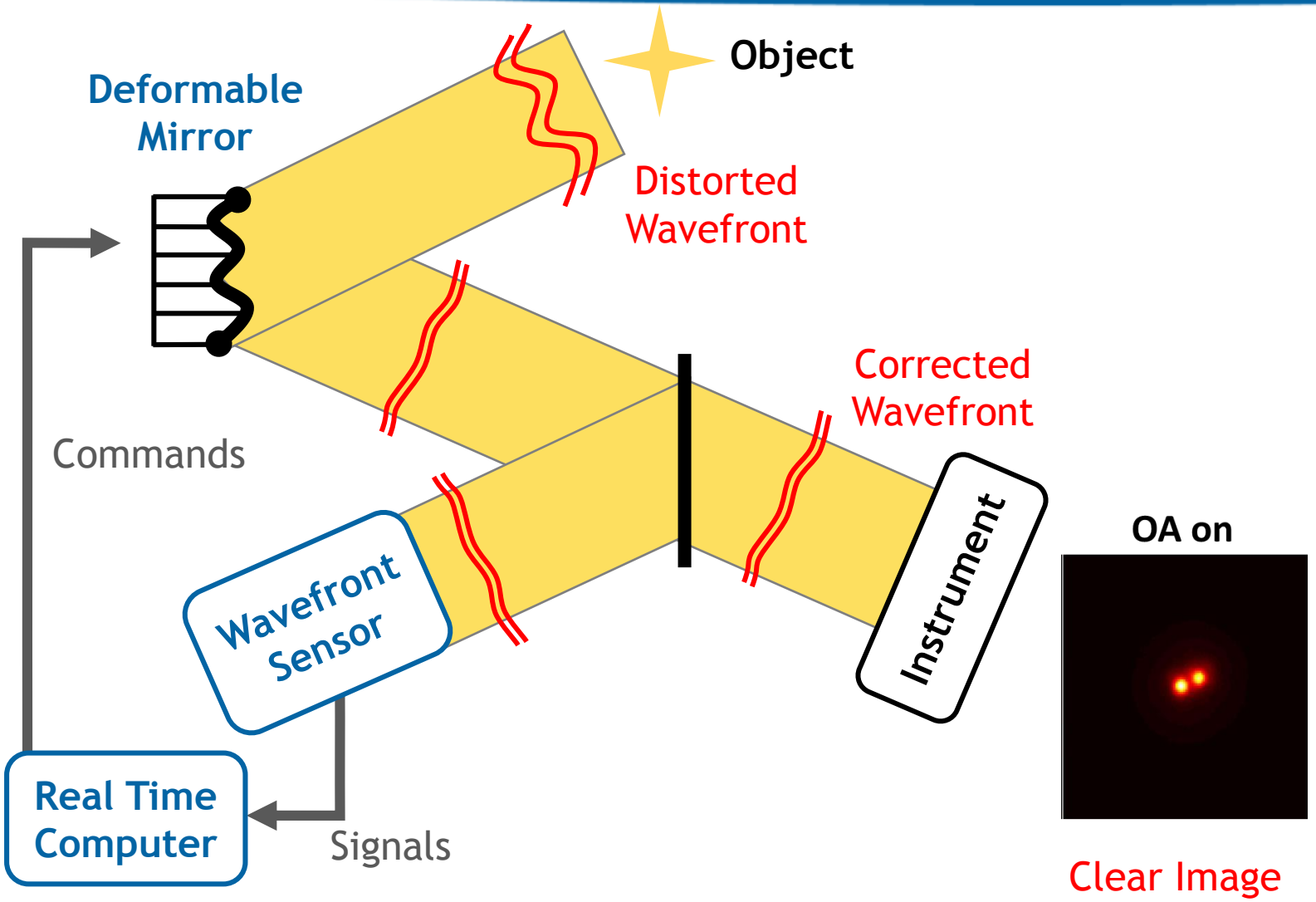
Adaptive Optics

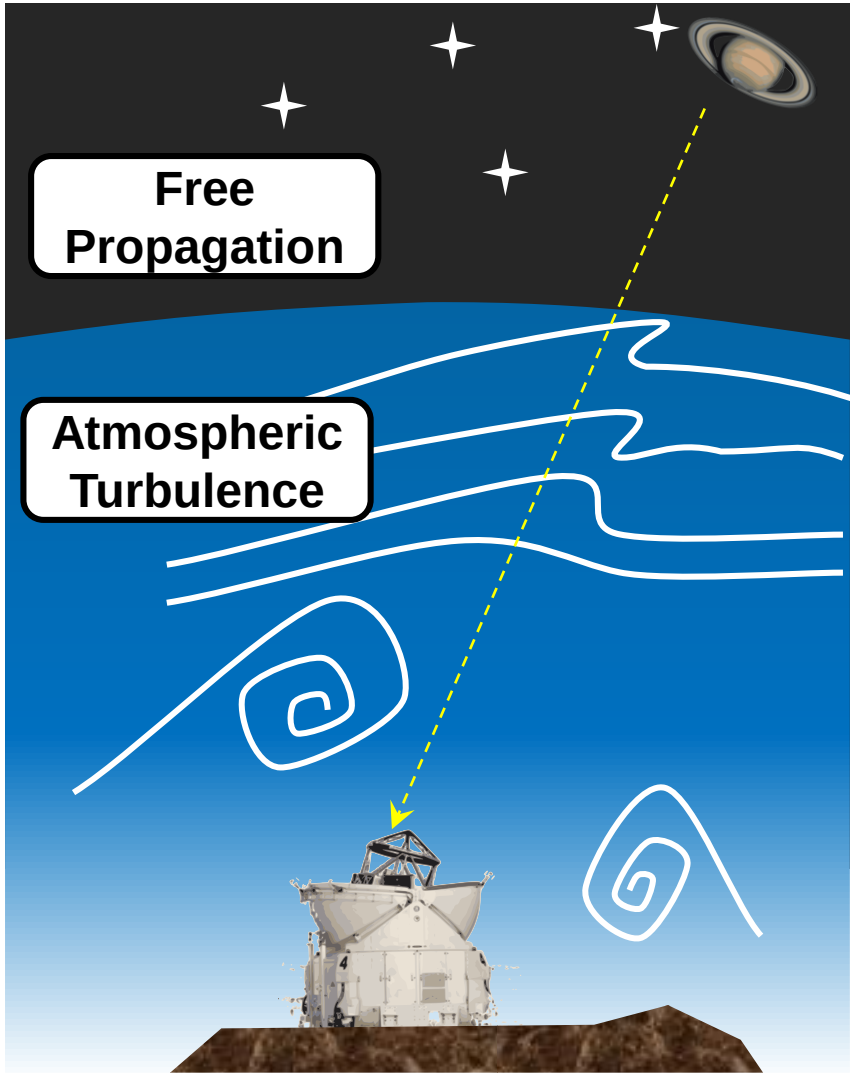




Credit images: ESO-MACAO @VLTI

Adaptive Optics





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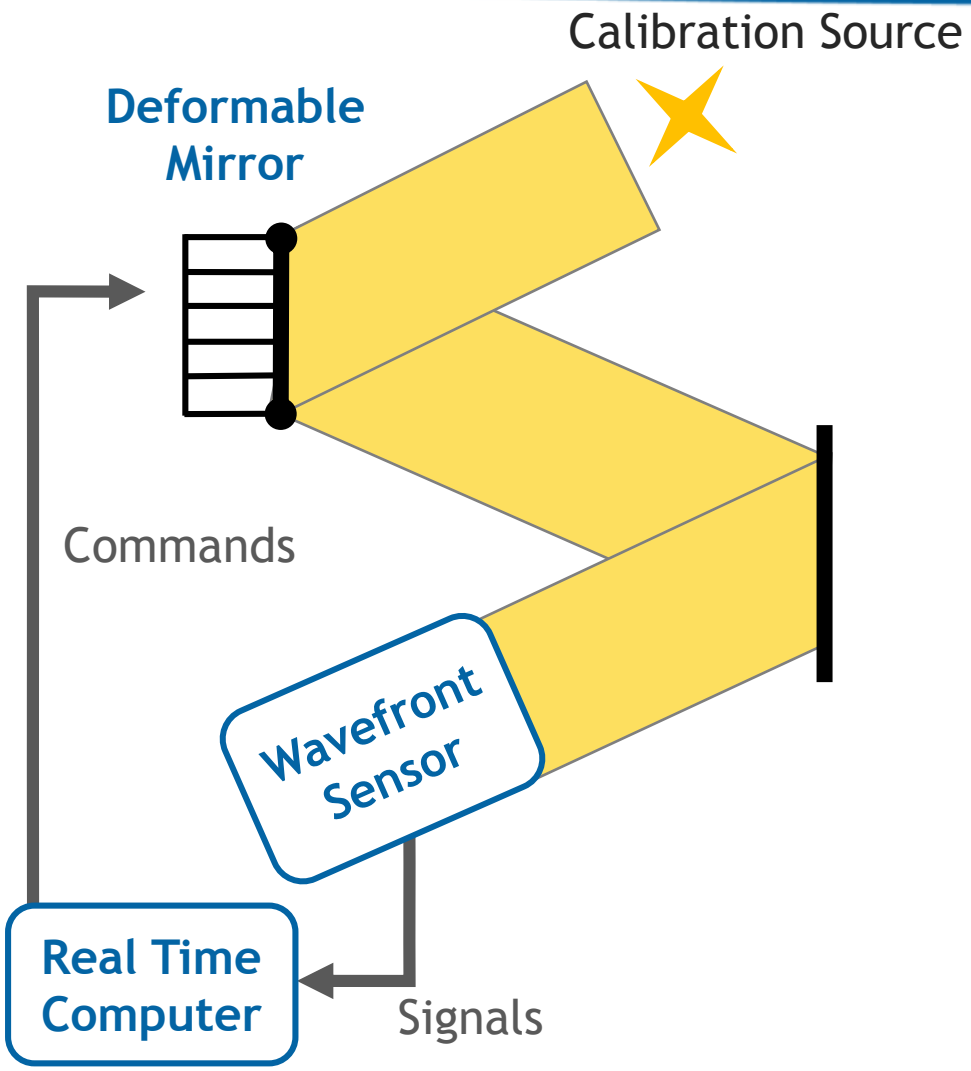
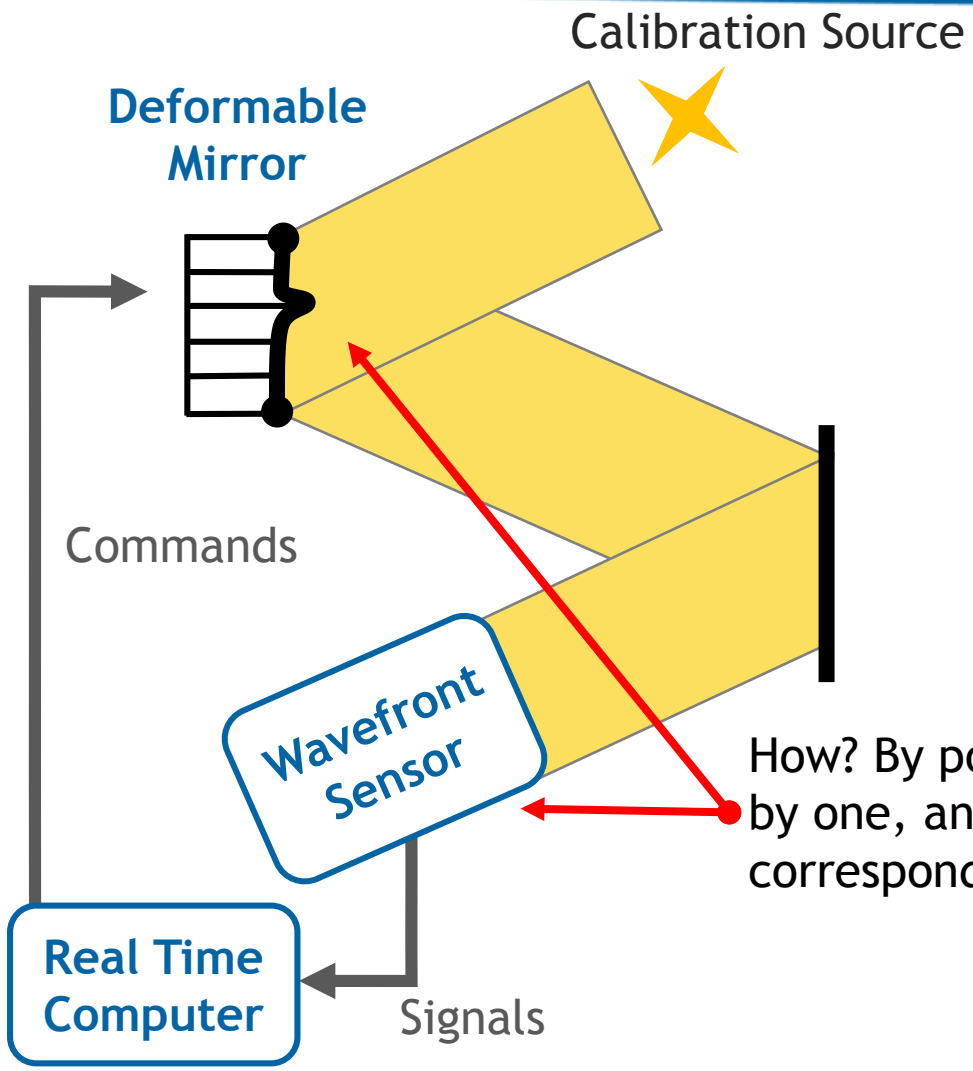
Adaptive Optics



Calibration is necessary!

Calibrate the link between the WFS signals and the DM actuators = Measure an **Interaction Matrix**

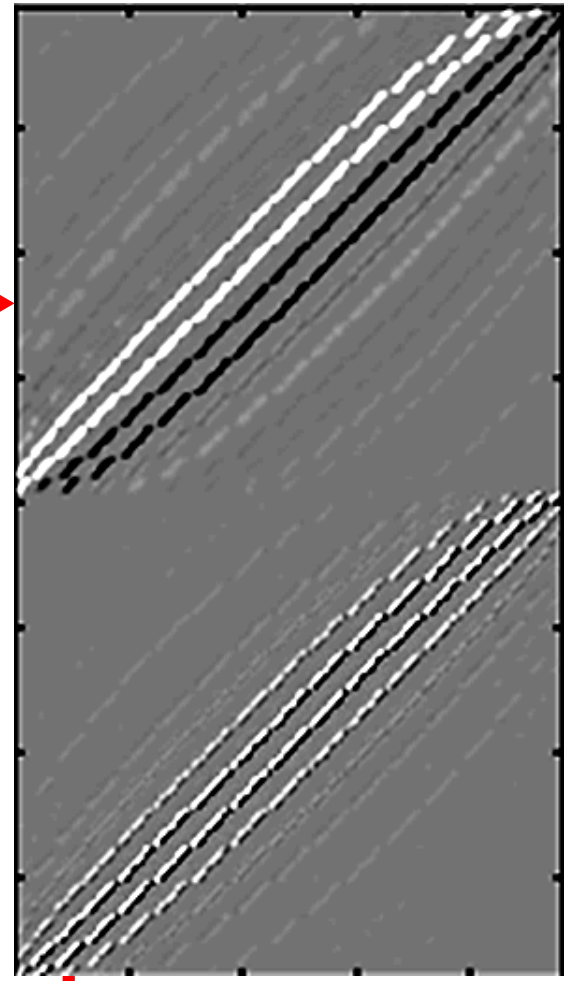
Adaptive Optics



Calibration is necessary!

Calibrate the link between the WFS signals and the DM actuators = Measure an **Interaction Matrix**

How? By poking on each actuator, one by one, and recording the corresponding WFS signal.



Context

Next generation of telescopes: the Extremely Large Telescopes

- Diameters up to 39 m => Get access to smaller details of the Universe!
- Problem: Atmospheric Turbulence => Instruments will rely on Adaptive Optics systems!
- Design of the E-ELT: constraining and challenging for the AO calibration

AO calibration in the ELT context

Constraining? Really?

- **No calibration source** ..... How do I **measure** the Interaction Matrix?
- Time to calibrate the system? ..... **Extremely Large** Telescope => **Extremely Large** Numbers of actuators!
- Adaptive Telescopes: Deformable Mirror inside the telescope ..... The DM will move with the telescope: shifts/rotation may appear between the DM and the WFS… **Fast updates** of the Interaction Matrix necessary!
- **Minimize impact on science**

AO calibration in the ELT context

Solutions?

- **On-Sky Interaction Matrix?**

I manage to calibrate the system, finding a way to get rid of the turbulence effect.

- **Synthetic Interaction Matrix?**

I reproduce my system in an AO simulator and generate the Interaction Matrix from there.

AO calibration in the ELT context

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Accurate

Noise-Free

Fast Update

AO calibration in the ELT context

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Accurate **Noise-Free** **Fast Update**

I want all of this!

AO calibration in the ELT context

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I manage to calibrate the system, finding a way to get rid of the turbulence effect.

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I try to reproduce my system in an AO simulator and generate the Interaction Matrix from there.

Pseudo-Synthetic Interaction Matrix!
Synthetic Models + On-Sky measurements of keys-parameters

Accurate, Noise-Free and fast to compute!

On going work

- Development of a synthetic model of the Large Binocular Telescope AO systems
- Validation of the model in AO simulator
- Tests of calibrations methods at the telescope + analysis of the model

Thank your for your attention!
Merci pour votre attention!