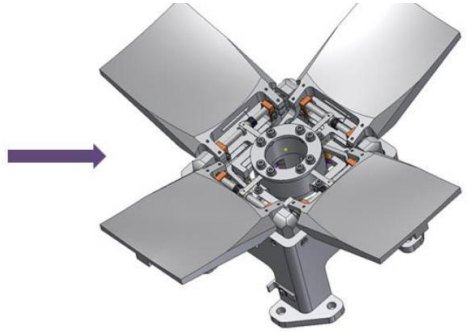
AZIMOV

A.I. for phasing a space deployable CubeSat telescope



ML/DL kick-off meeting, 2020-10-09

Institut Pythéas
Observatoire des Sciences de l'Univers
Aix*Marseille Université

AZIMOV concept : a deployable telescope for CubeSat

LAM
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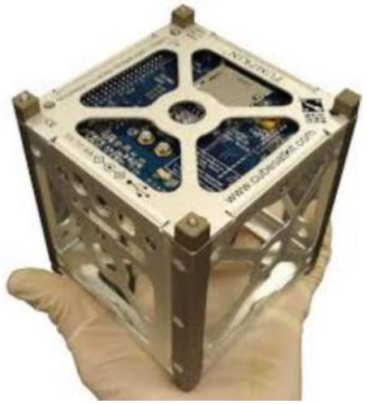
Context

- NewSpace
  - Low cost small platform
  - Naturally increases the revisit rate
  - CubeSat : 10cm size



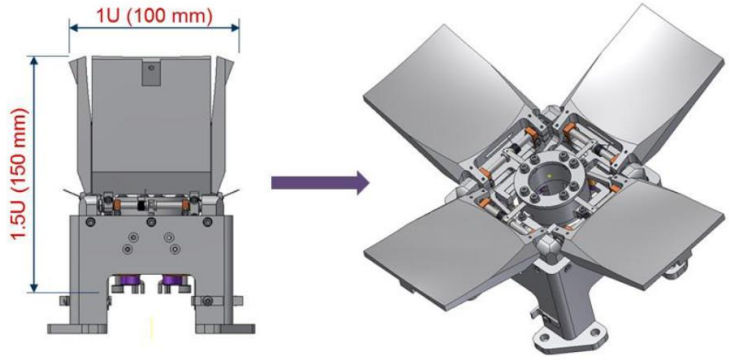
- Spatial resolution
  - Optics aperture limited to 10cm
  - Ground resolution limited to >3m

3.0 m resolution
(10 cm at 500 km)

1.0 m resolution
(30 cm at 500 km)

Objectives of the AZIMOV project

- Establish a scientific road-map
- Demonstrate large aperture on small platform in space
  - **Deployable telescope** (Primary, Secondary, Baffle)
    - 30cm deployed => Metric resolution on the ground
  - Combination of **Active optics** and **Artificial Intelligence**



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Solar system exploration

Transient phenomenon exploration

- Mars atmosphere seasonal variations
- Volcanisme or cryo-volcanism: Io / Encelade / Europe
- Comets (activity)

High spatial resolution

- State of the Art of large apertures for SS Exploration:
  - Caméra sur New Horizon : IFOV de 4 microrad (miroir de 20.8 cm)
  - Caméra NAC sur Rosetta : IFOV de 18 microrad (miroir 13.6 cm)
  - Caméra HRI sur Deep Impact : IFOV de 2 microrad (miroir 35.5 cm)
  - Caméra Cassis sur Mars TGO: FOV de 12 microrad (miroir 13.5 cm)

Stereo imaging

- Between CubeSat and mothership
- Formation flight with 2 CubeSats

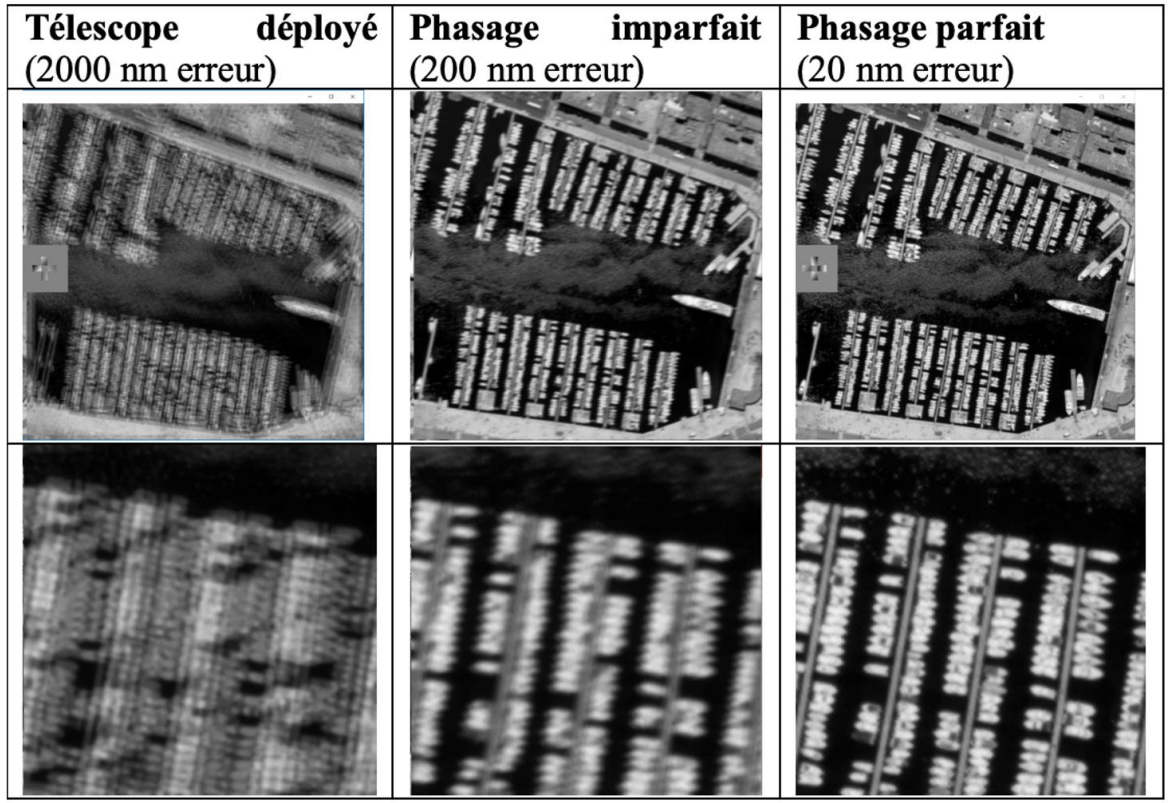
Allocating an error budget for a CubeSat

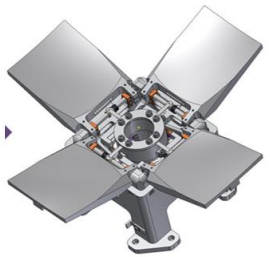
Quality criterion of a High Angular Resolution system:

- **Full Width Half Maximum** => Final resolution
- **Strehl Ratio** => SNR and resolution
- **Residual jitter** (PSF stability) => Final resolution

Typical acceptable errors for a diffraction limited system

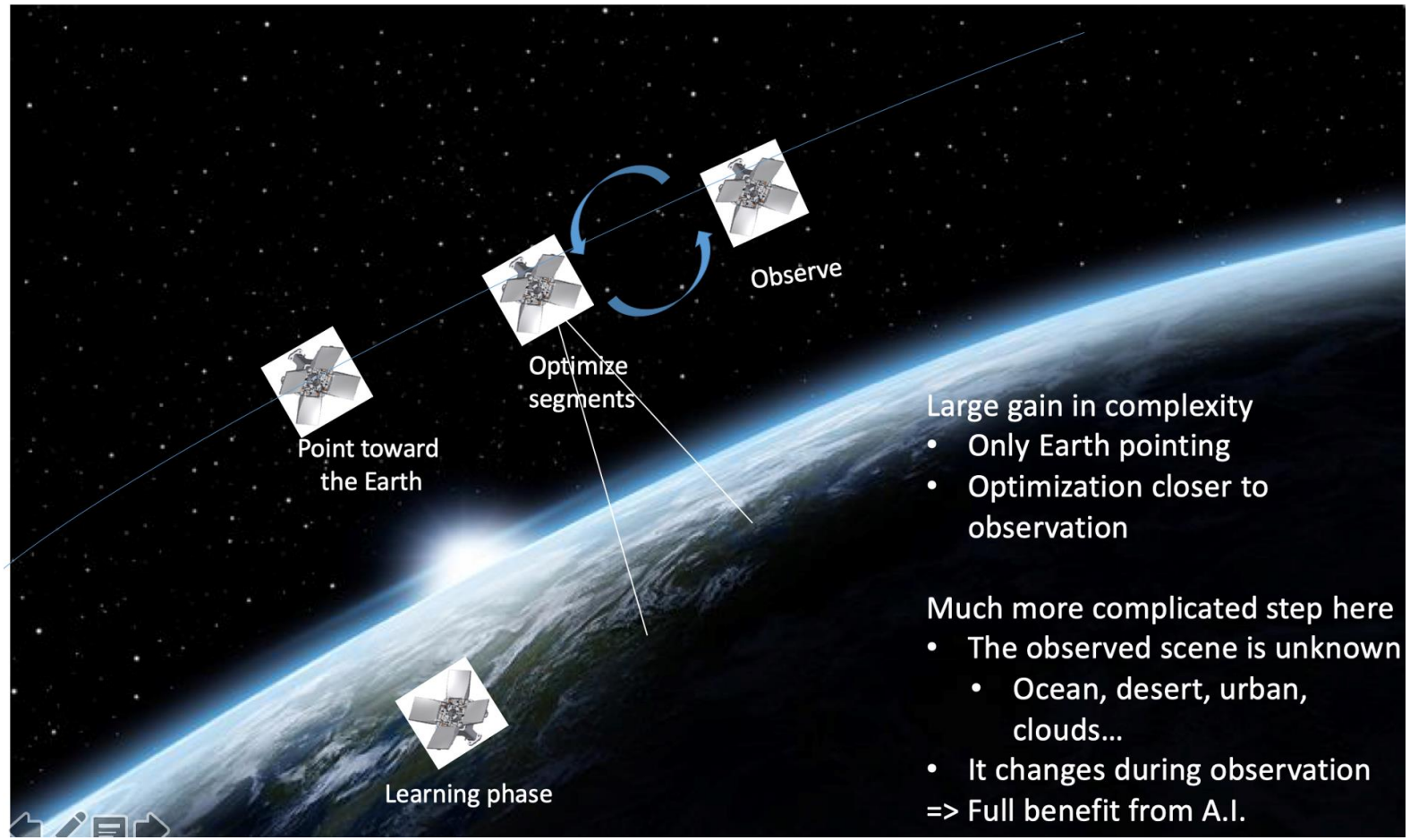
- Diffraction angle = **0.4 arcsec** (0.3m aperture @ λ = 0.6μm)
- **OPD error < lambda / 15**, goal lambda / 20
  - Lambda = 600nm => **OPD error < 40nm RMS residual** (goal 30nm)
- **Residual jitter < 0.04 arcsec** (goal 0.02 arcsec)
- **Drift during an exposure < 0.04 arcsec** (goal 0.02 arcsec)





AZIMOV – phasing segments in space

- Smart methods: artificial intelligence
  - Goal : perform phasing directly by observing the ground
  - Based on NN algorithms
  - Learning phase on the ground
  - How does NN algorithm behave for optical aberration measurement ?



- AZIMOV : request for funding at H2020
  - Build a demonstrator of CubeSat deployable telescope
- Collaboration with INESC-TEC (Porto Univ.)
  - Specialist of A.I.
  - Contact : C. Correia (ex GRD)
- PhD (start fall 2021) planned
  - A.I. for WFS on small platform

Attentes du pôle

- AI pour le WFS : domaine nouveau pour GRD
  - On a des contacts avec des Experts du sujet dans notre projet
  - Activité en lien fort avec d'autres activités GRD (Olivier B-M)

- Besoin d'un suivi / expertise externe pour suivre notre projet

- Besoin d'échanges
  - De type « journal club » : présentation régulières de méthodes existantes
  - De type « suivi / expertise externe » sur cette activité
  - De type « informations diverses » : workshop / conférences d'intérêt