

30th IADC meeting / WG1

# Optical tumbling rate observation LEO and GTO objects

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a part of this work was done by amateur Thierry Legault

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Montreal

# GTO observation using TAROT telescopes

## System description

- Site

- ◆ La Silla observatory (Chile)

- Tarot Telescope

- ◆ Aperture : 250 mm
- ◆ Field of view :  $1,86^\circ$

- Andor Camera

- ◆ efficiency about 90% in R and V band
- ◆ noise about 8 e<sup>-</sup> / pixel

- Exposure mode

- ◆ Motors off
- ◆ 10 second exposure time
- ◆ Series of three images
- ◆ 10 secondes between each image

### ●RADAR

- ◆Monge radar tracking campaign
  - » Collision avoidance experiments for CNES
  - » SSA experiments for ESA
- ◆Reentry campaigns
  - » IADC 2011 exercices : UARS, ROSAT
  - » International exchange of data : Phobos-Grunt

### ●Optical

- ◆Infrared Observations
  - » Theoretical study, Tarot experiments
- ◆Experimental catalog of GEO and GTO objects
- ◆Image processing
  - » Project of a WG1 processing description form

### ●Tumbling rates measurement experiments

- ◆Radar : Le Monge
- ◆Optical : Tarot + amateur observations

# GTO observation using TAROT telescopes

## Objects description

- 2011-049C : Ariane 5 R/B
  - ◆ Apogee altitude : 35500 km
  - ◆ Perigee altitude : 250 km
  - ◆ Measure conditions
    - » Date 2012-03-24T06:26:29
    - » Elevation on horizon : 11°
    - » Altitude : 10000 km
- Photometric cycle duration measured
  - ◆ 2,49+/- 0,02 seconds

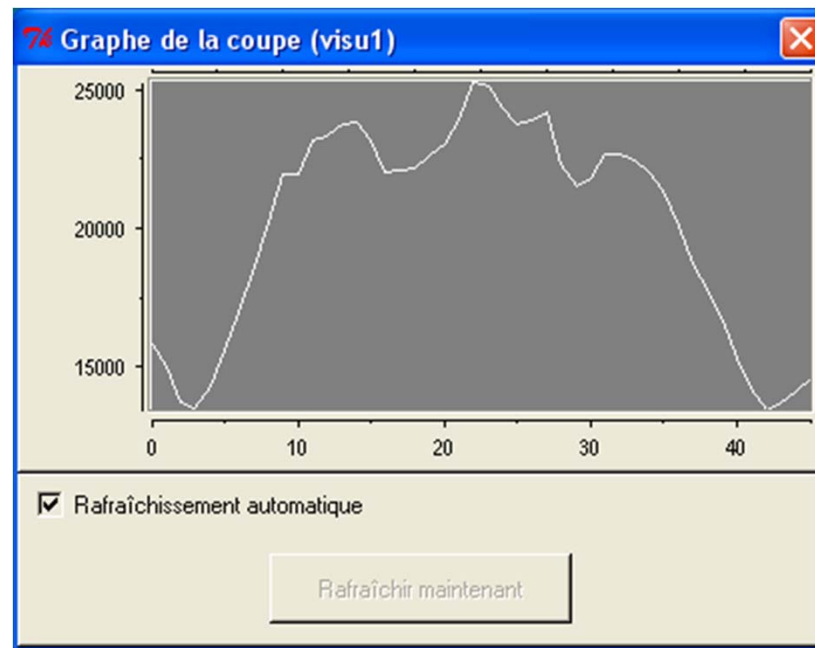
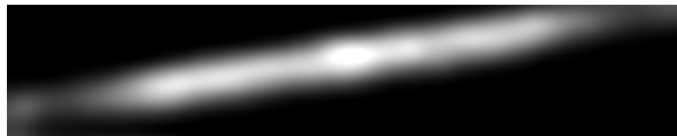


# GTO observation using TAROT telescopes

## Superposition of 9 photometric measures

● 2011-049C : Ariane 5 DEB

◆ The 3 cycles of the 3 images are summed to improve S/N ratio



## GTO observation using TAROT telescopes

### Objects description

- 2011-022C : Ariane 5 R/B

- ◆ Apogee altitude : 34200 km

- ◆ Perigee altitude : 230 km

- ◆ Measure conditions

- » Date 2012-03-11T05:45:54

- » Elevation on horizon : 22°

- » Altitude : 6300 km

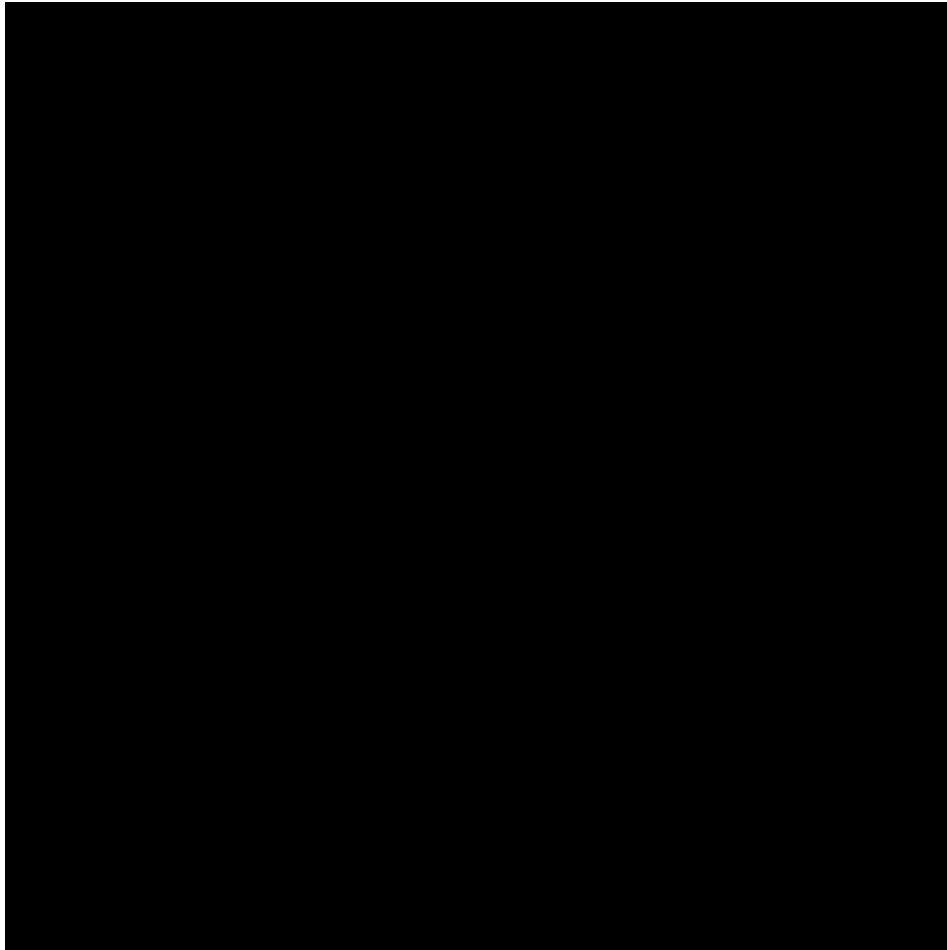
- Photometric cycle duration measured

- ◆ 1,29+/- 0,03 seconds



## LEO rocket body observation by amateur Thierry Legault

- Site : Elancourt, 30 km by car from Eiffel tower
- Telescope
  - ◆ Celestron 14 : 350 mm aperture
- Camera
  - ◆ Lumenera Skynyx L2-2
- Date : 2012-04- 01, altitude 772 km, min distance 896 km
- Image processing
  - ◆ Images are centered on the object
  - ◆ Each image of the movie presented is the sum of 10 images
  - ◆ Cadence of the movie is approximate real time





## Conclusions on tumbling rates

- These measures seem coherent with theory about tumbling rates
- LEO
  - ✦ Electromagnetic effects should stop tumbling in about 220 days
- GTO
  - ✦ High tumbling rates could be explained by the variations of excitation direction.
  
- French radar measurements of tumbling rates will be presented in WG1/WG2 joint session.