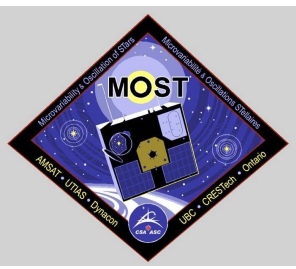


Mikro-satelita MOST

(Micro-Oscillations of STars)

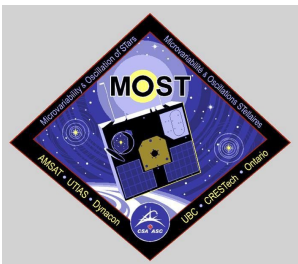
Slawek Rucinski

Zjazd Polskiego Towarzystwa Astronomicznego
Krakow 2009



Cele i założenia

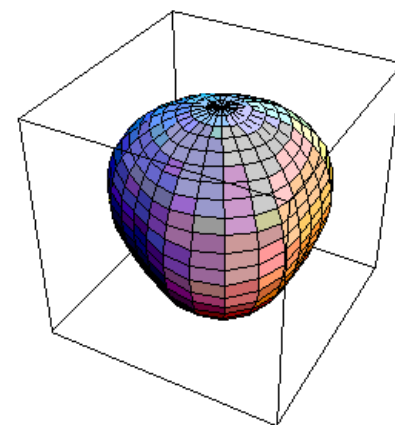
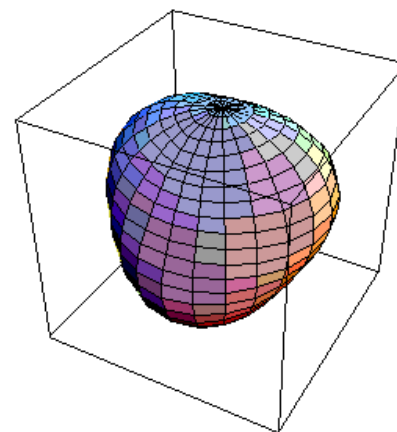
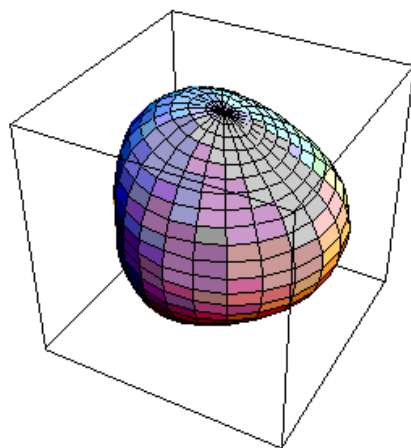
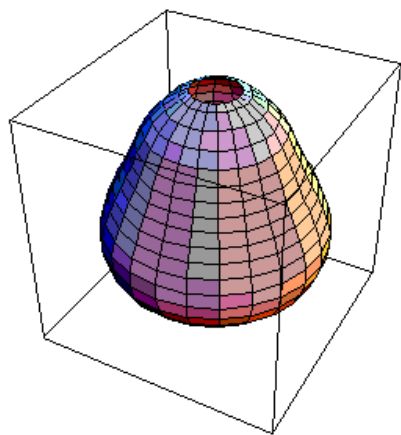
- Nieprzerwane obserwacje fotometryczne jasnych (<6 mag) gwiazd.
- Kadencja: ~minuta, ciągłość: ~miesiąc.
- Możliwość fotometrii do ~ 12 mag.
- Wysoka dokładność dla jasnych gwiazd:
 - $<0.05\%$ obserwacja (eksp. 15 sek – 1 min)
 - $<0.002\%$ składowa fourierowska.
- Test technologii stabilizacji małych satelitów.
- Pierwszy całkowicie kanadyjski satelita od 30 lat.
- Pierwszy mikro-satelita (<100 kg) do celów astronomicznych.

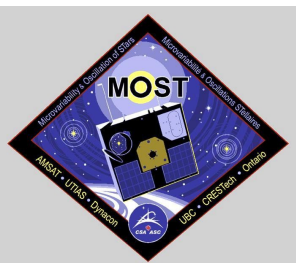


Cele naukowe

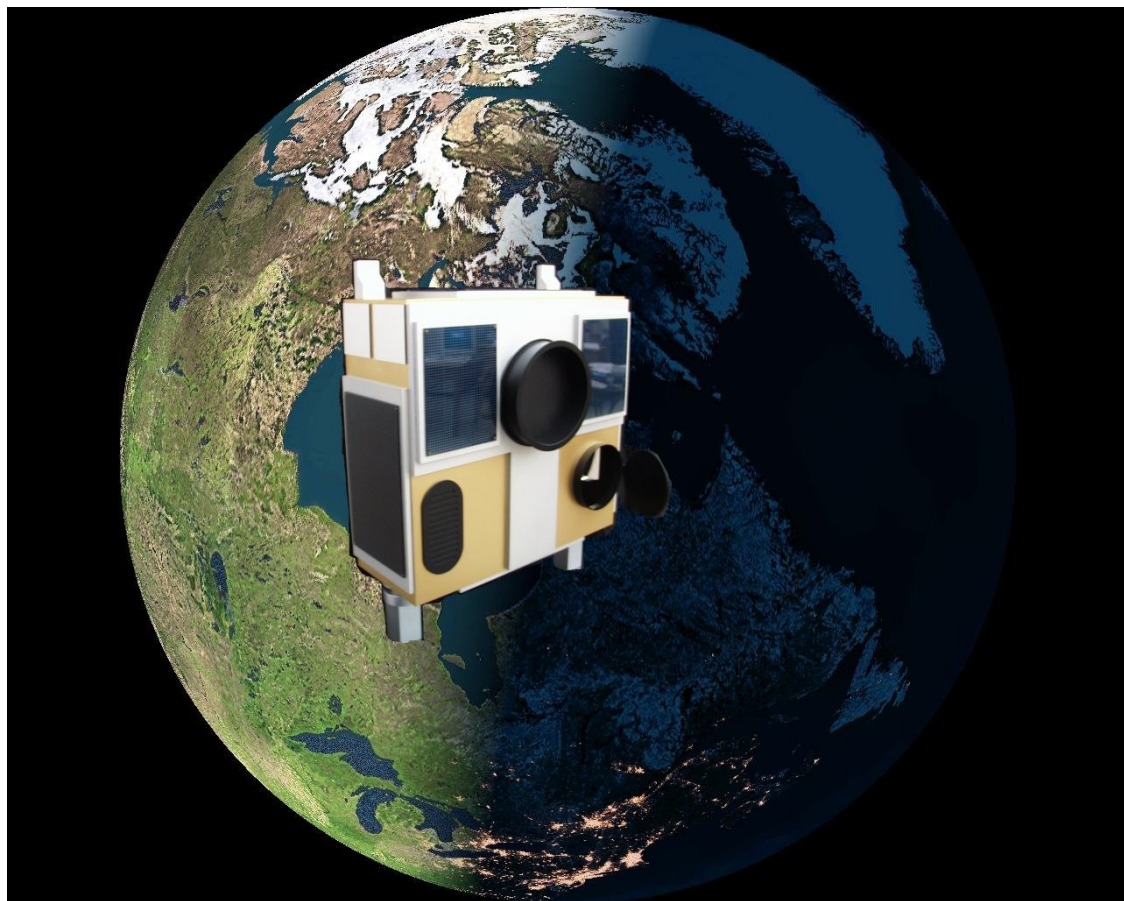
- Pulsacje gwiazd
- p-mode w gwiazdach ciągu głównego (Procyon)
- roAp, δ Sct, WD, etc

- Mechanizmy turbulencji w wiatrach gwiazd typu WR
- Zmiany jasności gwiazd z planetami
- Procesy akrecyjne w gwiazdach T Tauri





Dane techniczne



Rozmiary: $60 \times 60 \times 24$ cm

Waga: 54 kg

Pobor mocy: 30W

Orbita zmierzch/swit:
850 km

CVZ: 57 stopni

Stabilizacja: lepsza niz 15"

Teleskop 15 cm

CCD: $1K \times 1K(2K)$

Skala: 1.5"/pix

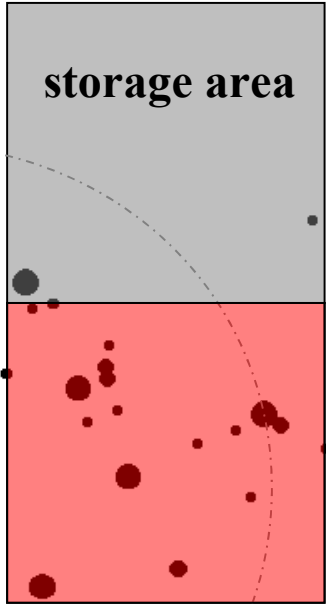


Target Star

unvignetted field

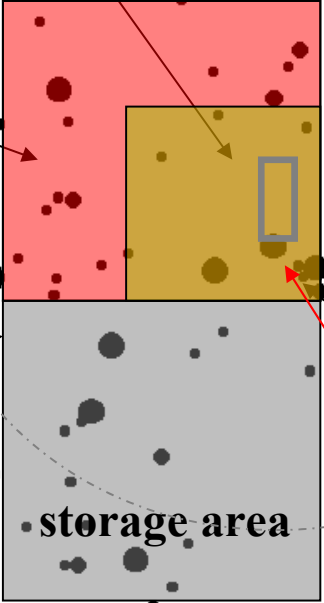
open field area

Science
CCD



ACS
CCD

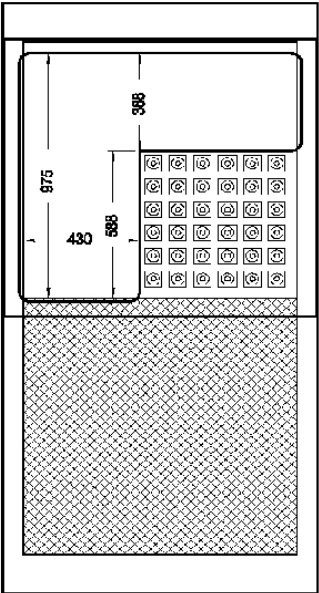
30'



Fabry lens array

storage area

30'

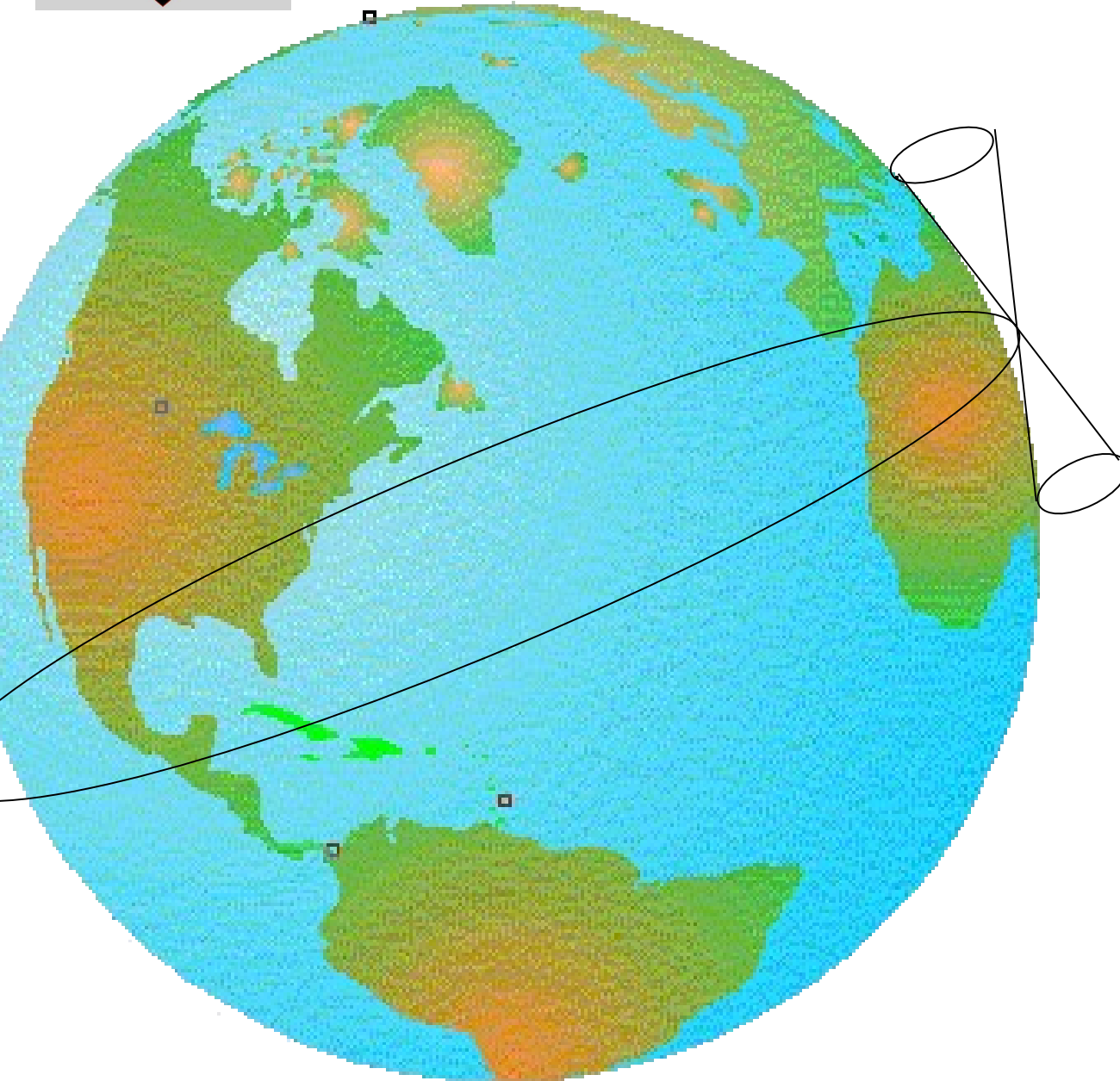


- < 9 mag
- 9-10 mag
- 10-11 mag

Pole Procyona

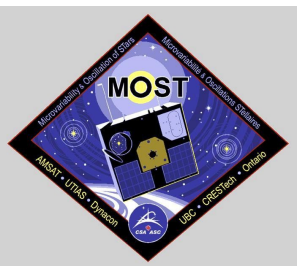


CVZ: Continuous Viewing Zone

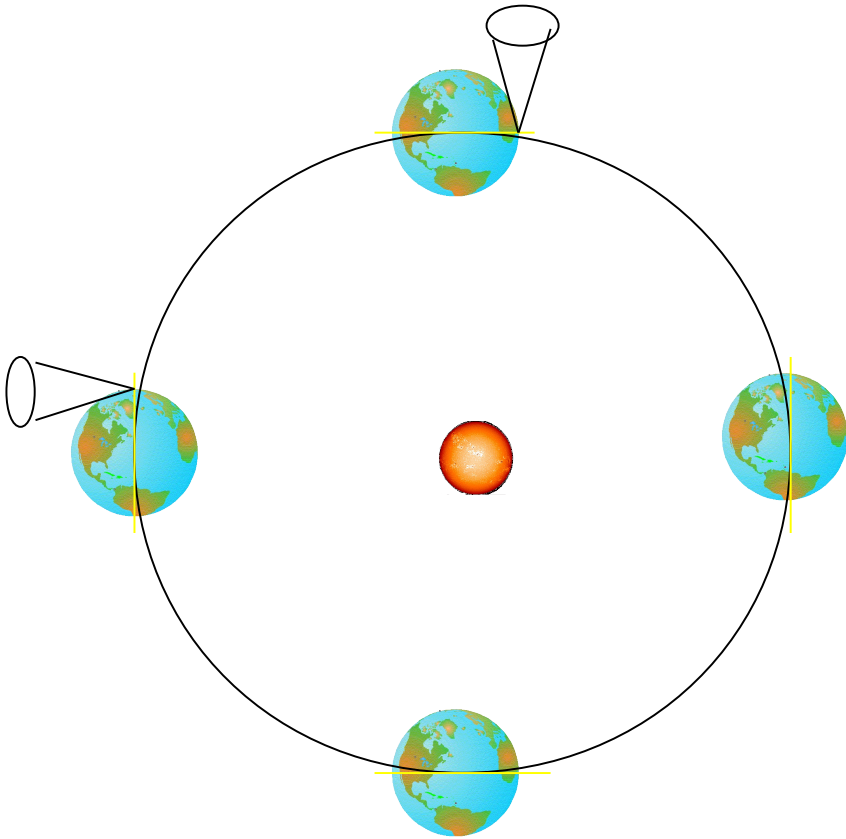


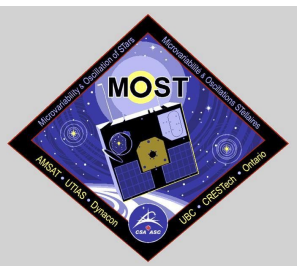
Hubble: CVZ <7 dni,
szerokosc 28° , precesja 56
dni.

MOST: CVZ <30 dni,
szerokosc 57° , precesja
365 dni.

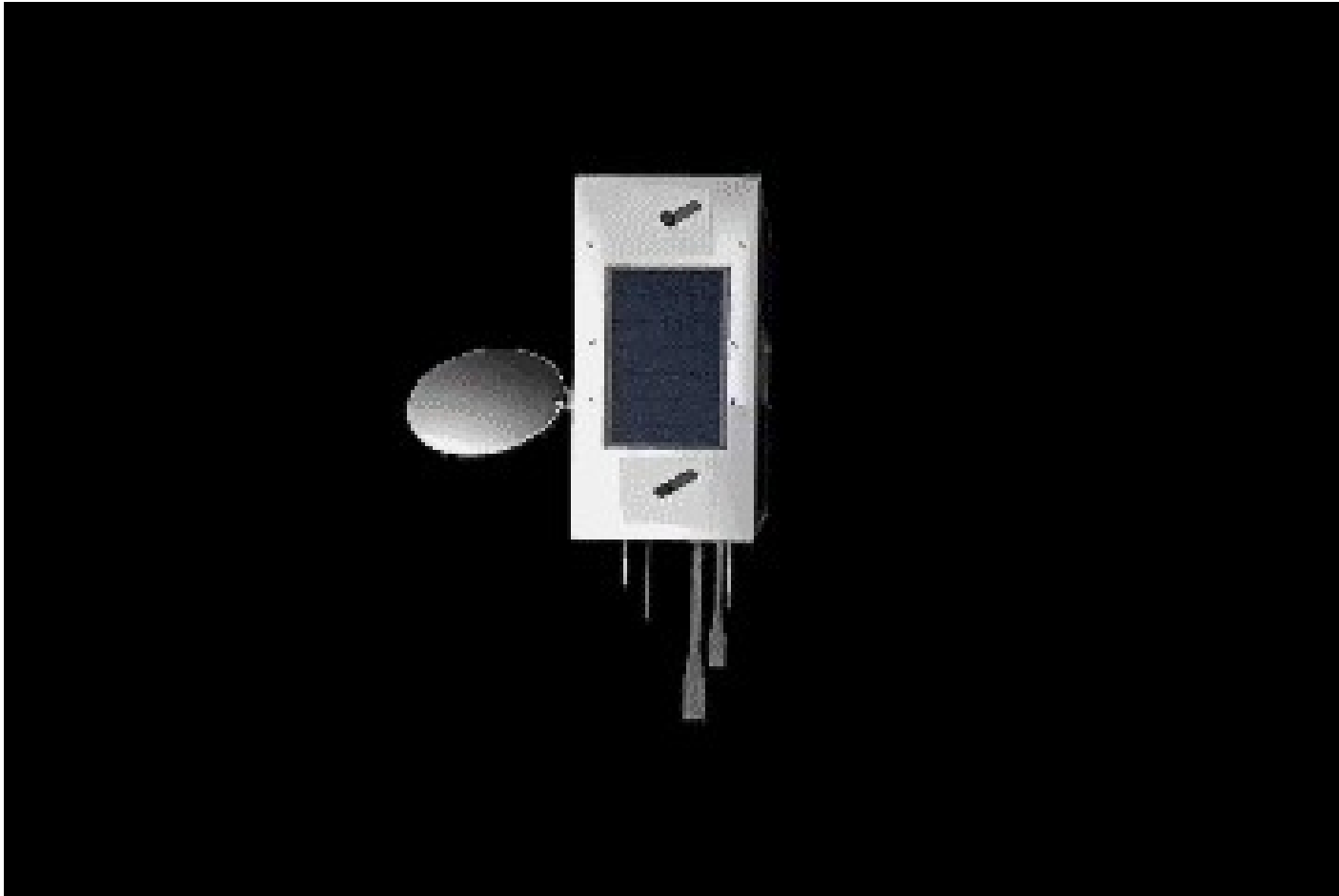


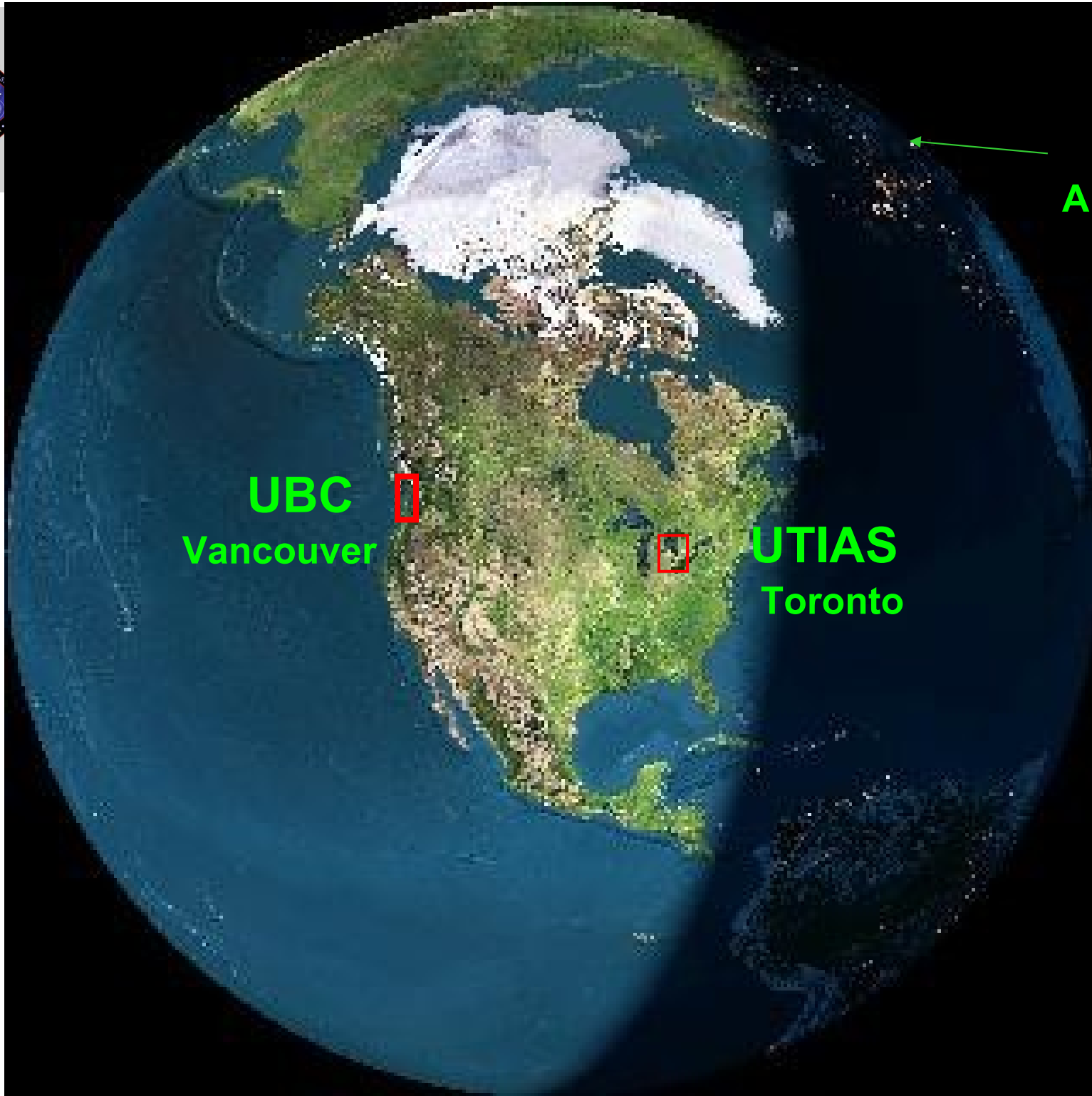
Orbita na linii zmierzch/swit





MOST i Hubble





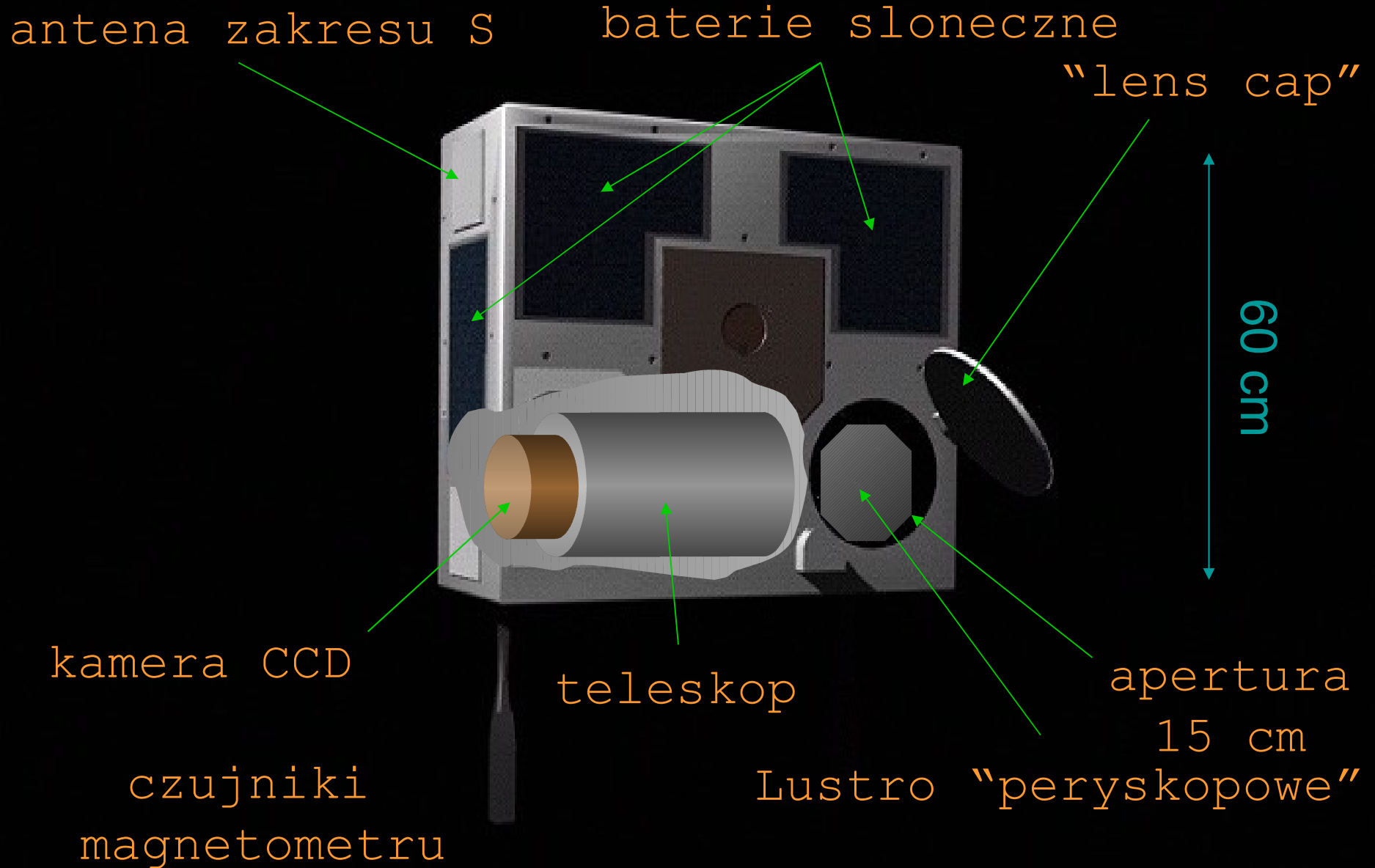
UBC
Vancouver

UTIAS
Toronto

IfA
Austria



Budowa MOST-a



Tony Moffat

David Guenther

Dimitar Sasselov

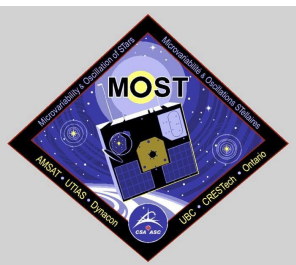
Werner Weiss

Gordon Walker

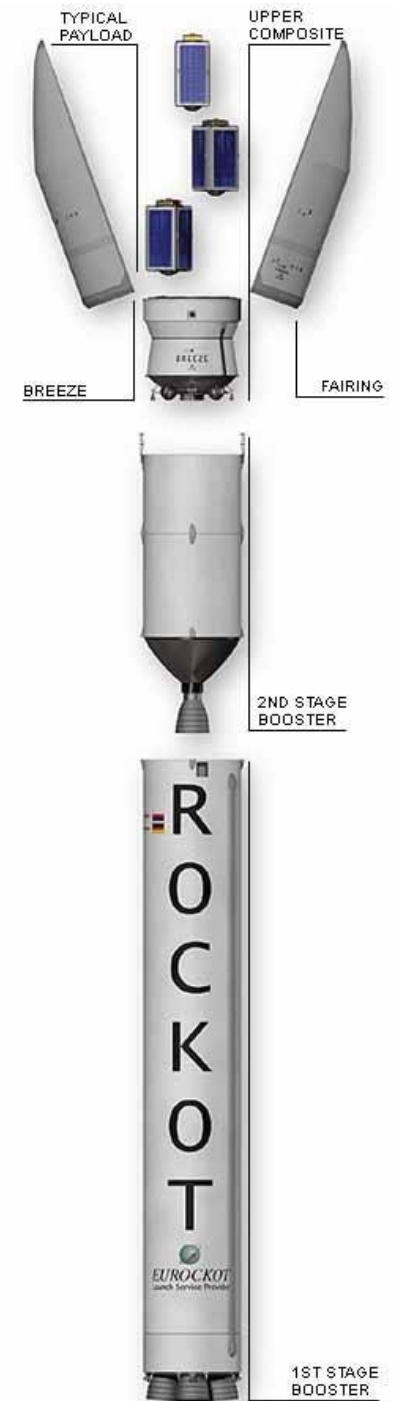
Rainer Kuschnig

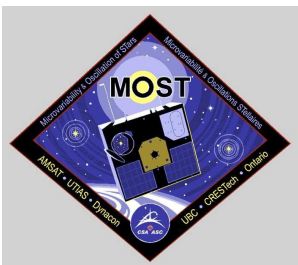
Jaymie Matthews Slavek Rucinski

MOST Science Team



Start: 30.06.2003



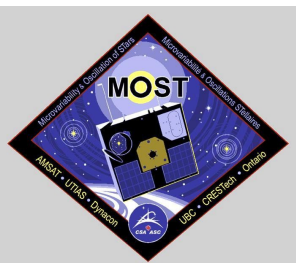


Obserwacje

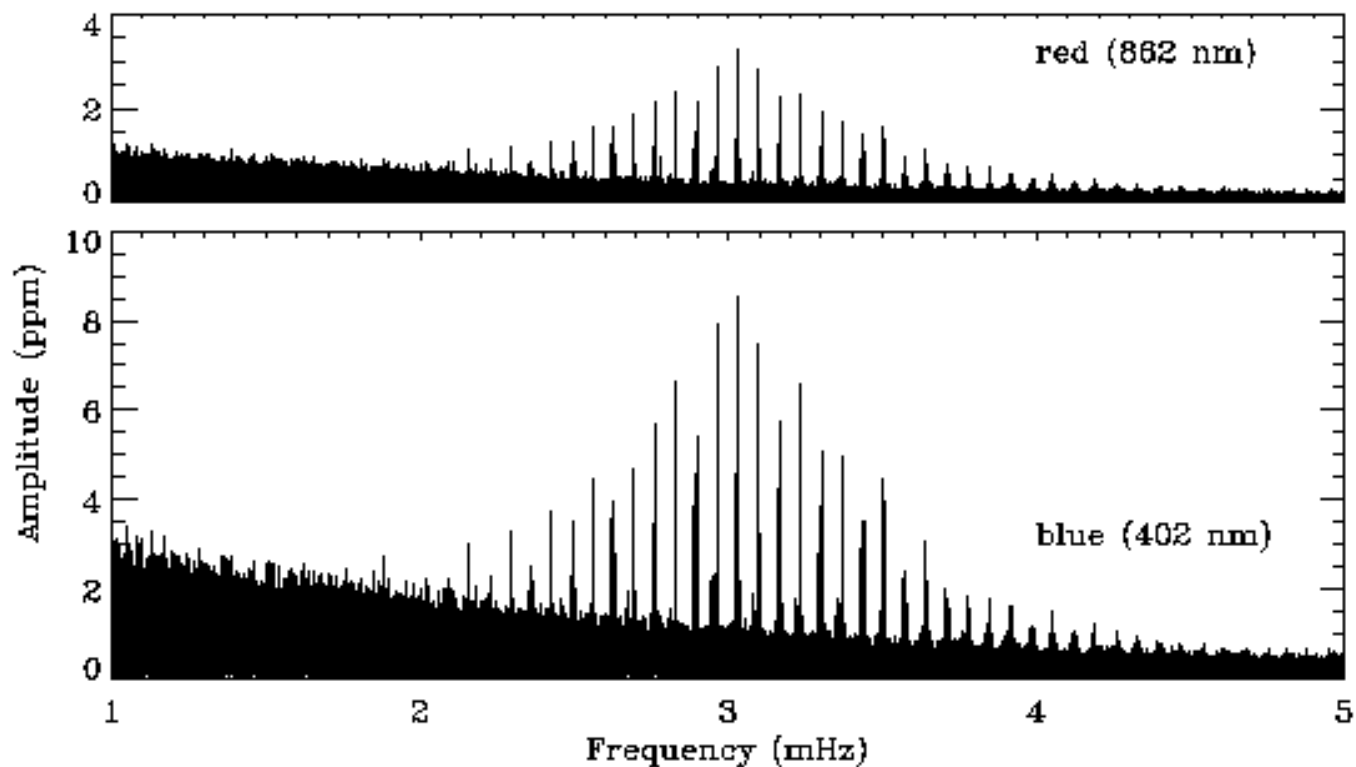
- Planowany okres działania: 2 lata
- W tej chwili: 130 ustawien w ciagu 6 lat
~1200 gwiazd
- Wykorzystane/opublikowane ~15% materialu

2 lata temu przestal dzialac CCD do stabilizacji:

- Koniecznosc uzycia “naukowego” CCD z krotkimi czasami ekspozycji ~1 sek.
- Ograniczenie zakresu jasnosci.



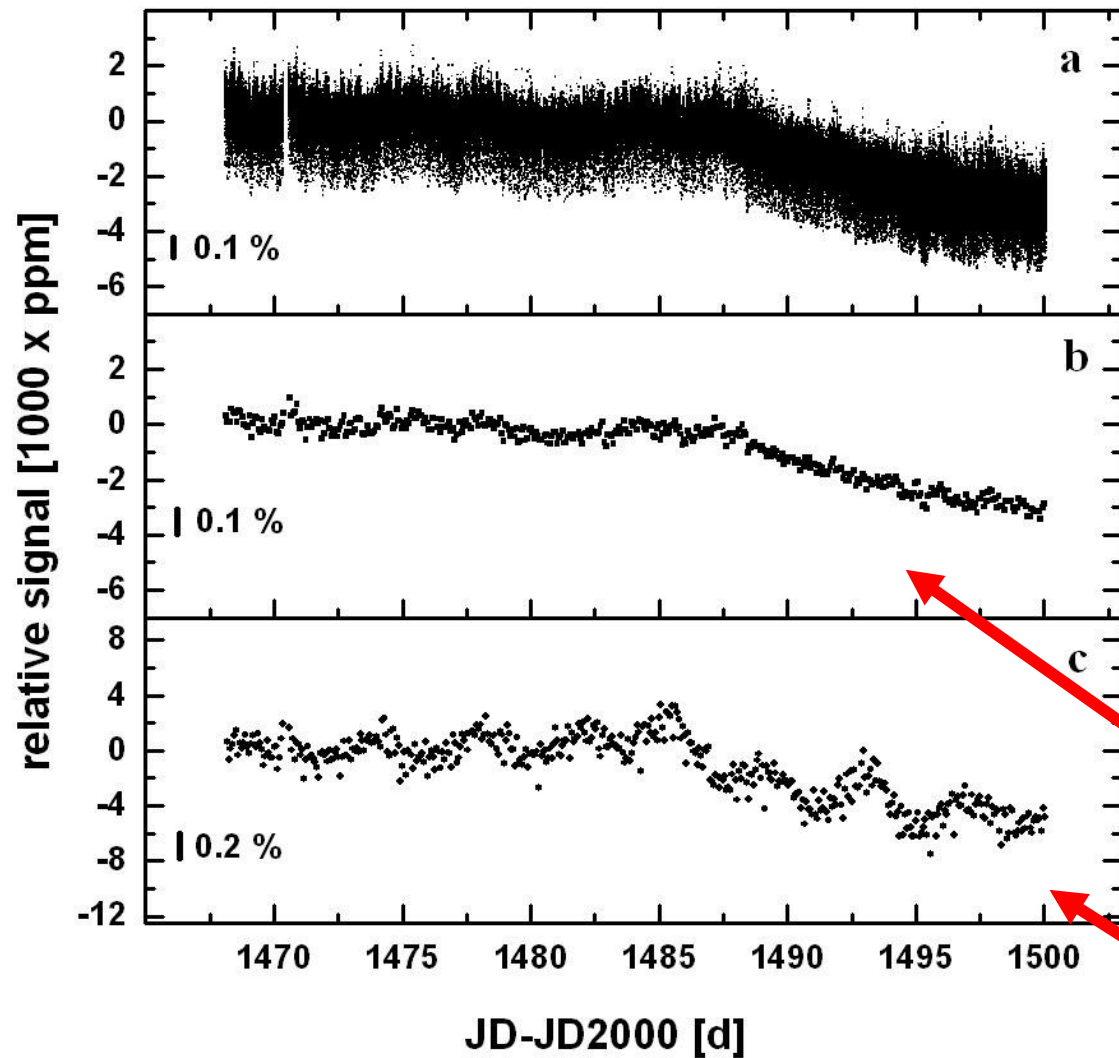
Oscylacje Słońca jako gwiazdy



Oscylacje Słońca w świetle zintegrowanym (SOHO/Virgo);
p-modes.



Procyon



Nature (2004):
 Nieobecność oscylacji
 typu p-mode:
 $< 3 \text{ ppm } (> 2 \text{ mHz})$
 $< 7 \text{ ppm } (0.5\text{-}2 \text{ mHz})$

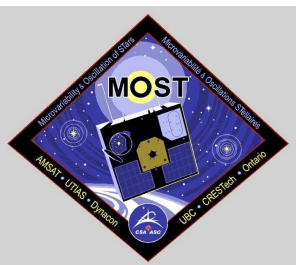
$$1 \text{ ppm} = 10^{-6} = 10^{-4} \%$$

(Nature, June 30, 2004)

Trend instrumentalny

Gw pola:
 podwójna & δ Sct

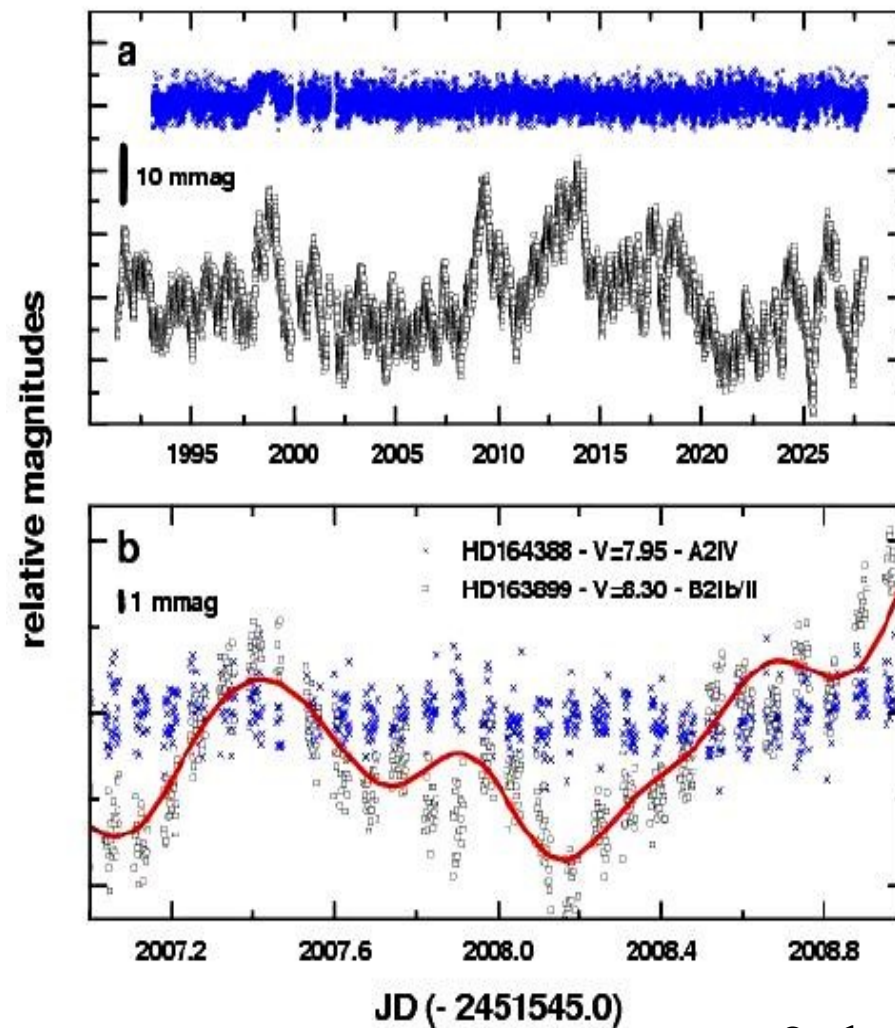
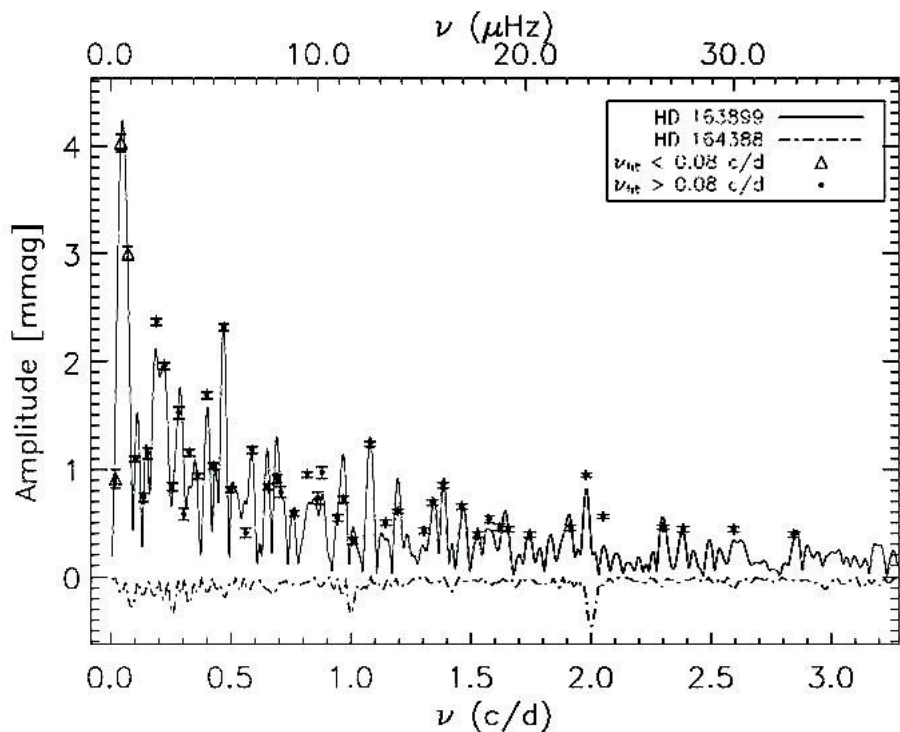
Kontrowersja do do Procyona trwa...



Supergiant HD163899

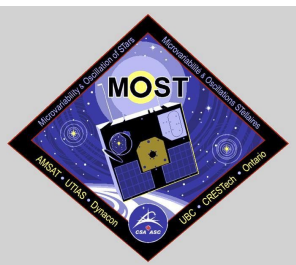
35 dni

Masywna, goraca gwiazda
(B2Ib/II): 48 p- i g-modow
nieradialnych

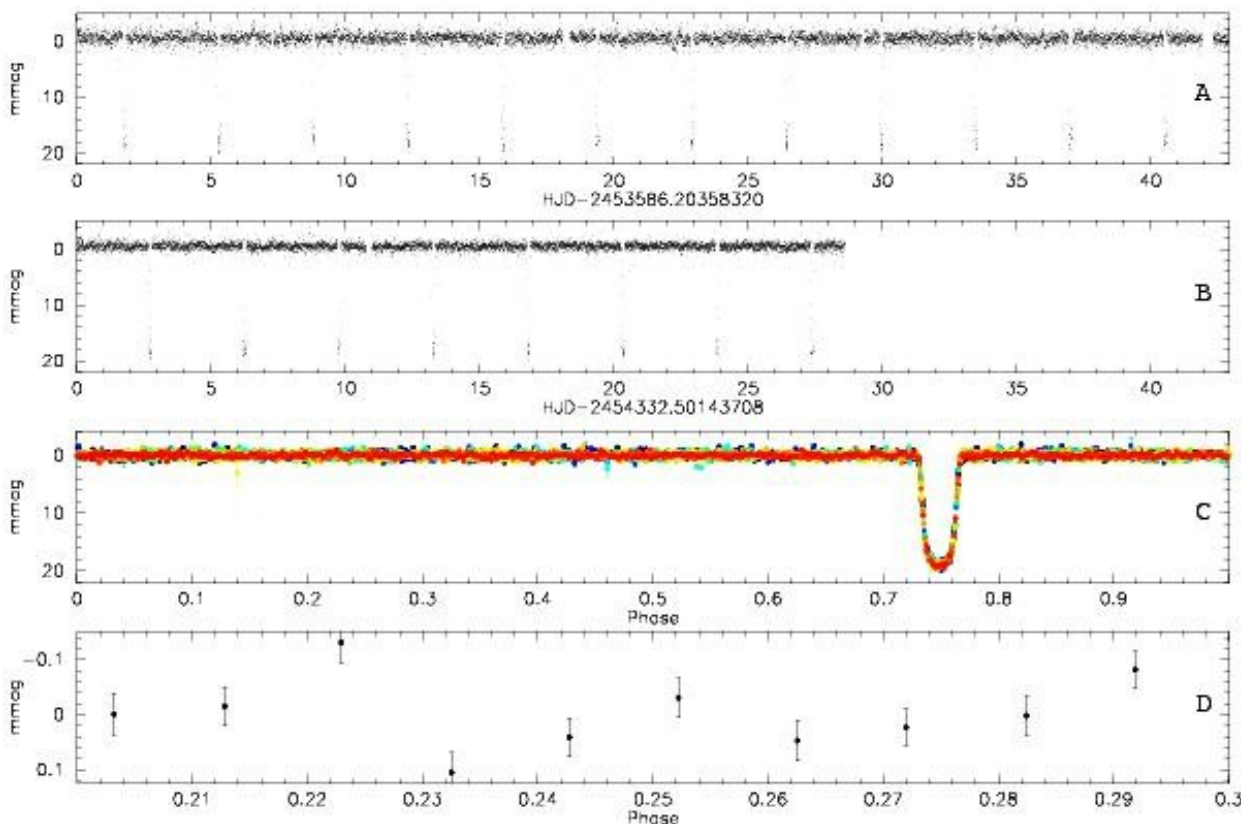


2 dni

Saio et al. 2006, ApJ, 650, 1111



Albedo planetarne HD 209458b

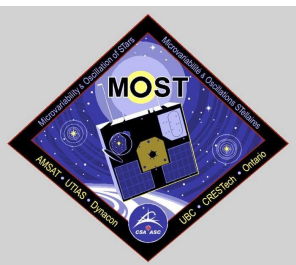


Rowe et al. 2008, ApJ, 689, 1345

Spitzer, IR 24 μm :
Zacmienie planety (de facto: efektu “odbicia”):
 $0.26\% \pm 0.05\%$.

MOST:
Efekt odbicia: 7 ± 9 ppm
Albedo $< 8.3\%$ ($3.8 \pm 4.5\%$).

Burrows et al. 2008, ApJ, 682, 1277

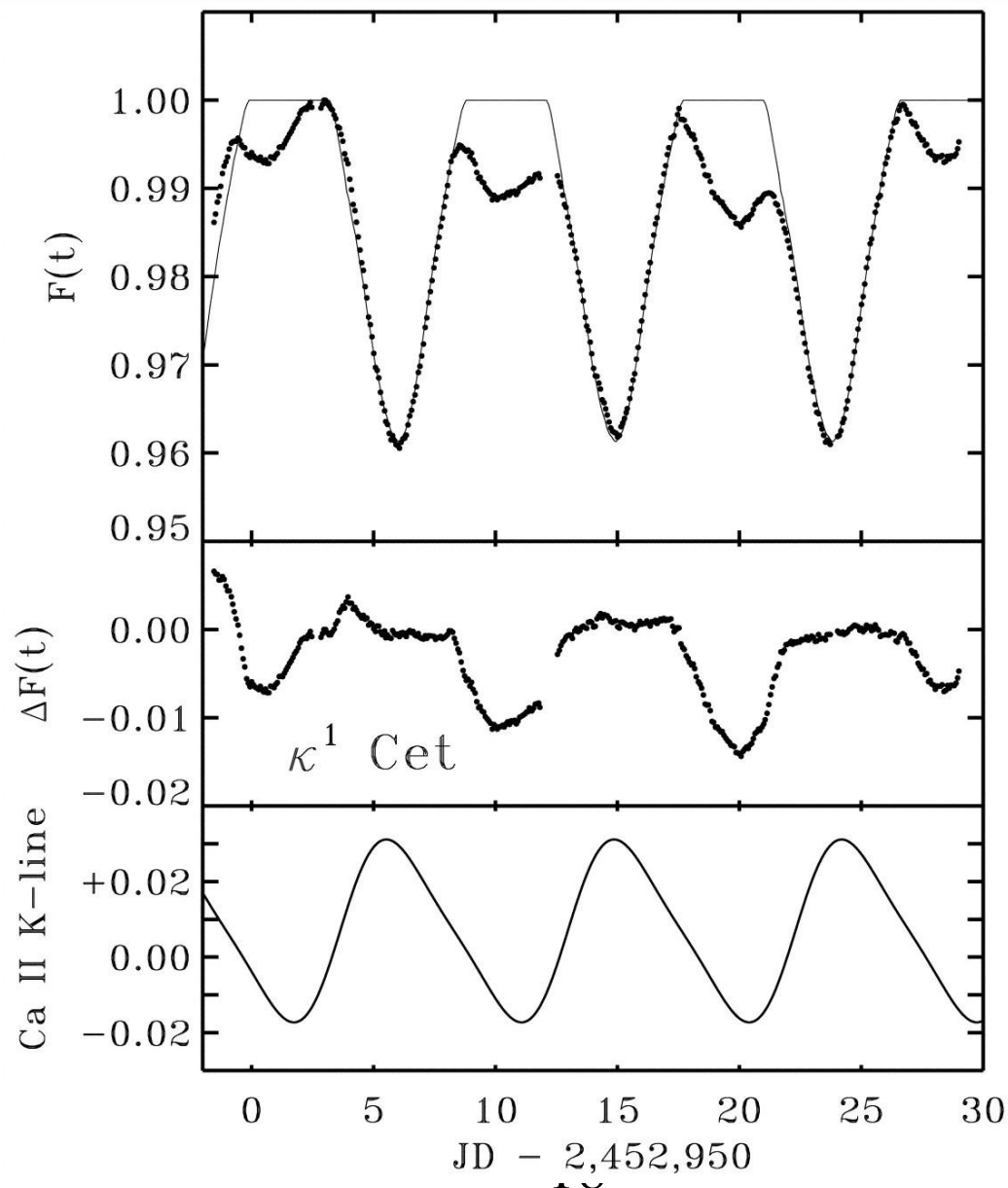


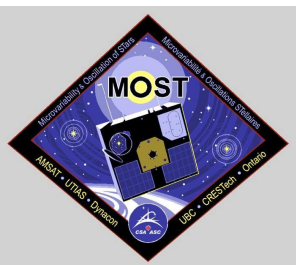
κ^1 Cet

Jasna ($V = 4.8$), mloda (~ 700 Myr) gwiazda typu G5V.

Dwie plamy: 8.9 i 9.3 dnia ($\Delta\Omega/\Omega \sim 4\%$).

PASP, 116, 1093 (2004)

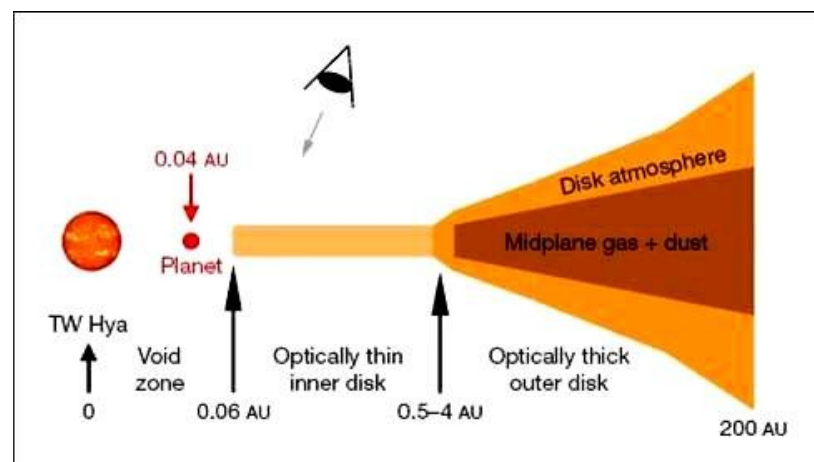
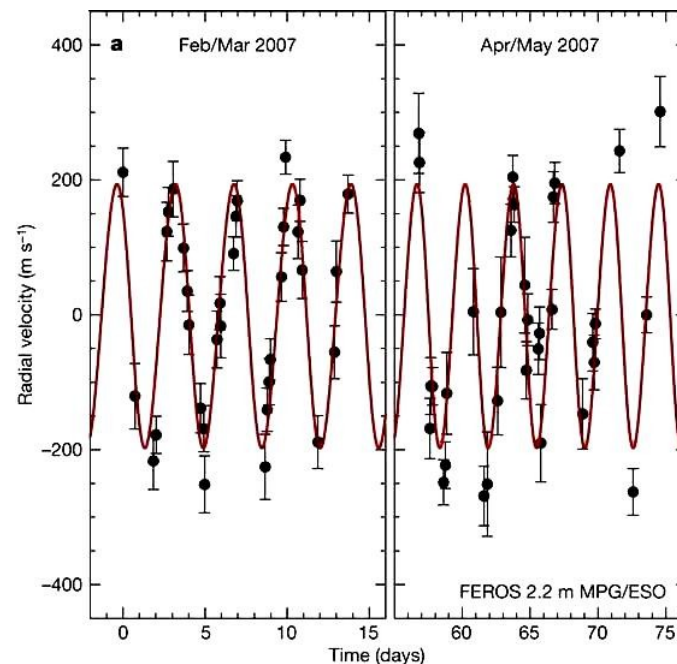
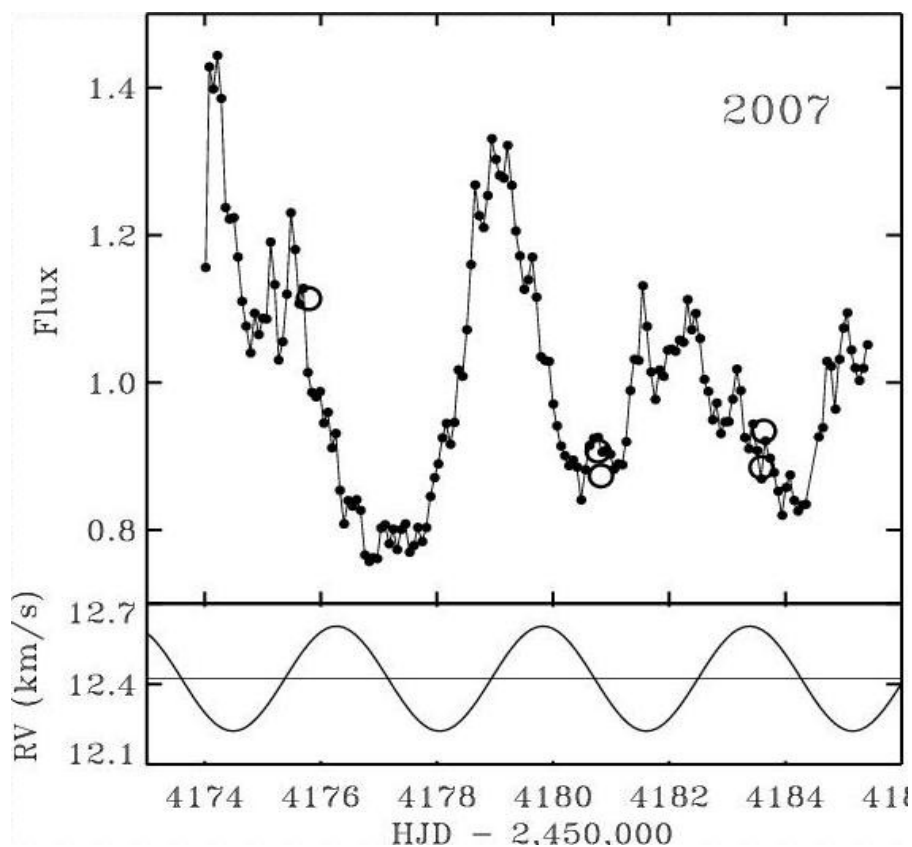




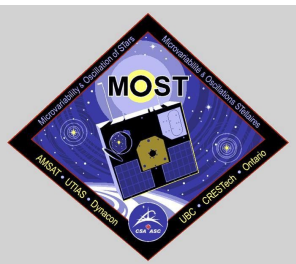
TW Hya 2007

MPG/ESO

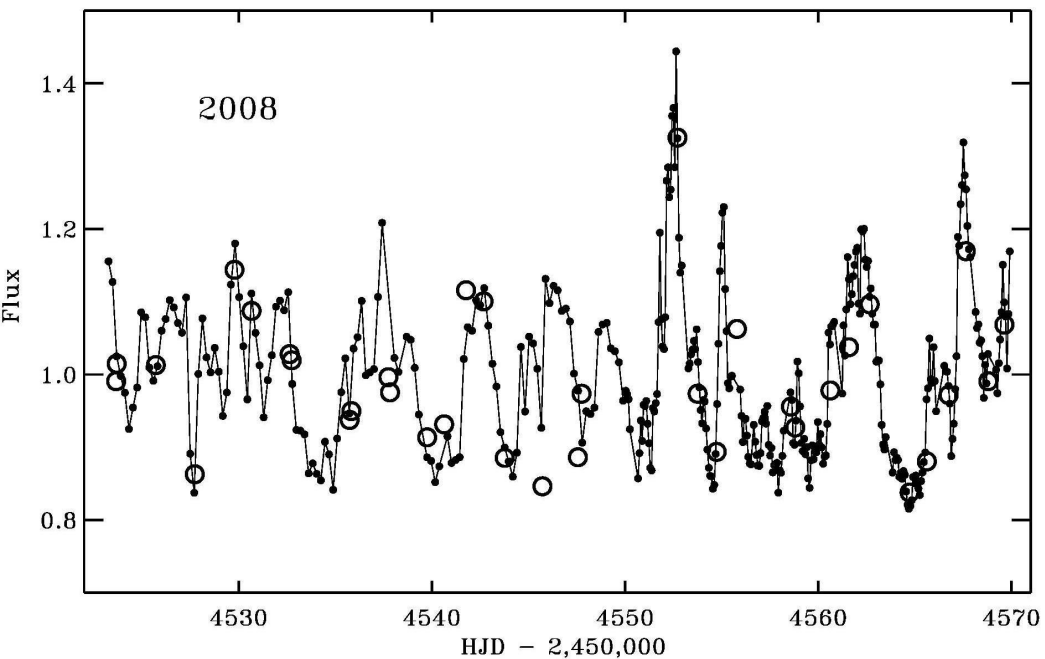
MOST (11 dni)



Nature, 451, 38 (2008)



TW Hya 2008

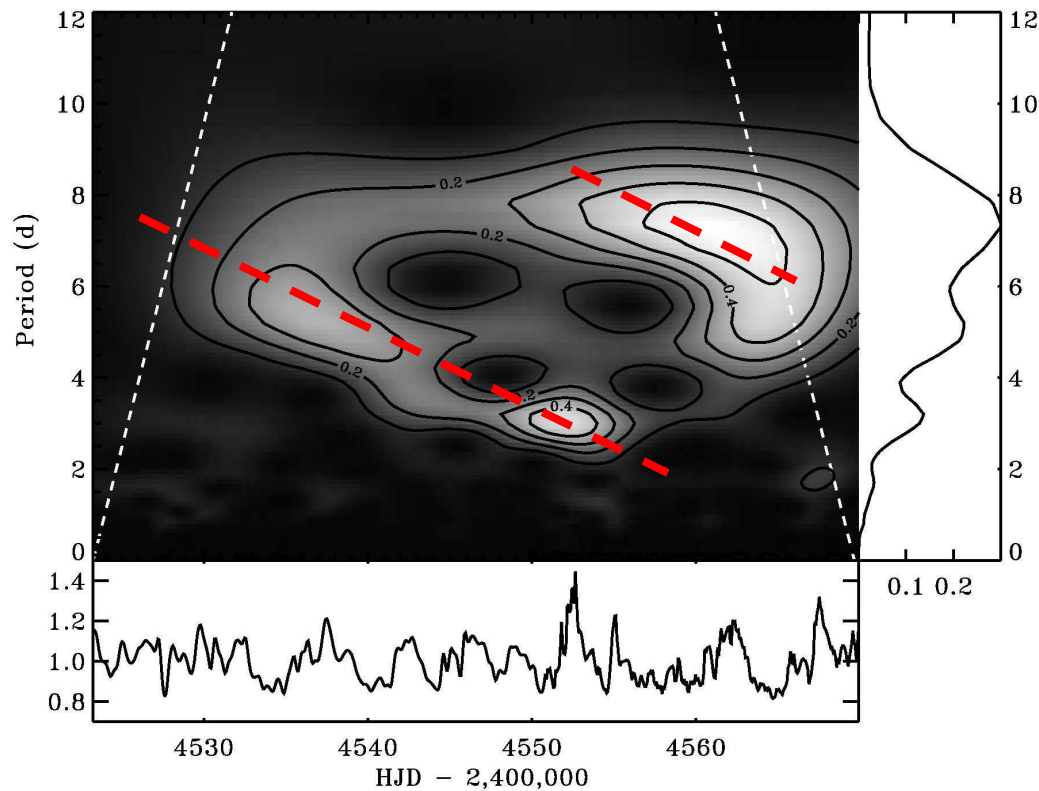


MOST (46 dni)

Otwarte kolka:
ASAS

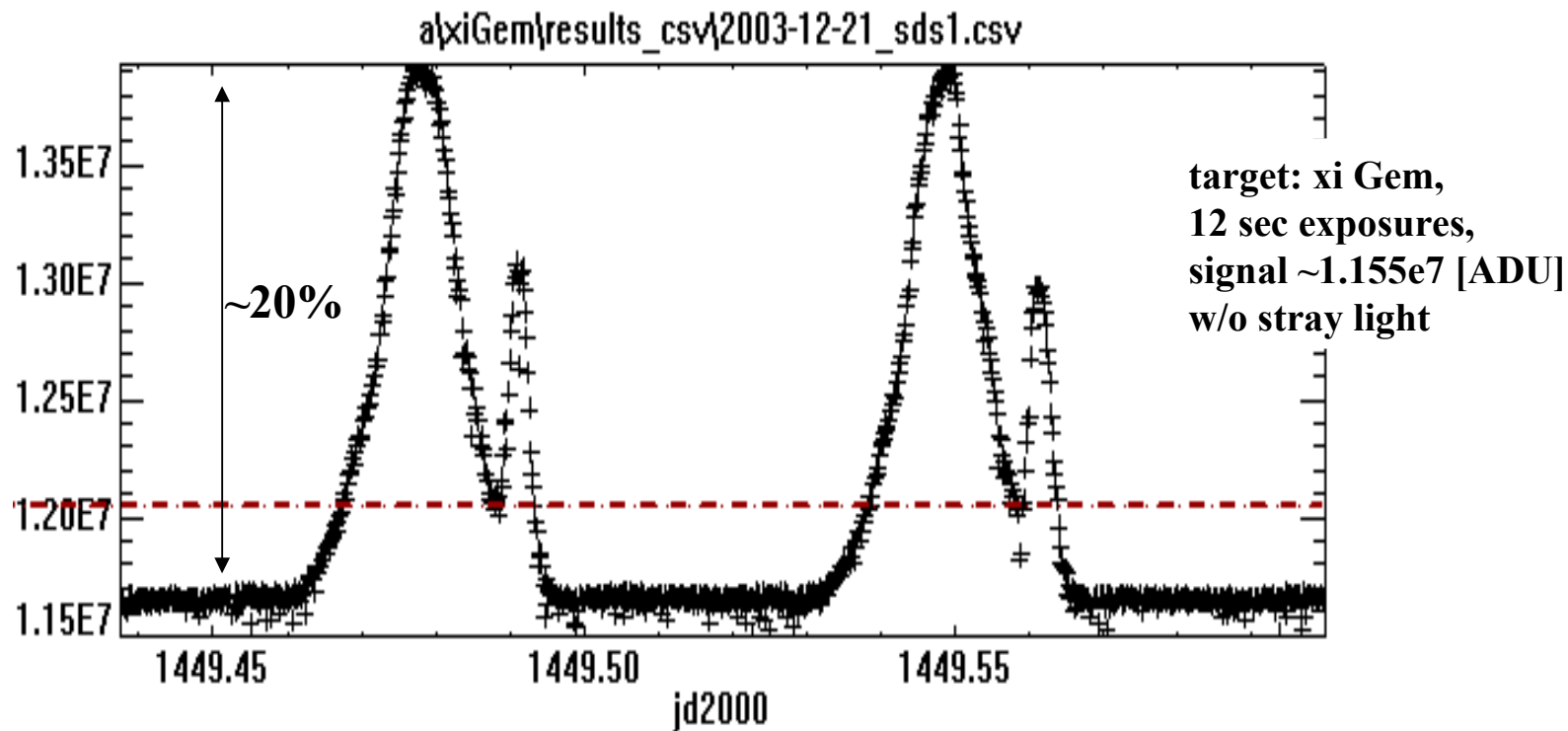
MNRAS, 391, 1913 (2008)

Analiza falkowa:
(wavelet analysis)

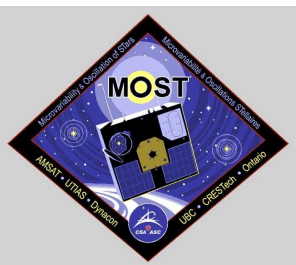




Problem: Swiatlo odbite od Ziemi

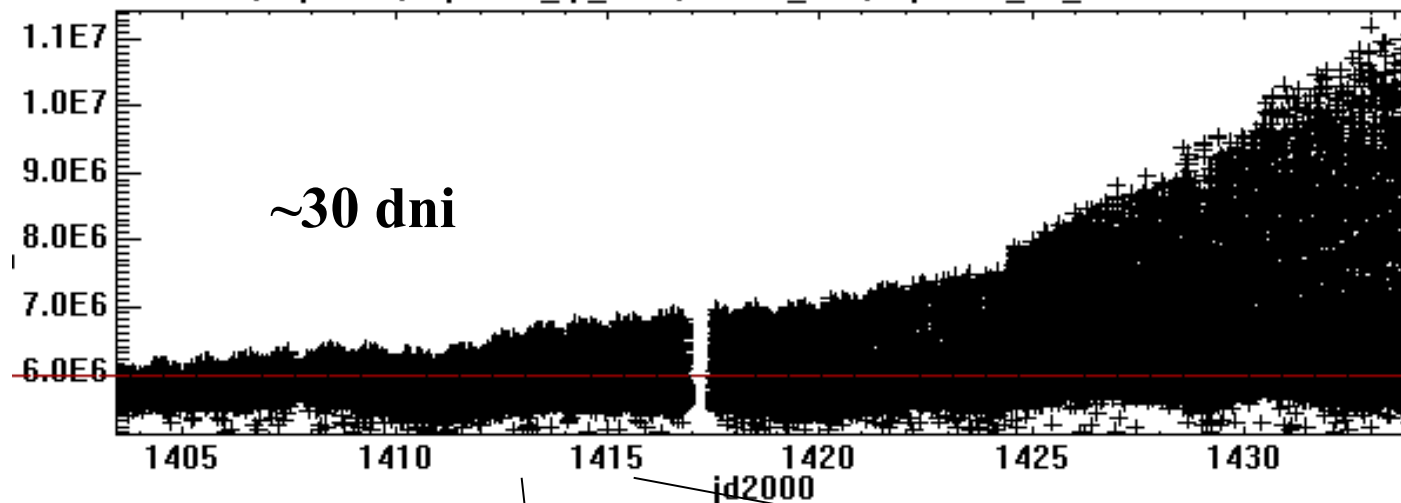


Odbicie swiatla od chmur na oswietlonej Ziemi podczas kazdej orbity satelity (103 minuty)



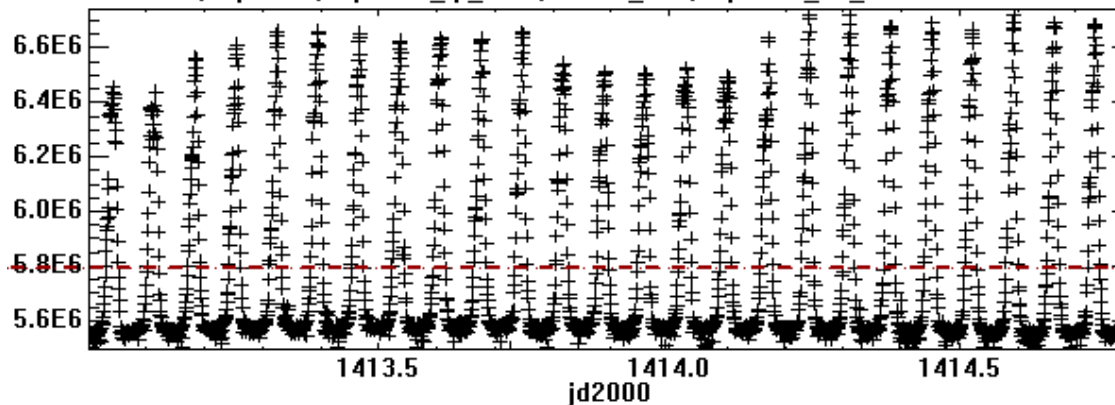
Problem: Swiatlo od Ziemi

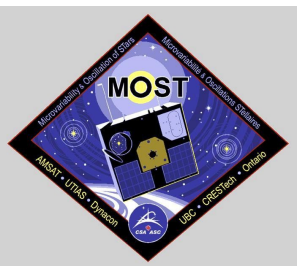
a\Kap1Ceti\Kap1Ceti_fp_data\results_csv\Kap1Ceti_all_sds1sds2.csv



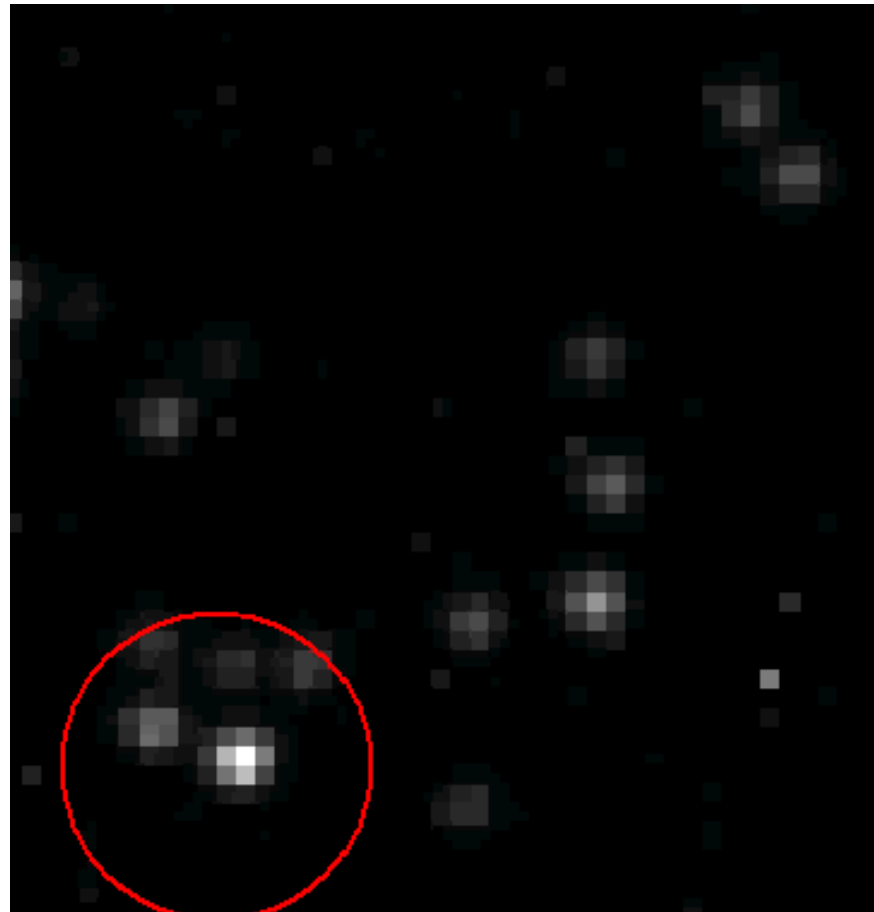
2 dni obserwacji

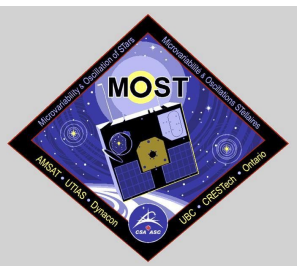
a\Kap1Ceti\Kap1Ceti_fp_data\results_csv\Kap1Ceti_all_sds1sds2.csv





Sukces: stabilizacja planowana 15", obecnie 1.5" Pole centrum M67

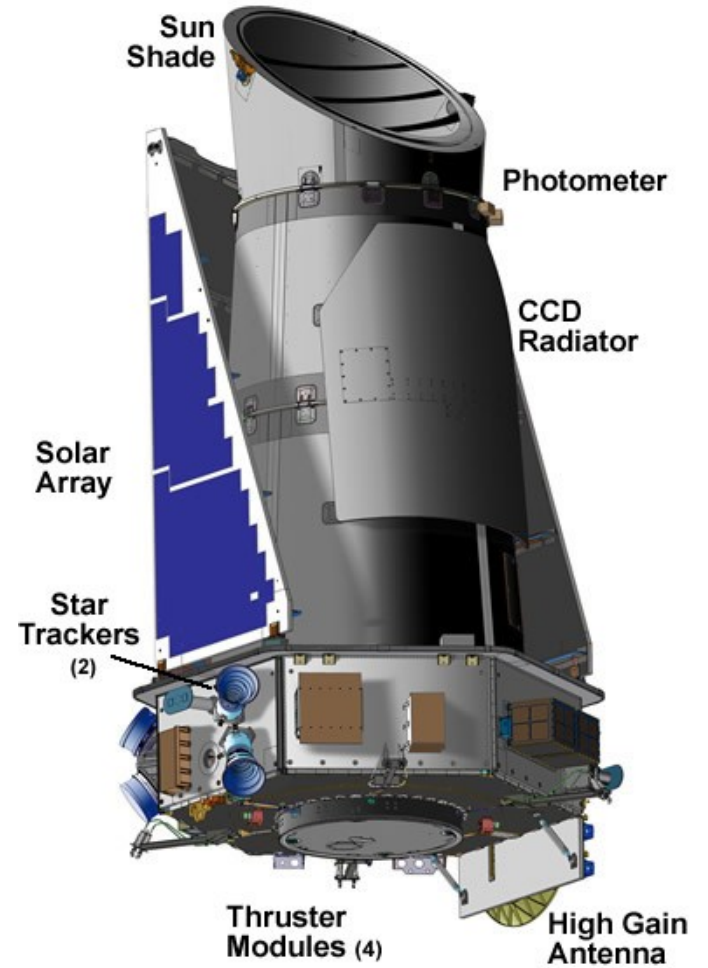




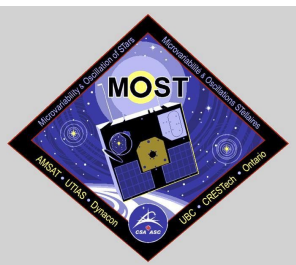
COROT (30 cm) i Kepler (95 cm)



2008



2009



BRITE

Nano-satellite, <10 kg.

Obserwacje jasnych gwiazd.

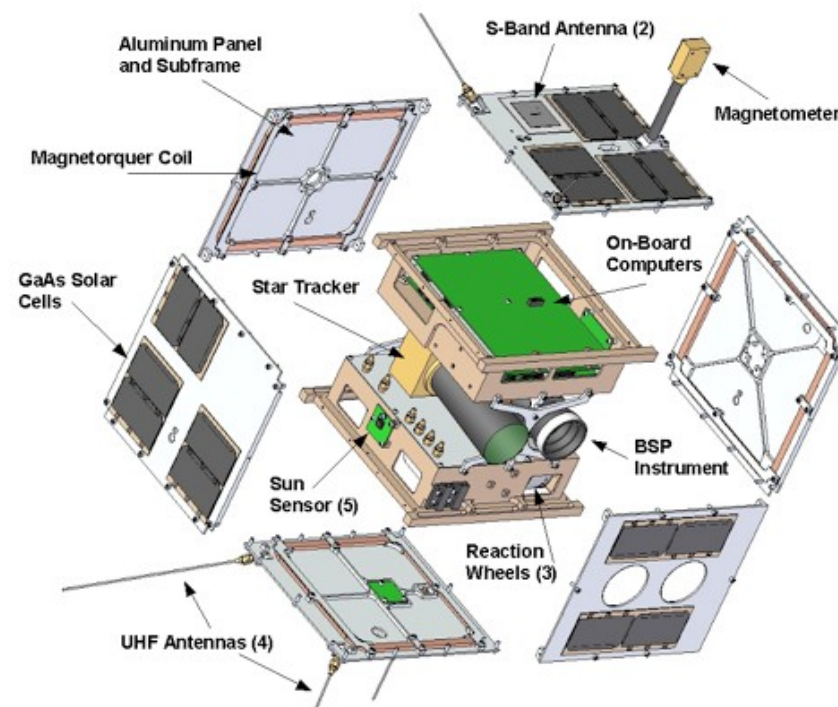
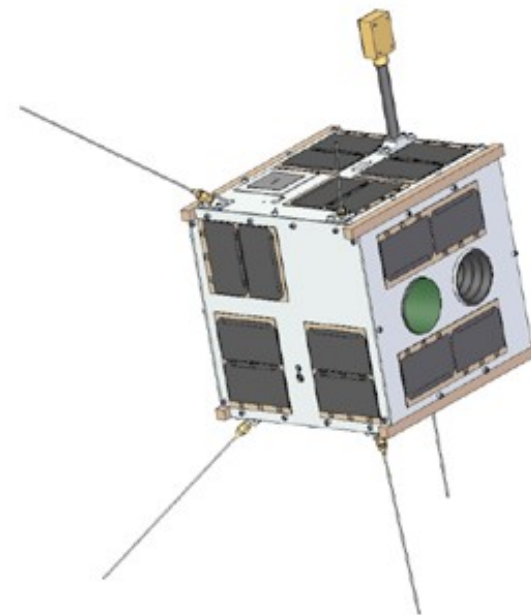
BRITE Constellation:

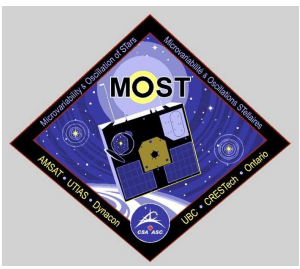
2 satelity dla Austrii (B & R)

Kanada (2)

Belgia, Hiszpania (?)

Polska (?)





MOST lata dalej!

