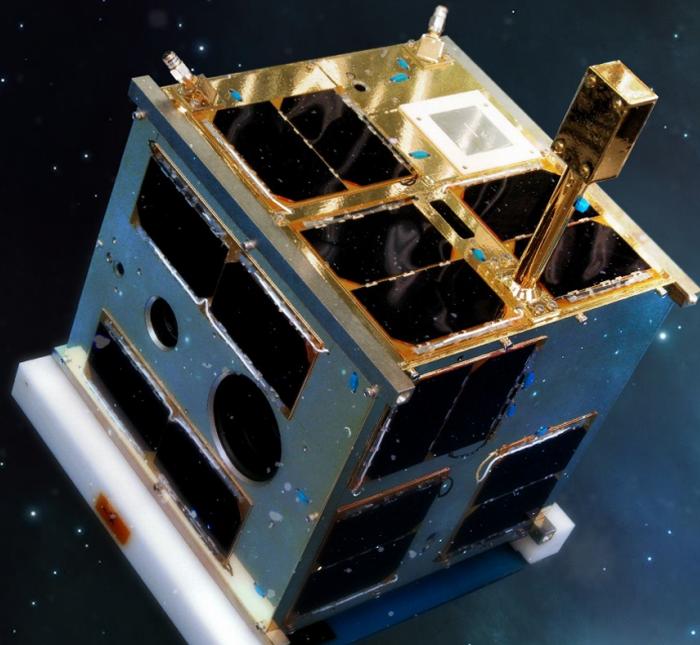
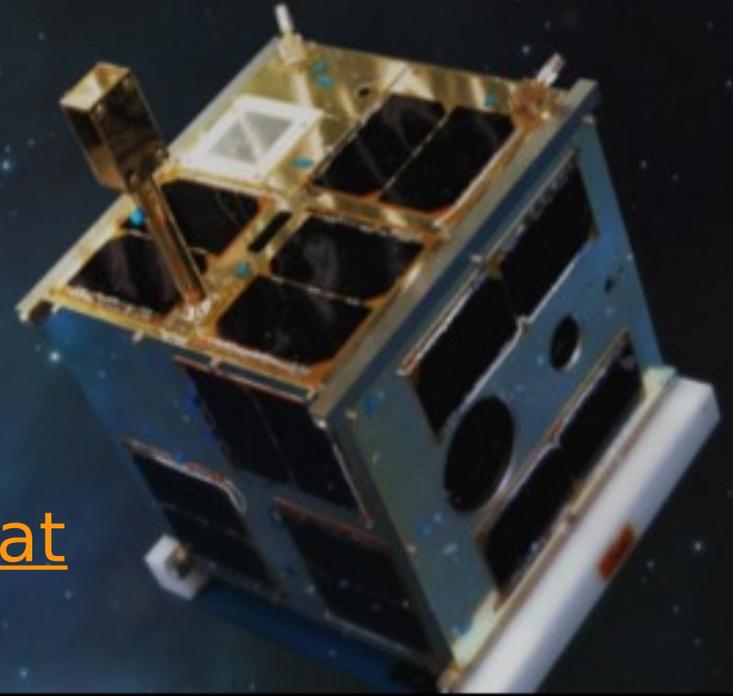




BRITE-Constellation

<http://www.brite-constellation.at>



Konstanze Zwintz
(University of Innsbruck)

Rainer Kuschnig
(University of Vienna)

Luca Fossati
(Space Research Institute, Graz)



BRITE - Constellation Overview

3 Countries - 6(5) Satellites - ONE MISSION

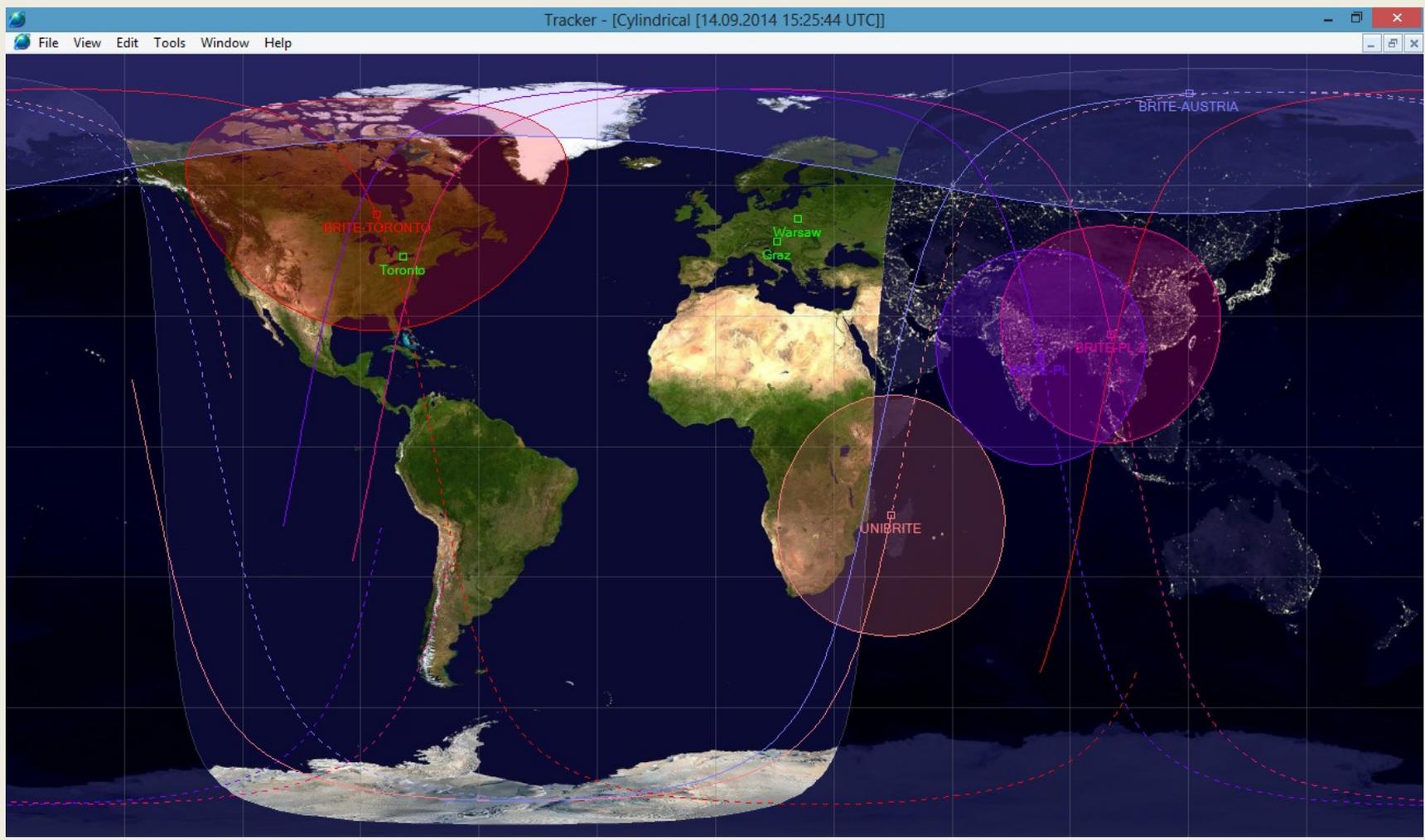
Country	Satellite Name	ID	Launch	Orbit-P(min)	Filter
AUT	UniBRITE	UBr	2013-02-25	100.37	red
AUT	BRITE-Austria 'TUG-SAT-1'	BAb	2013-02-25	100.36	blue
POL	BRITE-PL2 'Heweliusz'	BHr	2014-08-19	97.10	red
POL	BRITE-PL1 'Lem'	BLb	2013-11-21	99.57	blue
CAN	BRITE-CA1 'Toronto'	BTr	2014-06-19	98.24	red
CAN	BRITE-CA2 'Montreal'	BMb	2014-06-19	n/a	blue

BRITE-CA2 “Montreal” was launched with the same rocket as BRITE-CA1 “Toronto”, but did not separate from the upper stage



BRITE - Constellation

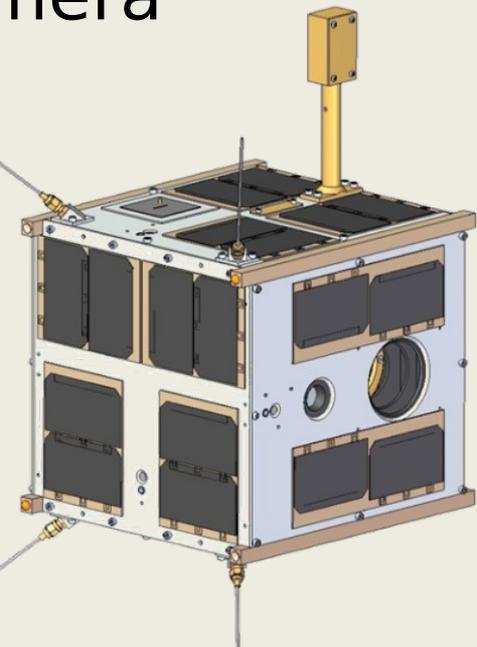
Orbits: all satellites are in polar LEOs





BRITE - Constellation Properties

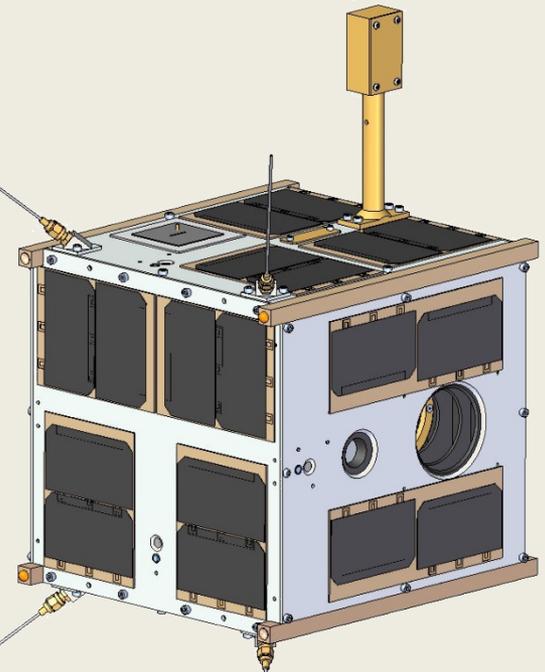
- 5 satellites in orbit and operational
- 3 cm space telescope, CCD camera
- **3 RED instruments**
- **2 BLUE instruments**
- Field-of-view $\sim 24^\circ$
- $0 < V < 4.5$ mag
- 3 - 4 exposures / min
- 15-30 min / orbit
- Time bases up to 6 months





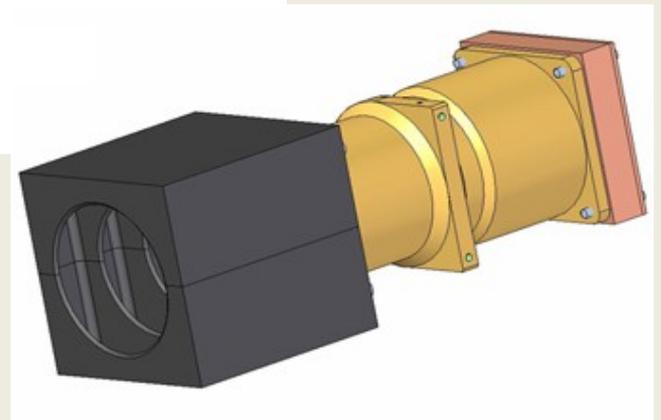
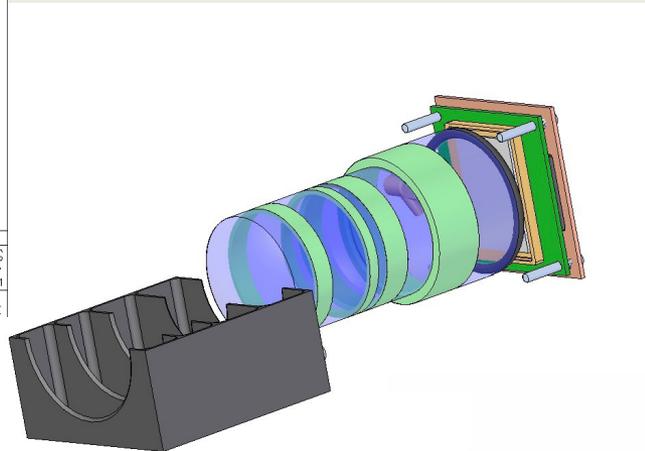
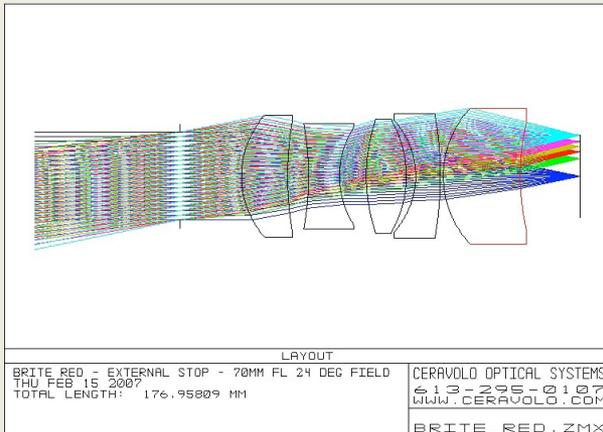
BRITE - Constellation Satellites

- **20cm cubes with mass < 8kg**
- Pre-deployed antennas and booms
- 11 Megapixel CCD
 - 30 arcsec / pixel
- Star tracker
- **Three-axis attitude control**
(~1.5 arcminute stability)
- UHF (up) and S-Band (down) communication





BRITE - Constellation Telescope

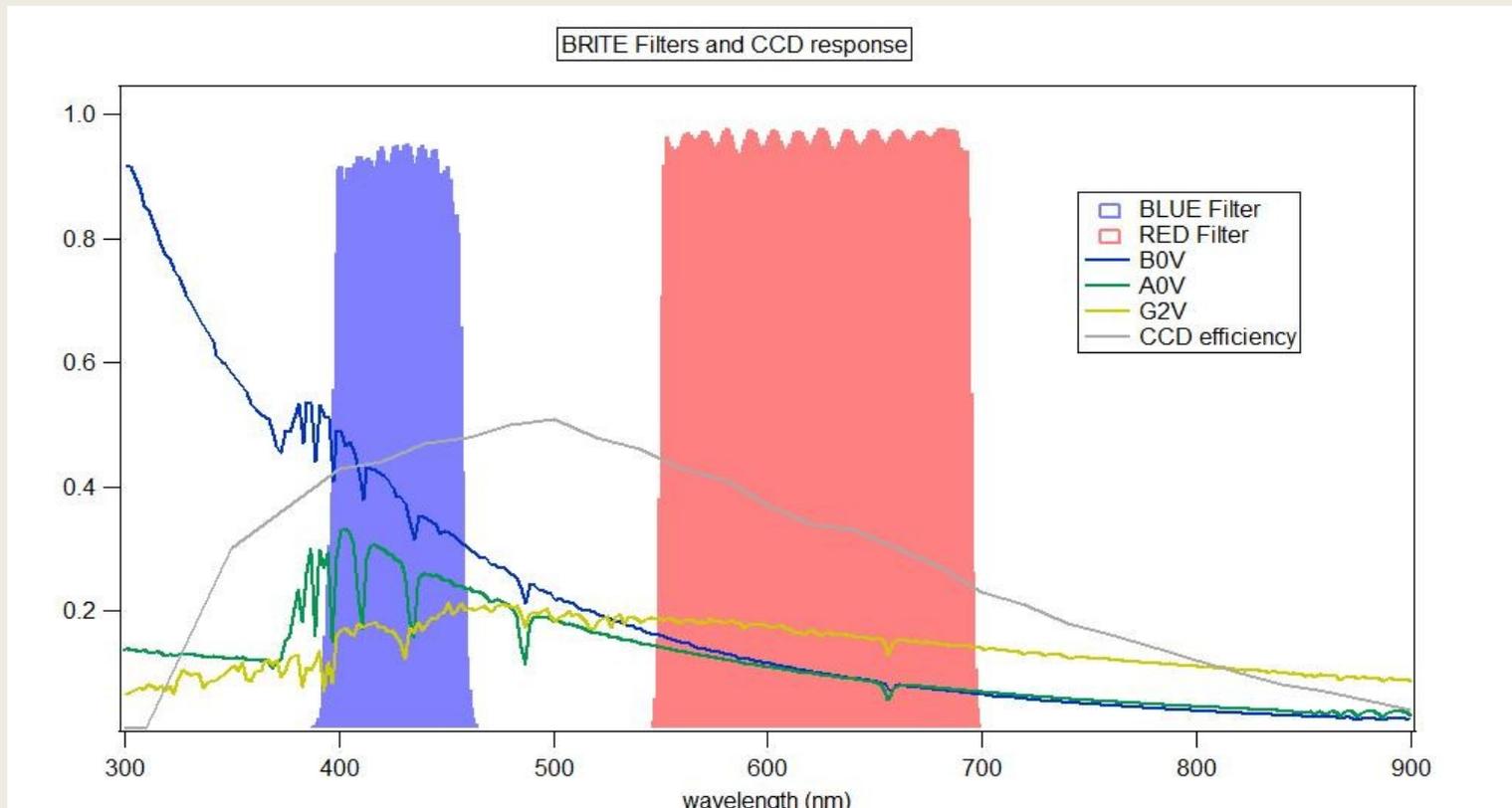


- 3 cm aperture
- 5 lenses telecentric design
- baffle + filter



BRITE - Constellation

Filters - two color photometry

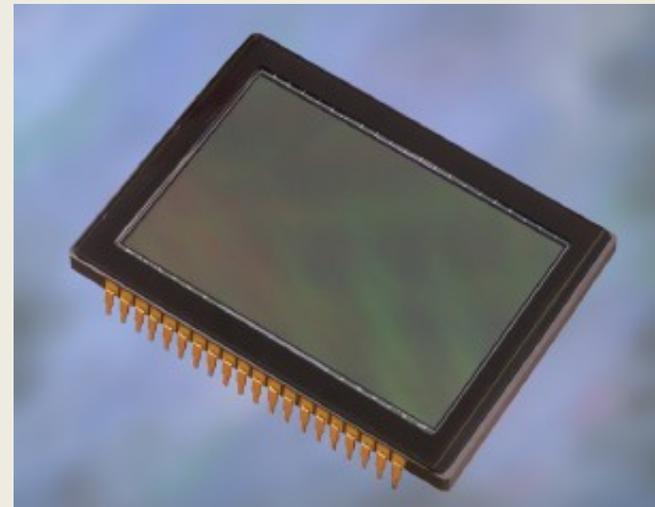
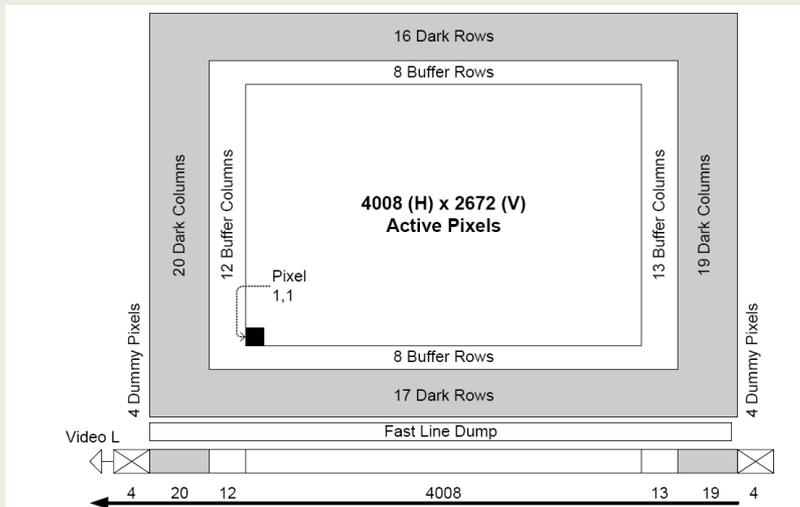


- BLUE 400-450 nm
- RED 550-700 nm



BRITE - Constellation

CCD : KODAK KA11002



- + Good performance at high temperature (+10 to +30C)
No cooling system is required
Low power consumption and reasonable price
- **Does not “like” low earth orbit radiation environment!**



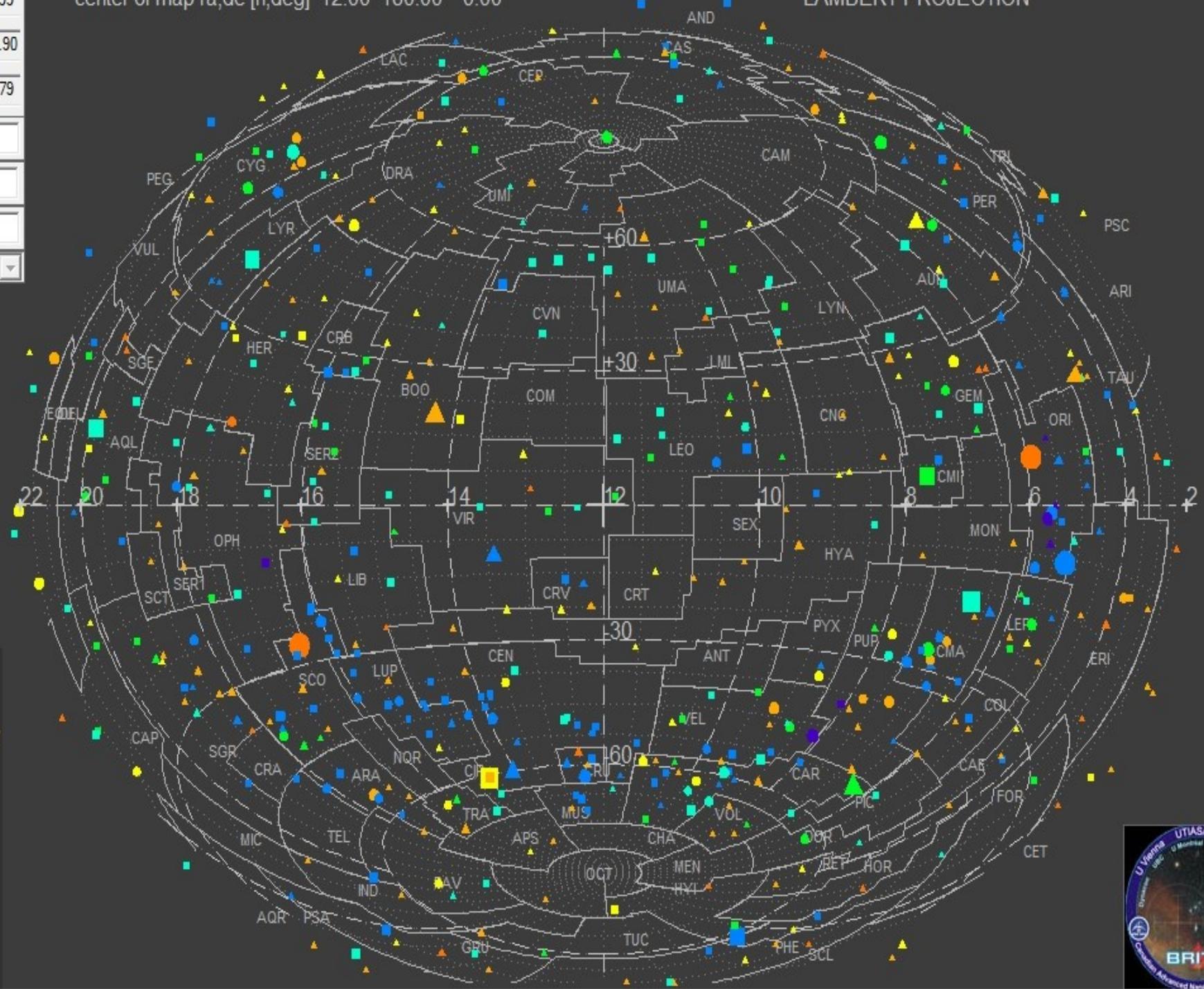
BRITE - Constellation

Mission Goals

- Collect time series photometry for some of the **brightest, most massive and luminous stars** in the sky, i.e., $V < 4 - 5$ mag
- 15 - 30 stars per observing field at once
- Photometry in **two colors**: red and blue
- Time bases of **up to 180 days** for a single observing campaign

RA | 22.55
RAd | 344.90
DEd | 10.79
mag | 4.0
multi | 3
weig | 2

zoom +
zoom -
LoadCat

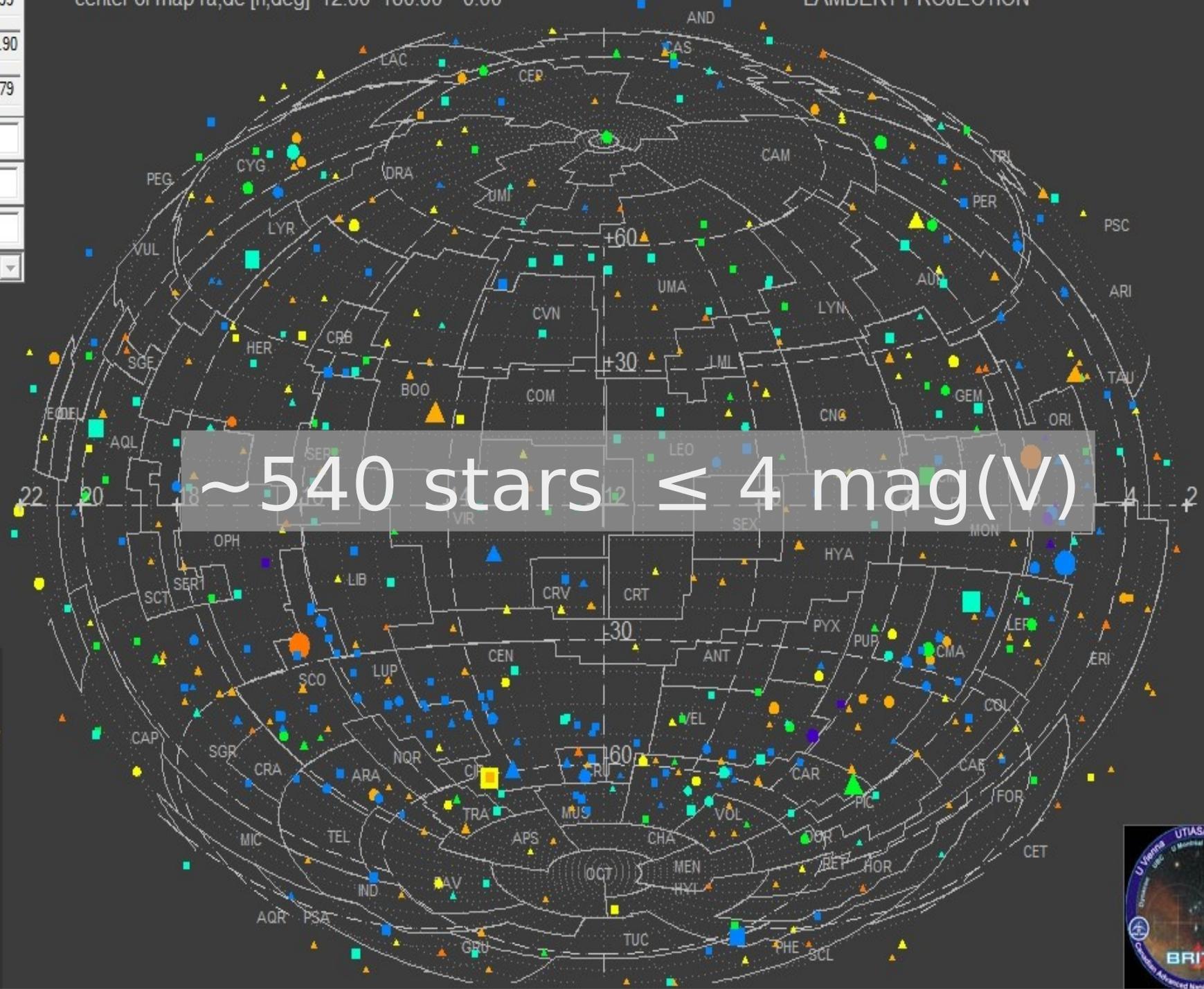


- I
- ▲ III, II
- V, IV
- (purple)
- (blue)
- (cyan)
- (green)
- (yellow)
- (orange)
- (red)



RA: 22.55
RA: 344.90
DE: 10.79
mag: 4.0
multi: 3
weig: 2

zoom +
zoom -
LoadCat



~540 stars \leq 4 mag(V)

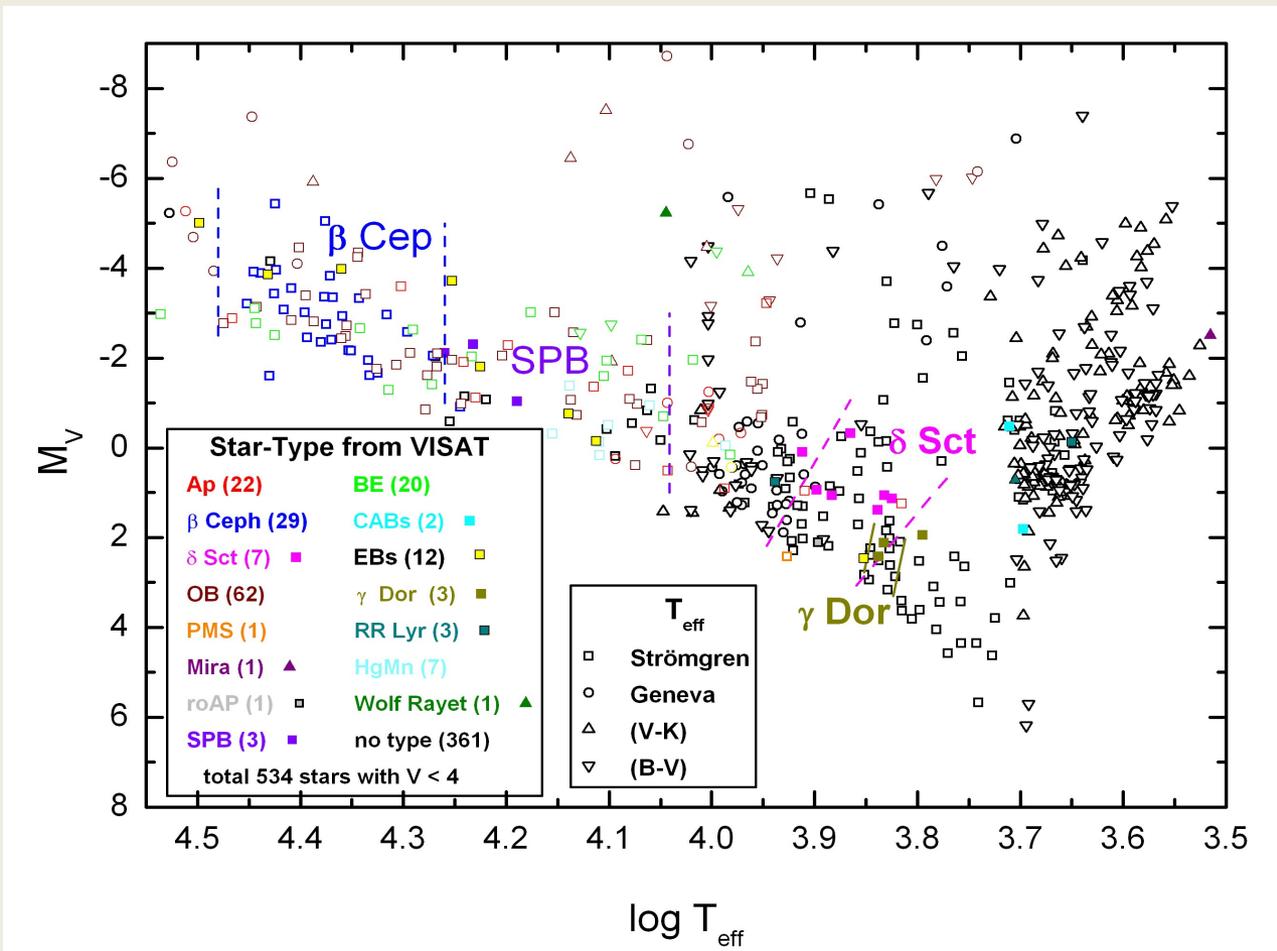
- I
- ▲ III, II
- V, IV
- G
- B
- A
- F
- G
- K
- M





BRITE - Constellation

Types of Targets



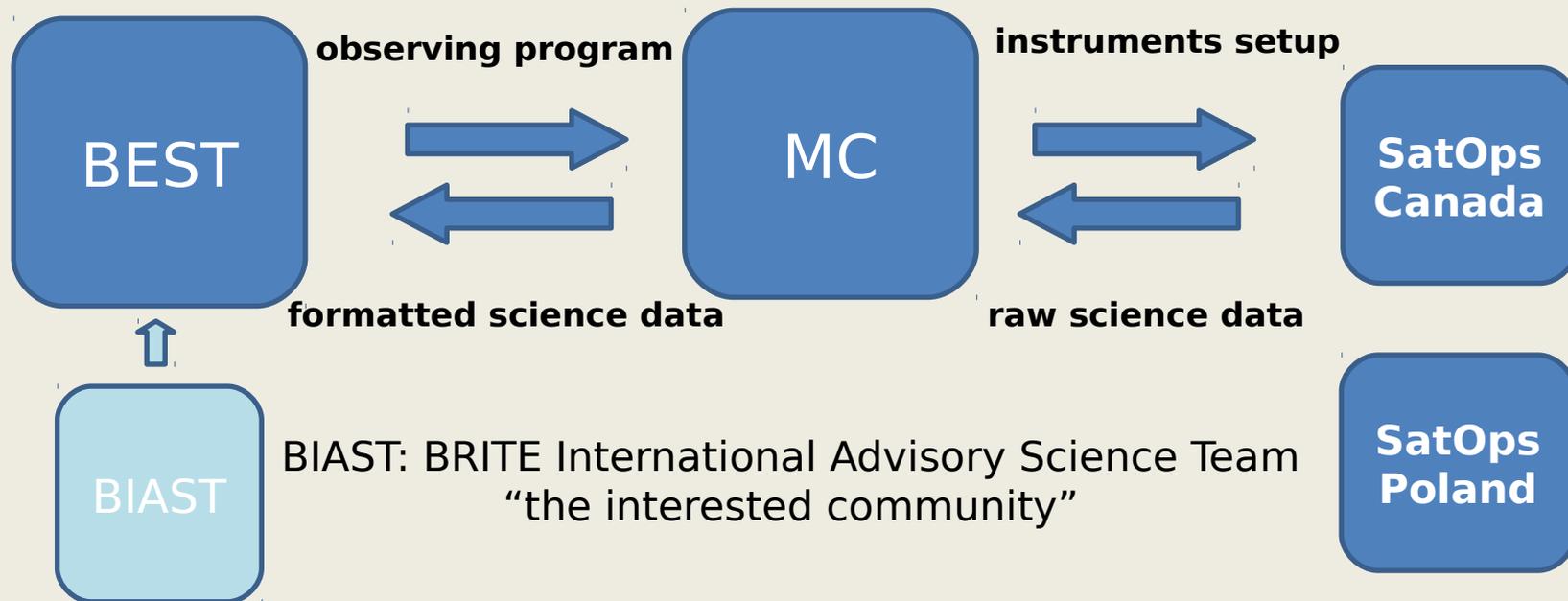


BRITE - Constellation Organization

BEST: BRITE Executive Science Team

MC: Mission Control Team

SatOps: Satellite Operations Team





BRITE - Constellation

Observing Program: General Scheme

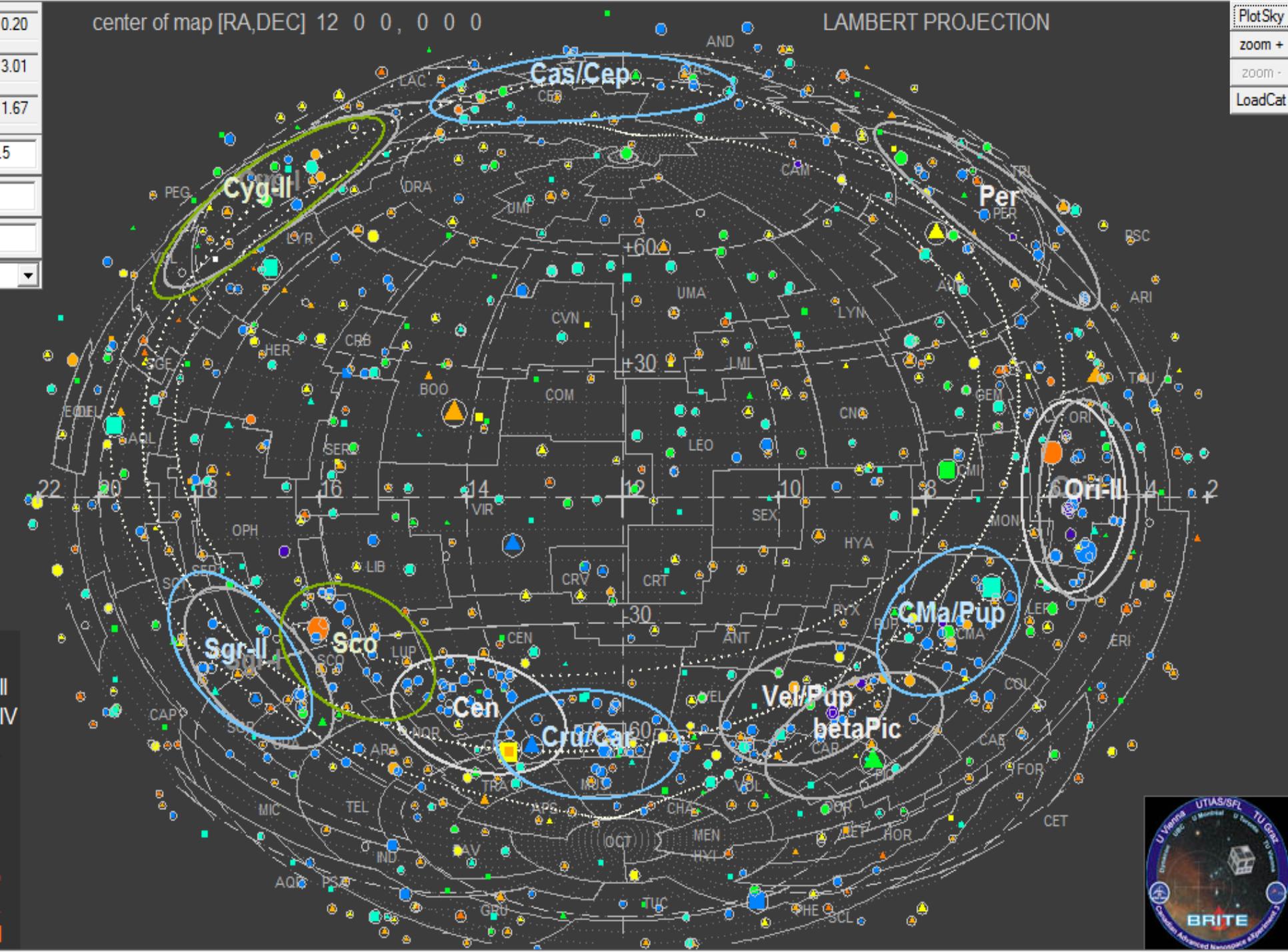
- For scientific and operational reasons BEST decided to focus on **fields along the galactic plane**
- There the **number of bright stars per field is highest** and it also helps the star tracker, i.e. the pointing performance
- Star selection is biased towards **O,B,(A) stars** due to a lack of signal collected from red stars in the blue filter with the same exposure time

0.20
3.01
1.67
5

center of map [RA,DEC] 12 0 0, 0 0 0

LAMBERT PROJECTION

PlotSky
zoom +
zoom
LoadCat



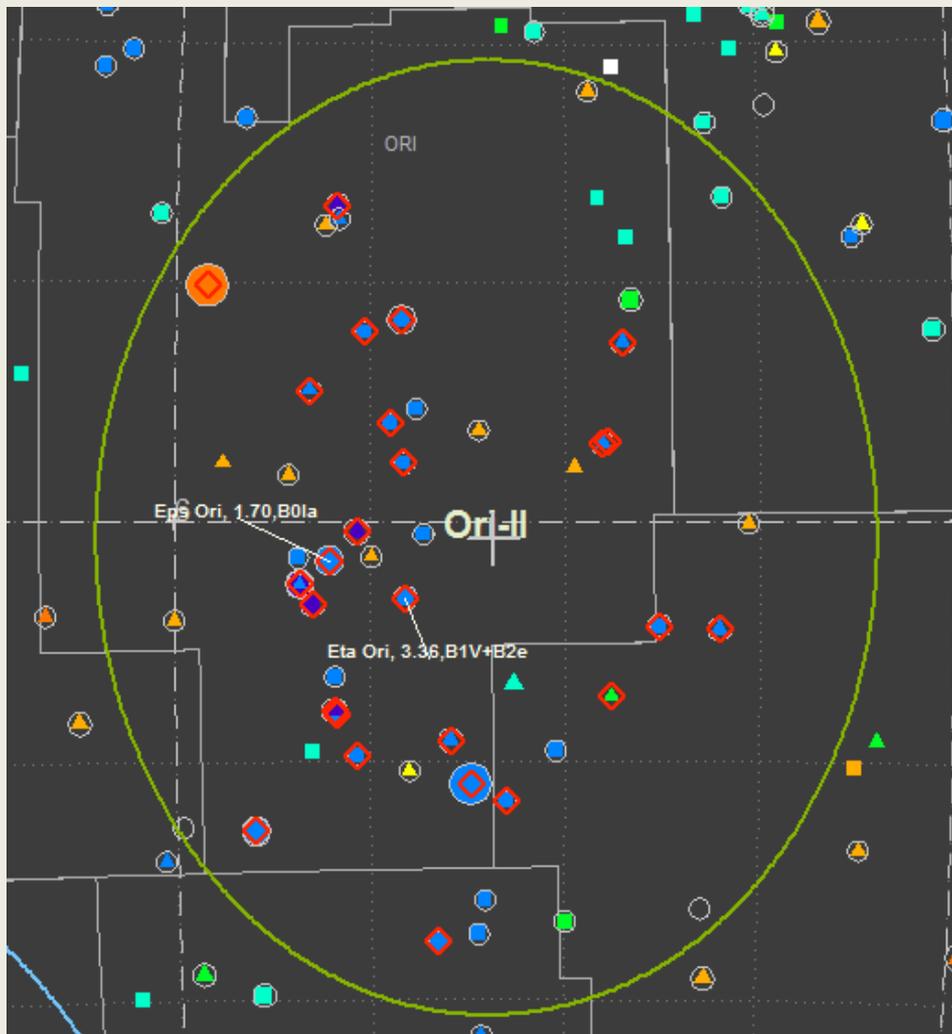
II
IV



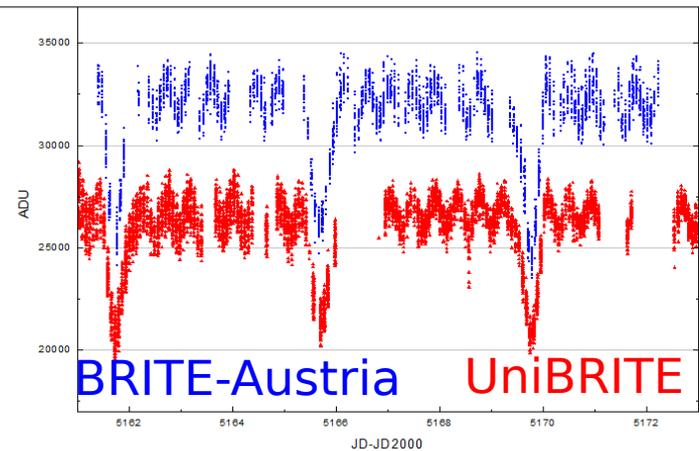


BRITE - Constellation

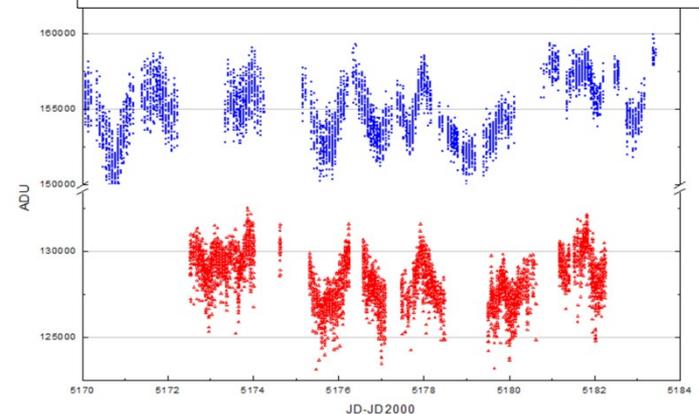
Orion-II: Sep 2014 - Mar 2015



η Ori: B1V + B2Ve, 3.4 mag (V)



ϵ Ori: B0 Ia, 2.7 mag (V)





BRITE - Constellation Observing Program

Nr	Field ID	RA	DEC	Start Date	End Date	[d]	Status
1	Orion-I_2013	05h30m00s	+00d00m00s	2013-01-12	2014-03-18	108	completed
2	Centaurus_2014	14h45m00s	-51d20m00s	2014-03-25	2014-08-18	147	completed
3	Sagittarius-I_2014	18h00m00s	-30d20m00s	2014-04-29	2014-06-09	42	completed
4	Cygnus-I_2014	20h40m00s	+40d10m00s	2014-06-12	2014-11-25	167	completed
5	Perseus_2014	03h27m00s	+37d06m00s	2014-09-02	2015-02-18	170	completed
6	Orion-II_2014	05h12m00s	-00d30m00s	2014-09-24	2015-03-17	175	completed
7	VelPup_2014	08h40m00s	-47d30m00s	2014-12-11	2015-05-28	169	completed
8	Scorpius_2015	15h58m00s	-30d00m00s	2015-02-22	2015-08-31	185	ongoing
9	Cygnus-II_2015	20h35m40s	+38d30m00s	2015-06-01	2015-11-25	178	ongoing
10	CasCep_2015	23h25m00s	+62d04m00s	2015-07-23	2016-01-20	182	planned
11	CMaPup_2015	07h09m00s	-24d30m00s	2015-10-18	2016-04-16	180	planned
12	CruCar_2016	12h47m50s	-61d50m00s	2016-01-22	2016-07-22	183	planned
13	Sagittarius-II_2016	18h11m00s	-27d30m00s	2016-04-15	2016-09-23	162	planned

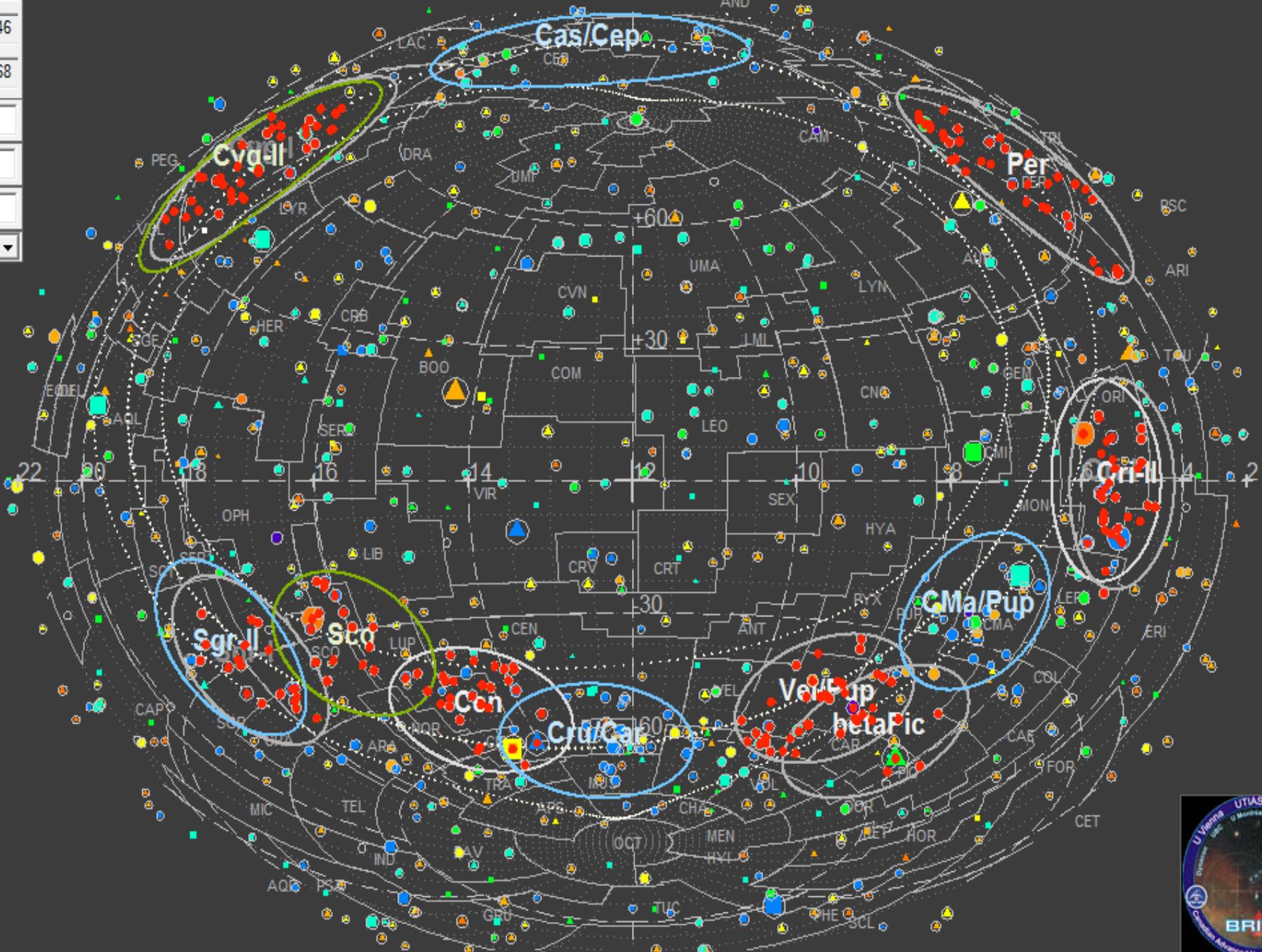
more than 210 stars have been observed so far
detailed infos can be inquired by BEST via best@physics.queensu.ca

4.03 center of map [RA,DEC] 12 0 0, 0 0 0

LAMBERT PROJECTION

PlotSky
zoom +
zoom -
LoadCat

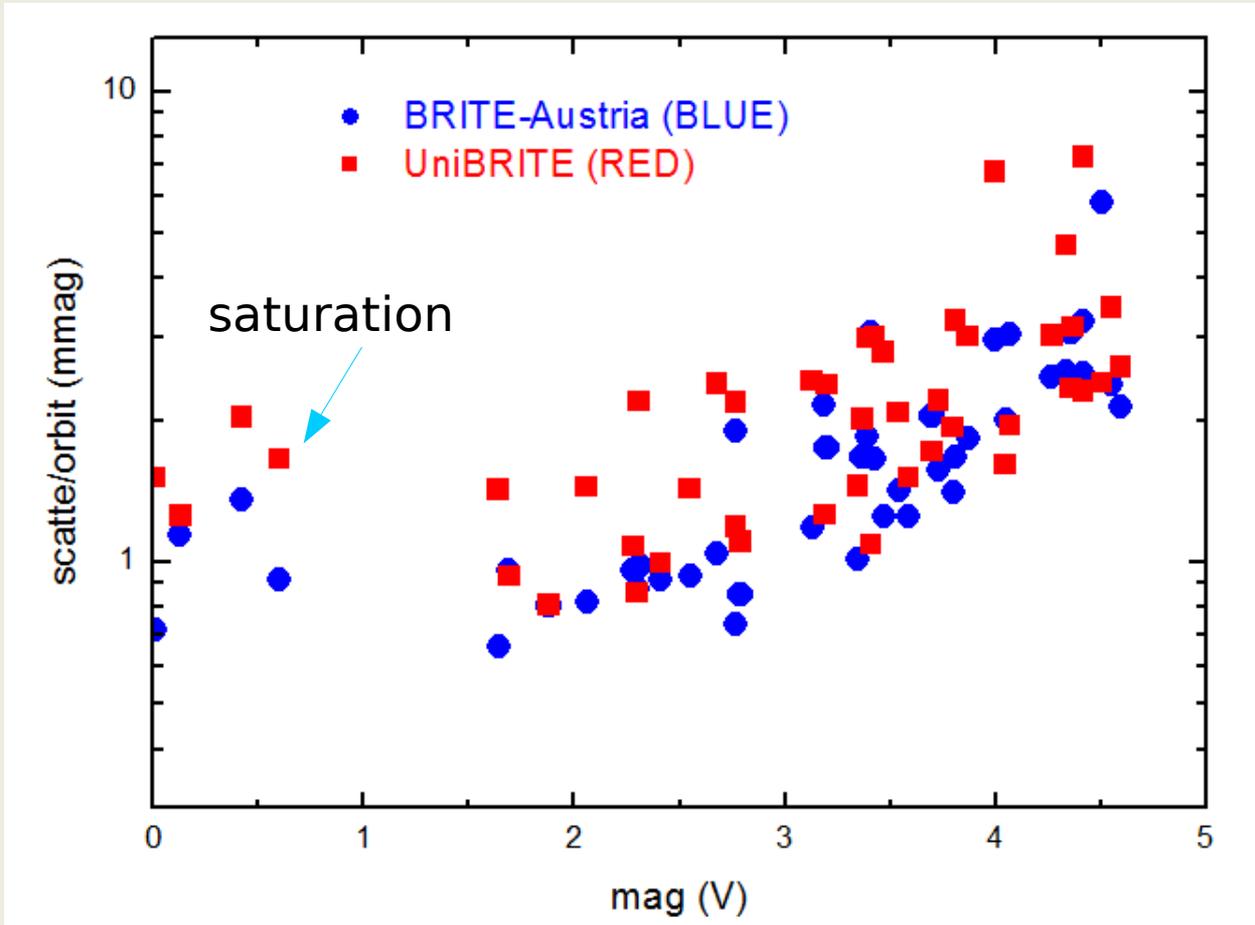
60.46
33.68
5





BRITE - Constellation

Photometric Precision





BRITE - Constellation

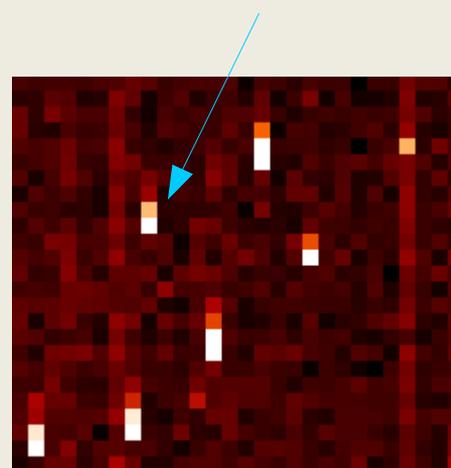
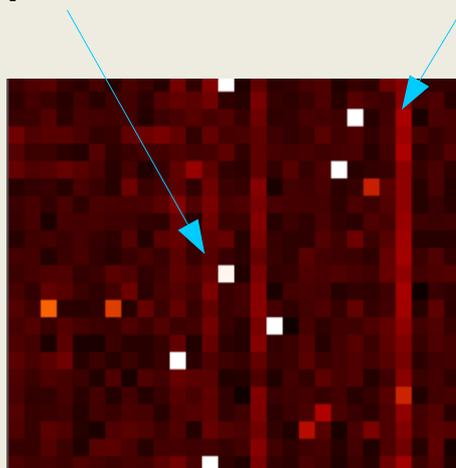
Main Issue: Radiation Damage

hot pixels

warm columns

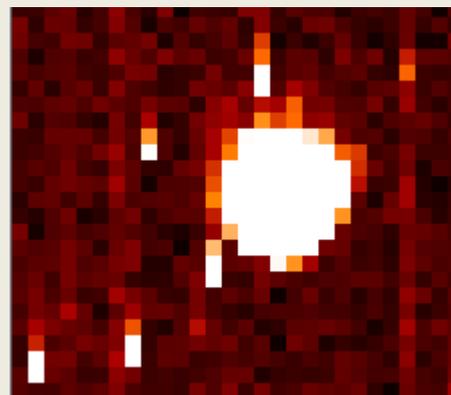
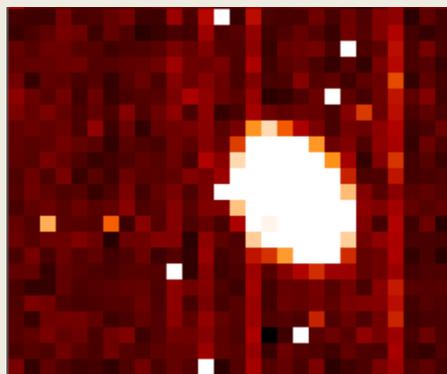
CTI domains

“empty”



Same CCD area with and w/o star

“with star”





BRITE - Constellation

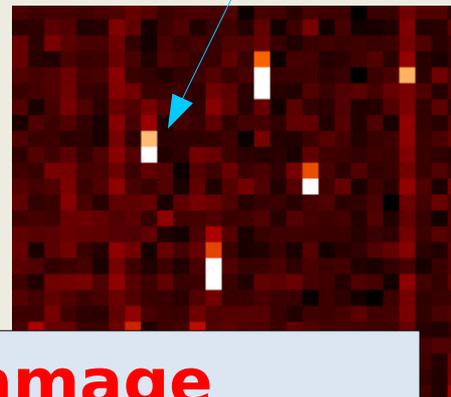
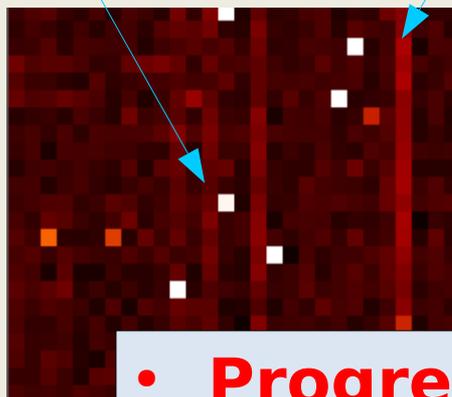
Main Issue: Radiation Damage

hot pixels

warm columns

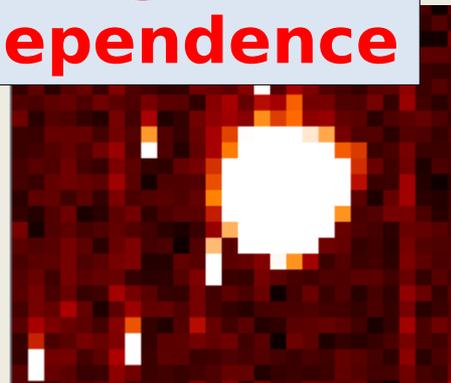
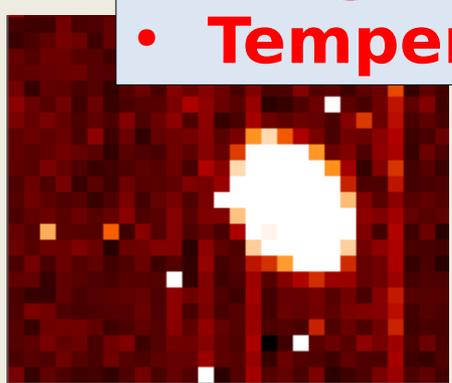
CTI domains

“empty”



Same CCD area with and w/o star

- **Progressive damage**
- **Temperature dependence**



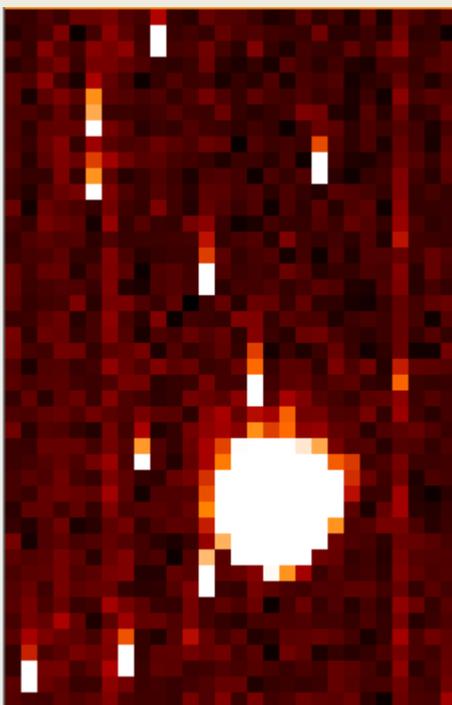
“with star”



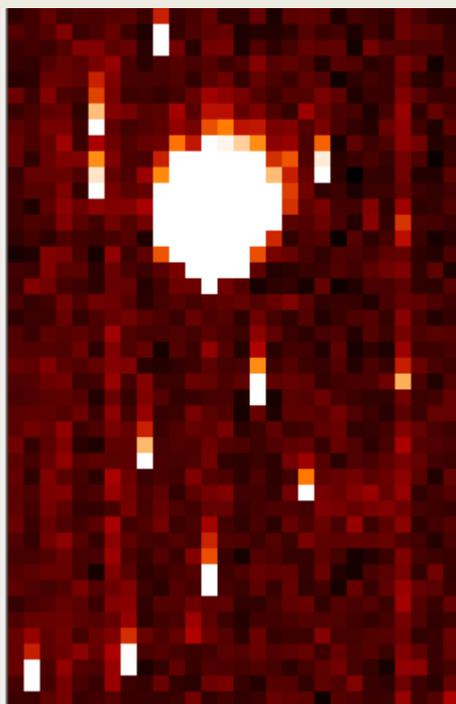
BRITE - Constellation

New Observing Strategy: "Chopping"

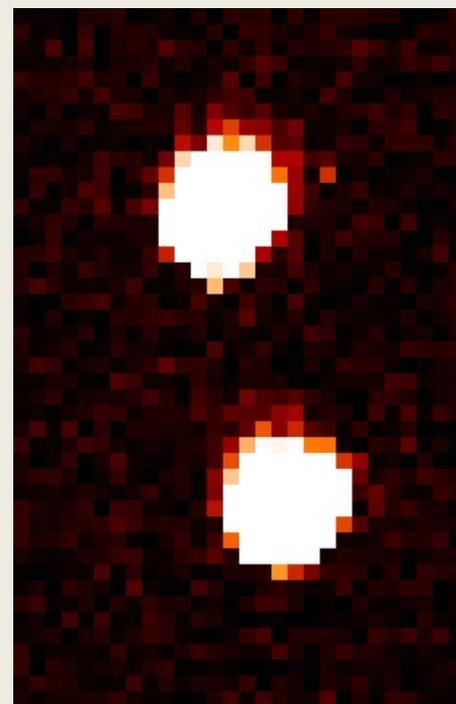
"image n"



" image n+1"



"abs((n+1)-n)"



0.15°

Chopping is now the standard operations scheme for all BRITE satellites



BRITE - Constellation Summary

- BRITE satellites are collecting **science data since December 2013** and now with 5 satellites operational **more than 210 stars have been observed** so far
- **Progressive radiation damage of CCDs** caused problems with data reduction but the **chopping scheme** reduces the artifacts and **improves data quality**
- **At least 2 more years of operations** are feasible and planned for all satellites



BRITE - Constellation Events / Info

The first BRITE Science Conference:
“Science with BRITE-Constellation: initial results”

14 - 18 September 2015

Hotel Orle, Gdansk Sobieszewo, Poland

www.briteconf.pl

website: <http://www.brite-constellation.at/>

wiki page: <http://brite.craq-astro.ca/doku.php>