LOMONOSOV MOSCOW STATE UNIVERSITY

Sternberg Astronomical Institute, Nuclear Physics Intstitute,
Extreme Universe Laboratory, Space Monitoring Laboratory, Ural State University,
Irkutsk State University, Blagoveshchensk State Edicational University, Instituto de
Ciencias Astronomicas, de la Tierra y del Espacio (ICATE), San Juan University
(Argentina), OAFA, IAC (Spain)

Polarization observations with the MASTER Global Robotic Net

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G. Lipunova, E. Gorbovskoy,
Prof. V. Lipunov

http://observ.pereplet.ru

Outline

MASTER polarization measurements:

- Blazars
- Supernovae
- GRBs (Evgenij Gorbovskoy “GRB prompt observations on MASTER telescope robotic network”)

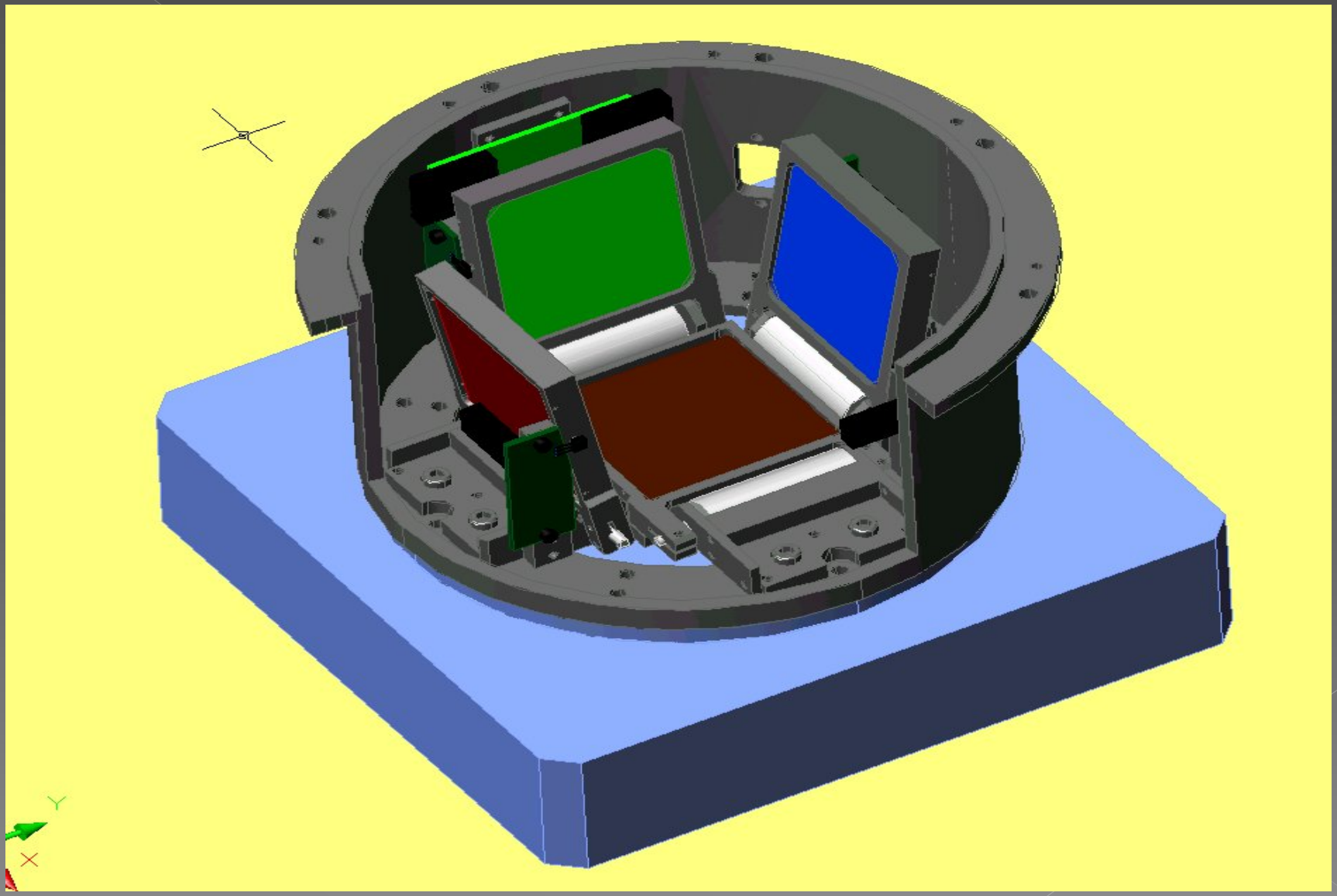
Global MASTER Robotic Net

MASTER II (D=400mm)

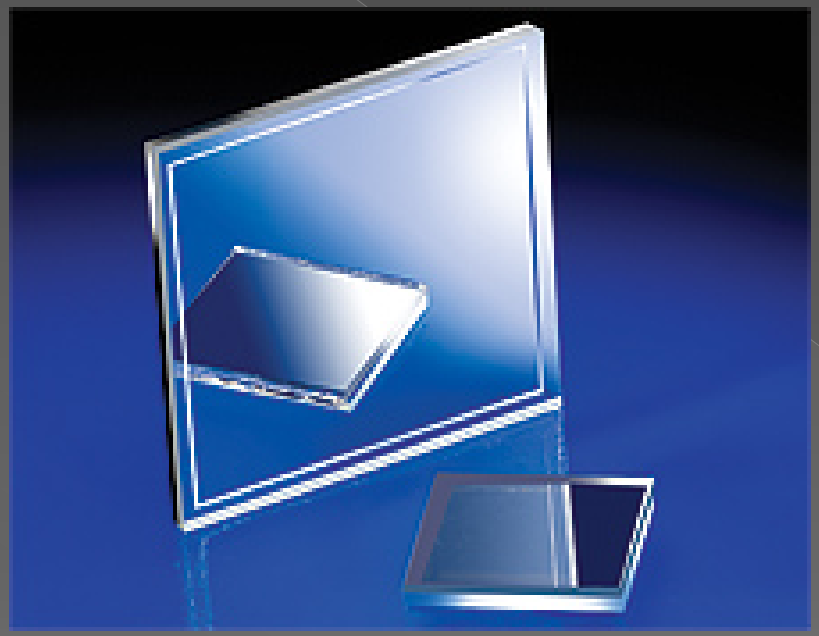
- FOV= 2x4 = 8 square degrees
- up to 20-21 up.

- Very Wide Field Cameras MASTER-VWF
- FOV=400 square degrees
- Diameter 70mm
- up to 12 mag per 1 s.

MASTER photometer

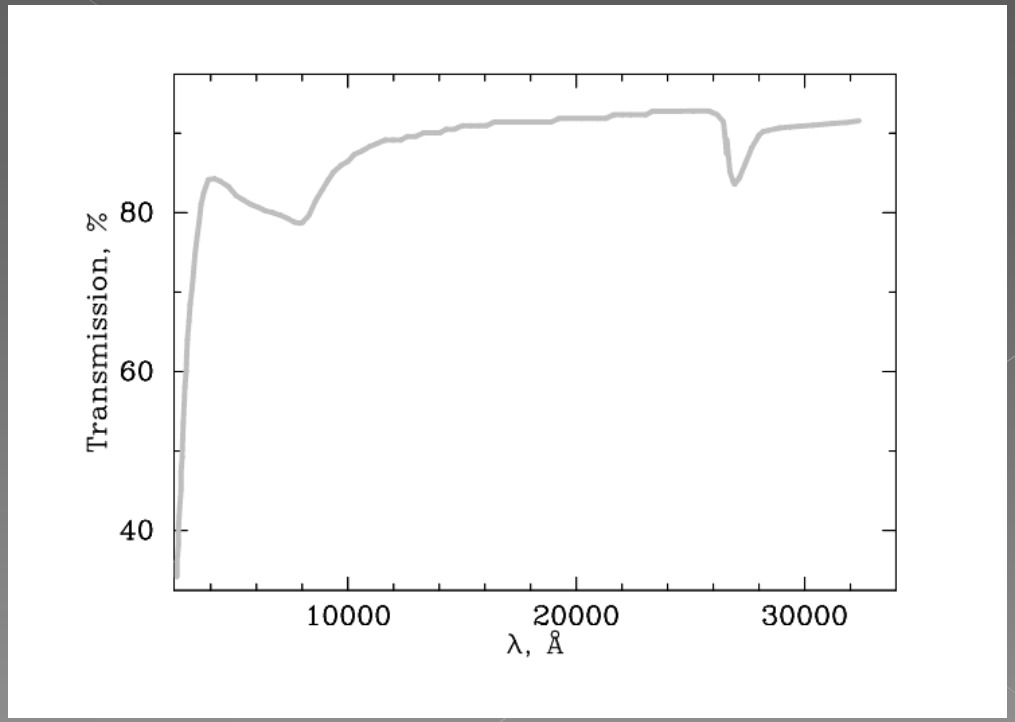


MASTER polarizers



Ultra Broadband Wire Grid Polarizers consist of a thin layer of aluminum MicroWires layered between two Fused Silica windows. Designed for multi-wavelength applications, these polarizers have excellent heat resistance and performance beginning in the UV and extending into the infrared (IR).

50mm x 50mm Ultra Broadband Wire Grid Linear Polarizer



Orientation of polarizers

Atel 4779

OC 457

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Present Time: 7 Oct 2013; 10:50 UT

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Optical and gamma-ray brightening of blazar OC 457

ATel #4779; *D. Blinov, (St. Petersburg Univ.), I. Myserlis, E. Angelakis (MPIfR), O. King (Caltech), V. Pavlidou (Univ. of Crete) for the RoboPol Collaboration*
on 2 Feb 2013; 16:08 UT
Credential Certification: Oliver King (ogk@astro.caltech.edu)

Subjects: Optical, Gamma Ray, AGN, Black Hole, Blazar

The RoboPol Collaboration is currently performing a preliminary photopolarimetric survey of gamma-ray bright blazars in the frame of the RoboPol project. We report that blazar OC 457 (a.k.a. S4 0133+47) is now in a flaring state. Preliminary estimated R magnitude was 14.9 on 2013 Jan. 24.70 UT and R=15.0 on Jan. 26.77 UT, which is significantly brighter than previously reported R=19.25 (Healey et al., 2008). R-band polarization is also high PD=16.4+-0.6%. Analysis of publicly available data of the LAT onboard of the Fermi gamma-observatory also reveals a brightening at gamma-ray wavelengths. Weekly averaged gamma-ray flux reached 2.5E-7 ph cm^-2s^-1 (E>100MeV) on Jan. 24, about 6 times greater than the average flux reported in the second Fermi LAT catalog (2FGL). Multifrequency observations of the blazar are encouraged.

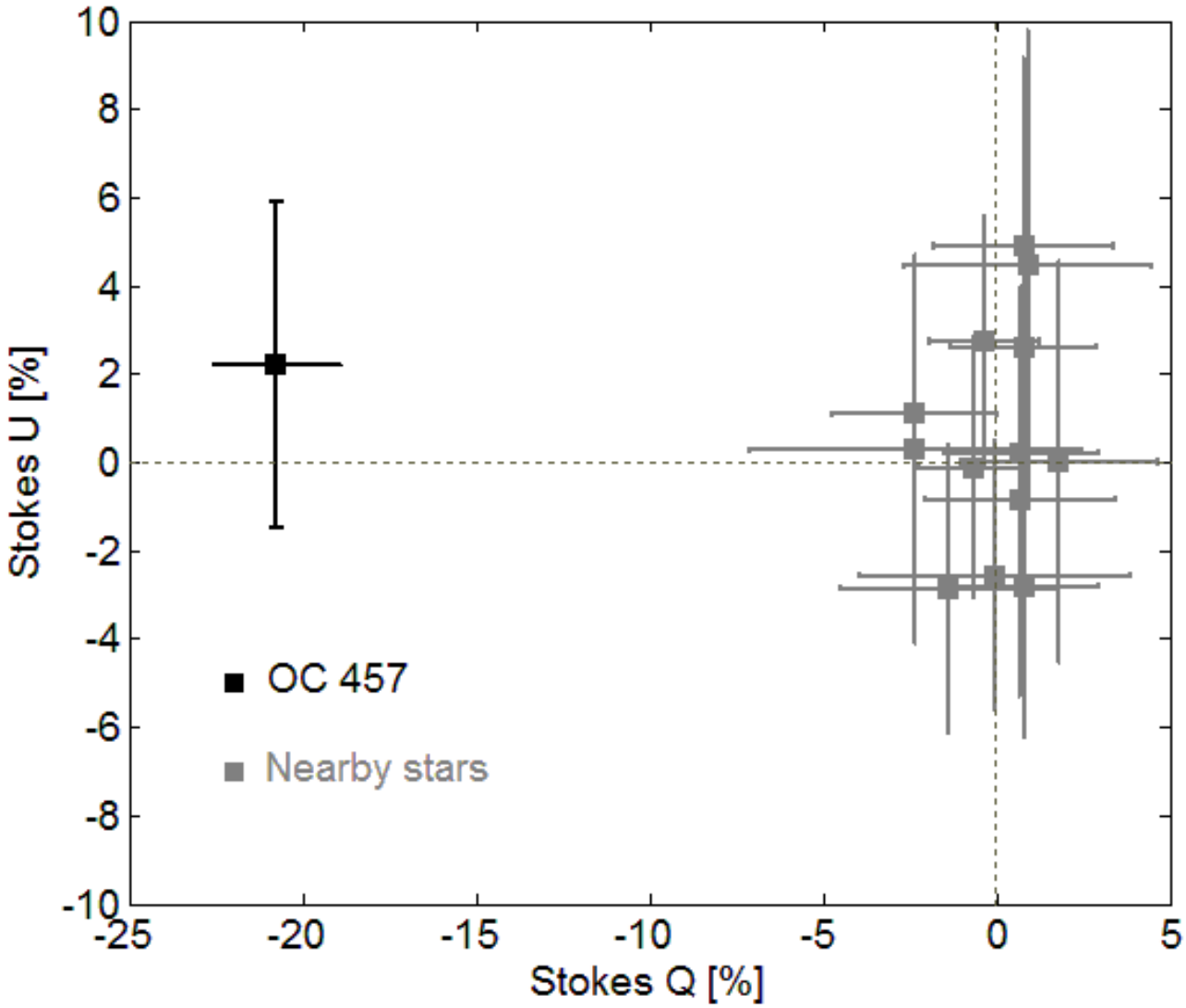
Its brightness in R filter went up a fifty-fold

z = 0.859 (Barkhouse and Hall 2001)

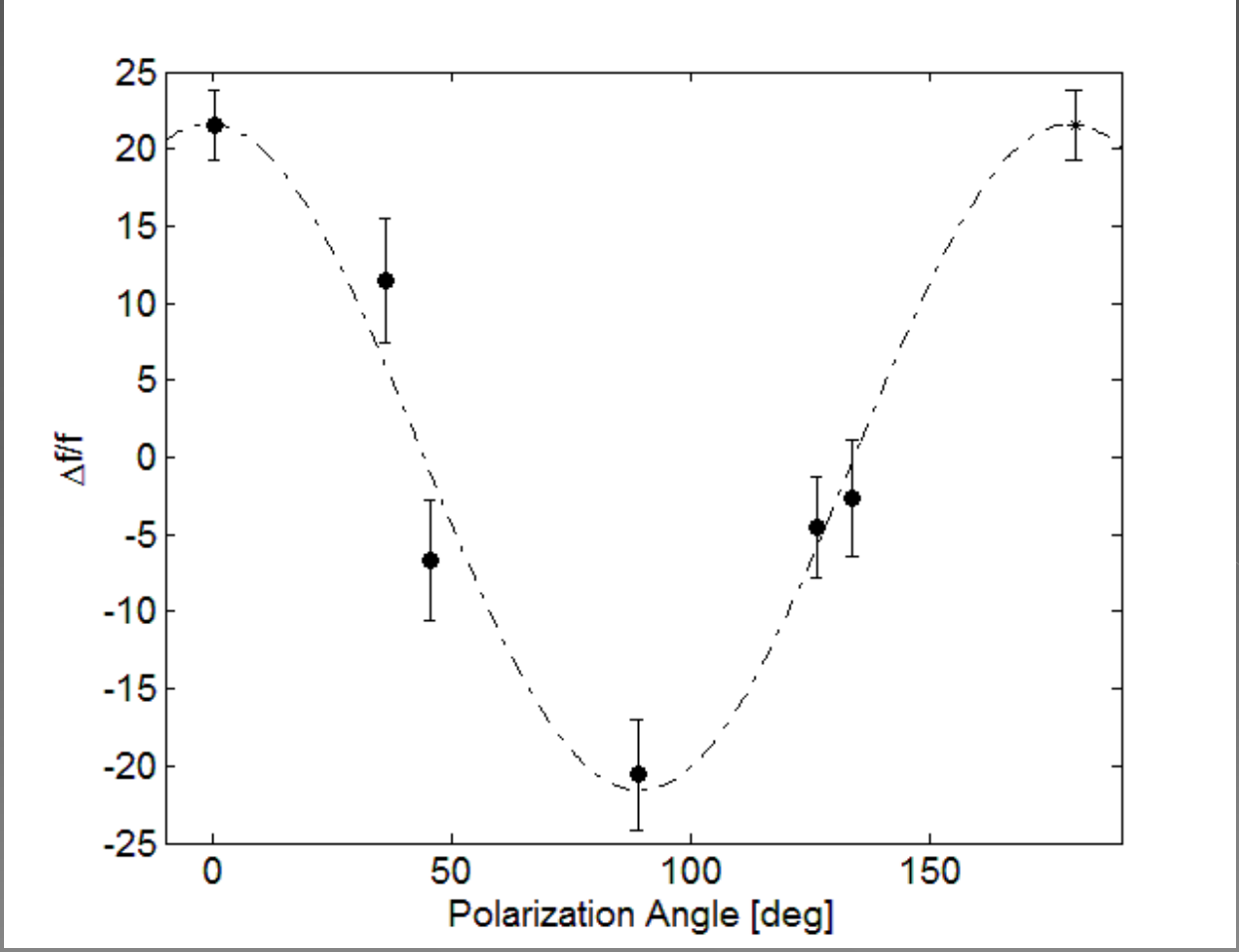
$$P = \sqrt{\frac{Q^2 + U^2}{I}}$$

$$\theta = \frac{1}{2}\arctan\left(\frac{U}{Q}\right)$$

QU diagram of OC 457 and nearby stars



Residual flux differences as measured through the polarization filters



Kislovodsk + Blagoveshchensk 07.02.2013

$$P = 21 \pm 2\%$$

$$\theta = 87^{\circ} \pm 5^{\circ}$$

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Present Time: 8 Oct 2013; 10:59 UT

3C_454.3

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Multi-wavelength activity of blazar 3C 454.3

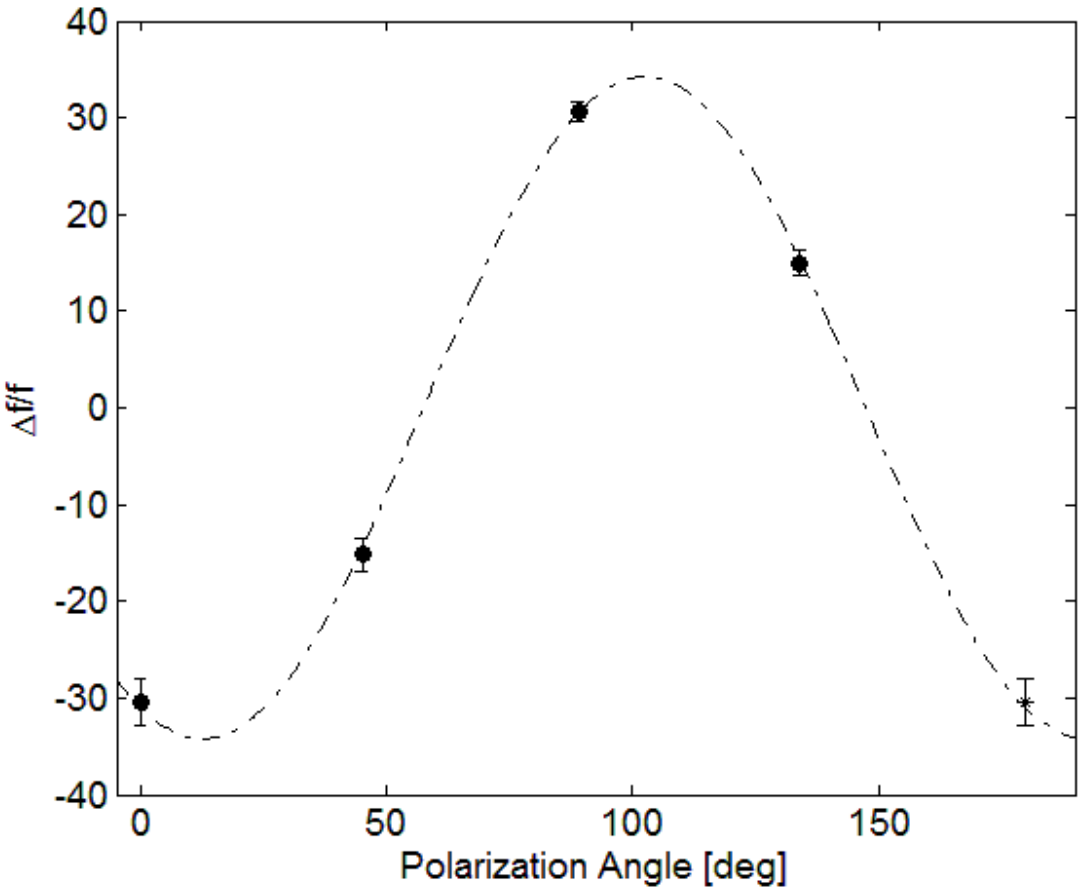
ATel #5423; *V. M. Larionov, D. A. Morozova, N. V. Efimova (St. Petersburg Univ. and Pulkovo Observatory, Russia), D. A. Blinov (Univ. of Crete, Greece; St. Petersburg Univ., Russia), A. Di Paola (INAF - Osservatorio Astronomico di Roma, I*
on 26 Sep 2013; 18:53 UT
Credential Certification: V. Larionov (vlar@a

Related
5436 Yet another NIR flare of 4C+38.41
5423 Multi-wavelength activity of blazar 3C 454.3
5418 Optical/Near-Infrared Flare in 3C 454.3
5412 Fast optical brightening of

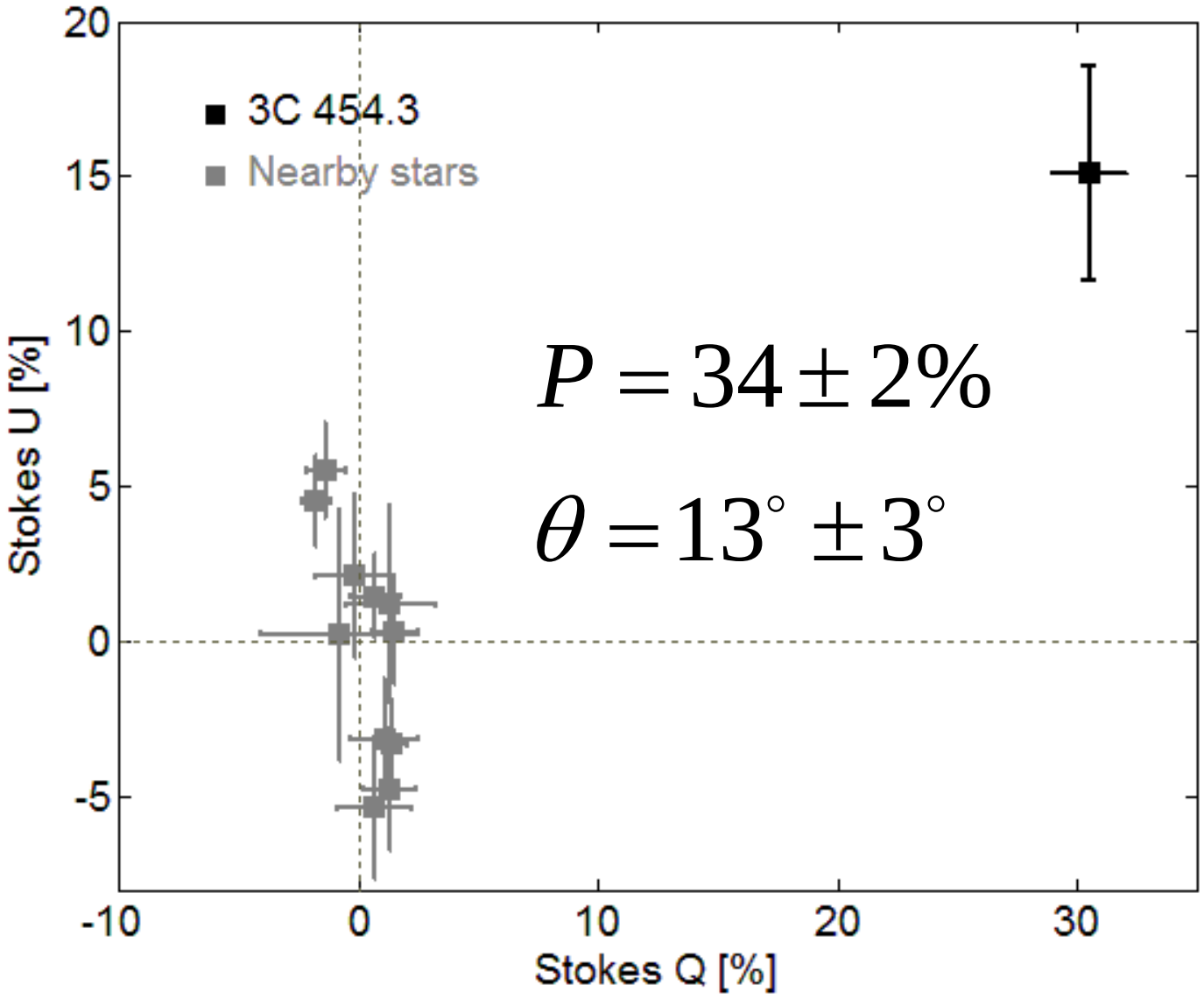
Subjects: AGN, Blazar

Referred to by ATel #: 5436

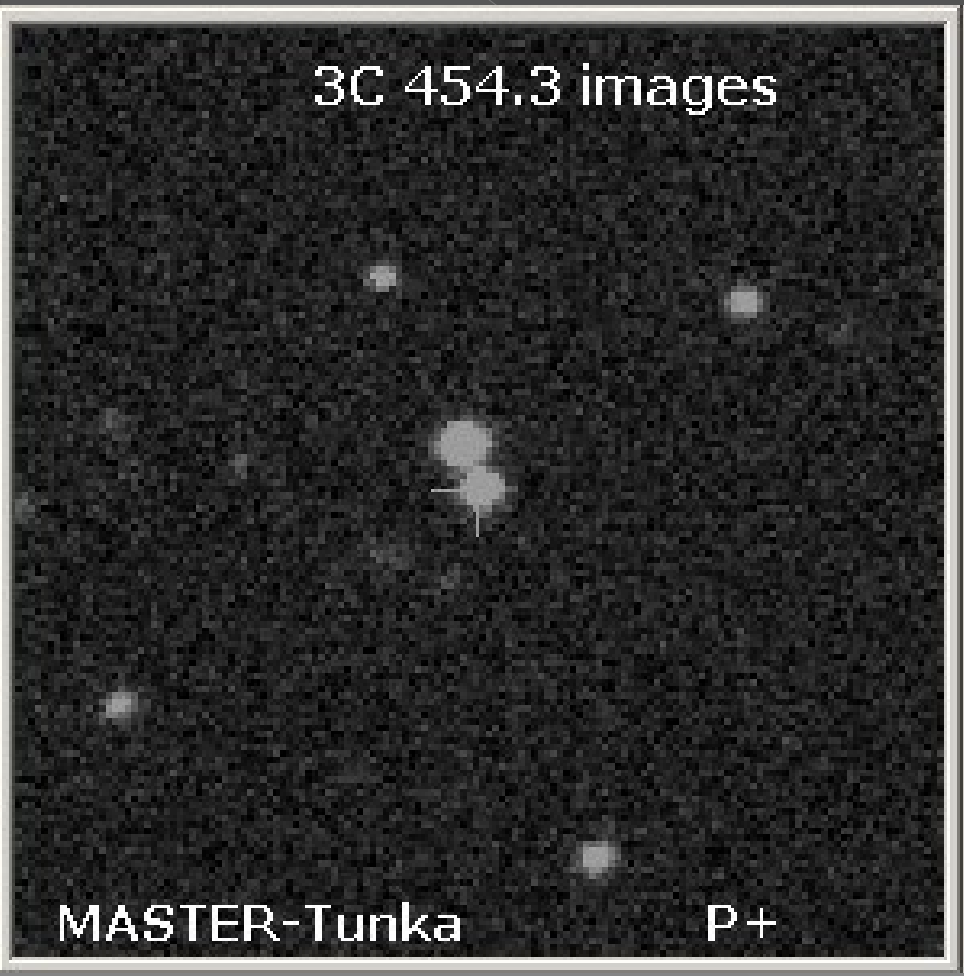
In addition to ATel#5411 and in reference to ATel#5412 and ATel#
announced flare of the blazar 3C 454.3 seems to have culminated a
(AZT-8, Crimea) and NIR (AZT-24, Campo Imperatore, Italy) phot
night yield, correspondingly, R=13.427 at JD2456561.336 and J=1
Afterwards we see a clear decline (0.1 mag) in all bands. This outb
level of optical polarization: 33% during the nights of September 2
positional angle of polarization is approximately perpendicular to t
The maximum level of Fermi gamma-ray flux is rather modest, 5.0
shows the evolution of optical flux and polarization parameters, an
during last month. It may be noted that previous outbursts of this bl
(Jorstad et al, 2013, ApJ, 773, 147), and a renewed activity may be
got also NIR spectrum of 3C454.3 during the night of September 2
H_alpha is now (2.8+/-03)E-16 W m-2, that is markedly more than
2007, when it was in the range of [2.0-2.5] E-16 W m-2 (Raiteri et
reflect a higher level of current BLR activity than that seen in 2007

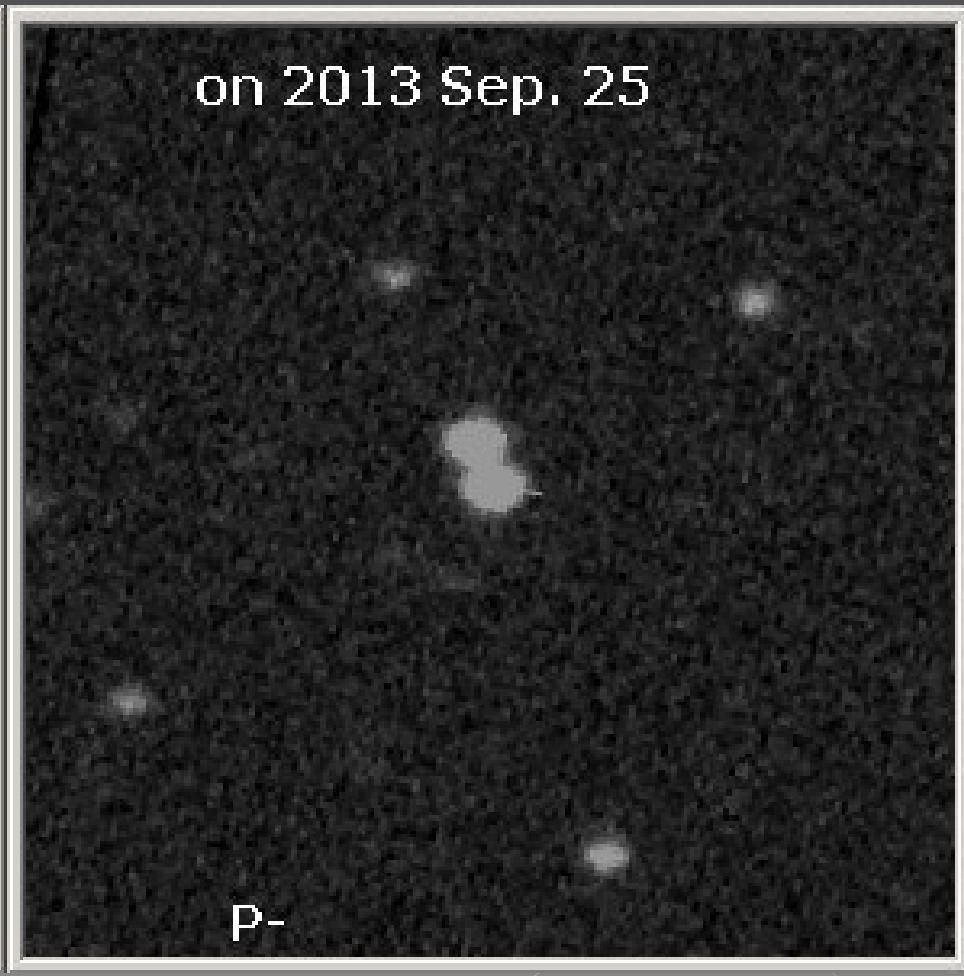


QU diagram of 3C_454.3



3C_454.3

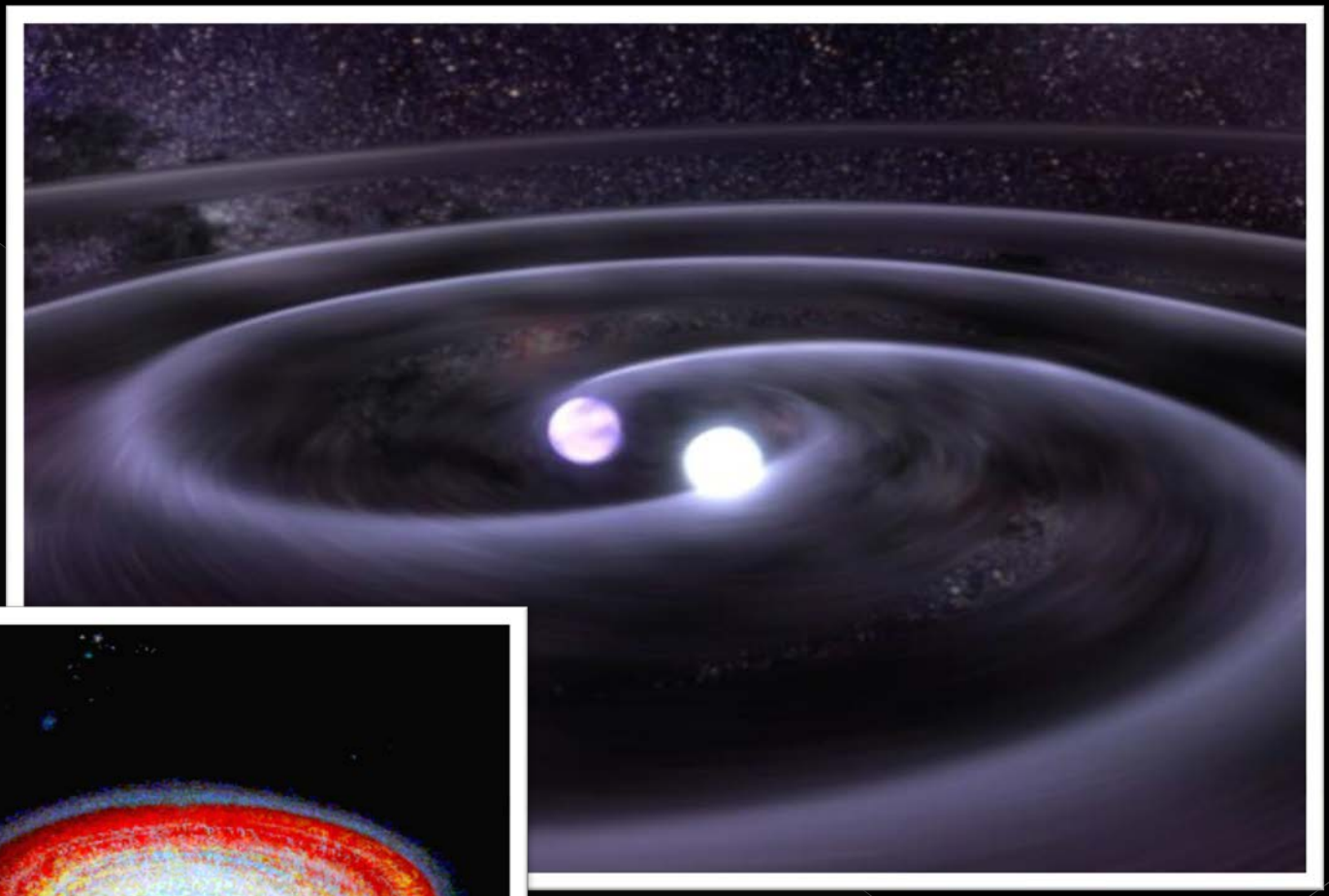


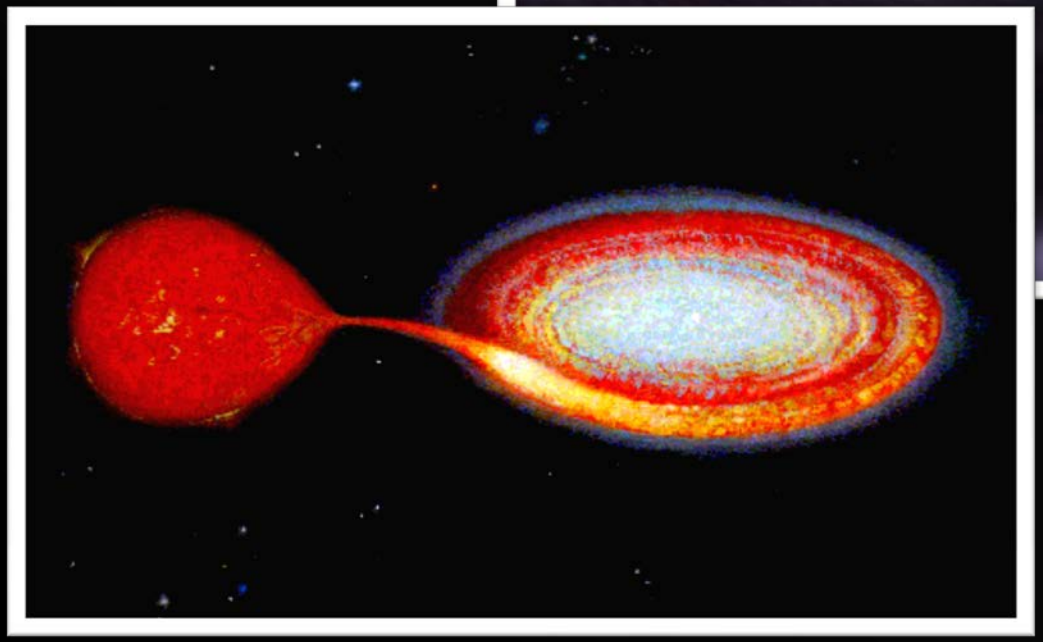


The mechanisms of SN Ia explosions

DD-mechanism

(Iben and Tutukov , 1984; Webbink , 1984)





SD-mechanism

(Whelan and Iben , 1973)

- Continuum polarization for **SN 1999by** (prototype of which is SN 1991bg) was **0.3 – 0.8%** (Howell et al. , 2001)
- Continuum polarization **for SN 2005hk 0.4%** (Chornock et al. , 2006)
- **SN 1996X** was the first SN Ia with spectropolarimetry prior to optical maximum. The broadband polarimetry showed that continuum polarization **is zero**. The spectropolarimetry demonstrated spectral features with a rather low polarization **0.3%** (Wang et al. , 1997)
- In the paper (Leonard et al. , 2005) are reported about spectropolarimetric observations of **SN 1997dt** 21 days after optical maximum. Polarization wasn't detected but inessential line polarization in FeII and SiII were found
- Another example can be **SN 2001el** (Wang et al., 2003). Before optical maximum the linear polarization in the continuum was **0.2 – 0.3%.** During the last 10 days the degree of continuum and line polarization decreased and disappeared entirely 19 days after optical maximum
- Spectropolarimetry of **SN 2004S** 9 days after maximum light displayed very low polarization (Chornock et al. , 2008)
- The significant line polarization was found for **SN 2004dt**, for which there are data approximately 7 days before maximum light (Wang et al. , 2006) and 4 days after maximum (Leonard et al. , 2005). During this period polarization of the SiII line changed within the range **2%.**
- Measurements of polarization of the **SN 2002bf** at approximately the same period as for the SN 2004dt showed CaII line polarization **2%** (Leonard et al. , 2005).
- **SN 1997bp** and **SN 2002bo** also showed significant line polarization (Wang et al., 2006).
- **SN 2006X** observed prior to maximum light and 40 days after maximum polarization uncorrected for ISP declines from **8%** at 4000A to **2%** at 8000A (Patat et al. , 2009). In fact polarization of the CaII IR line IR was **1.5%** and the SiII line was **0.5%** (10 days before maximum light).

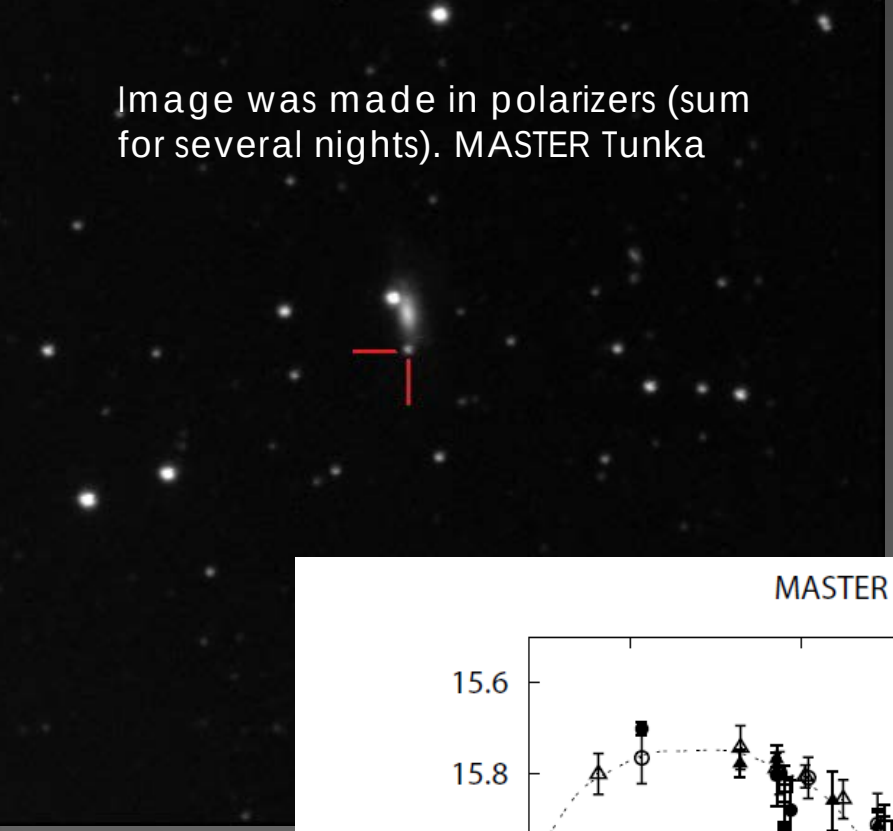
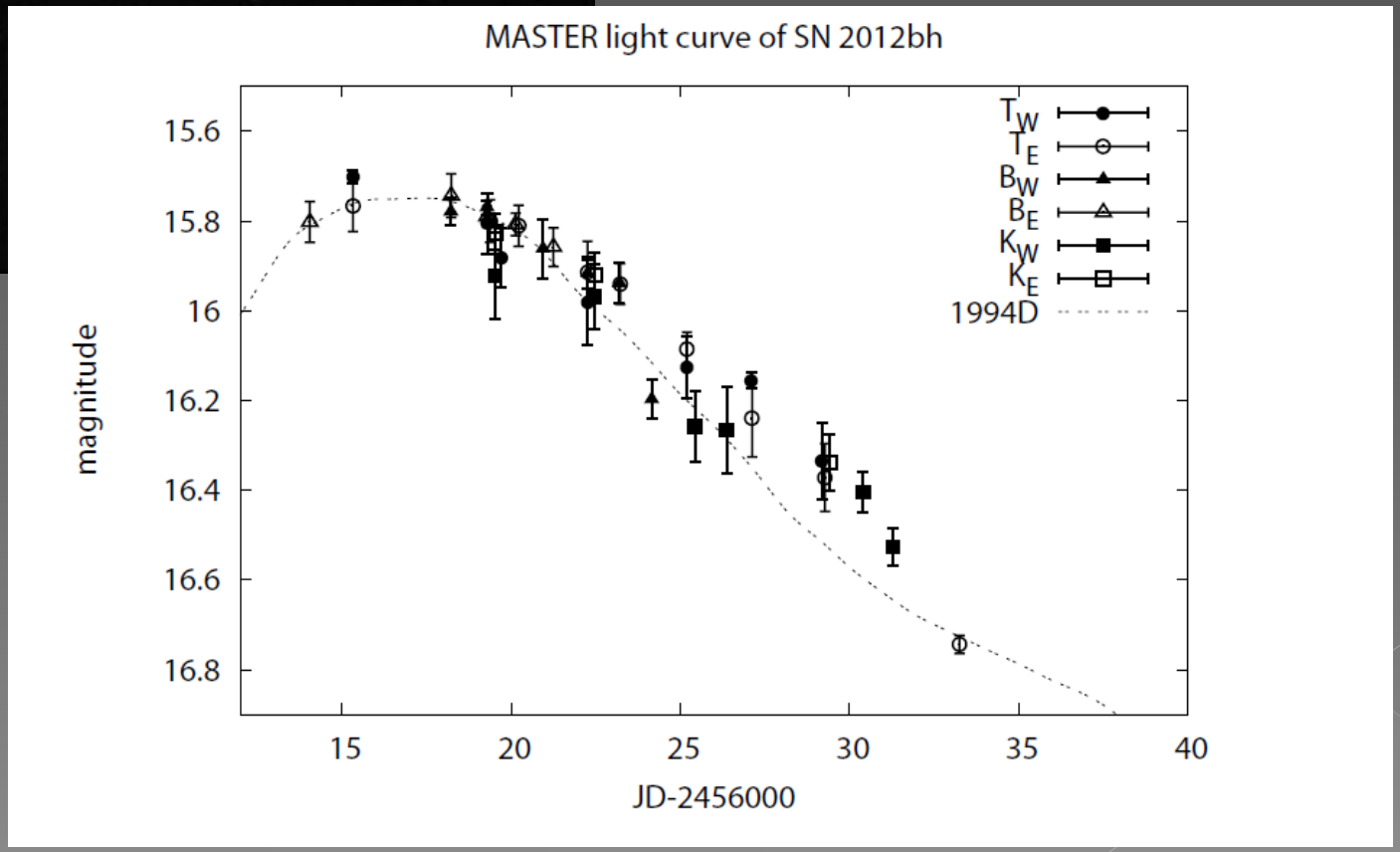


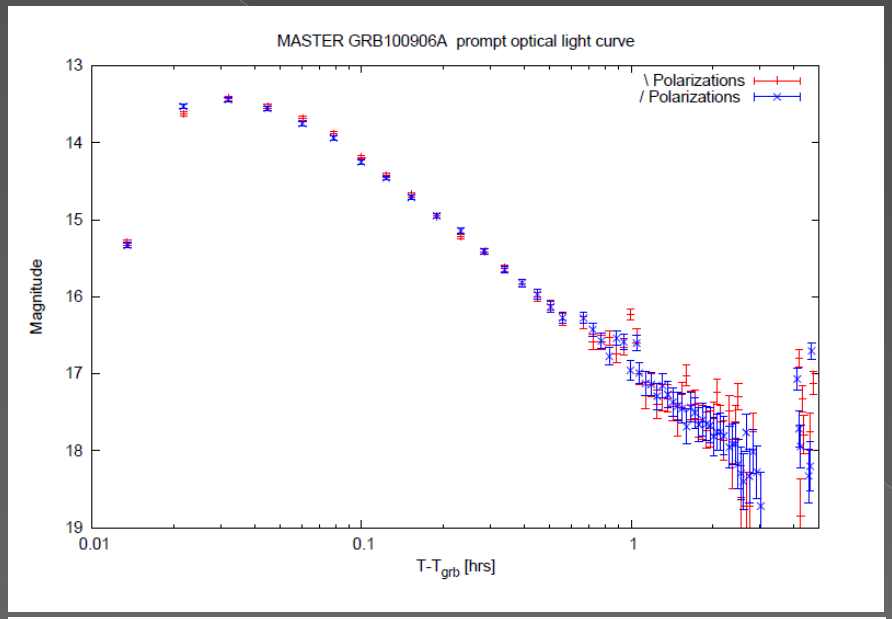
Image was made in polarizers (sum for several nights). MASTER Tunka

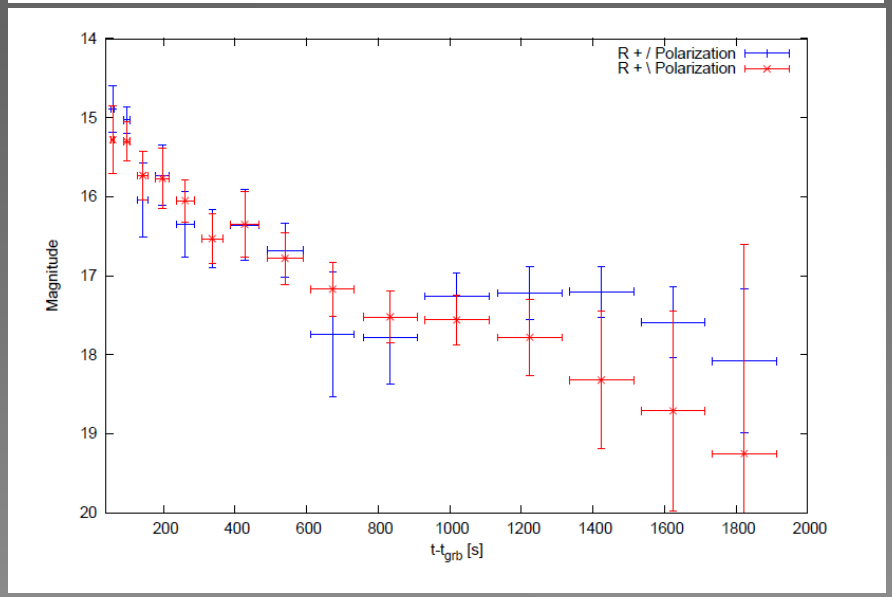
Type Ia SN 2012bh in UGC 7228

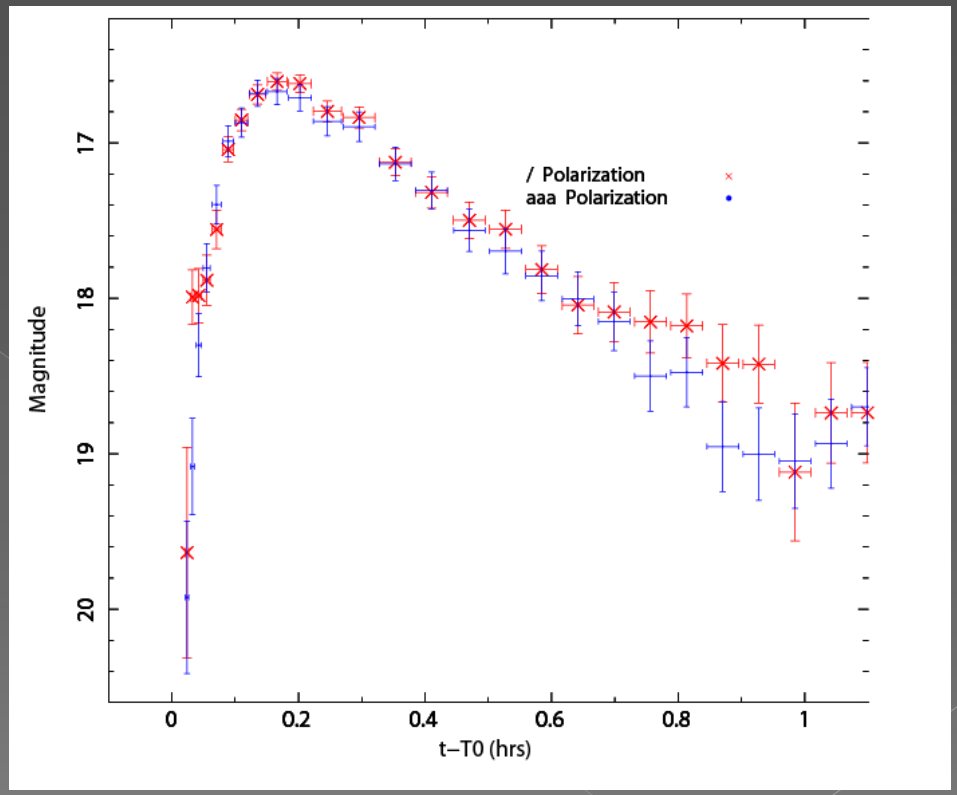
$$P < 2.5\%$$



GRB 100906A, GRB 110422A, GRB 121011A

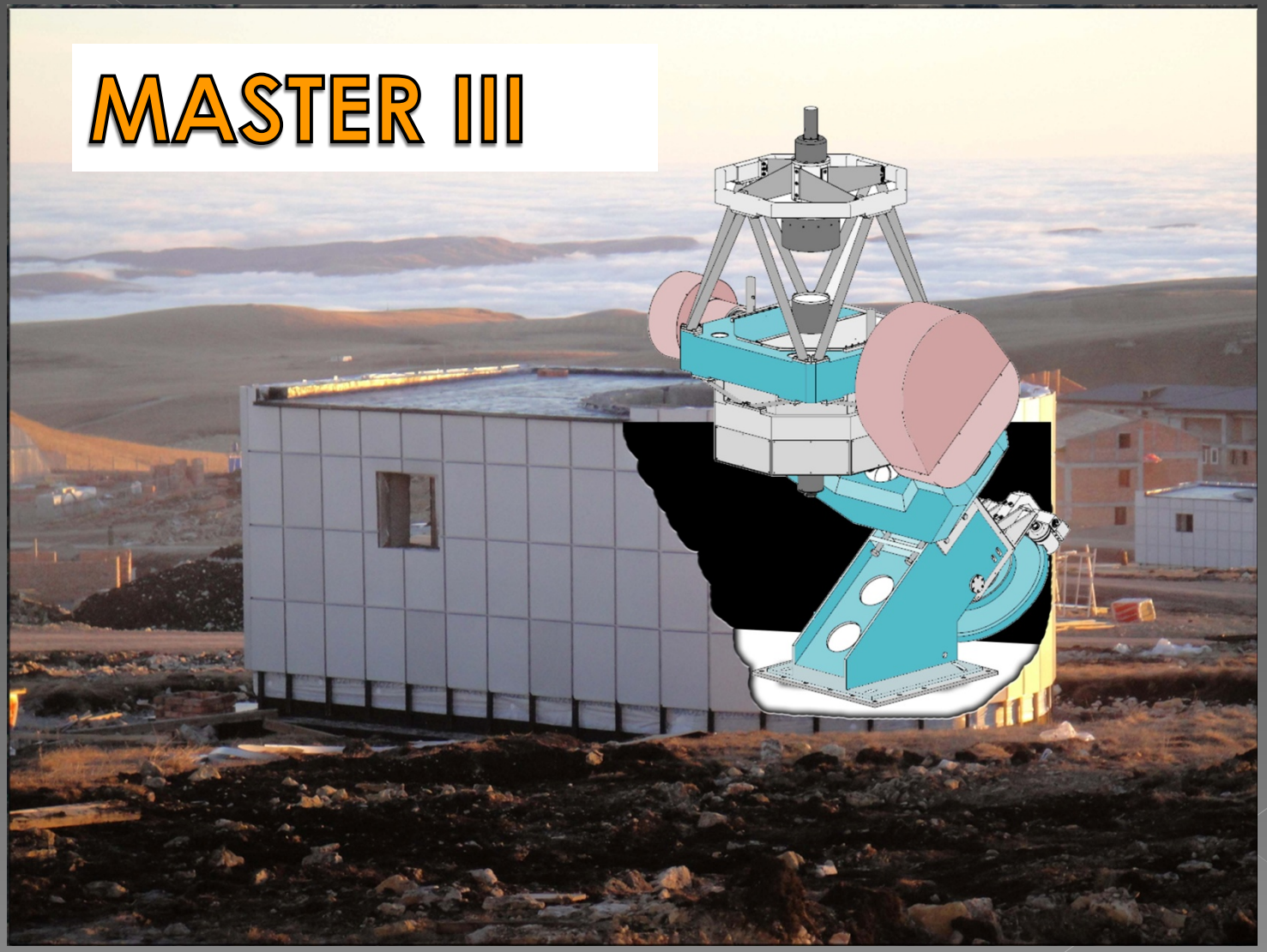






See E. Gorbovskoy presentation…

Future…



Conclusions

- The polarization observations of blazar OC 457 and 3C_454.3 showed that MASTER's polarizers can be successfully used for measuring polarization more than 10 -15%.
- The accuracy of observations is not enough for lowpolarized objects measurements. However the accuracy of measurements increases for bright objects.
- MASTER's telescopes are able to register the GRB's polarization that exceeds 10% according to theoretical models.

Thank you for attention!