The Swift/UVOT Blazar image processing for multi-wavelength campaigns and OJ287

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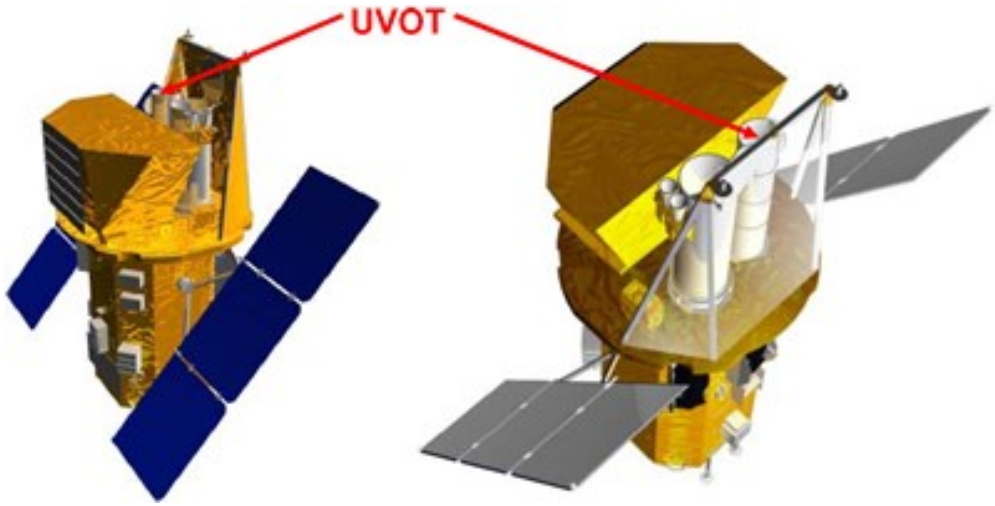
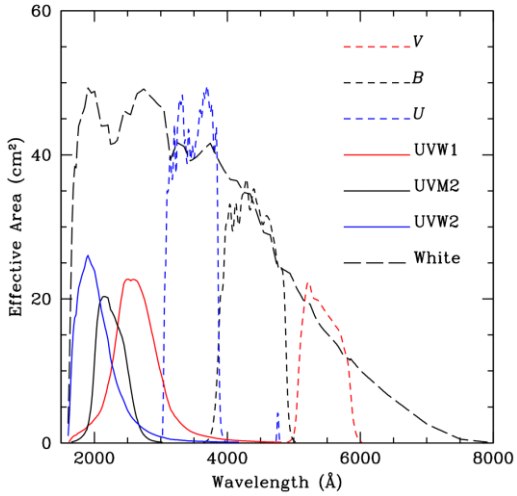
Outline

- Blazar multi-wavelength campaigns: past and present
- UVOT various results: collaborations
- Swift/UVOT Blazar catalog: work in progress

UltraViolet-Optical Telescope





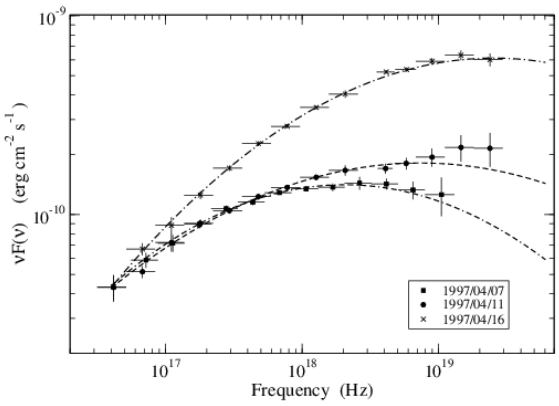
(UVOT: Roming et al. 2005; photometry calibration: Breeveld et al. 2011); six lenticular filters: V, B, U optical bands; W1, M2, W2 UV bands, from 2030 to 5402Å

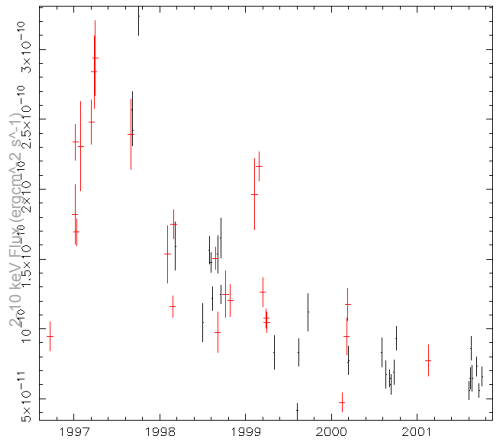
Blazar Multi-Wavelength campaigns@ ASDC

- **BeppoSAX data processing of Blazars:** (P. Giommi, et al., 2002, babs.conf...63G)

BeppoSAX Narrow Field Instrument (NFI) X-ray data processing on-going since 1996 to create updated Spectral Energy Distributions (SEDs), then (2001-2002) a Blazar Wide Field Camera (WFC) processing began within the official catalog creation and brought to specific works, e.g. Mkn 501 (E.Massaro, et al., 2004, A&A). Log-parabolic model on SEDs including archival radio, and IR-optical-UV data but…

Mkn501



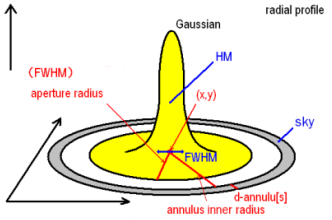


=>in 2004: ASDC one of the official Swift Data Centers

Blazars Swift/UVOT images data reduction:

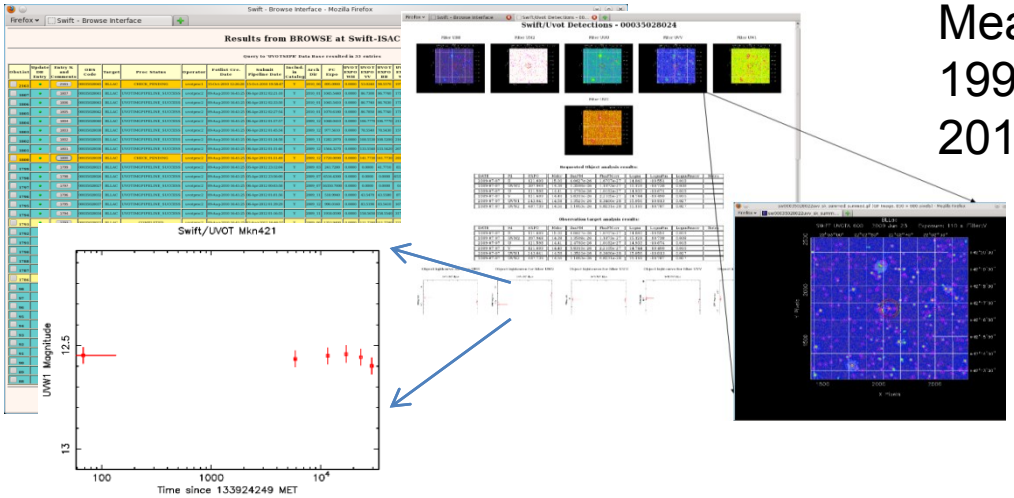
Blazars campaigns included Swift data processing in 2005-2006:

A dedicated archival data processing procedure development was planned in 2006 for the Swift Blazar key-project in collaboration with A. Antonelli, G. Tosti, E.Massaro, to process with HEAsoft tasks UVOT total exposure images and also single “slices” with aperture photometry and detection algorithm official tasks.
Also support the Swift/XRT surveys (“Serendipitous” and “Deep”).



- =>aperture photometry of an object, @input position
- =>detection algorithm execution, to review object position due to single image astrometry problems

Ex.: the Data Processing management system preview



Mean galactic extinction law (Fitzpatrick 1999) and E (B-V) maps (Schlafly et al 2011) flux dereddening

But processing results NEED Careful revision: image and SED inspection

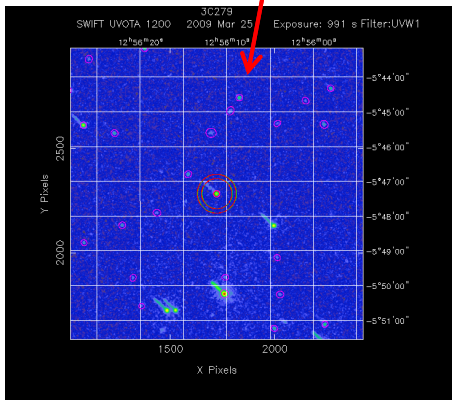
- **Data processing results: an on-going optical-UV Blazar survey; included in dedicated source detections DB’s, will be enlarged including also intra-observation light curves**

Blazars Swift/UVOT images data reduction:

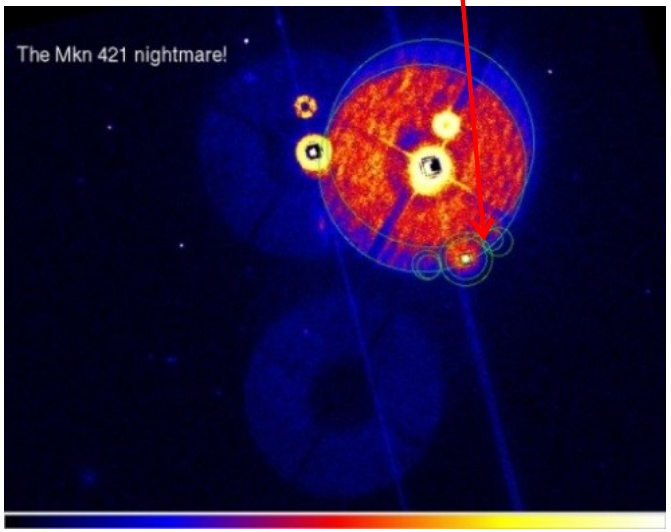
Careful revision of the results is needed, image detection check, and even inspecting the full SED, due to:

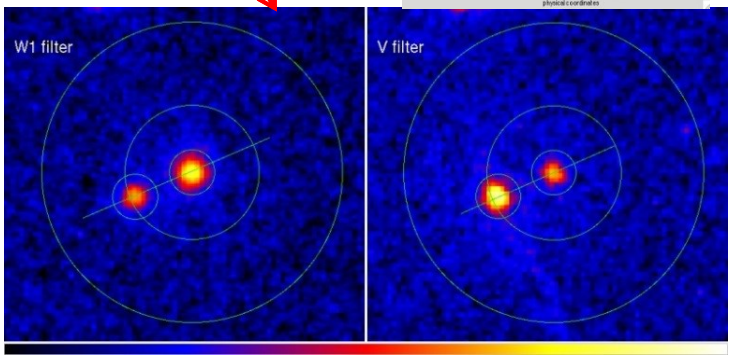
- not correct astrometry: use of sky image in Swift archive -> some case of discarded (not good) astrometry ->recover/reprocess data
- possible contaminating nearby objects, saturation and artifacts, and contaminated bkg
- uncorrect flux conversion pb!

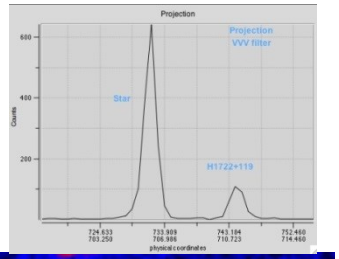
=>verify SED validity



Mkn 421, the WORST CASE!





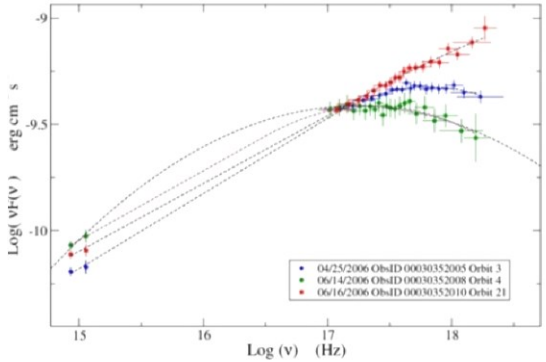


Blazars multi-frequencies campaigns with Swift:

- **First results: log-parabolic modeling of flare SED**

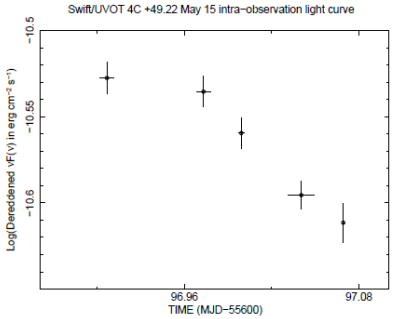
A.Tramacere, et al., 2009

From log-par to PL



- **Main recent Blazar SEDs papers: surveys & single sources**

- A. Tramacere, et al., 2009, A&A 501, 879: Mkn421
- A.A. Abdo, et al., 2010, ApJ, 716, 30: SEDs of Fermi Blazars
- P. Giommi, et al., 2012, A&A, 541A, 160: Planck, Fermi, Swift
- C. Cutini, et al., 2014, MNRAS, 445, 4316: Radio-gamma-ray, 4C +49.22 spectral evolution
- J. Aleksič, et al. (MAGIC Collaboration), A&A, 572A, 121:
- A. Furniss,et al., 2015, ApJ, 812, 65: Mkn501 with NuSTAR
- M. Balokovic, et al., 2016, ApJ, 819, 156: Mkn421 with NuSTAR
- M.J. Valtonen, et al., 2016, ApJ, 819L, 37: OJ287 new outburst, Ciprini's talk!
- Ahnen, M.L., et al., 2016, MNRAS,459, 3271:VHE gamma-ray source H1722+119

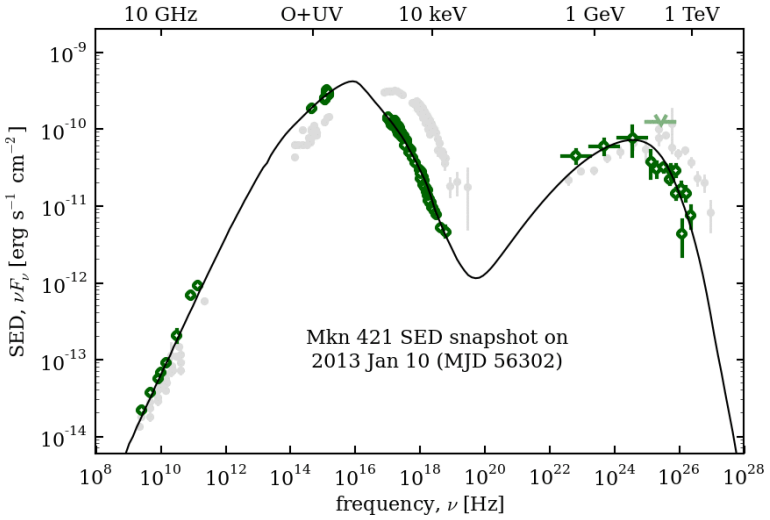


C.Cutini, et al., 2014

Some results: collaboration to SED modeling and macroscopic parameter determination; detected flux variation in a few objects; SED evolution studies

Blazars multi-frequencies campaigns with Swift:

Variability studies: light curves, time resolved SEDs



courtesy M. Balokovic, 2016

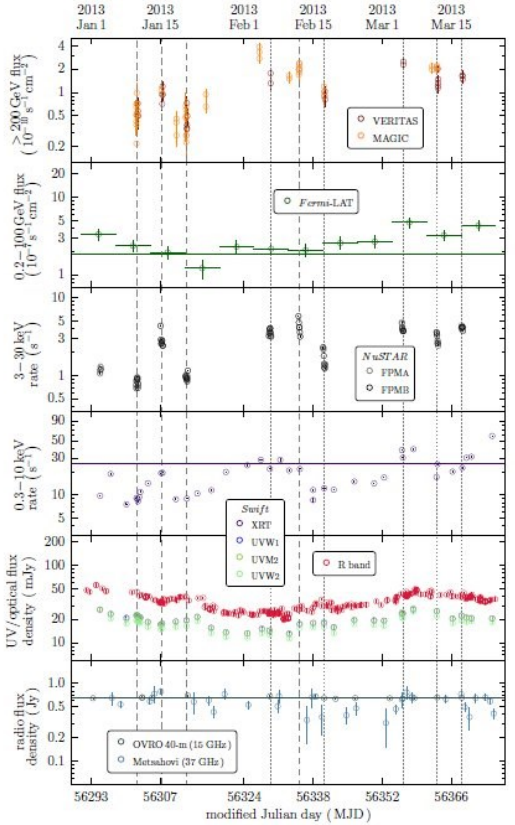
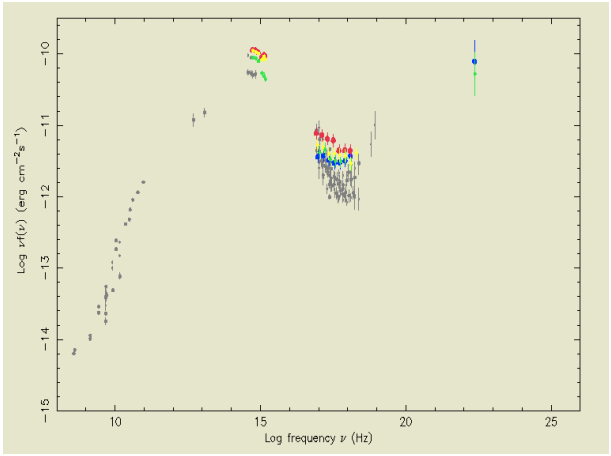
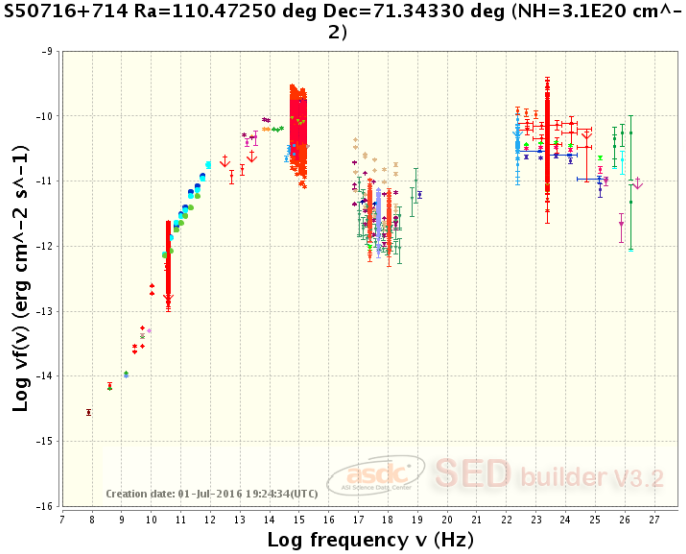


FIG. 7.— Light curves for Mrk 421 from MAGIC, VERITAS

Inserting data in ASDC SED Builder tool:



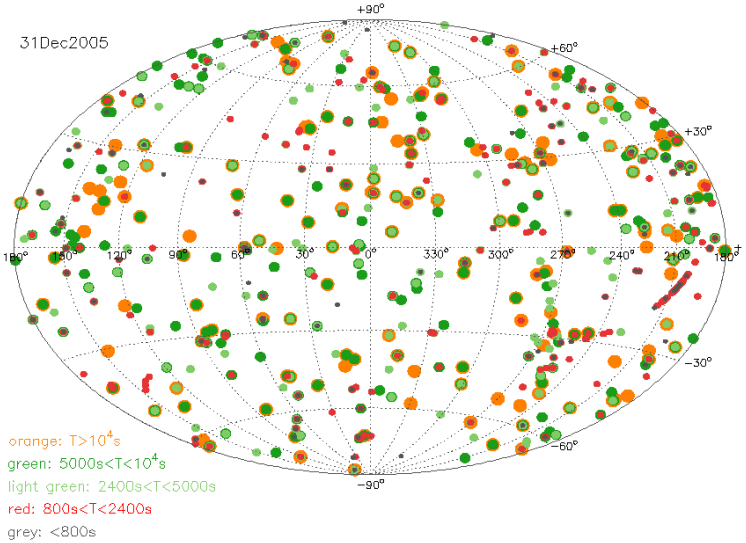


Archival improvement: S5 0716+714 SED evolution

Some results: detected flux variations in a few objects; SED evolution

Recent Blazar data processing updates:

- **UVOT exposure evolution: e.g.2006->2016**



- **Comparison with official catalogues: UVOTSSC, 1st UVOT catalogue,** 23059 Swift datasets taken within the first 5 years of observations with the Swift UVOT (between 10th Jan 2005 and 1st Oct 2010) **->larger time coverage; dedicated analysis/verification**

- **Reprocessing + processing updates: in 2015 a complete reprocessing with new software and calibration:**

Recent Blazar data processing updates:

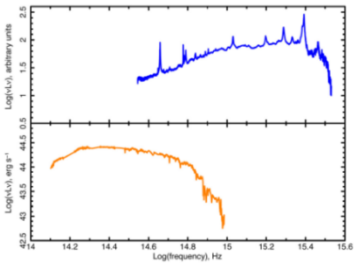
Revision of results on some source, Mkn421 and 501, on summer 2015 a complete reprocessing with update HEAsoft version (v6.16) and CALDB was decided and started, together with processing of further obs.s contemporaneous to NuSTAR ones and the adding of new objects for Planck ones. Processing was completed on Dec. (~8000 obs.s). Revision of the results has continued in 2016, for pbs cited and:

- check source colors validity for all detections
- verify SED validity =>uncorrect flux conversion pb! Curved UV trend

The case of H1722+119: from Ahnen, M.L., et al., 2016, in particular in collaboration with A. Stamerra and C. Raiteri

…Checking the source SED (Fig. 5), we noticed that a monotonic connection between optical-UV and X-ray spectrum was not possible, which motivated us to analyze possible sources of errors affecting the data. An aperture correction procedure was executed for the 2013 May 20 UVOT images in all filters, ..
Another check was required because the source colour, b − v ∼ 0.7, is out of the range to which the average count rate to flux ratios (CFR) estimated by Breeveld et al. (2011) are applicable.

- Take into account Galaxy contamination



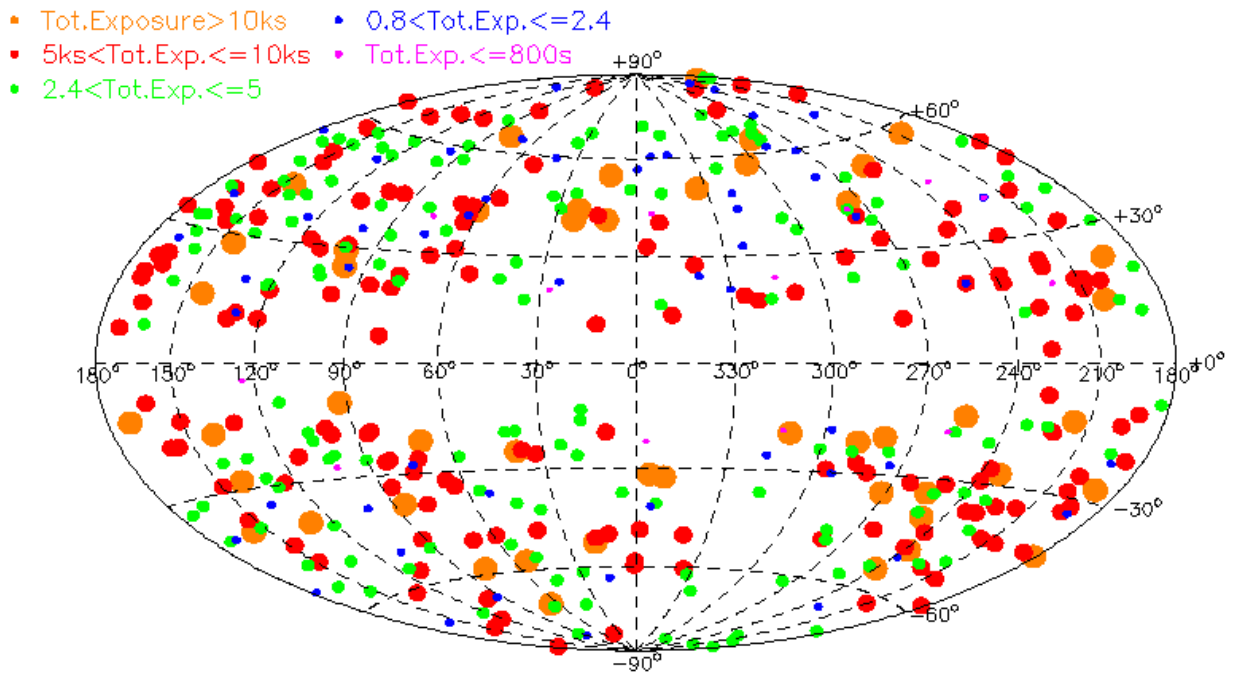
Templates:QSO, thermal emission
giant elliptical galaxies

Recent Blazar data processing updates:

Results: current Blazar sample covered:
total ~**440** sources with ~32000 detections, 5**2** are TeV sources and:

- **191** FSRQ
- **184** BL Lacs
- 70 uncertain

The complete sample will be described in a dedicated work, while a sample of 147 sources will be in next multi-frequency work with Swift, Fermi and NuSTAR data, and 94 with in one with Planck, Swift and Fermi data.

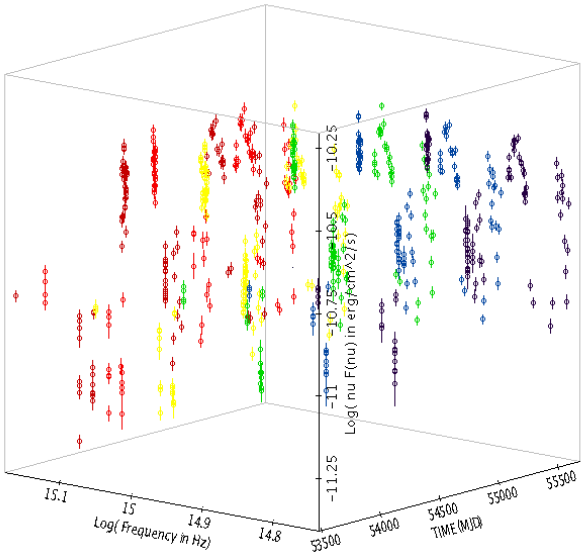


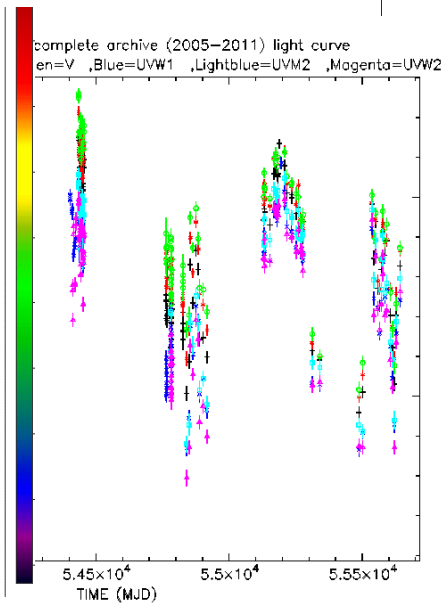
OJ 287 with Swift/UVOT:

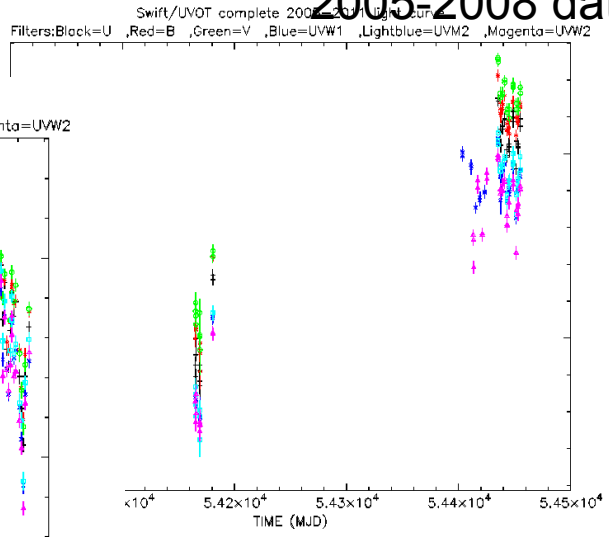
OJ 287 (z=0.306): famous, peculiar and optically highly-variable (>3 mag variations) low/intermediate-energy peaked BL Lac object (LBL/IBL), and historically among the best observed AGN allowing more significant statistical and variability studies. Moreover it is one of the very few extragalactic sources, where a major periodical/quasi-periodical signature is claimed (e.g., Valtonen 2007, 2008, Nilsson et al. 2006): 12 years optical cycle.

- **Long-term monitoring since 2008: updating**
  light curves
  - v*F(v) as a function of time

2005-2008 data





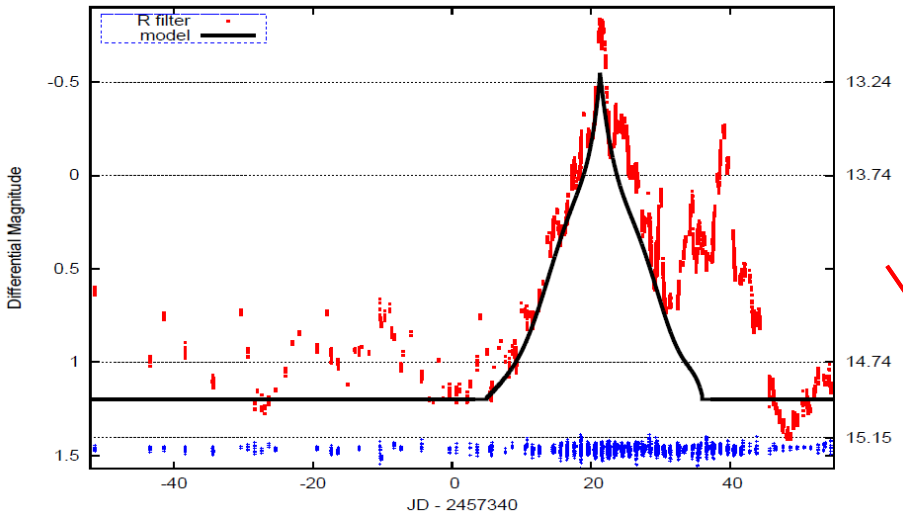


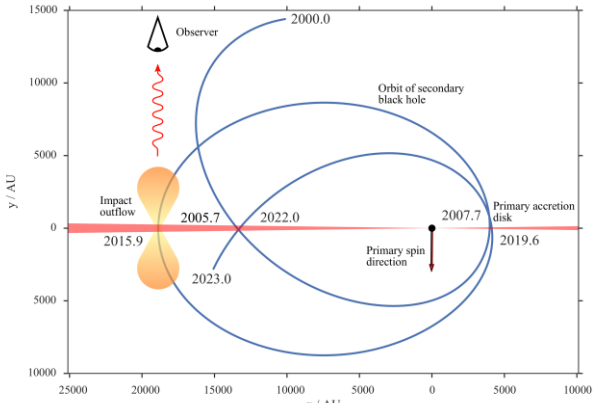
Variability studies: color-color evolution, within validity range!

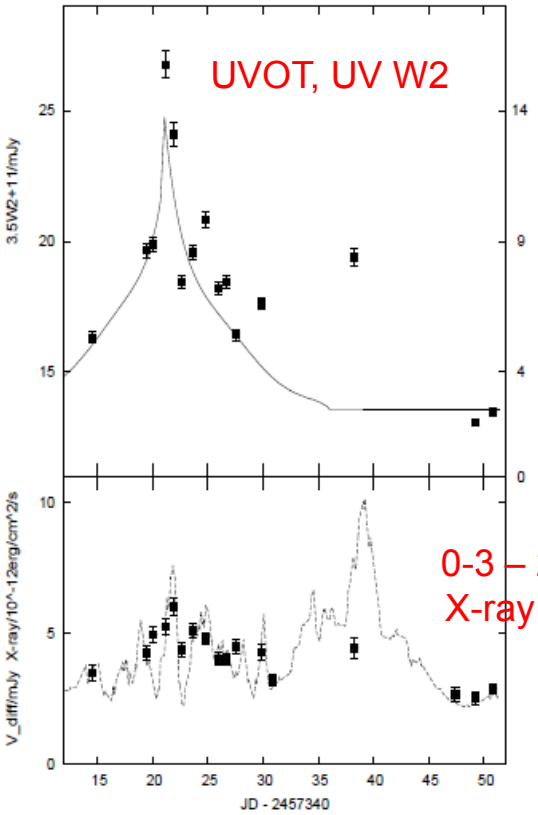
OJ 287 with Swift/UVOT:

- **Recent new optical-UV outburst!**

M.J. Valtonen, et al., 2016, ApJ, 819L, 37:



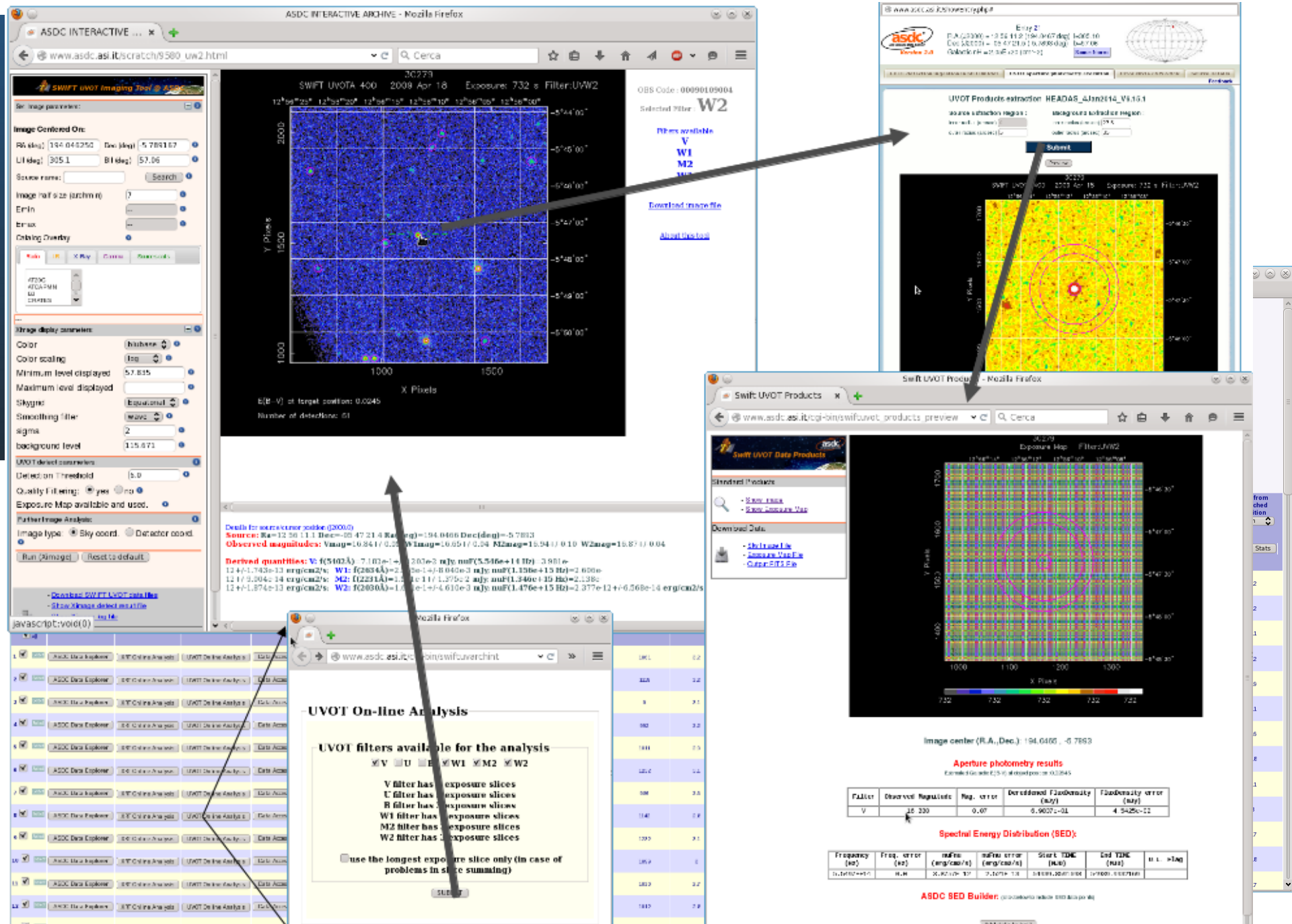




Optical R band differential photometry with respect ot reference star; black line: model of a uniform expanding sphere of plasma (Pihajoki 2016), unpolarized, as thermal bremsstrahlung.

Results: the outburst light curve confirmed in UV (in all 3 bands), but much smaller X-ray flux flare detected using contemporaneous Swift data! Even if well correlated ->variability detected above model line in optical and UV, + polarized second flare-> secondary BH jet?

… inheritance: the ASDC Swift/UVOT imaging tool



Thank you