AGILE and γ-ray blazars: highlights and perspectives

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On behalf of the AGILE AGN Working Group

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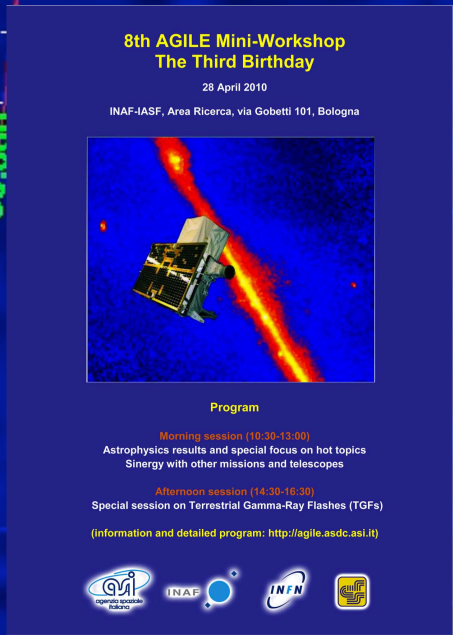
3C 454.3 (Crazy Diamond)


8th AGILE Mini-Workshop
The Third Birthday
28 April 2010
INAF-IASF, Area Ricerca, via Gobetti 101, Bologna

Program

Morning session (10:30-13:00)
Astrophysics results and special focus on hot topics
Sinergy with other missions and telescopes

Afternoon session (14:30-16:30)
Special session on Terrestrial Gamma-Ray Flashes (TGFs)

(information and detailed program: http://agile.asdc.asi.it)

Introduction

The “pointing life” results

The “second life” results & new perspectives

Introduction

The “pointing life” results

The “second life” results & new perspectives

The AGILE AGN Working Group

Name	Affiliation
A. Bulgarelli	INAF-IASF Bologna
A.W. Chen	INAF-IASF Milano
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I. Donnarumma (*Co-Chair*)	INAF-IASF Roma
A. Giuliani	INAF-IASF Milano
F. Longo	INFN Trieste
L. Pacciani	INAF-IASF Roma
G. Pucella	ENEA Roma
E. Striani	INAF-IASF Roma
S. Vercellone (*Chair*)	INAF-IASF Palermo
V. Vittorini	INAF-IASF Roma & Univ. Tor Vergata

AGILE γ-ray and X-ray data analysis

M-λ programs coordination

M-λ data analysis

Proposals and science cases

Papers, Conferences, Workshops

Weekly telecons

Inter-play with other WGs

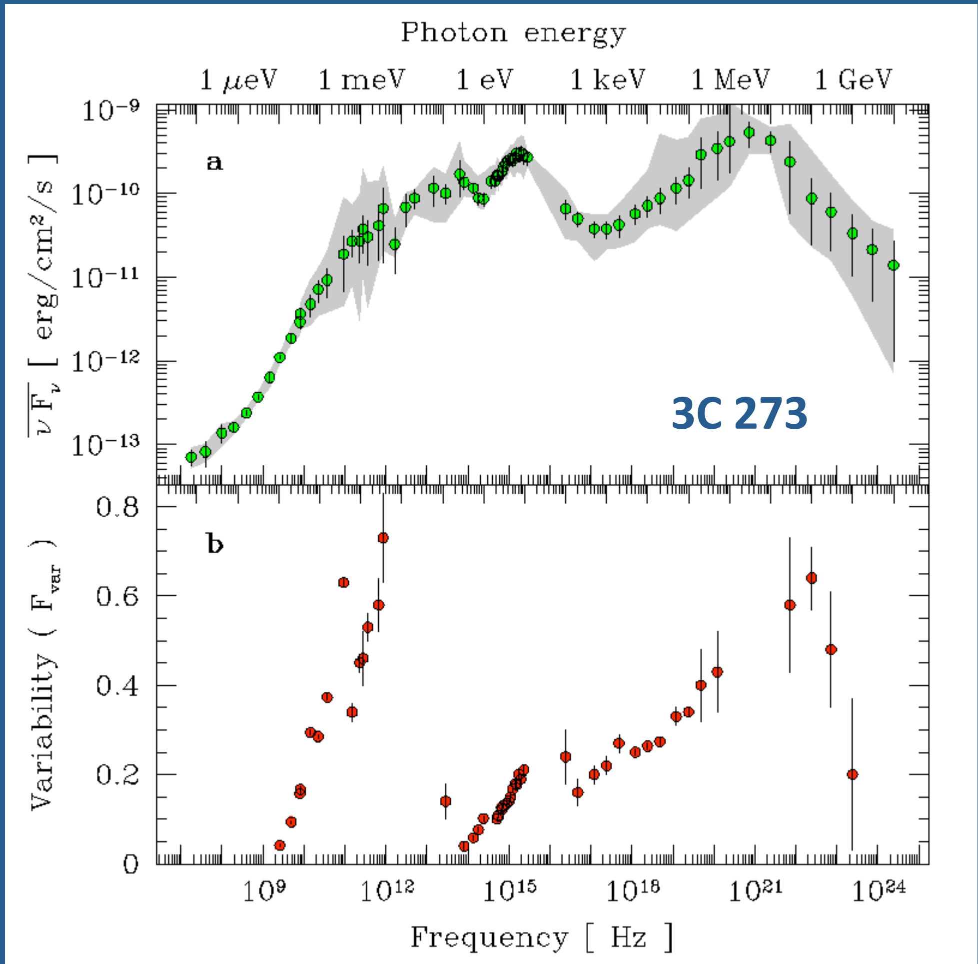
Calibration duties

SW development and testing

ASDC support

The multi wavelength approach

Soldi et al., 2008, A&A, 486, 411



Observatory	Energy domain
VLBA/UMRAO	Radio
Spitzer	IR
REM	IR-Optical
WEBT-GASP	Radio-mm-Optical-IR
XMM-*Newton*	UV + soft X-ray
Swift	UV + soft X-ray + hard X-ray
Suzaku	Soft X-ray + hard X-ray
RXTE	Hard X-ray
INTEGRAL	Hard X-ray
Super-AGILE	Hard X-ray
AGILE/GRID	Gamma-ray
MAGIC	TeV
VERITAS	TeV
ARGO	TeV
H.E.S.S.	TeV

The AGILE blazar flavours

AGILE investigated at least one object for each blazar category, e.g.:			
FSRQ → 3C 454.3	LBL → PKS 0537-441	IBL → S5 0716+714	HBL → MKN 421
Some sources were detected in an high state more than once, e.g.:			
3C 454.3	PKS 1510-089	S5 0716+714	3C 273
Variability level could be very different, e.g.:			
Low → MKN 421		Extremely high → PKS 1510-089 / 3C 454.3	
Gamma-ray activity could vary on different time scale, e.g.:			
A few days → W Com		Several months → 3C 454.3	

Introduction

The "pointing life" results

The "second life" results & new perspectives

The "pointing life" results → the blazar properties

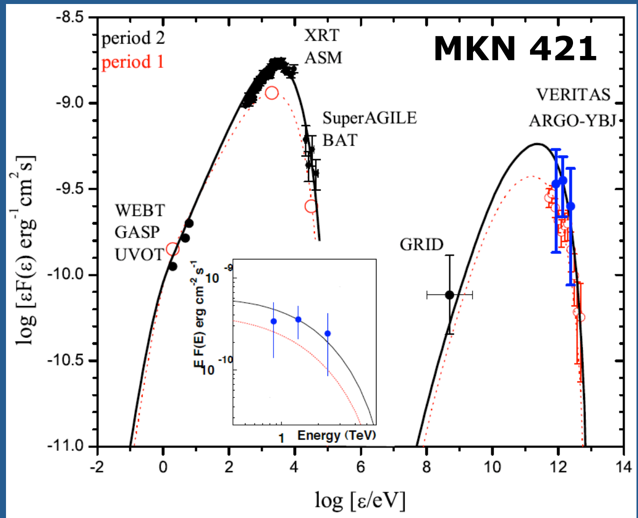
SED, energetic & spectral features

Long time-scale monitoring
- spectral trends
- time-lags

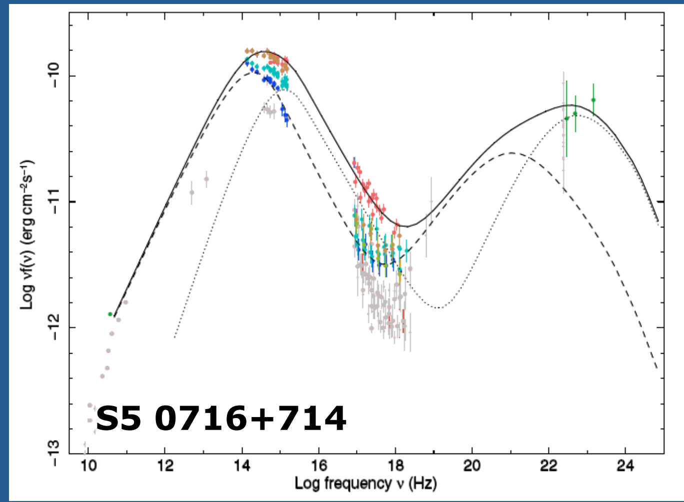
The GeV – TeV connection

The Radio – GeV connection

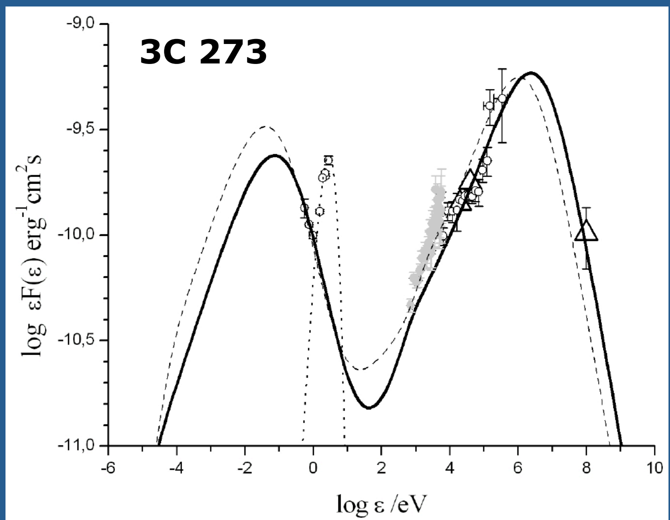
SSC 1-comp



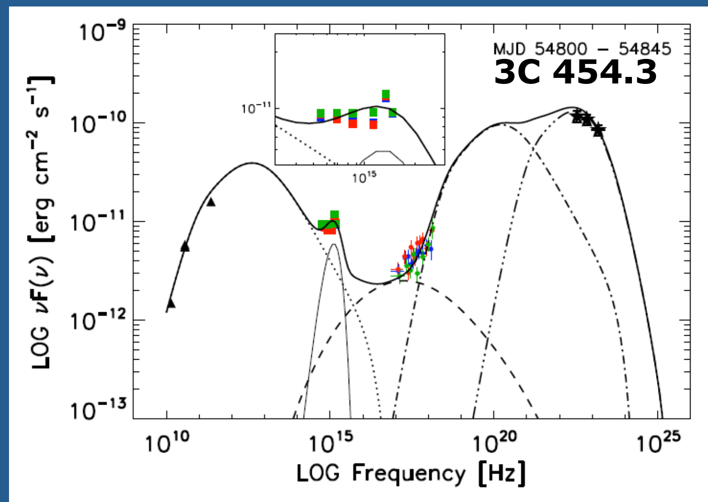
SSC 2-comp



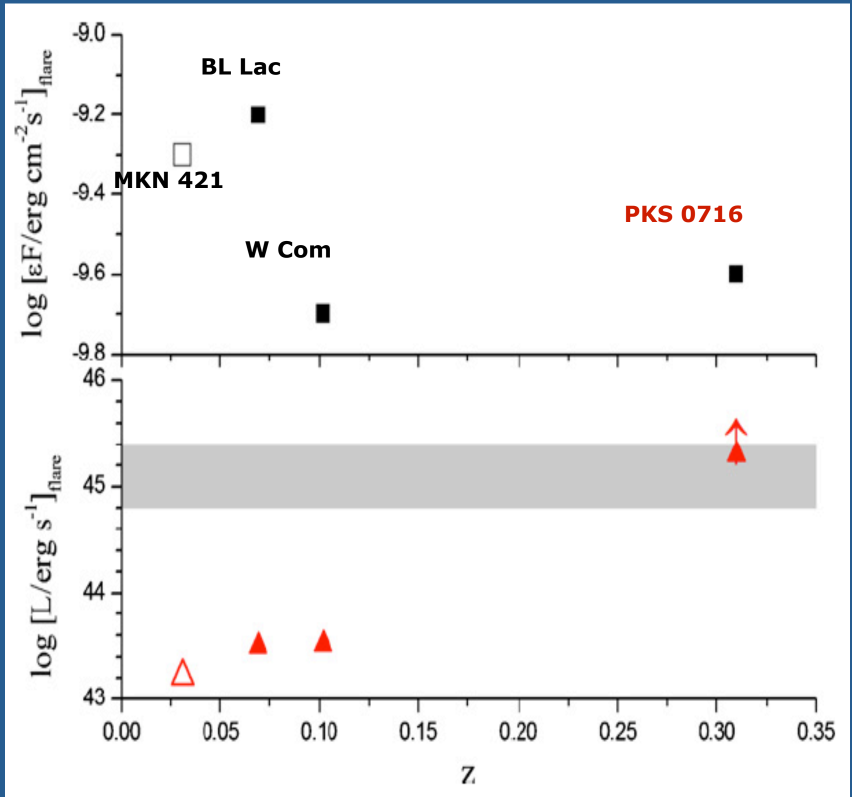
EC(disk)



EC(BLR)



Extreme energetics: limits on the power of a Kerr black hole



Vittorini et al., 2009, ApJL, 706, 1433

Sept. 2007, $<F_\gamma> = (97 \pm 15)$E-8 ph cm^{-2} s^{-1} E>100 MeV

z = 0.31 ± 0.08 (Nilsson et al., 2008)

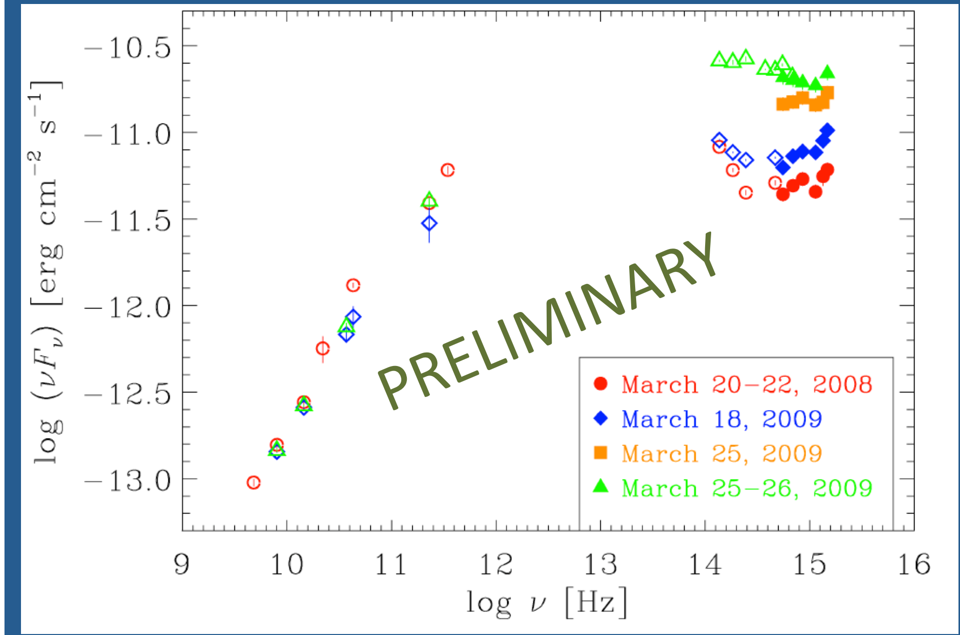
Very high total jet power (L>3x10^{45} erg/s).

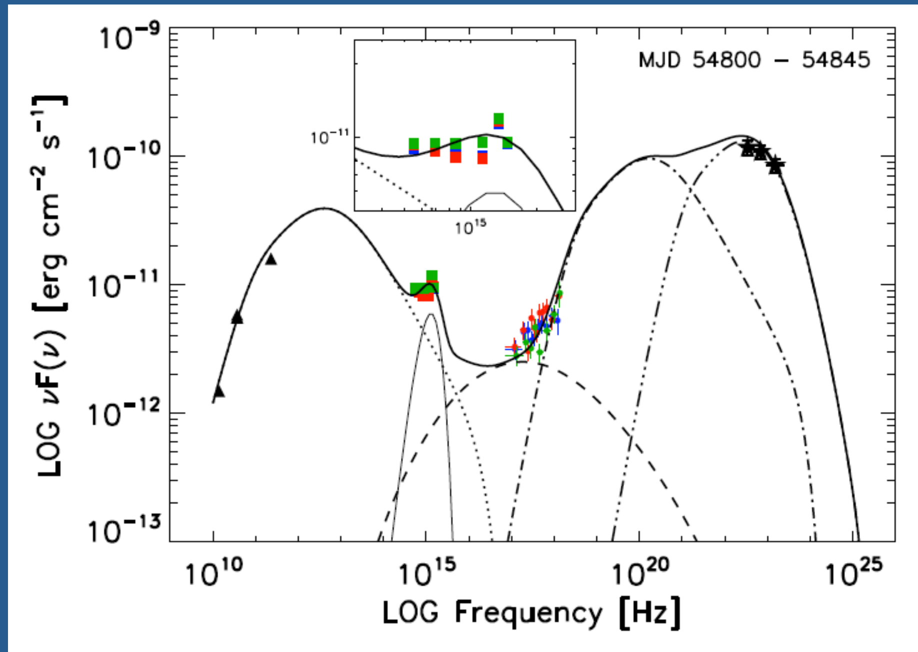
This may exceed the maximum power generated by a Kerr BH with M_{BH}~10^9 M_{sun}

The shaded area represents the BZ limiting luminosity range for a BH mass in the range (3×10^8 – 10^9)$M_\odot$.

$$P_{tot,flare} = L_r + L_{kin} + L_B$$

Spectral features: the sync peak and disc blue bump





D'Ammando et al., 2010, A&A, in preparation

PKS 1510-089 – March 2009 campaign

Swift/UVOT and GASP-WEBT observations show the presence of thermal signatures in the radio-to-UV spectrum.

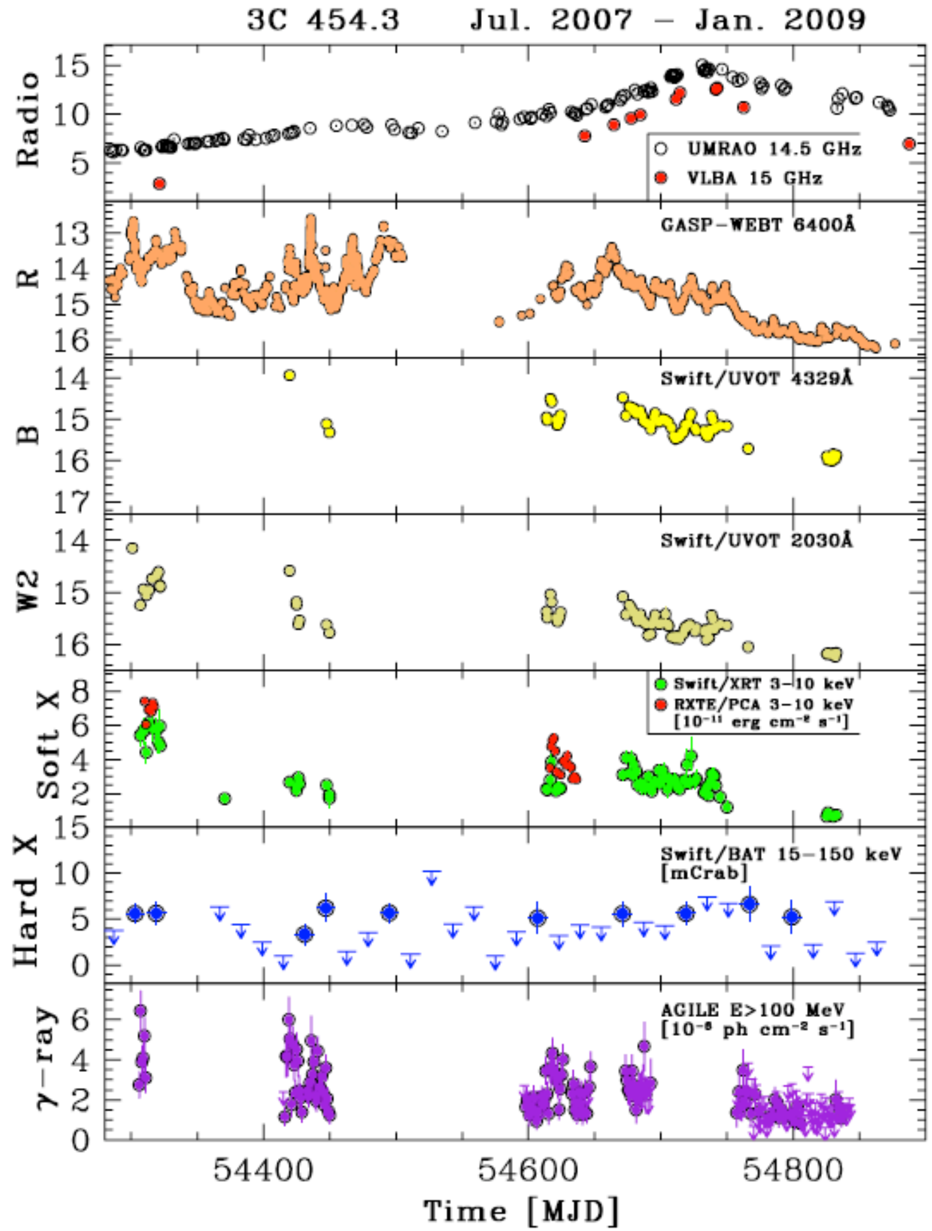
Vercellone et al., 2010, ApJ, 712, 405

3C 454.3 – October 2008 campaign

Low γ-ray state: the thermal disc contribution becomes prominent.

Long time-scale monitoring

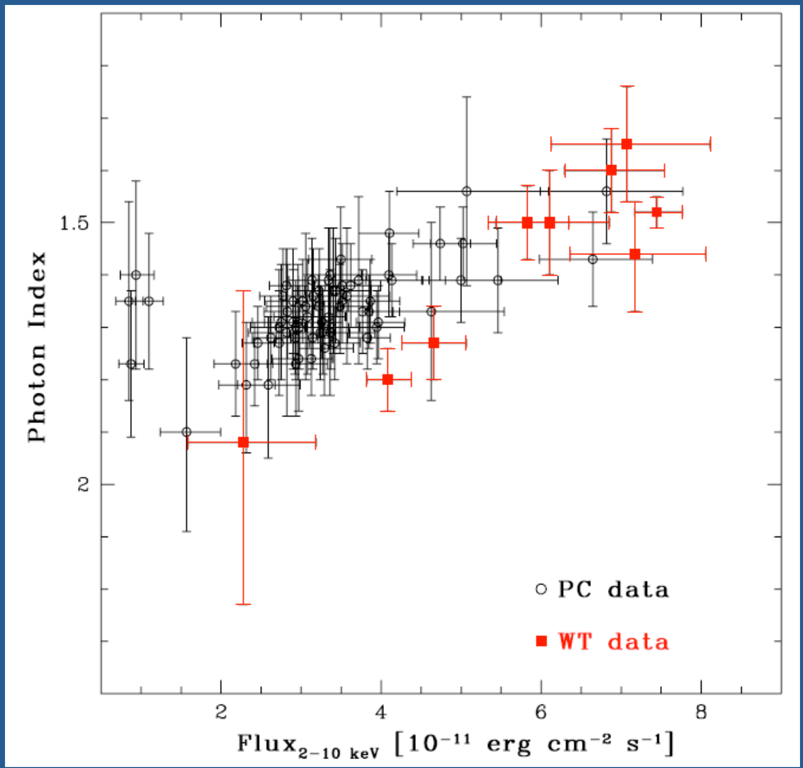
18 months campaign



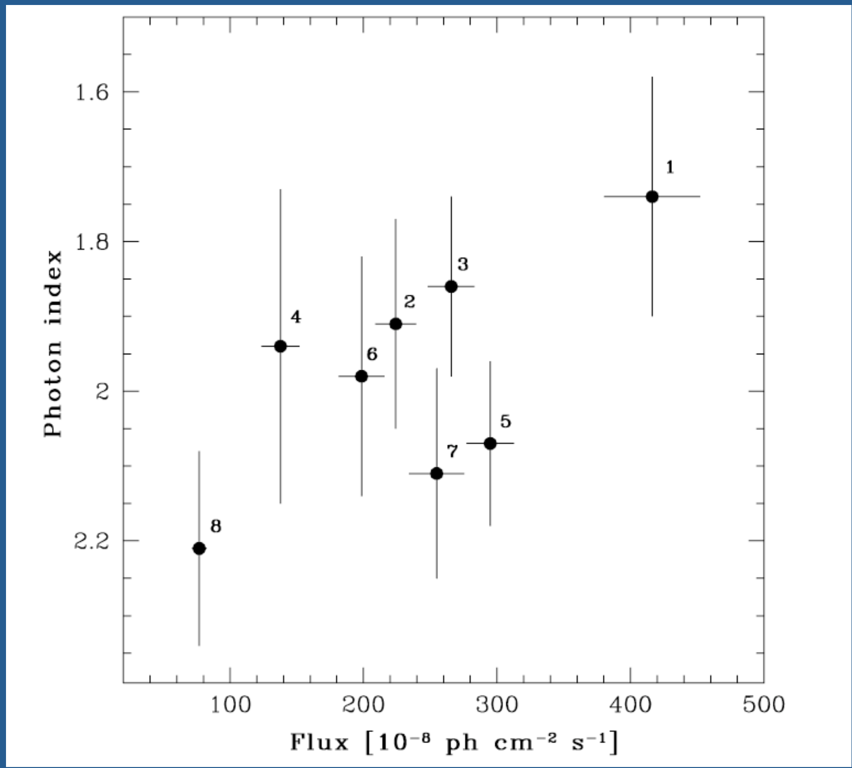
Long-term X-ray and γ-ray data show an harder-when-brighter spectral trend.

During intense γ-ray flares EC(BLR) could contribute more than EC(disk)

Swift/XRT

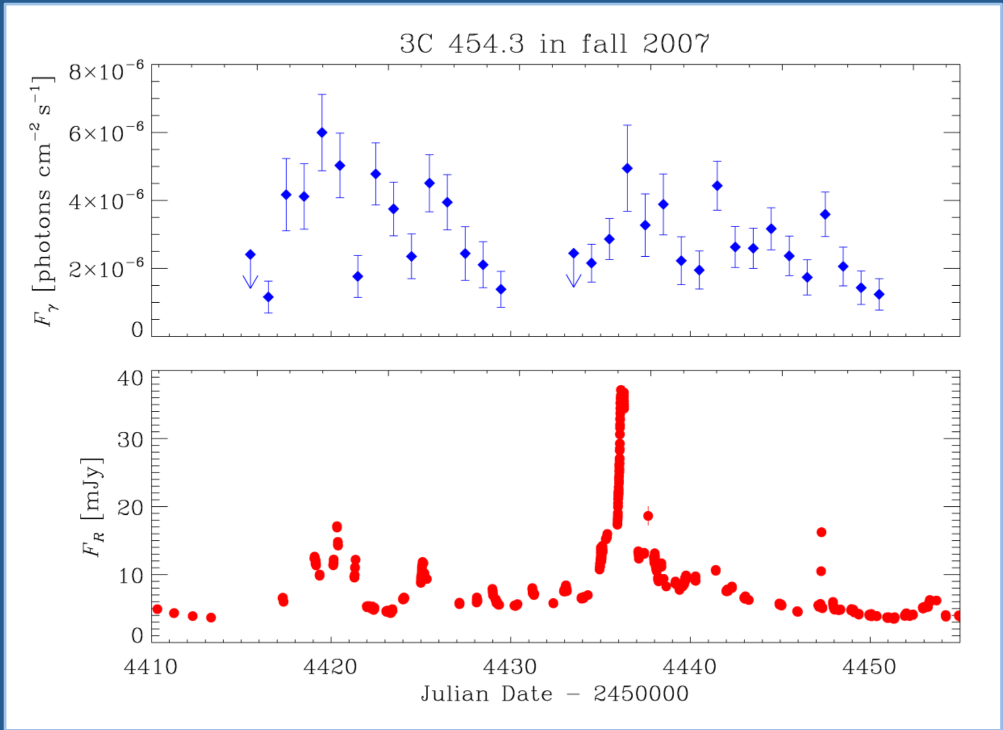


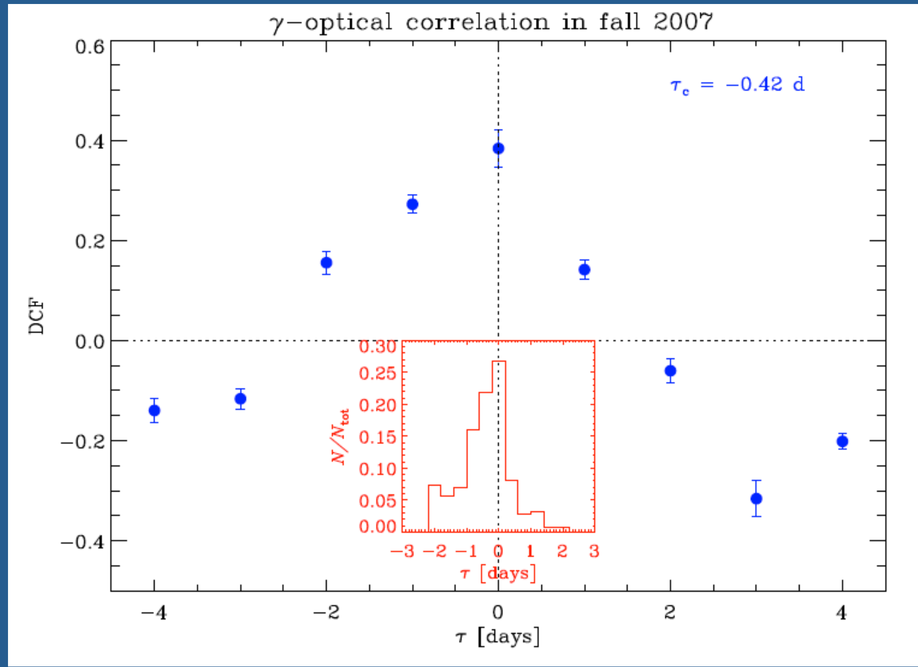
AGILE/GRID



Vercellone et al., 2010, ApJ, 712, 405

Time-lags: 3C 454.3



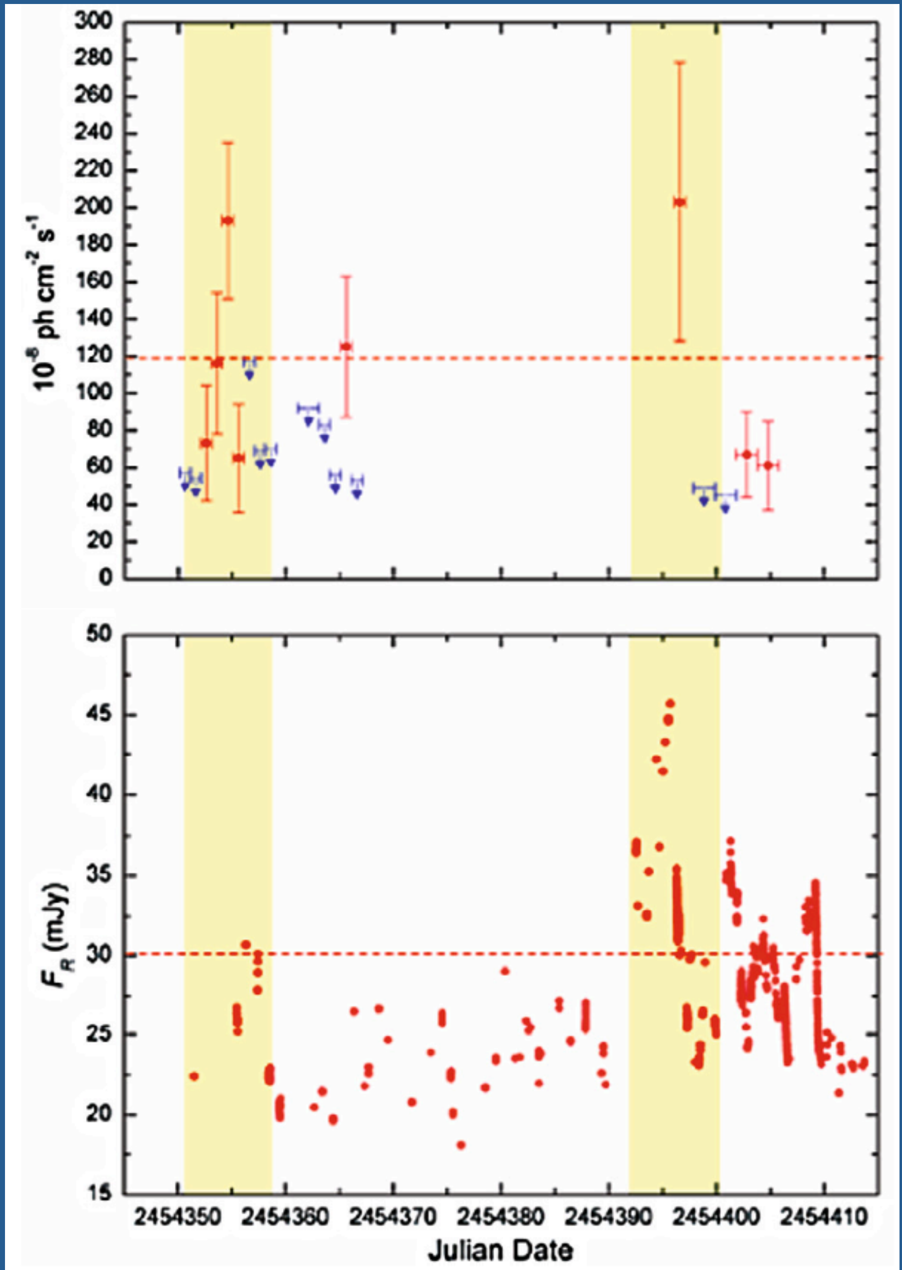


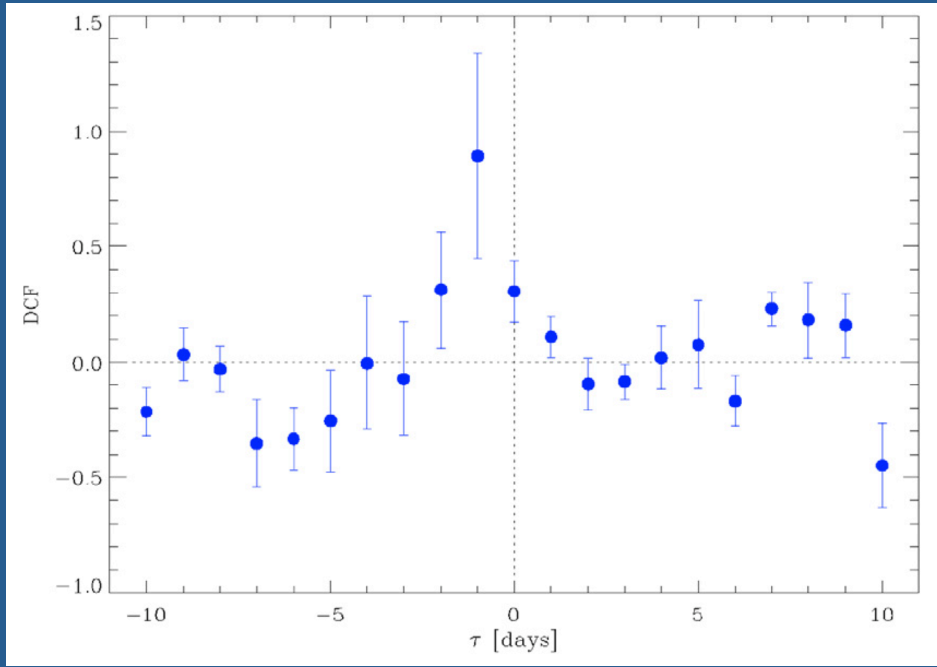
Vercellone et al., 2010, ApJ, 712, 405

3C 454.3 – Nov.—Dec 2007 campaign

The shape of the DCF peak is asymmetric, and if we calculate the centroid distribution, we find that the time-lag is −0.42 days, i.e. the γ-ray flux has a delay w.r.t the optical one of about half a day.

Time-lags: S5 0716+714

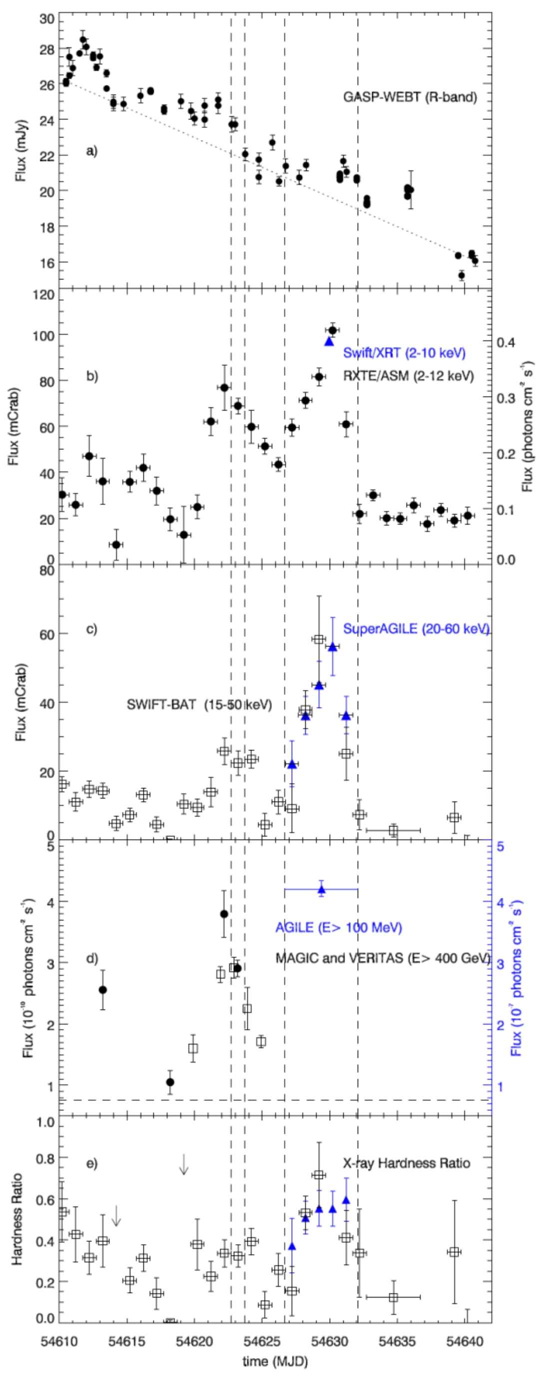




Chen et al., 2008, A&A, 489, L37

S5 0716+714: Sep.—Oct. 2007 campaign.

The DCF shows a significant peak for a time-lag of –1 day, suggesting a possible delay in the γ-ray flux variations with respect to optical ones.



Time-lags: MKN 421

Donnarumma et al., 2009, ApJL, 691, 13

The optical light curve shows variations of the order of 10% on a time scale of a few days, superimposed on a long decay during the entire period.

Soft, hard X-ray and TeV emissions seem to be correlated

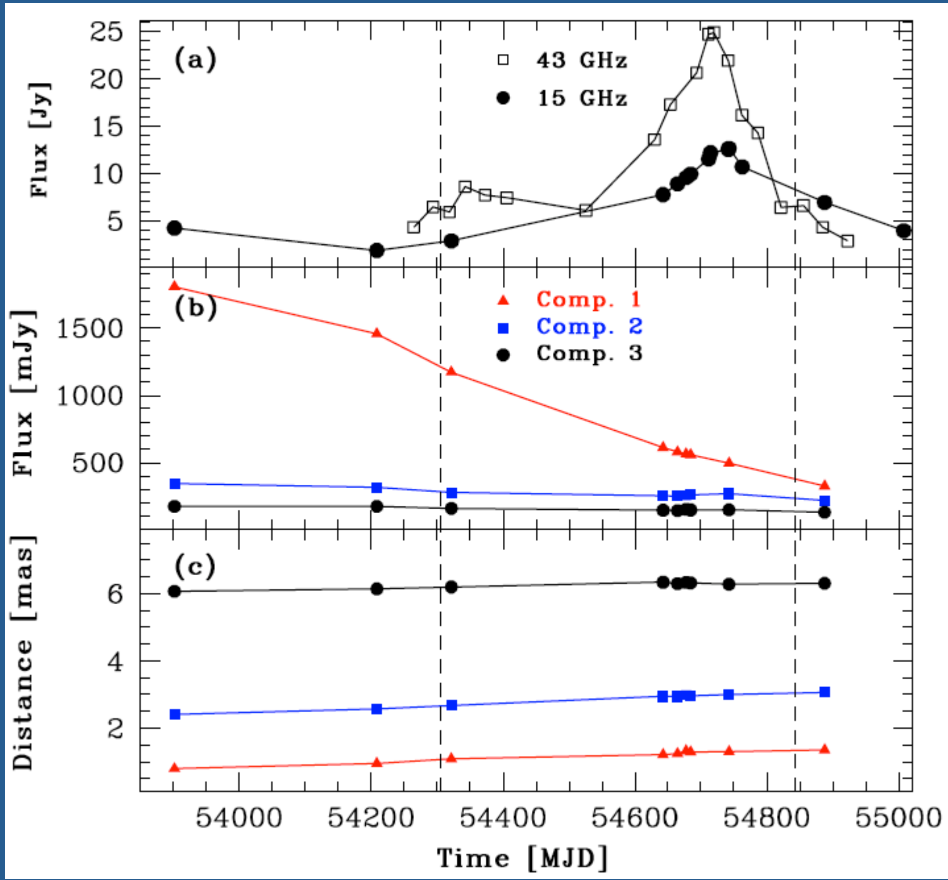
Individual soft and hard X-ray peaks show flux rising by a factor of ~ 2.5 and ~5, respectively, with growing peak-to-valley amplitudes on longer time scales.

Clear spectral hardening (X-ray) of the source during the flaring activity.

MAGIC and VERITAS data were missing during the AGILE γ-ray flare.

Radio, optical & γ-ray: 3C 454.3

Jul07 Jan09



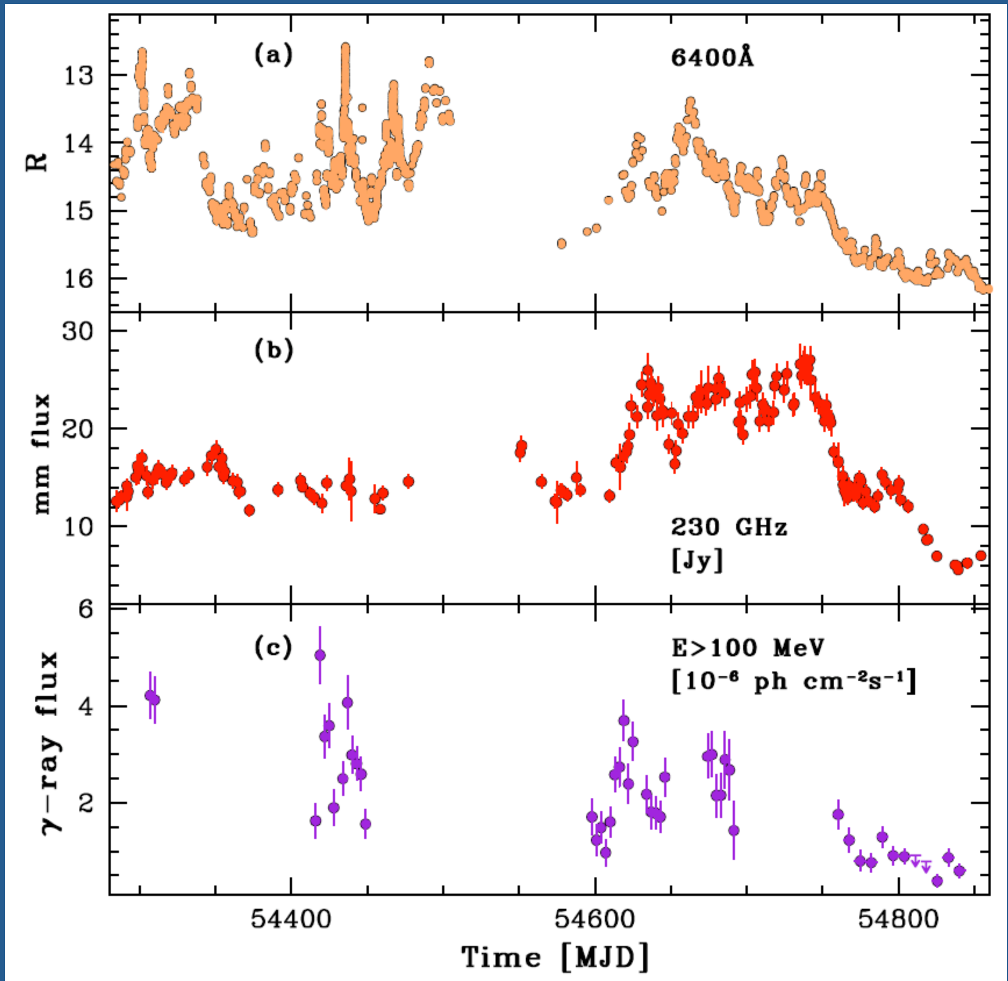
The presence of one or more new jet components is not revealed in the high resolution VLBA images.

The most recent VLBA images at 43 GHz suggest a jet expansion near to the radio core starting from MJD 54600 (2008-05-14)

It is not possible to correlate the radio peak with a single γ-ray or optical burst → a multiple source activity in the optical and γ-ray bands is integrated in the radio emitting region in a single event on MJD 54720 (2008-09-11).

Strong core flux density variability possibly connected to the γ -ray activity.

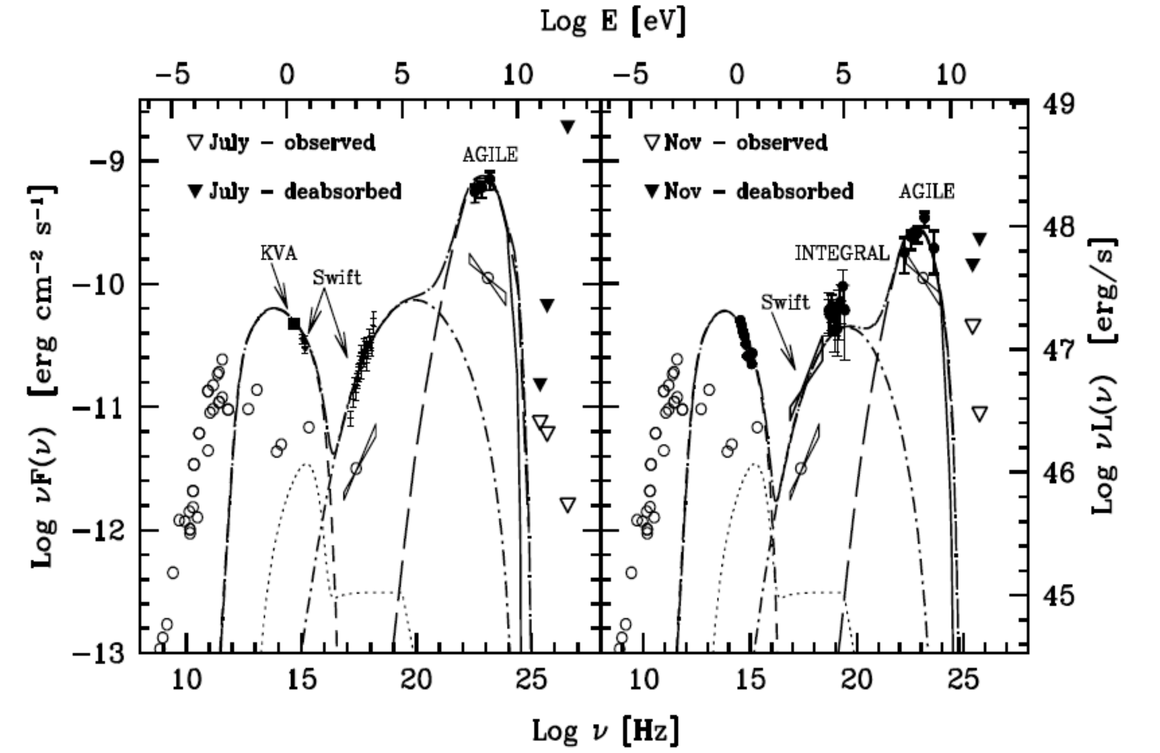
Jet components are moving away and slowly decreasing in flux density, not affected by the recent core activity (see also Kovalev et al., 2009)



Light curves show a different behavior starting from the end of 2007 among the different energy bands.

Change in the orientation of a curved jet → different alignment configurations within the jet itself (see also Villata et al., 2009).
2007: the inner portion of the jet might the more beamed one.
2008: the higher mm flux emission and its enhanced variability seem to indicate that the more extended region of the jet became more aligned w.r.t. the observer l.o.s.

The GeV – TeV connection: 3C 454.3



Anderhub et al., 2009, A&A, 498, 83 (MAGIC observations)

3C 454.3 is a relatively high-z source (z = 0.859), difficult to be detected at TeV energies.

Observations occurred during Jul-Aug 2007 and Nov-Dec 2007, but only UL were reported.

The SED modeling is consistent with a leptonic model (SSC+EC(BLR)), predicting a decrease of the flux above few tens of GeV, due to the internal absorption of γ-rays and the decreased efficiency of the inverse Compton emission at high energy.

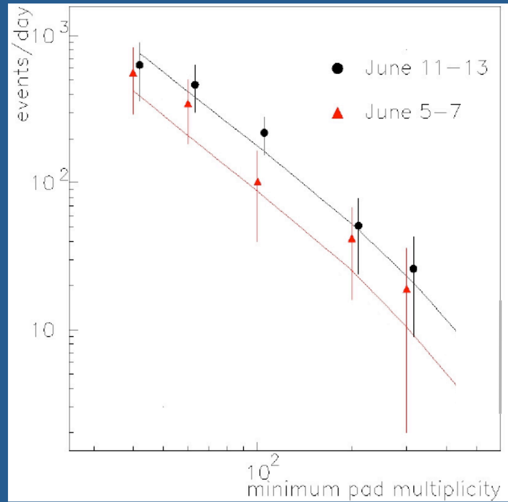
The GeV – TeV connection: MKN 421

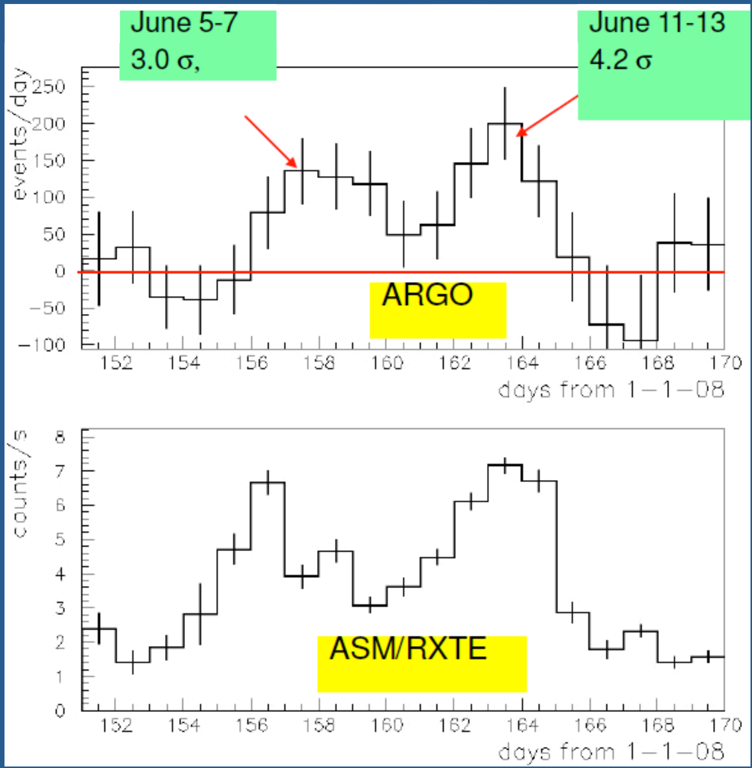
Donnarumma et al., 2009, ApJL, 691, 13

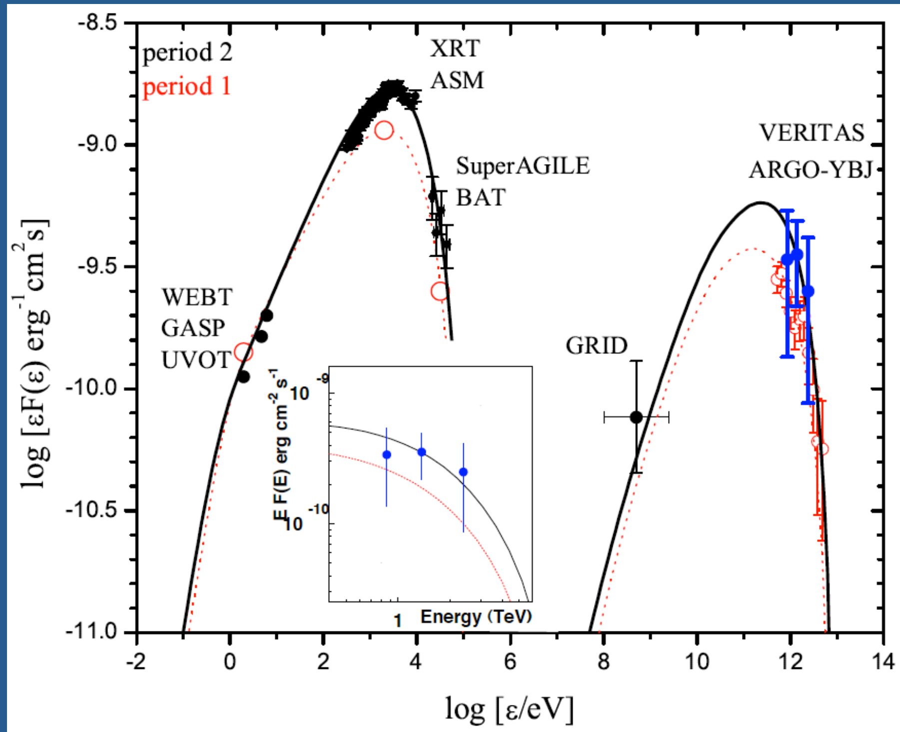
Aielli et al., 2010, ApJL, 714, 208

ARGO/YBJ and RXTE/ASM correlate quite well

Good agreement between ARGO points and our theoretical modeling.







The GeV – TeV connection: W Comae

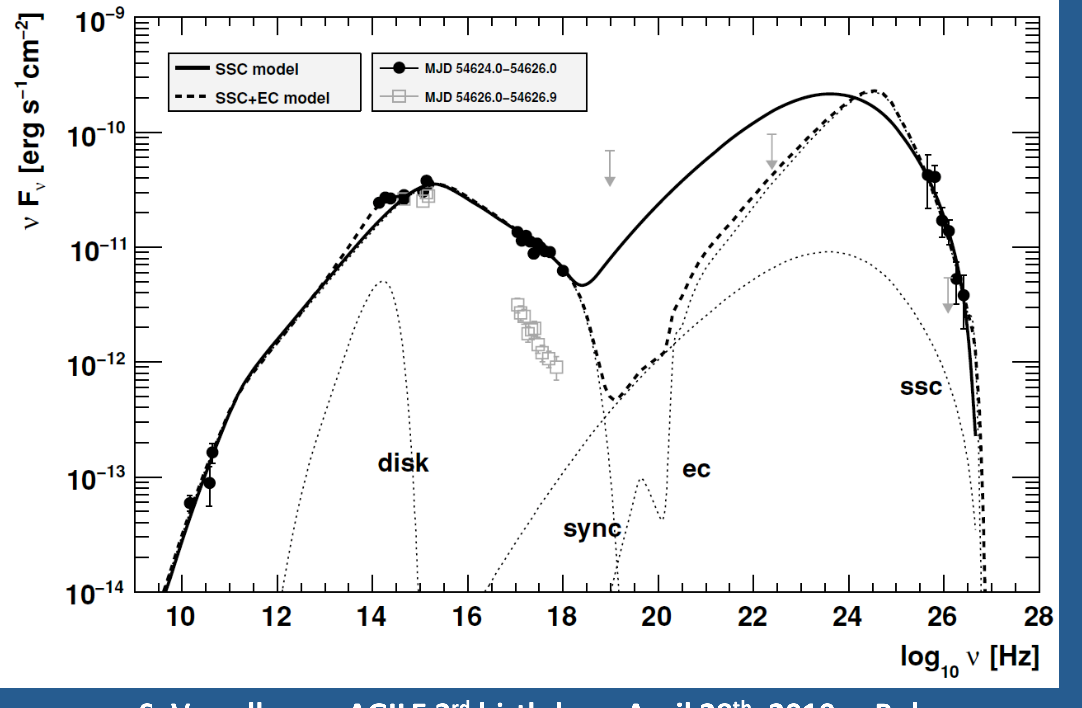
Acciari et al., 2009, ApJ, 707, 612

The simple SSC model did not allow equipartion in the emitting region.

Adding an EC component, the fit and the physical parameters are adequately represented.

The external radiation field could be produced by a torus whose emission peaks at $\nu=1.5\times10^{14}$ Hz→ see the IR bump in the SED.

Simultaneous γ-ray – TeV firm detections will allow to better disentangle between the different emission models.



The GeV – TeV connection: PG 1553+113

Aleksic et al., 2009, A&A, accepted [ArXiv:0911.1088]

A multi-λ campaign in March-April 2008 involved:

KVA, REM (optical)

RXTE/ASM (X-ray)

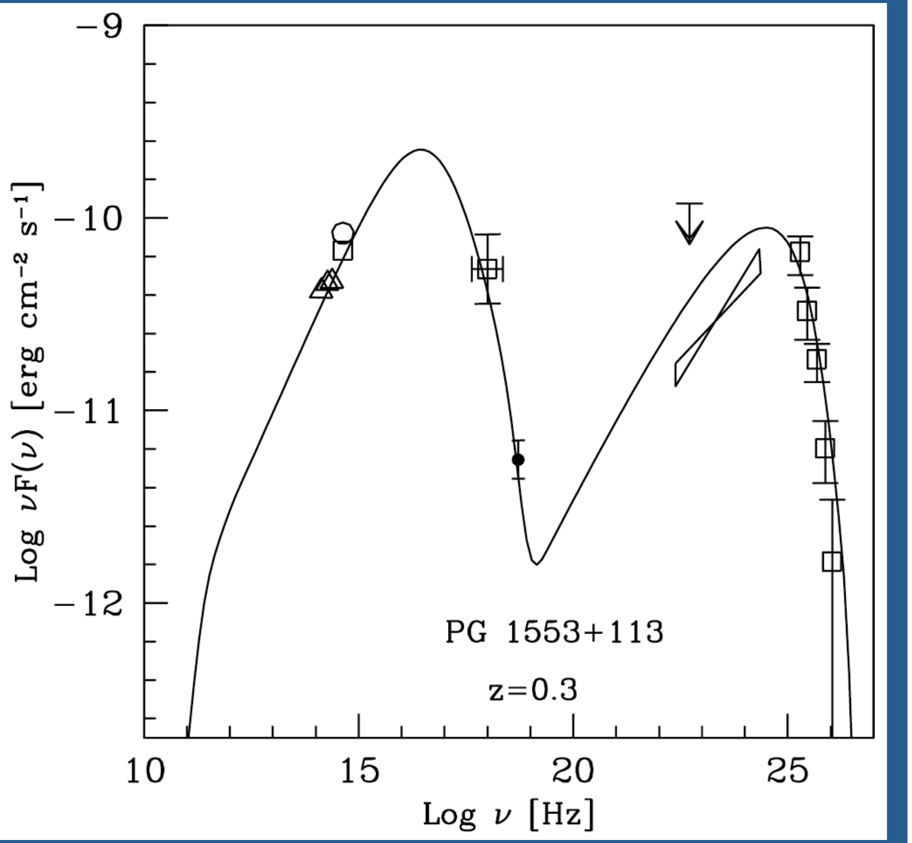
AGILE (E> 100 MeV)

MAGIC (TeV energies)

No significant flux or spectral variability is found at VHE (F(E>200 GeV)~10-7 ph cm^{-2} s^{-1}, Γ_{ph}~3.5) during the 2008 March and April observations.

The SED fit is performed by means of an homogeneous one-zone SSC model.

Previous observations (Albert et al., 2007) yield a similar VHE flux, but with a different X-ray flux, showing the relevance of simultaneous data for a correct SED interpretation.



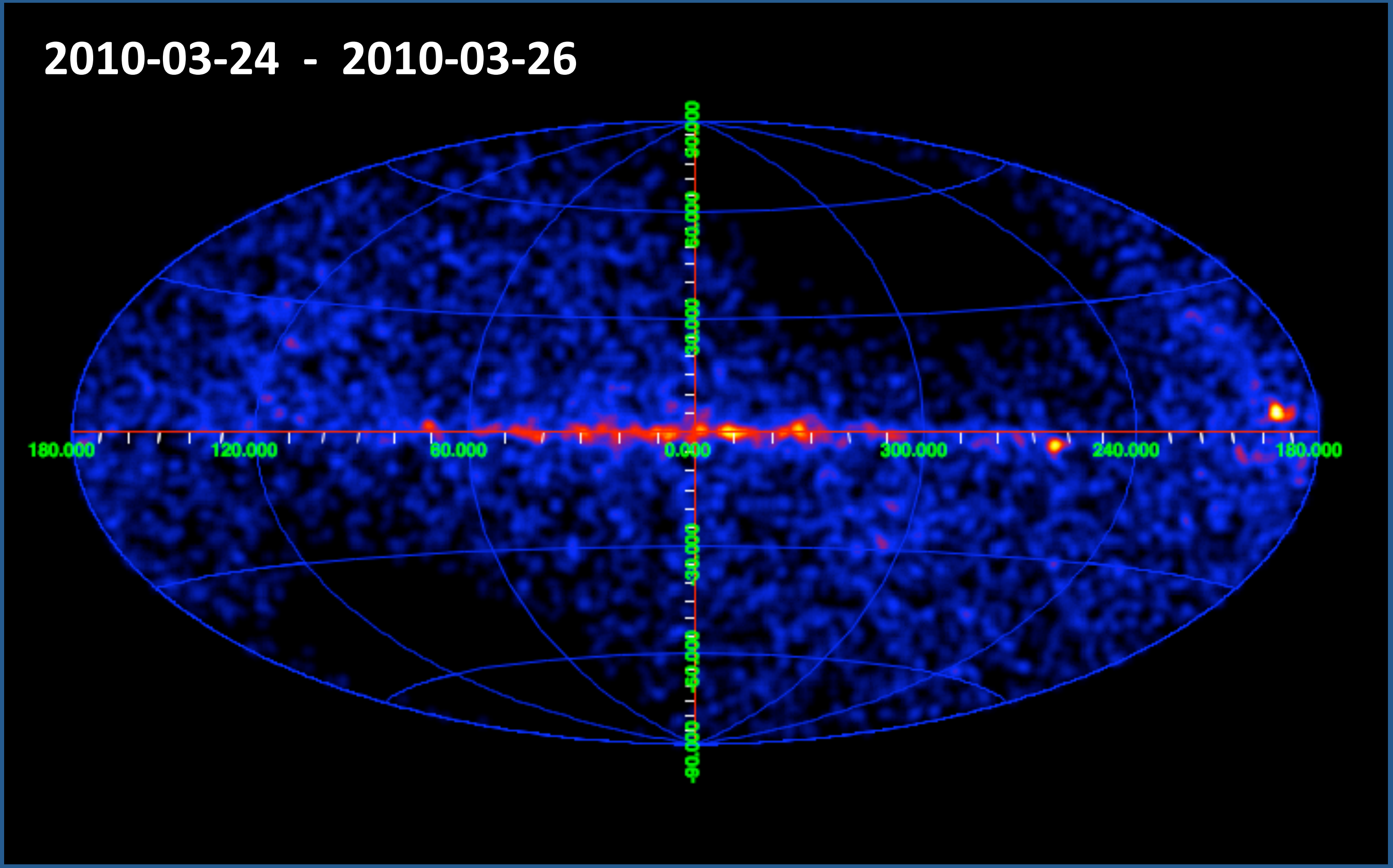
Introduction

The “pointing life” results

The “second life” results & new perspectives

AGILE in *Spinning* Pointing Mode

Since Nov. 2009, AGILE is no longer performing pointed observations.
The spinning pointing mode allows to monitor a large (>70%) fraction of the sky.
More than 15.500 orbits completed.



PKS 2142-758 (ATel #2551, 2010-04-13)

PKS 0402-362 (ATel #2484, 2010-03-16)

PKS 0537-441 (ATel #2454, 2010-02-24)

PKS 1510-089 (ATel #2385, 2010-01-14)

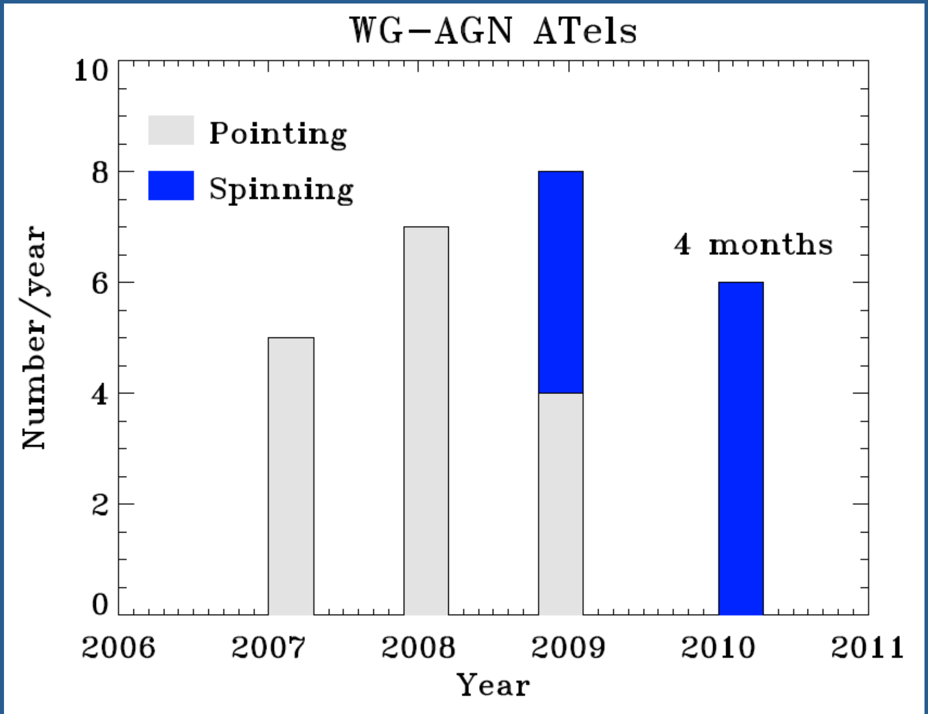
3C 273 (ATel #2376, 2010-01-08)

PKS 1222+216 (ATel #2348, 2009-12-15)

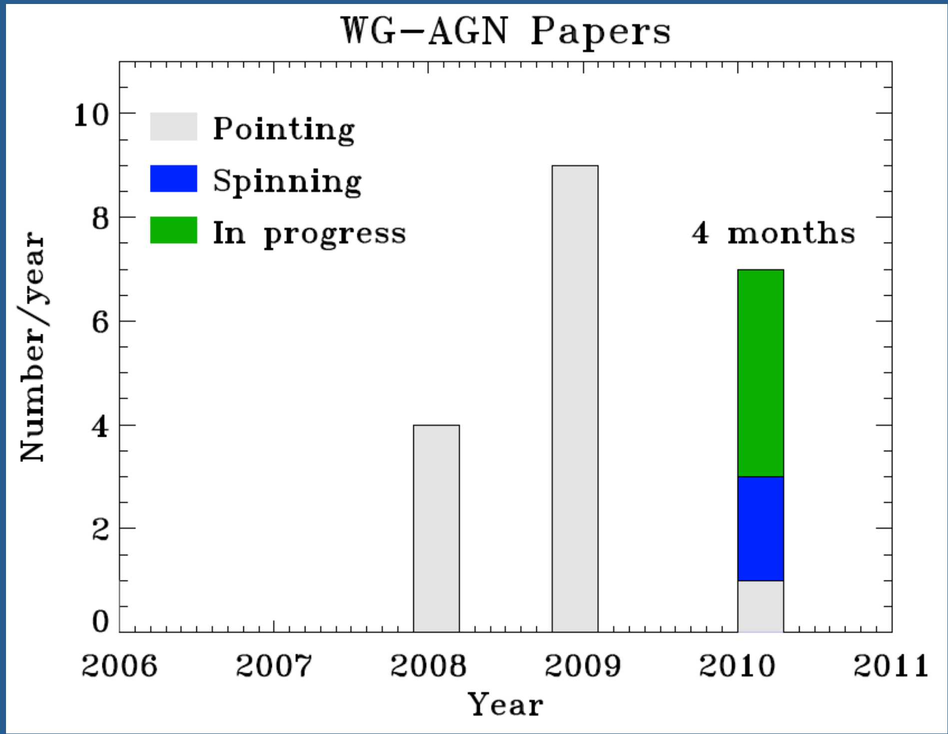
3C 454.3 (ATel #2326, 2009-12-03)

3C 454.3 (ATel #2322, 2009-12-02)

GB6 B1310+4844 (ATel #2310, 2009-11-23)



A rapid (a few hours) distribution of Astronomer's Telegrams provides an excellent tool to obtain almost simultaneous ToO observations at other wavelengths.



The coverage of a large fraction of the sky maximizes the number of multi-wavelength campaigns

3C 454.3 super-flare

Striani et al., 2010, ApJL, Submitted on Feb. 02, 2010

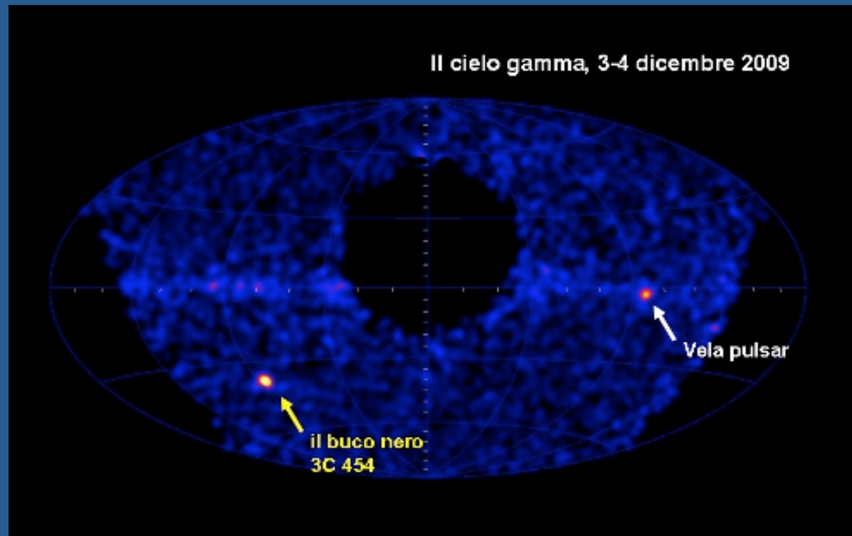
3C 454.3 underwent the most dramatic γ-ray flare, reaching a γ-ray flux of about 2000E-8 ph cm^{-2} s^{-1}, 2.5 times brighter than the Vela Pulsar.

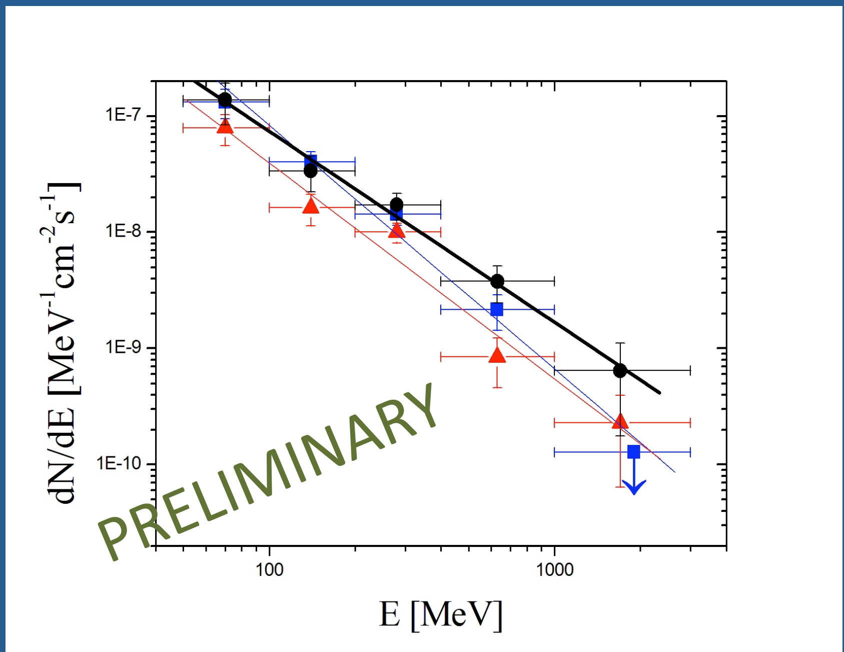
Photon index:

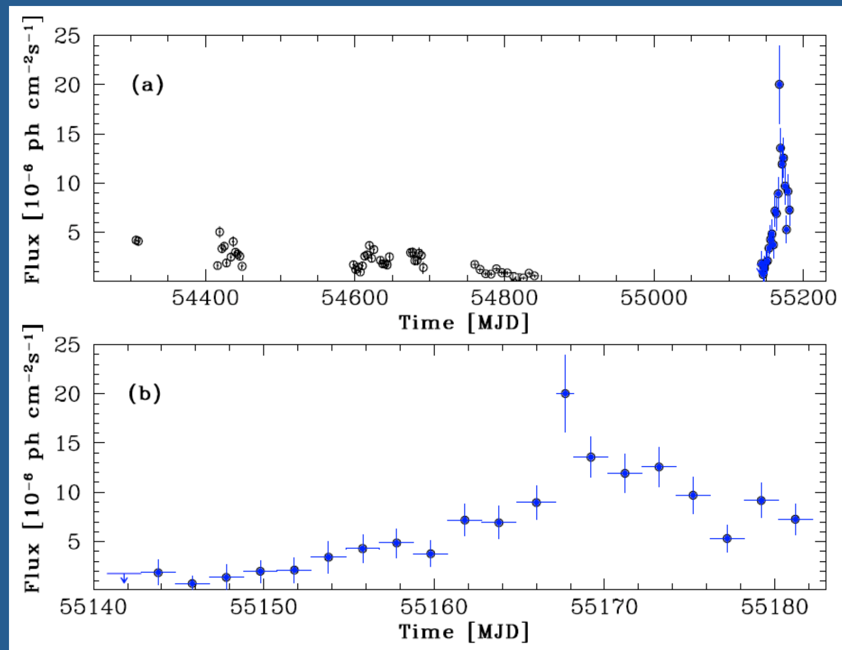
pre-flare = 1.85±0.26

flare = 1.66±0.32

post-flare = 2.04±0.26







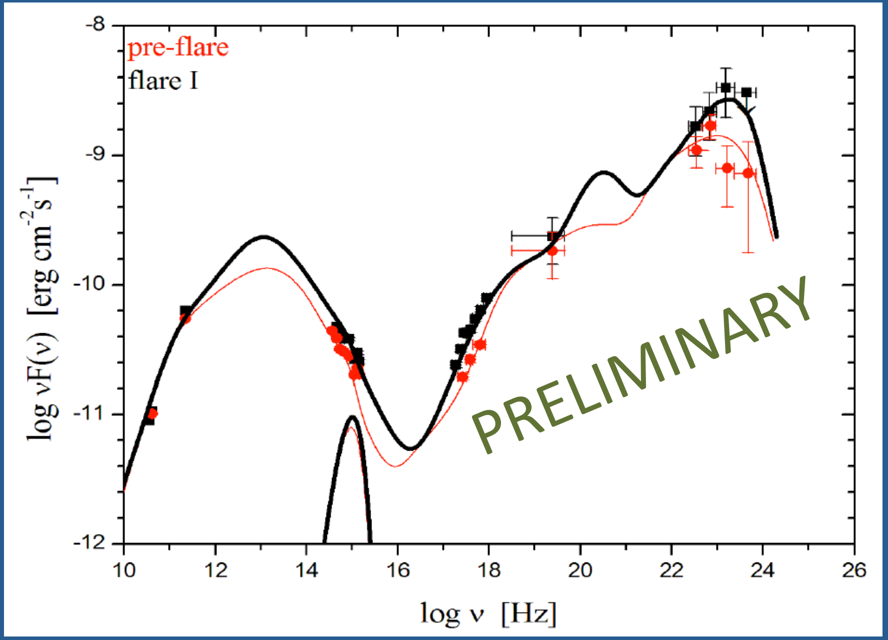
Pacciani et al., 2010, ApJL, Submitted

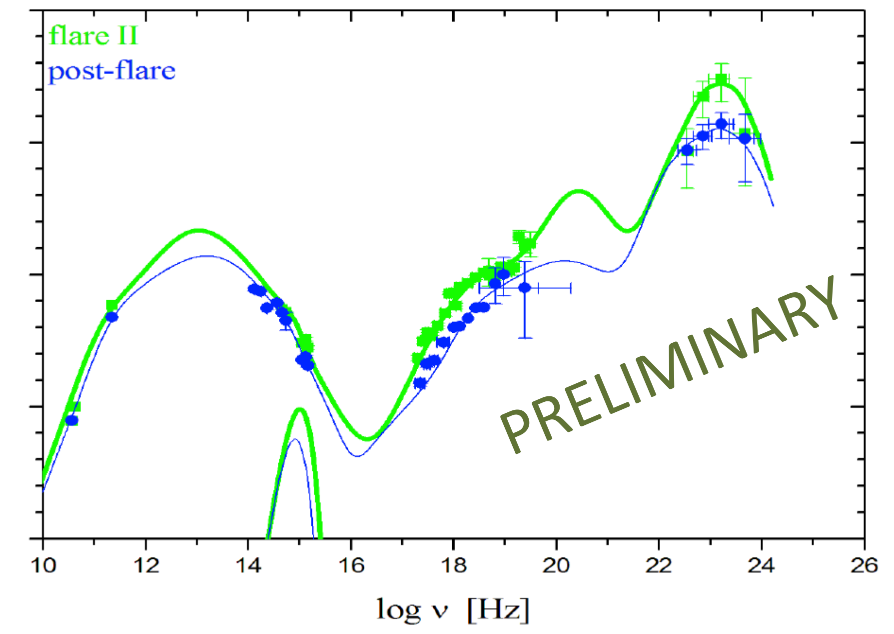
MW campaign involving AGILE, INTEGRAL, *Swift*, and several ground-based observatories.

Pre- and post-flare SEDs are adequately represented by a simple one-zone SSC model plus External Compton (disk + BLR)

The lack of simultaneous strong optical (and X-ray) emission → a simple one-zone model is problematic to explain the super-flare and the secondary flare episodes.

An additional particle component is most likely active during these states, as a consequence of additional particle acceleration and/or plasmoid ejection near the jet basis.





ASI, INAF, and INFN press release on the giant γ-ray flare of the blazar 3C 454.3 "Crazy Diamond" detected by AGILE

Home > News > Un "Crazy Diamond" nel cielo gamma

Un "Crazy Diamond" nel cielo gamma

Il quasar 3C454.3, distante miliardi di anni luce, è iperattivo. E conquista lo scettro di sorgente più energetica del cosmo

09 Dic 2009

Una galassia lontanissima, a sette miliardi e duecento milioni di anni luce, sta attirando l'attenzione degli astronomi di tutto il mondo. È iperattiva. Come impazzita. I satelliti per lo studio dei raggi gamma **AGILE** (dell'ASI, con INAF e INFN) e **FERMI** (della NASA, con l'importante partecipazione italiana) stanno registrando un'eccezionale produzione di emissioni gamma proveniente dalla galassia soprannominata "Crazy Diamond", nella costellazione Pegaso. Al punto che **3C 454.3**, questo il nome in sigla del nucleo galattico attivo, ha rubato lo scettro alla "reginetta" del cielo gamma, la pulsar Vela, distante appena mille anni luce. Pur essendo milioni di volte più lontana, 3C 454.3 con i suoi getti di lampi gamma brilla due volte più di Vela, la sorgente persistente più luminosa. Questo incredibile rilascio di energia dipende dal **buco nero supermassivo** nel centro del quasar 3C454.3.

You are here: Home → Ufficio Stampa → Comunicati Stampa del 2009 → cs-44-09 → L'indigestione di un buco nero

L'indigestione di un buco nero

7 dicembre 2009

COMUNICATO STAMPA CONGIUNTO INAF-ASI-INFN

Il mostruoso buco nero nel centro del quasar 3C454.3 ha polverizzato tutti i suoi record precedenti, diventando la sorgente più brillante del cielo. Si tratta di un sorpasso storico visto che nessuna sorgente aveva mai eguagliato il pulsar delle Vele.

Ti trovi in: Notizie » Dal mondo della fisi...

L'indigestione di un buco nero

Dal mondo della fisica (comunicati sede centrale), 09.12.09 00:00

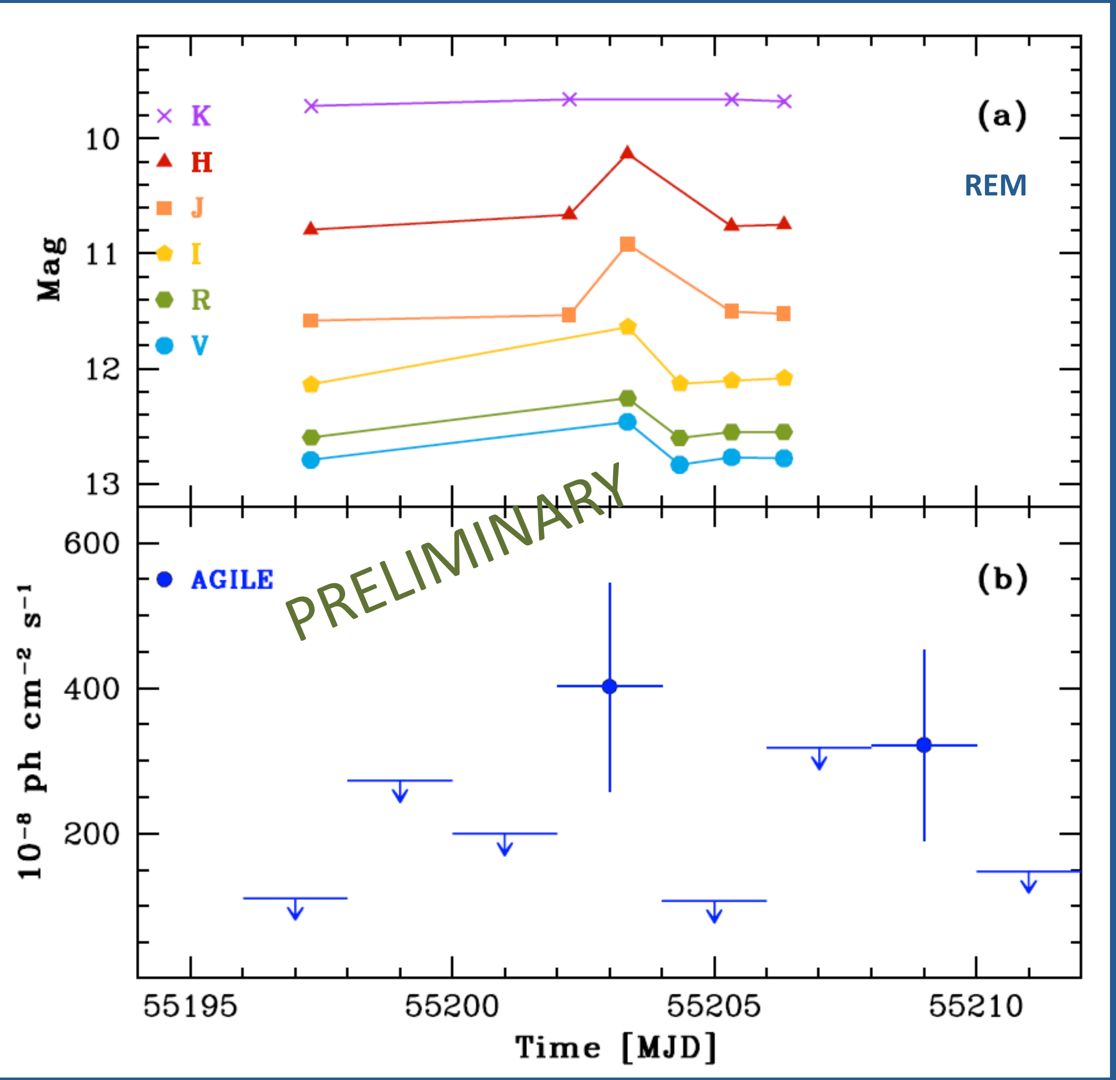
I satelliti per lo studio dei raggi gamma Agile e Fermi, ai quali collaborano l'Istituto Nazionale di Astrofisica (INAF), l'Istituto Nazionale di Fisica Nucleare (INFN) e l'Agenzia Spaziale Italiana (ASI) stanno seguendo in diretta le bizze...

I satelliti per lo studio dei raggi gamma Agile e Fermi, ai quali collaborano l'Istituto Nazionale di Astrofisica (INAF), l'Istituto Nazionale di Fisica Nucleare (INFN) e l'Agenzia Spaziale Italiana (ASI) stanno seguendo in diretta le bizze del mostruoso buco nero nel centro del quasar 3C454.3. Il livello di emissione gamma di sorgenti di questo tipo dipende dalla quantita' di materia che viene accresciuta dal buco nero, in altre parole, dal suo regime alimentare. Quando il buco nero e' a dieta, l'emissione e' stazionaria. Invece, quando il buco nero si ingozza di materia, l'emissione aumenta e diventa variabilissima. In questi giorni 3C454.3 deve avere veramente fatto indigestione, perche' e' diventato la sorgente gamma piÃ¹ brillante del cielo. Un evento raro che sta mobilitando tutta la comunita' astronomica mondiale.

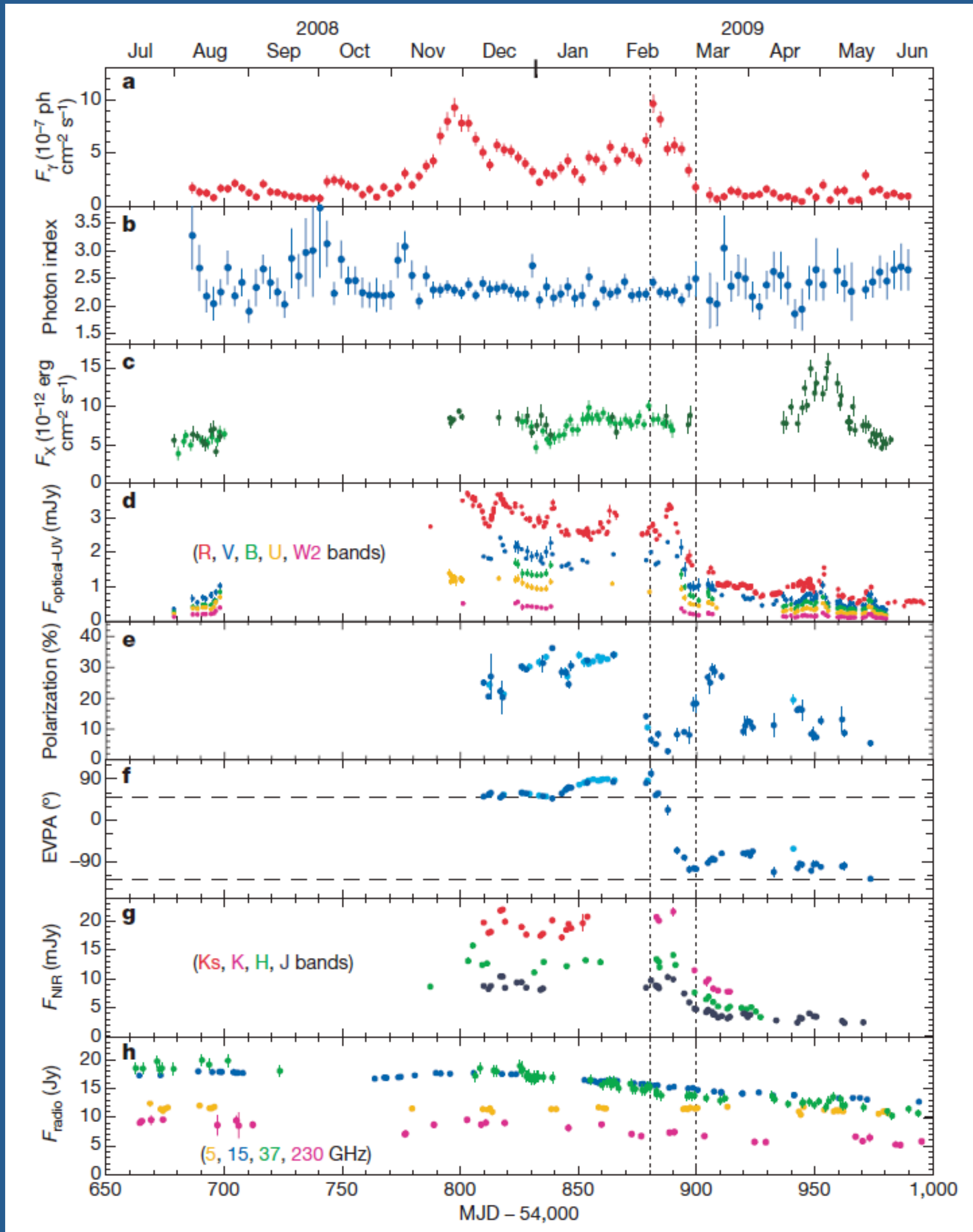
'3C 454.3' e' la sigla che individua una sorgente di emissione radio prodotta da un buco nero super-massivo (miliardi di masse solari) ospitato in una galassia lontana miliardi di anni luce.
Da quando Agile e' entrato in attivita', a meta' 2007, la sorgente alterna periodi tranquilli con periodi di grande attivita', durante i quali diventa molto brillante in raggi gamma, arrivando ad essere paragonabile alla piÃ¹ brillante sorgente del cielo gamma, una pulsar nella costellazione delle Vele. La sorgente viene seguita anche da Fermi, che registra giornalmente il livello di emissione.

Vercellone et al., in preparation

Extremely fast (1—2 days) γ-ray flare observed also by REM in the IR—Opt band



Prospects: radio & optical polarimetry



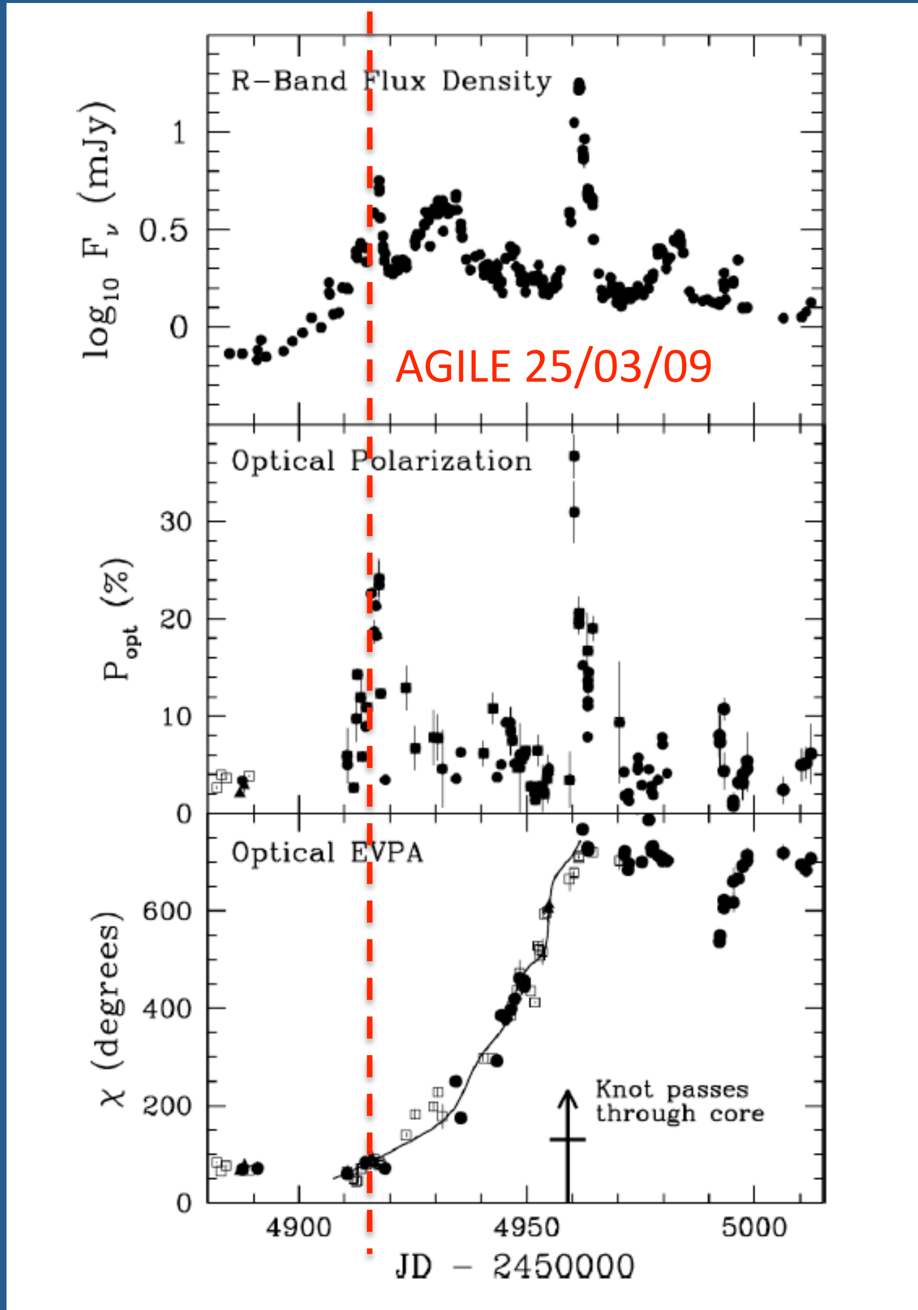
Abdo et al., 2010, Nature, 463
→ 3C 279

Coincidence of a gamma γ-ray flare with a change of optical polarization angle.

Evidence for co-spatiality of optical and γ-ray emission regions.

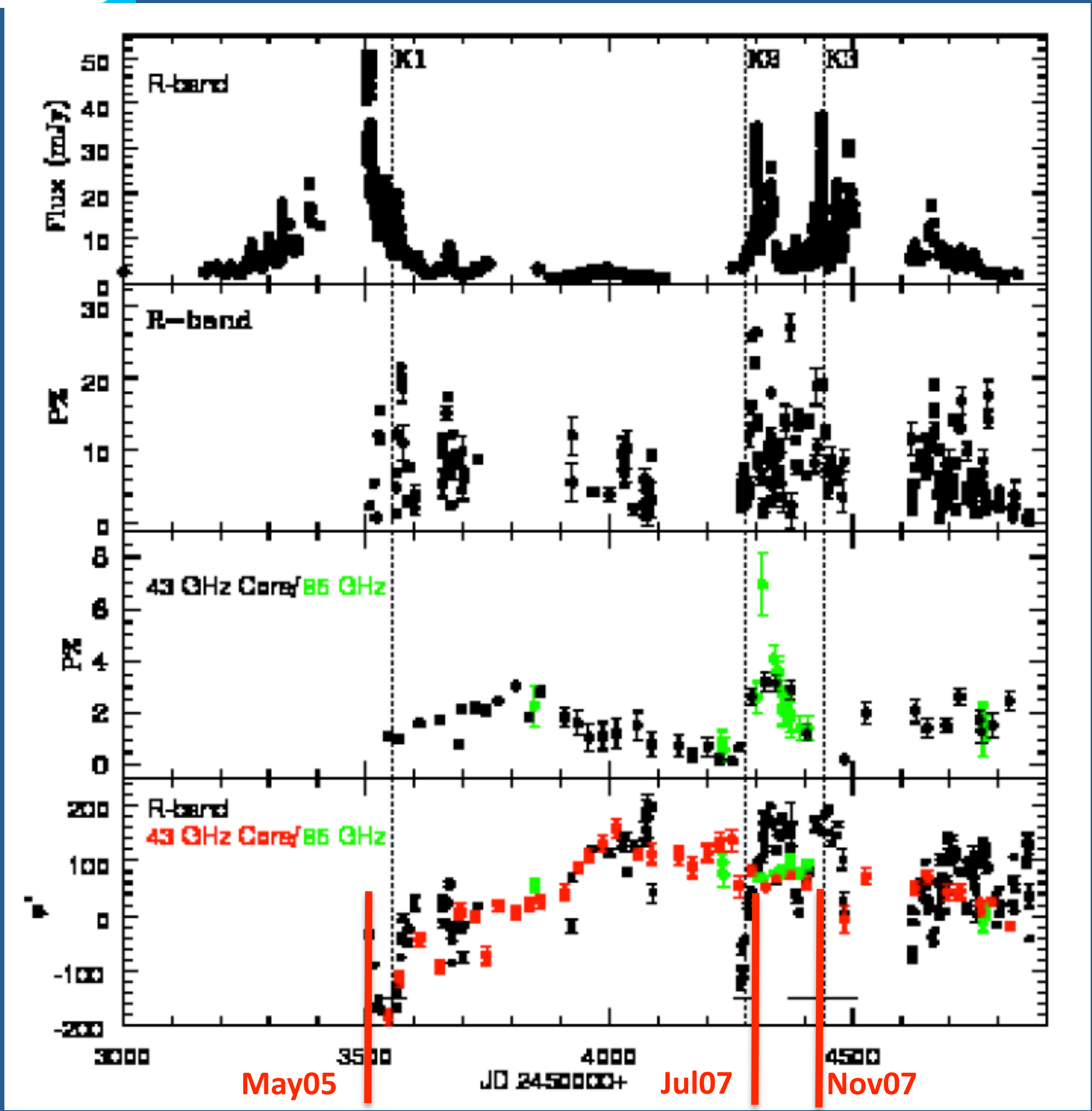
Suggestion for a highly ordered jet magnetic field.

Prospects: radio & optical polarimetry



Marscher et al., ArXiv:1001.2574
→ PKS 1510-089

Prospects: radio & optical polarimetry



Jorstad et al., ArXiv:1003.4293
→ 3C 454.3

Summary

During the first 3 years, AGILE investigated the blazar properties by means of MW programs on specific sources.

The current spinning pointing mode allows us to cover a large fraction of the sky with a good sensitivity for transient events.

The fast and accurate data analysis and the rapid alert disseminations (ATels) allows us to trigger MW observations with several observatories.

The next step: investigate the 50 – 200 MeV band in order to study peculiar blazars peaking in this “soft” γ-ray band

Conclusions

"When life gets you down do you wanna know what you've gotta do?

Just keep swimming. Just keep swimming. Just keep swimming, swimming, swimming.

What do we do? We swim, swim."

Finding Nemo, the movie (2003)

Conclusions

"When γ-ray data gets you down do you wanna know what you've gotta do?

Just keep spinning. Just keep spinning. Just keep spinning, spinning, spinning.

What do we do? We spin, spin."

AGILE, the satellite (2009-now)