l'Observatoire de Paris — LUTH
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# A new look at the multi-wavelength SED of TeV LSP and ISP BL Lacs

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**&**
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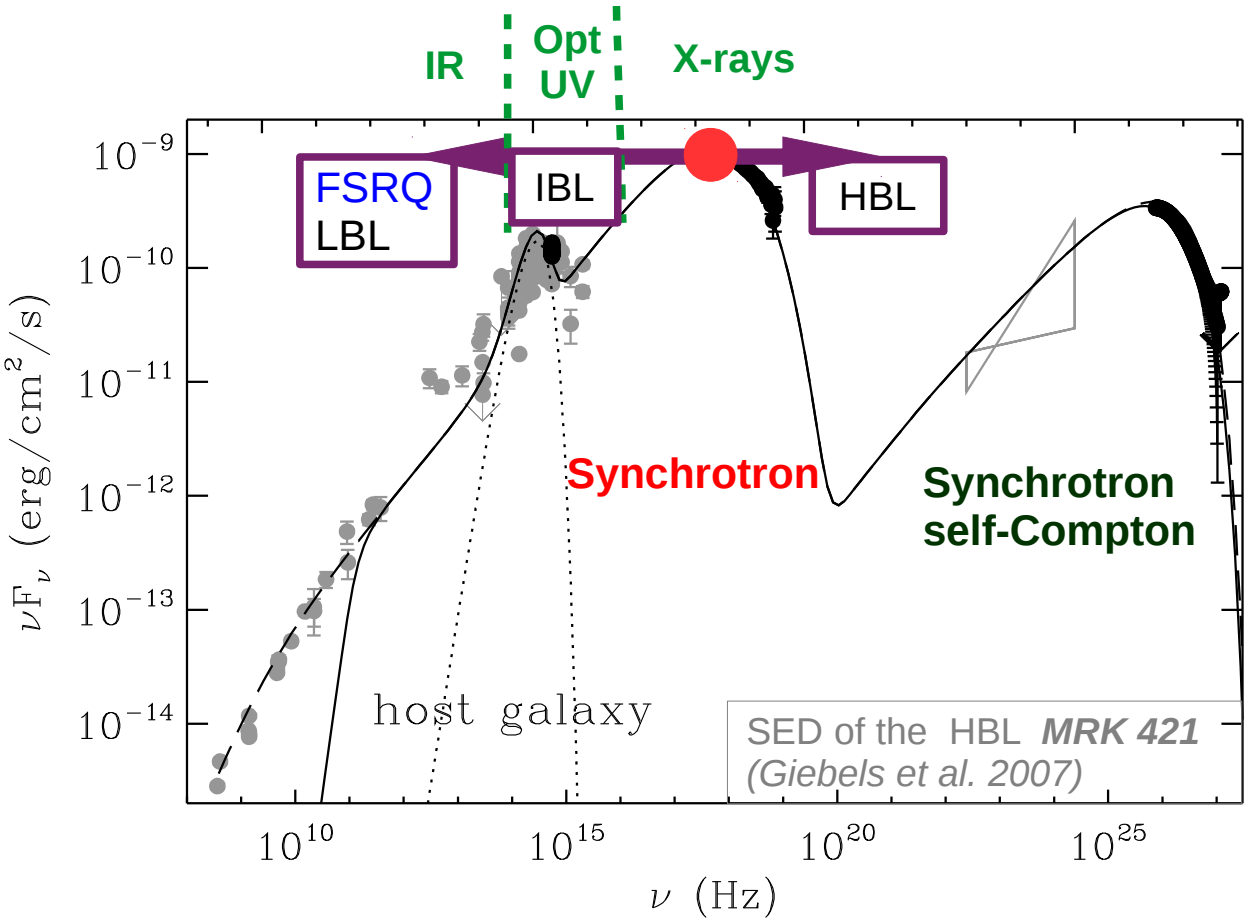
*Thanks to C. Boisson*

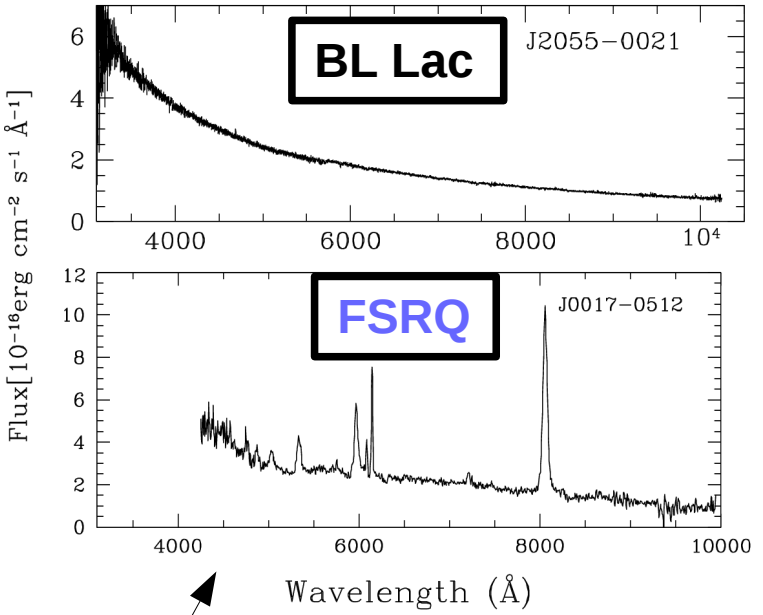
*6th Fermi symposium*
*November 2015, Washington D.C.*

# Blazar emission

## Reminder of the spectral classification




**Optical spectrum**

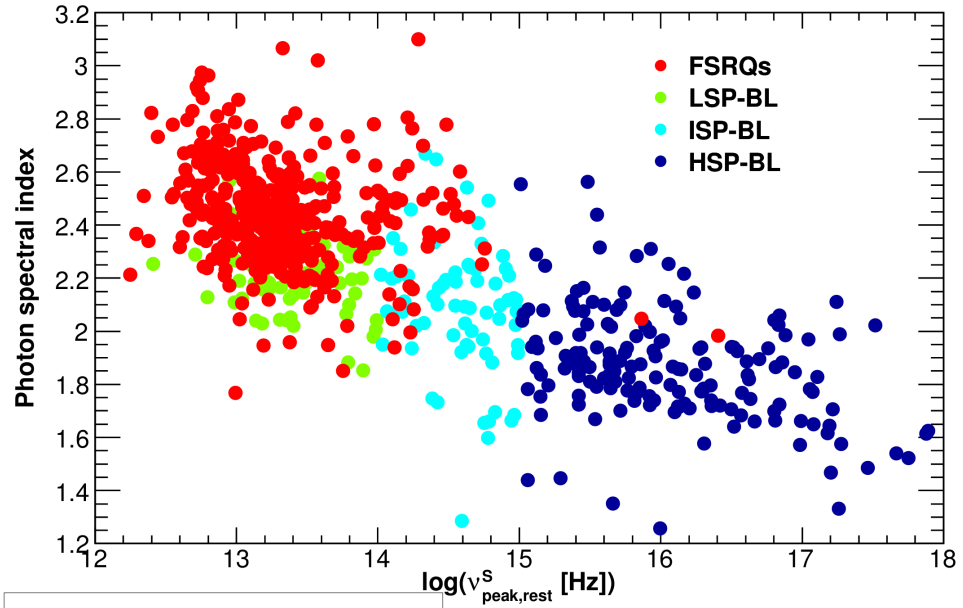



*(Shaw et al. 2007 ; 2012)*

Strong BLR and accretion disk

# Blazars seen at high energy

## Fermi

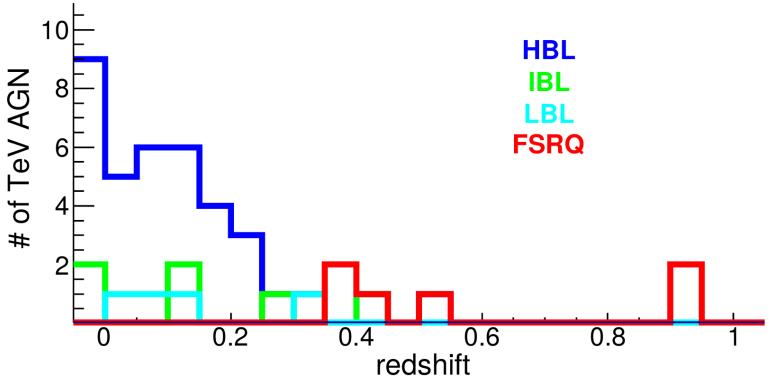


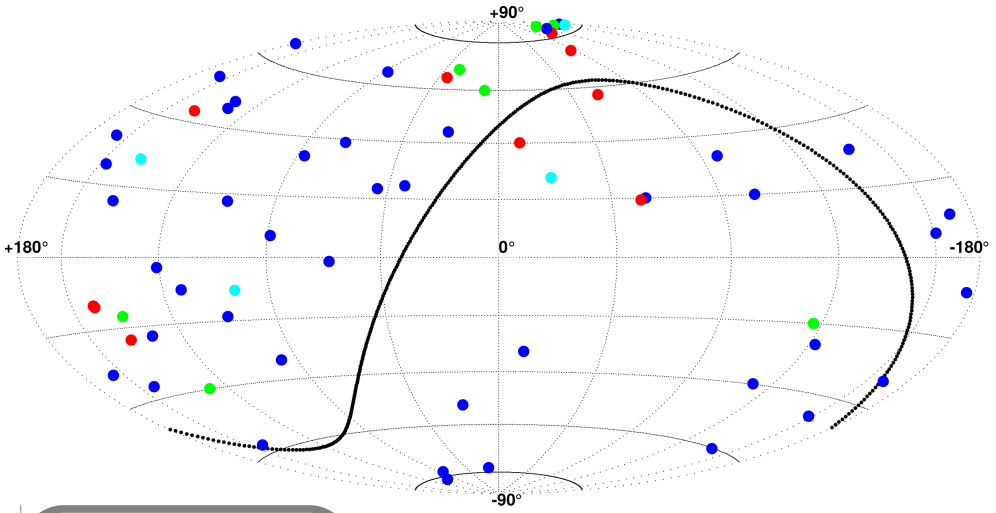

*3LAC*
*Ackermann et al. (2015)*

414 FSRQs
150 LBLs
173 IBLs
265 HBLs

**Dominated by FSRQs**

## VHE




6 FSRQs
4 LBLs
6 IBLs
44 HBLs

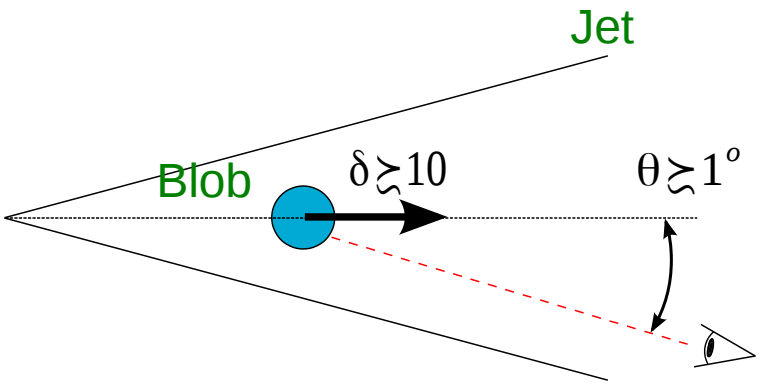
**Dominated by HBLs**

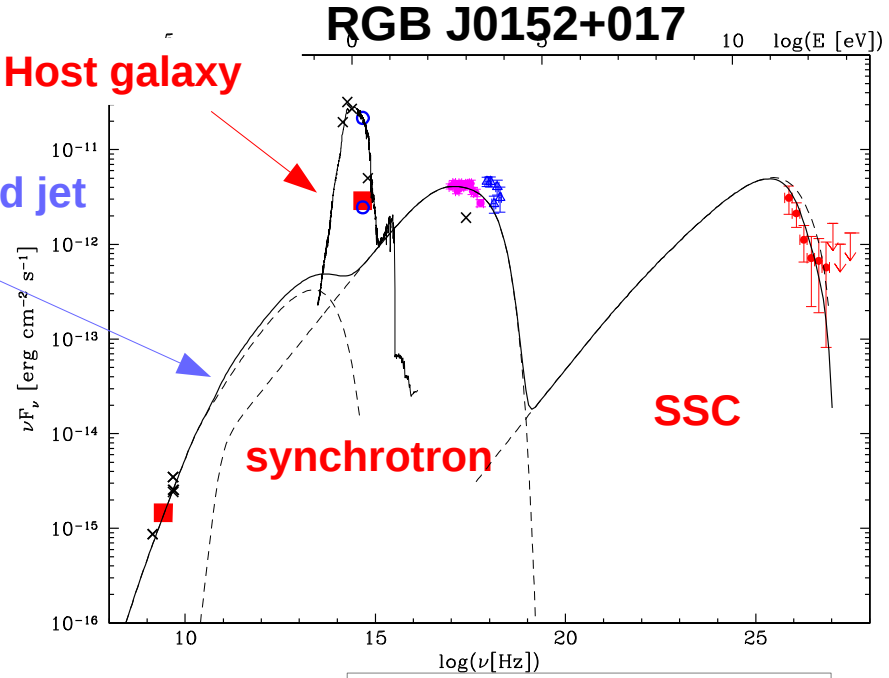
# SED modelling: HBLs / FSRQs

## HBLs

- Synchrotron and SSC peaks have similar flux density (υFυ)
- Low accretion disk luminosity

***Stationary leptonic SSC model***



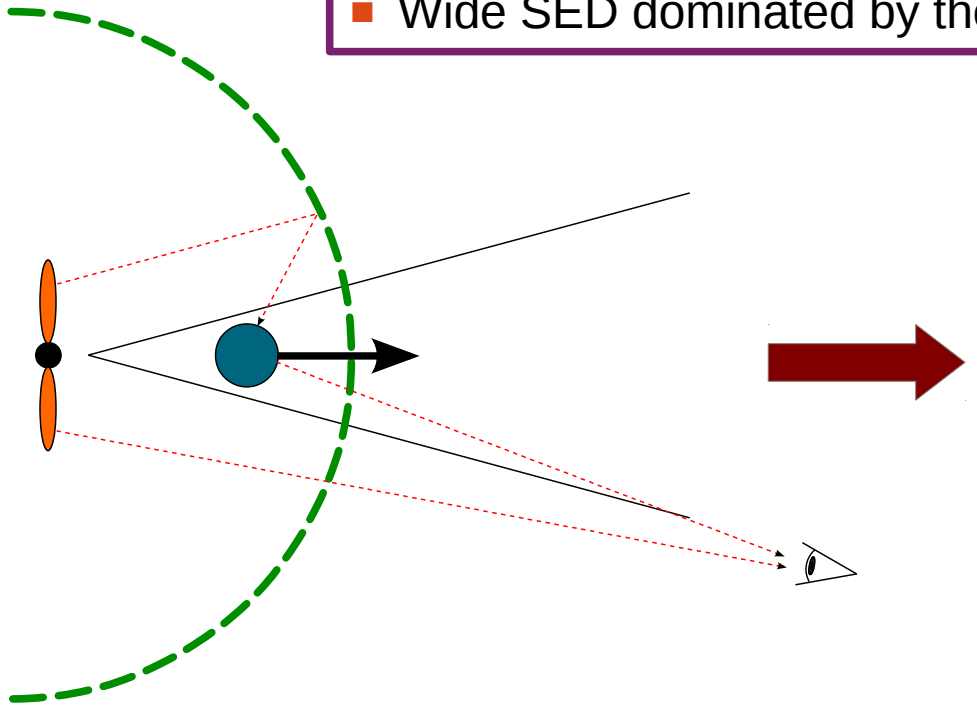

*Aharonian et al. (2008)*

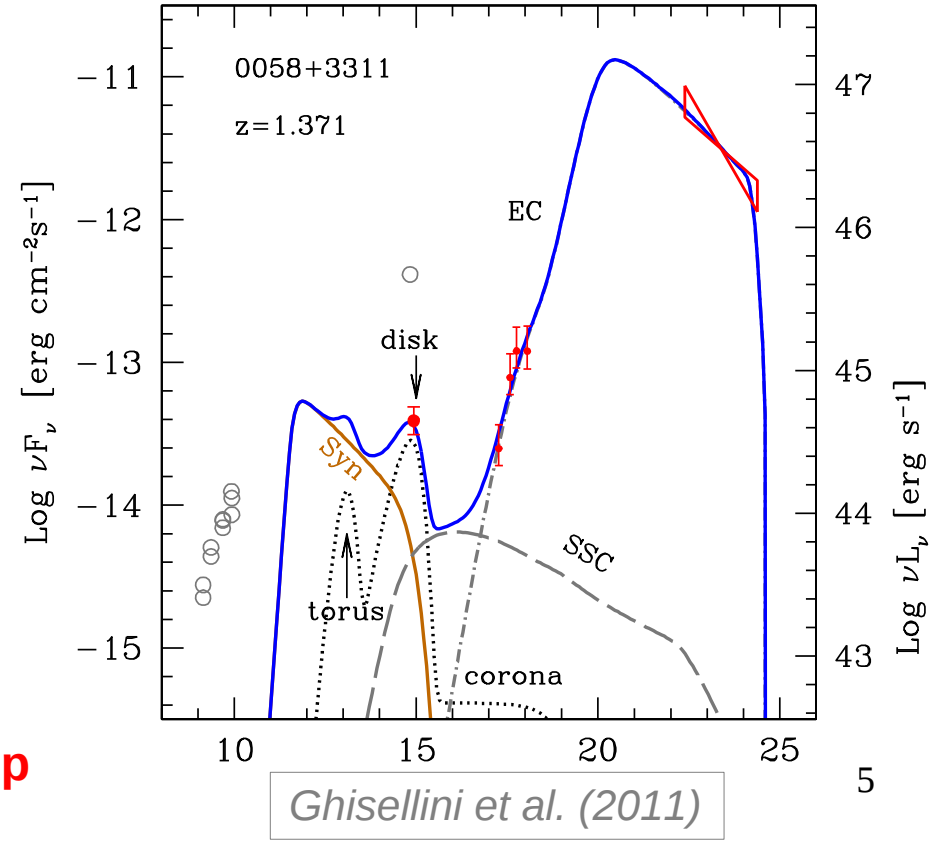
**Multi-Wavelength SED widely dominated by an SSC plasma bulk (blob)**

# SED modelling: HBLs / FSRQs

## FSRQs

- High disk emission
- Low frequency synchrotron peak
- High source luminosity
- Wide SED dominated by the High energy bump






Ghisellini et al. (2011)

**External radiation of the disk reprocessed on BLR clouds can explain the high energy bump**

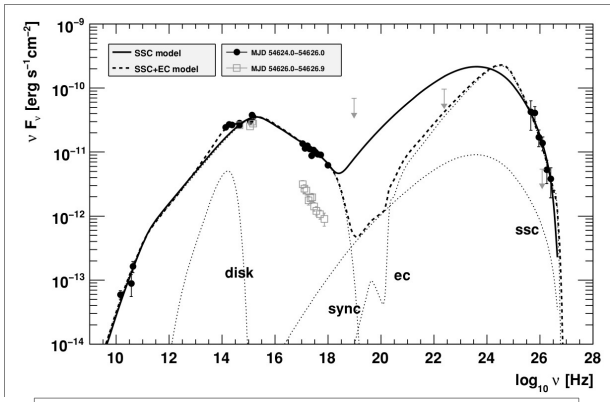
# Problematic of IBL and LBL TeV blazars

- Low frequency peak
- But weak accretion disk emission

**How can they reach very high energies ?**

## W Comae

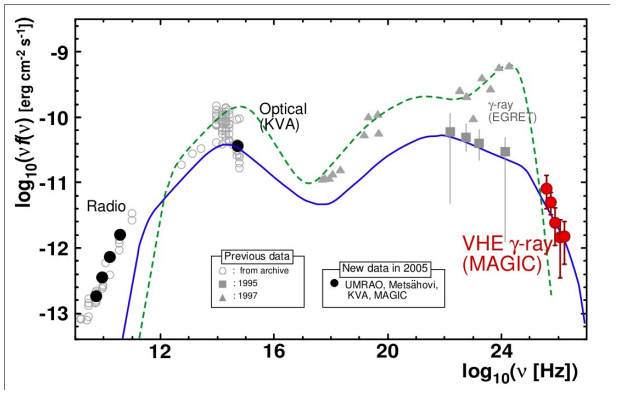
EIC on dust torus ?




*VERITAS collaboration (2009)*

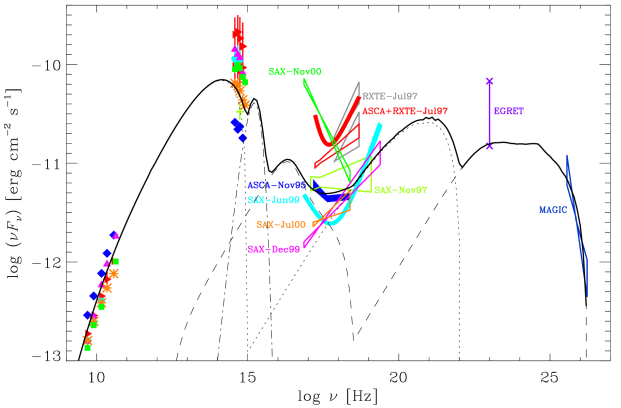
## BL Lacertae

EIC on BLR emission line ?




*Hayashida et al. 2007* (MAGIC data)
*Ravasio et al. 2002* (SEDs)

Multiple SSC blobs ?




*Raiteri et al. (2010)*

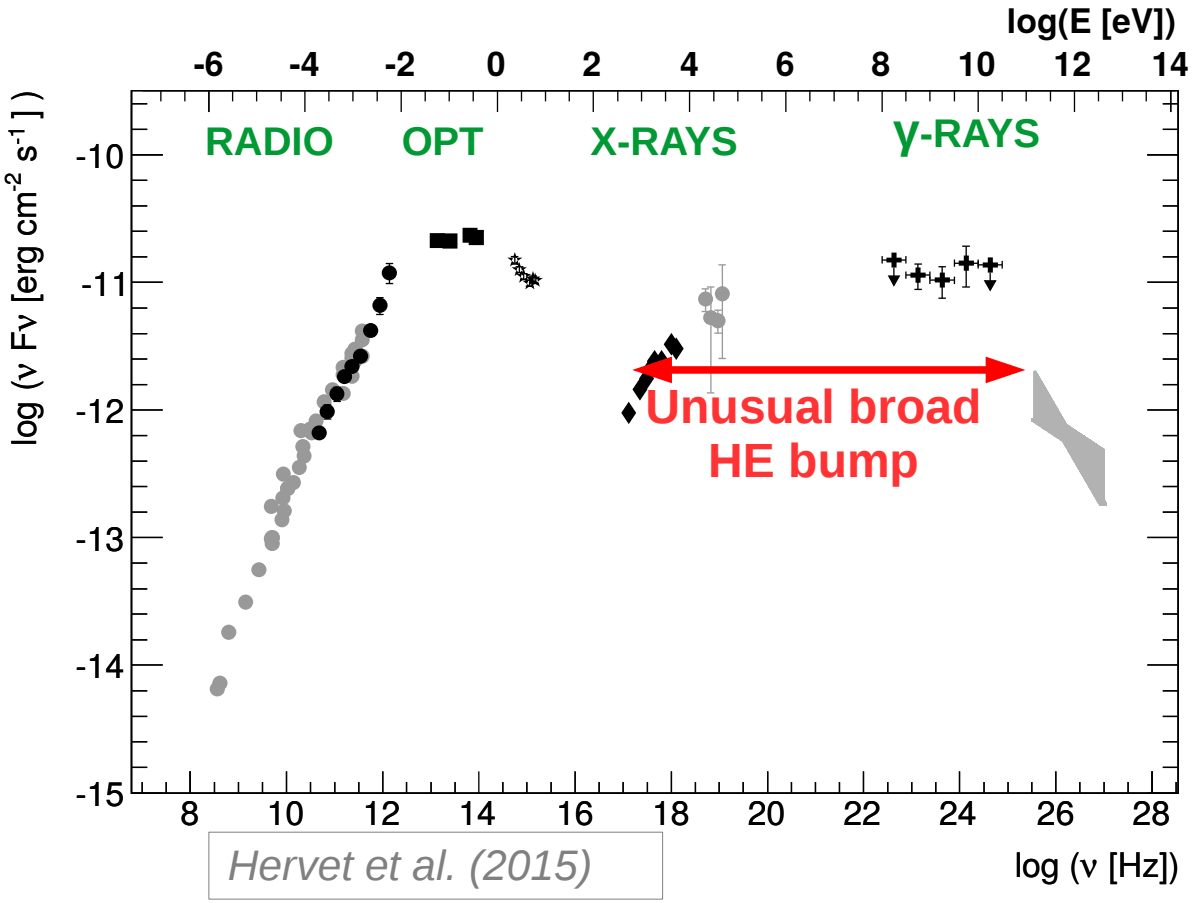
**NO CONSENSUS**

# Complex case of the LBL Ap Librae

## Some clues on the SED

**Wide quasi-simulaneous data coverage :**

Planck
Wise
UVOT
XRT
Fermi




*Hervet et al. (2015)*

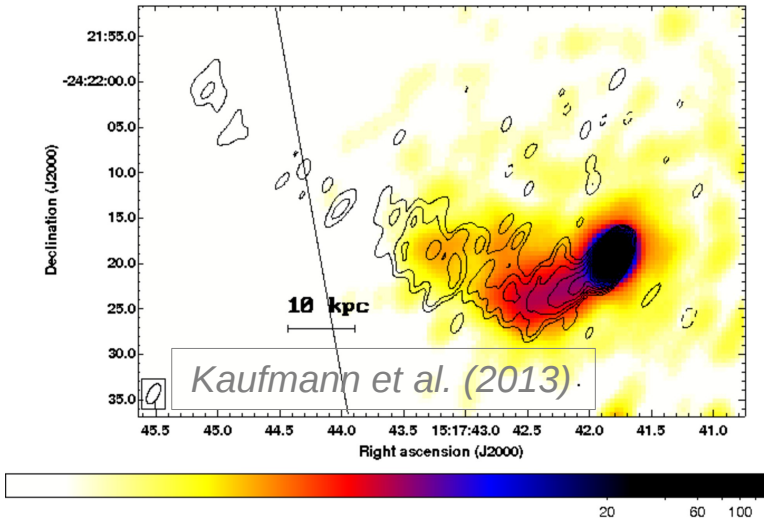
**Black :** quasi-simultaneous data
**Grey :** non-simultaneous data

# Complex case of the LBL Ap Librae

## Some clues on the SED

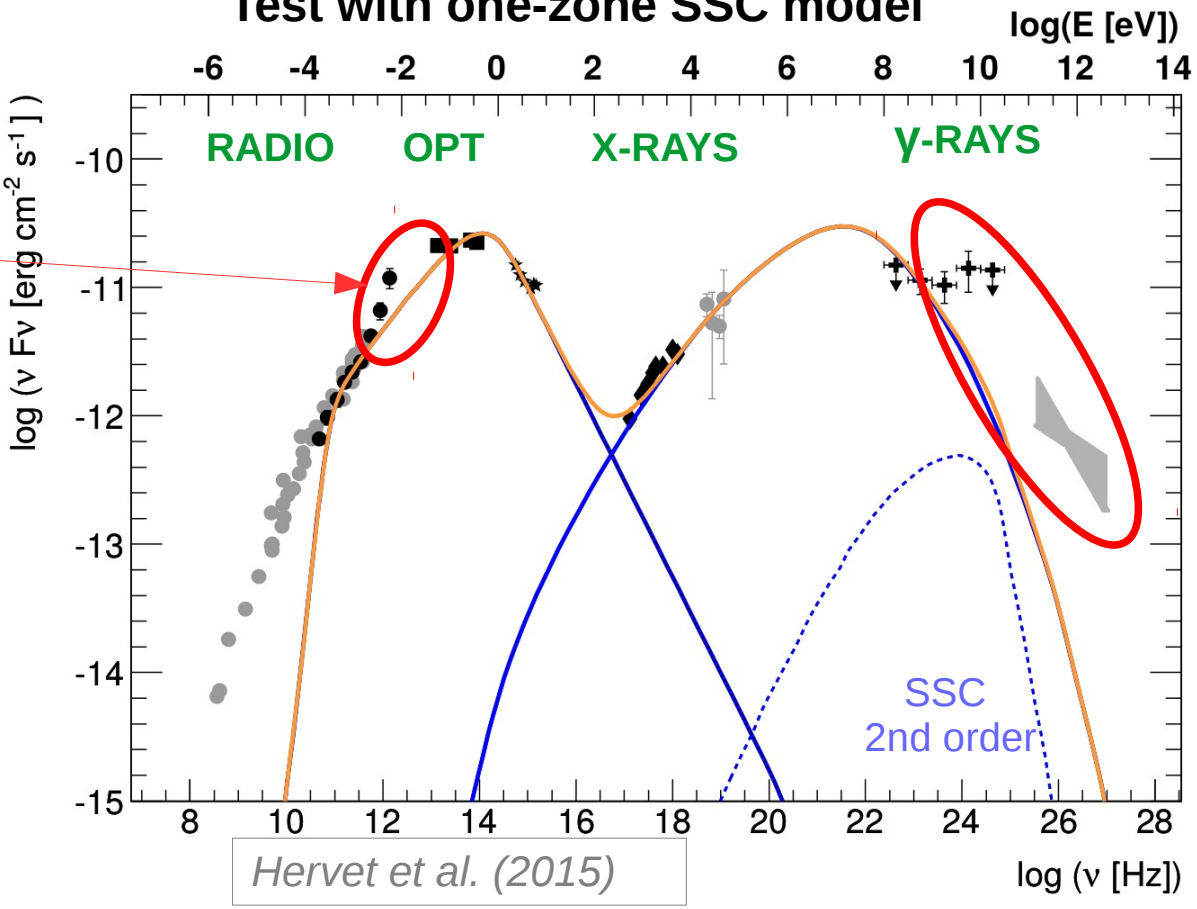
- Simple SSC modelling doesn't work
- Excess due to a non thermal component (incompatible temp.)

### Strong extended X-ray jet



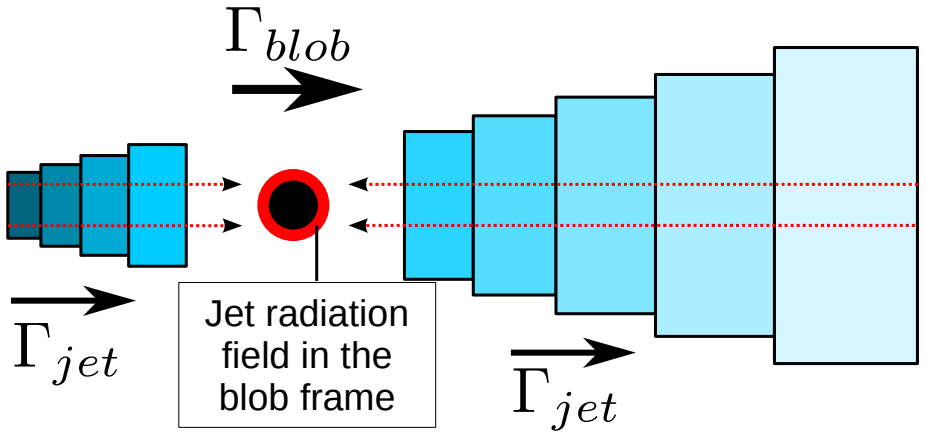

**We have to take into account an extended jet emission**

### Test with one-zone SSC model




**Black :** quasi-simultaneous data
**Grey :** non-simultaneous data

# Multicomponent model “Bjet”




Takes into account the interaction between a stratified jet radiaton field and blob particles

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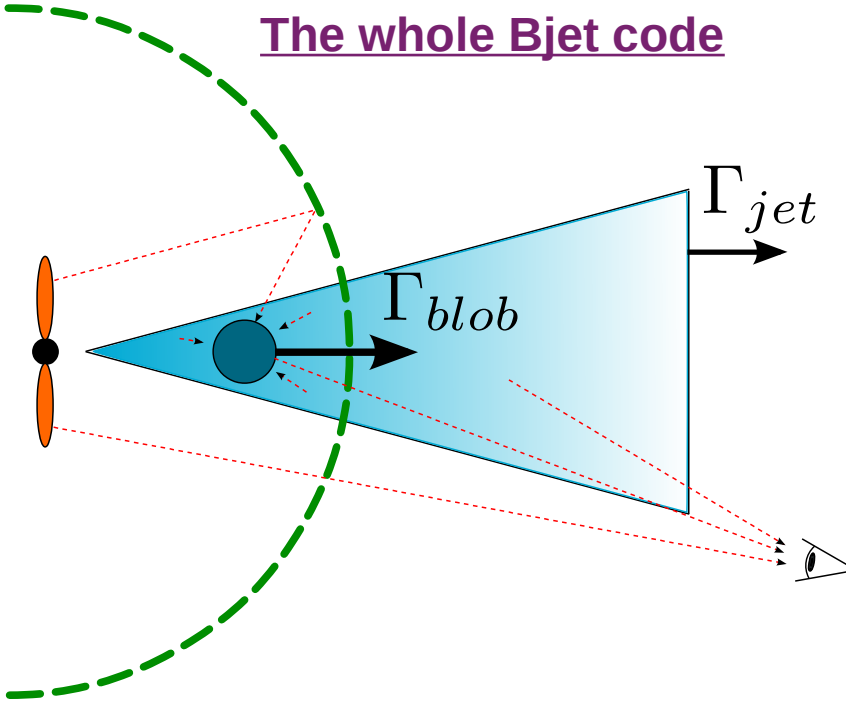
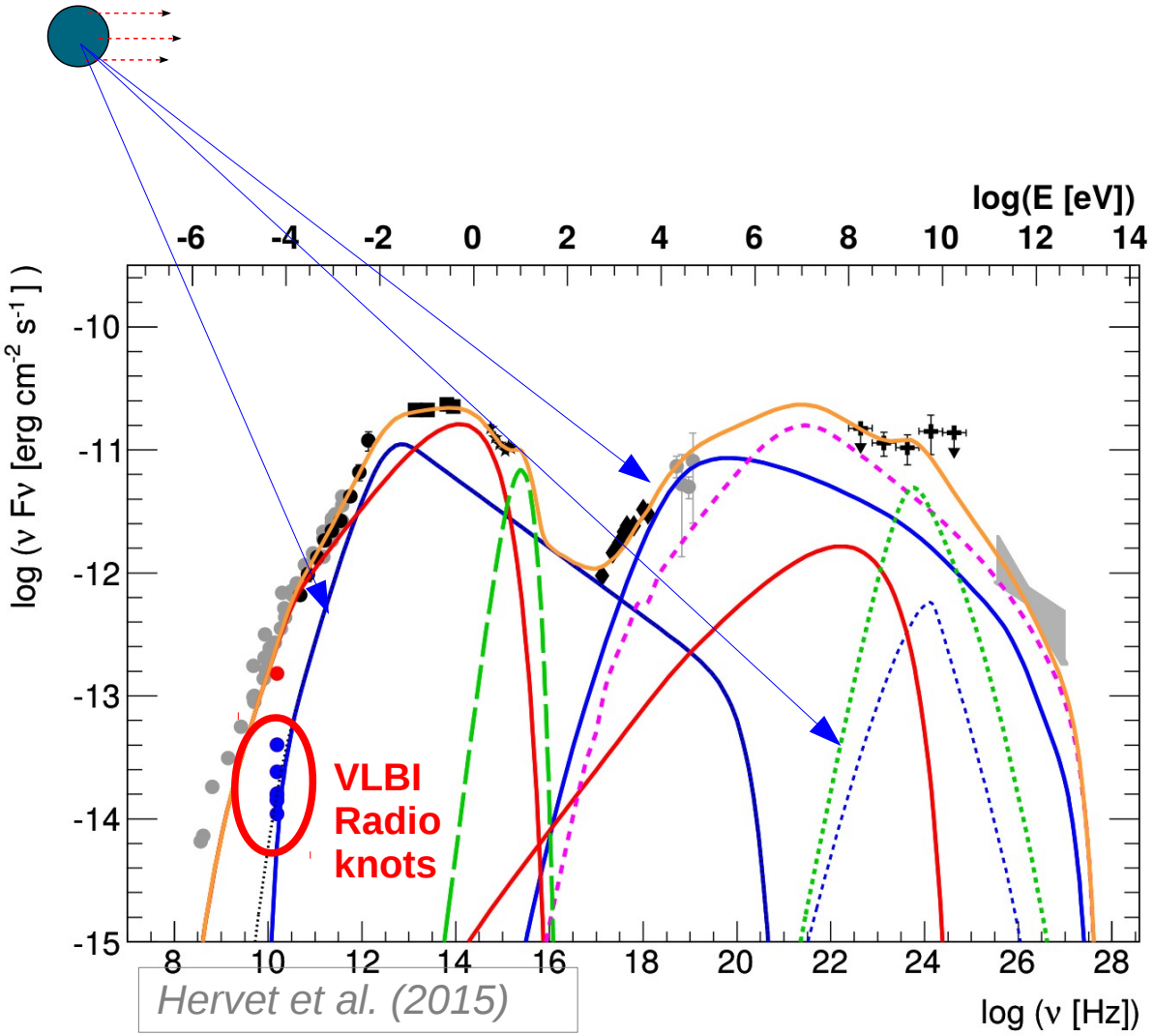
## The whole Bjet code




- Blob SSC emission
- Stratified jet SSC emission
- Inverse Compton process of the blob particles onto the synchrotron jet
- Disk thermal radiation
- Inverse Compton process of the blob particles onto the disk radiation scattered by the BLR

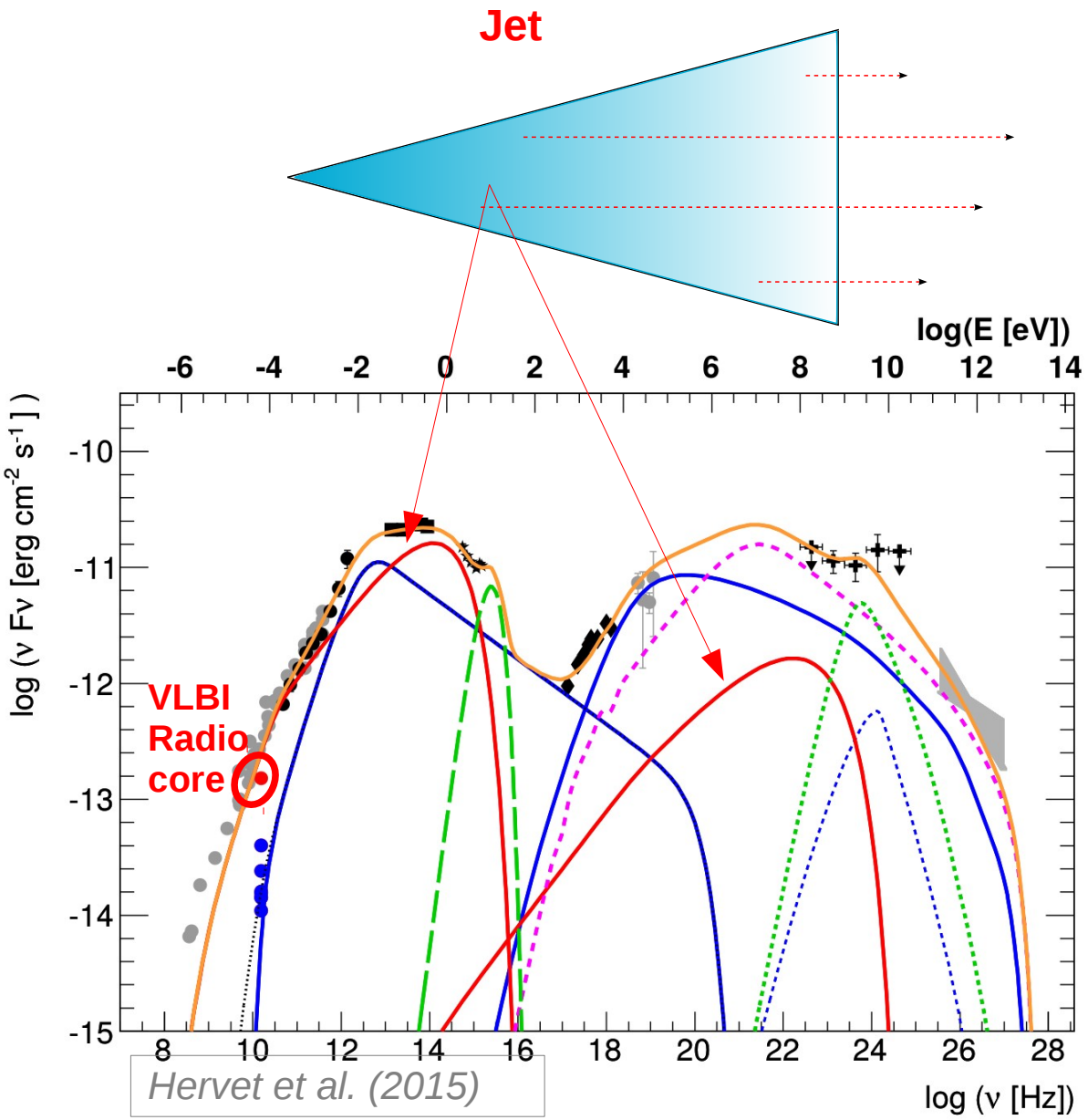
# Modelling

**Blob**




*Hervet et al. (2015)*

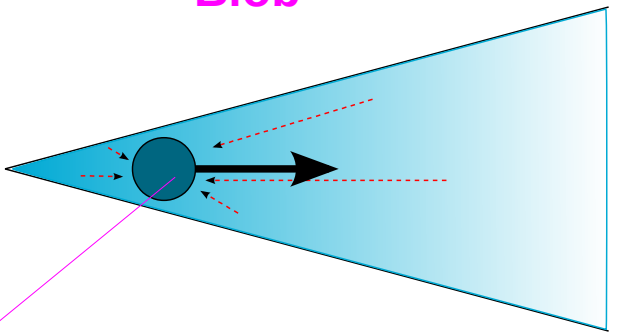
# Modelling

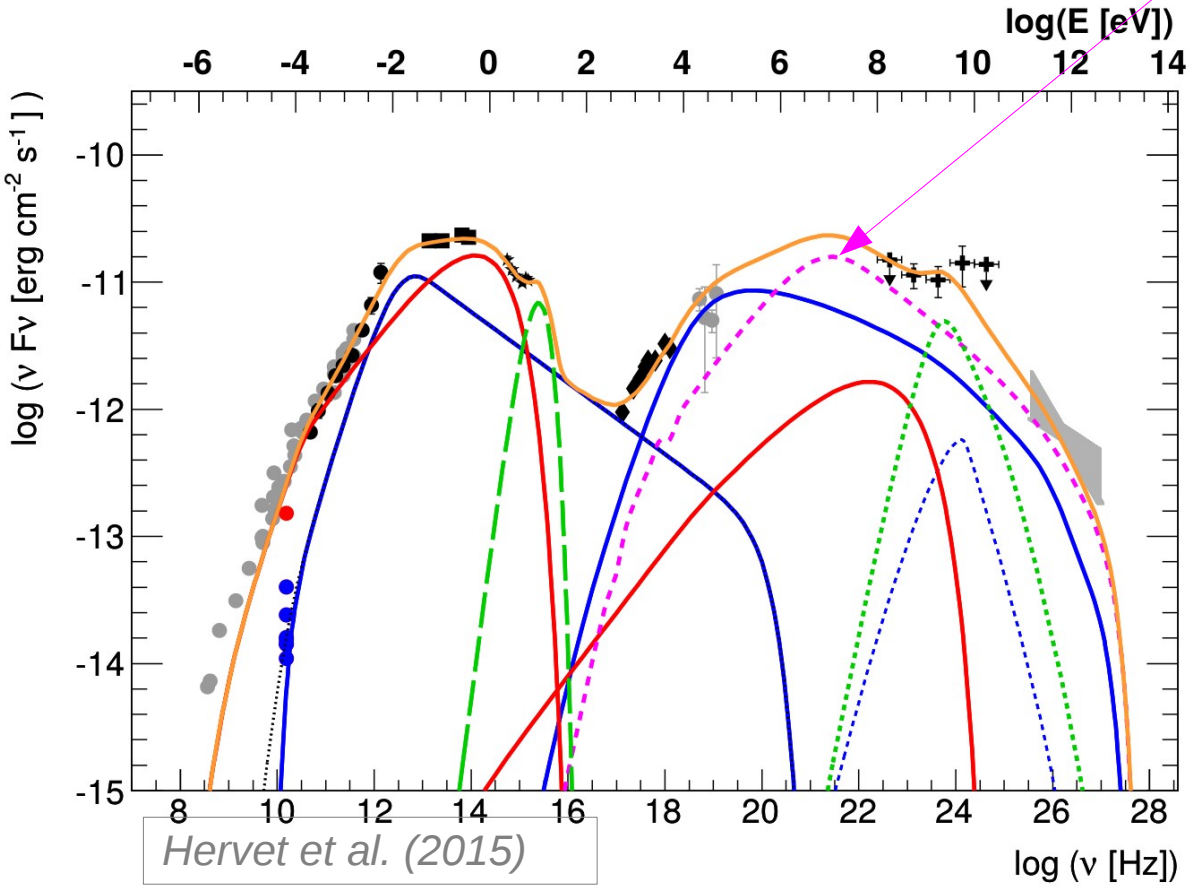



*Hervet et al. (2015)*

# Modelling

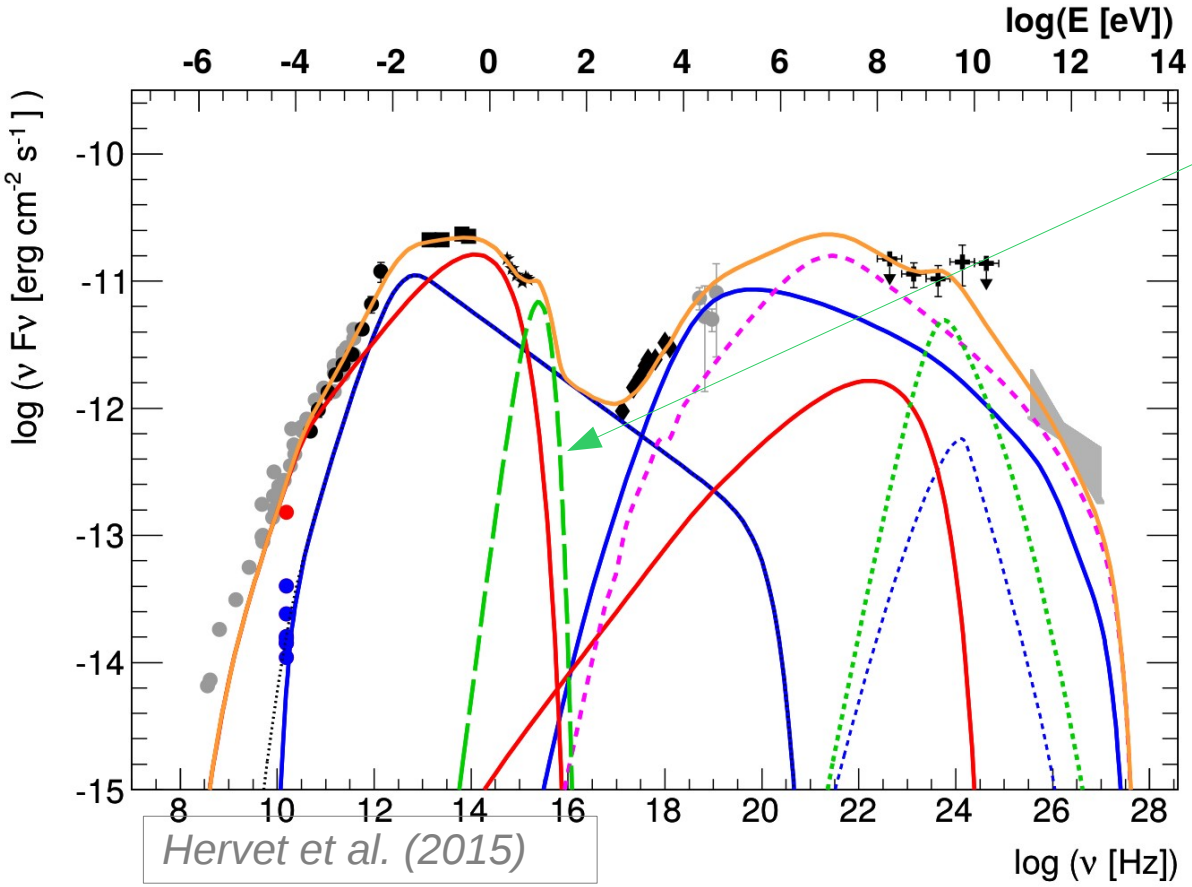
**External Compton Jet-Blob**



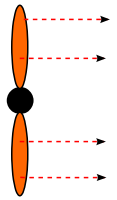



*Hervet et al. (2015)*

# Modelling

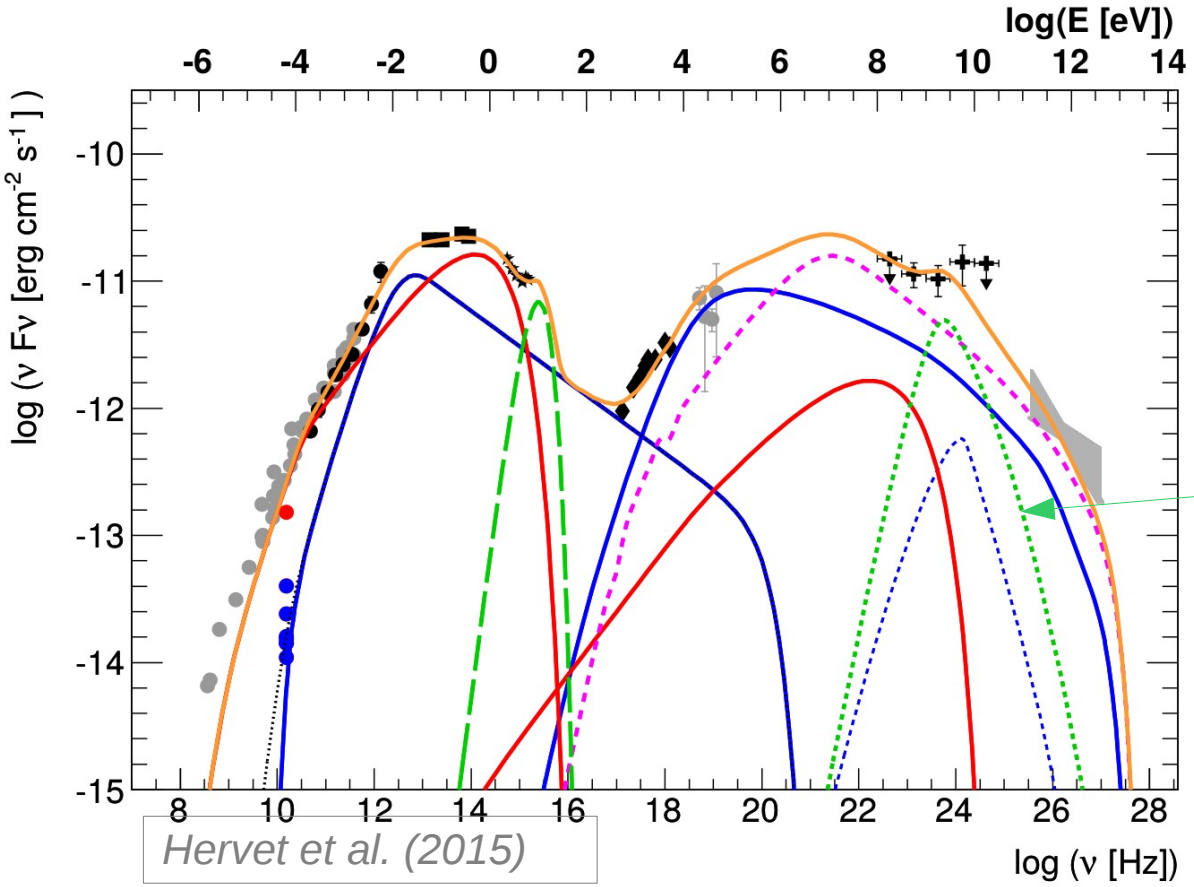



*Hervet et al. (2015)*

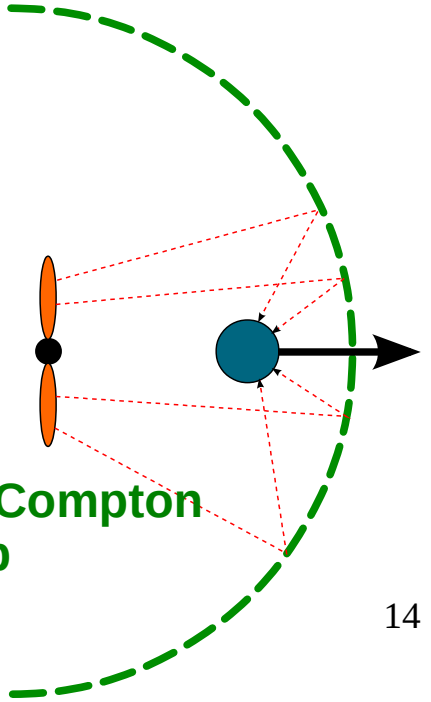


**Disk**

# Modelling




*Hervet et al. (2015)*



**External Compton**
**BLR-Blob**

# What about other TeV LBLs/IBLs ?

## Modelling of 3 other sources

**BL Lacertae :** low state

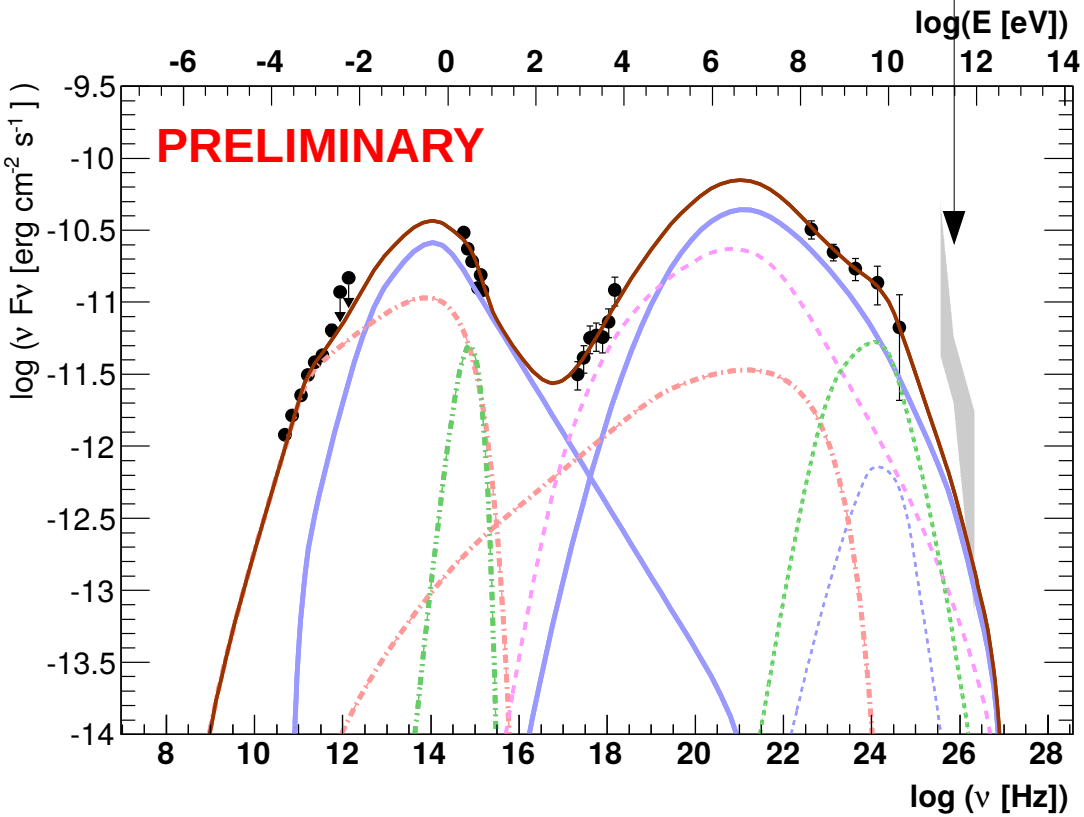
**W Comae :** low & high state

**VER J0521+211 :** low & high state

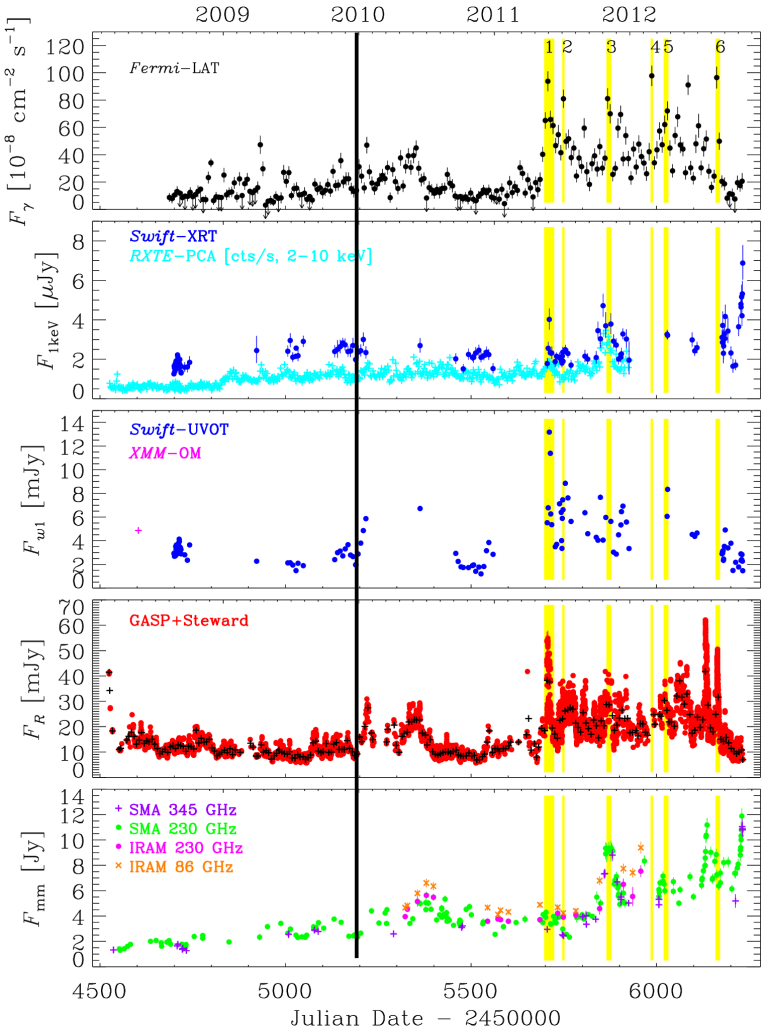
# BL Lacertae

**Same scenario as Ap Lib**

Non-simultaneous VHE data
MAGIC collaboration (2008)




**Black:** quasi-simultaneous data
Giommi et al. (2012)



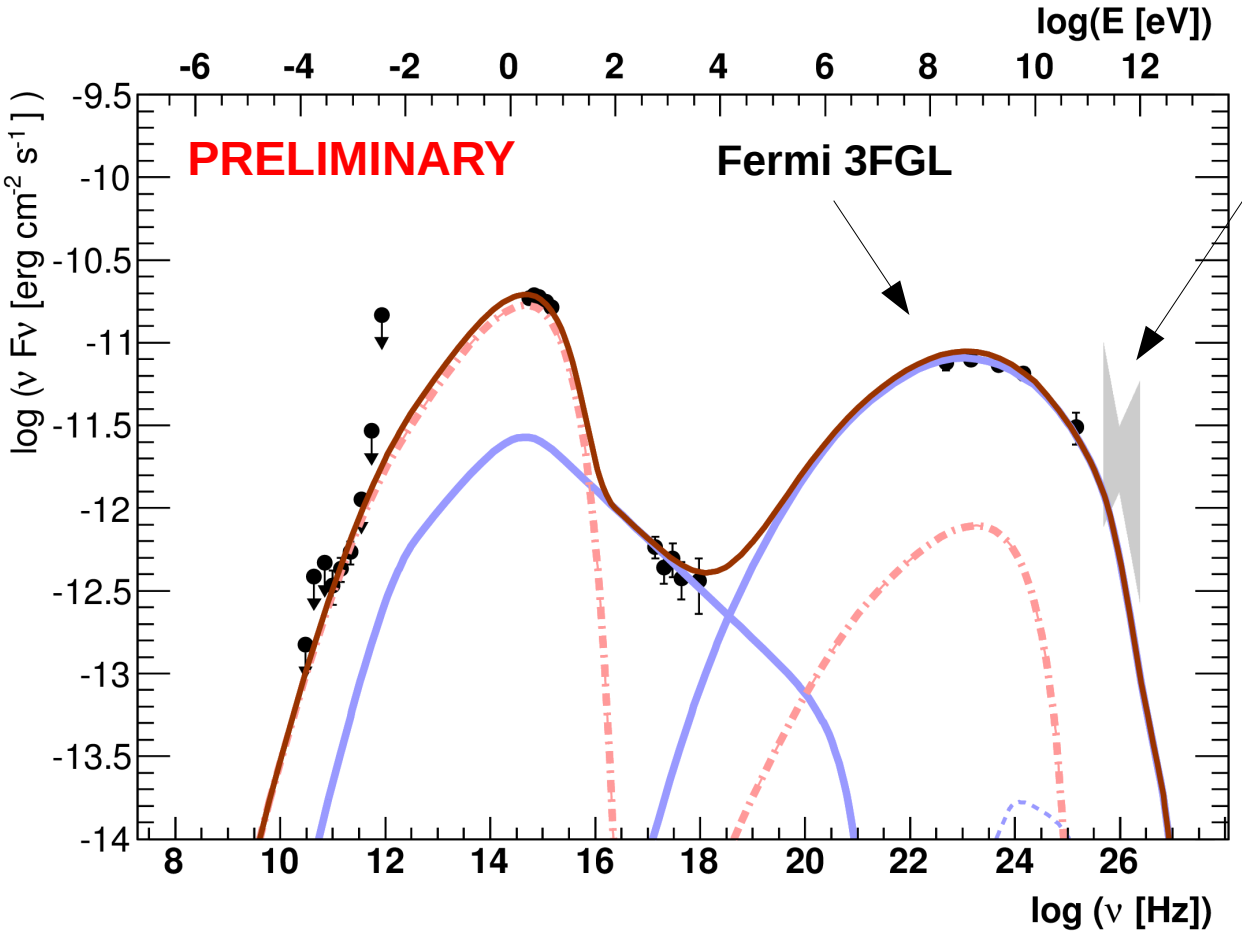

Low state 23/12/2009

**Significant jet but less powerful than Ap Librae**

# W Comae

Non-simultaneous VHE
*VERITAS PoS (2015)*

**Low state**
2009 Dec. 10




Simultaneous : **Planck, UVOT, XRT**

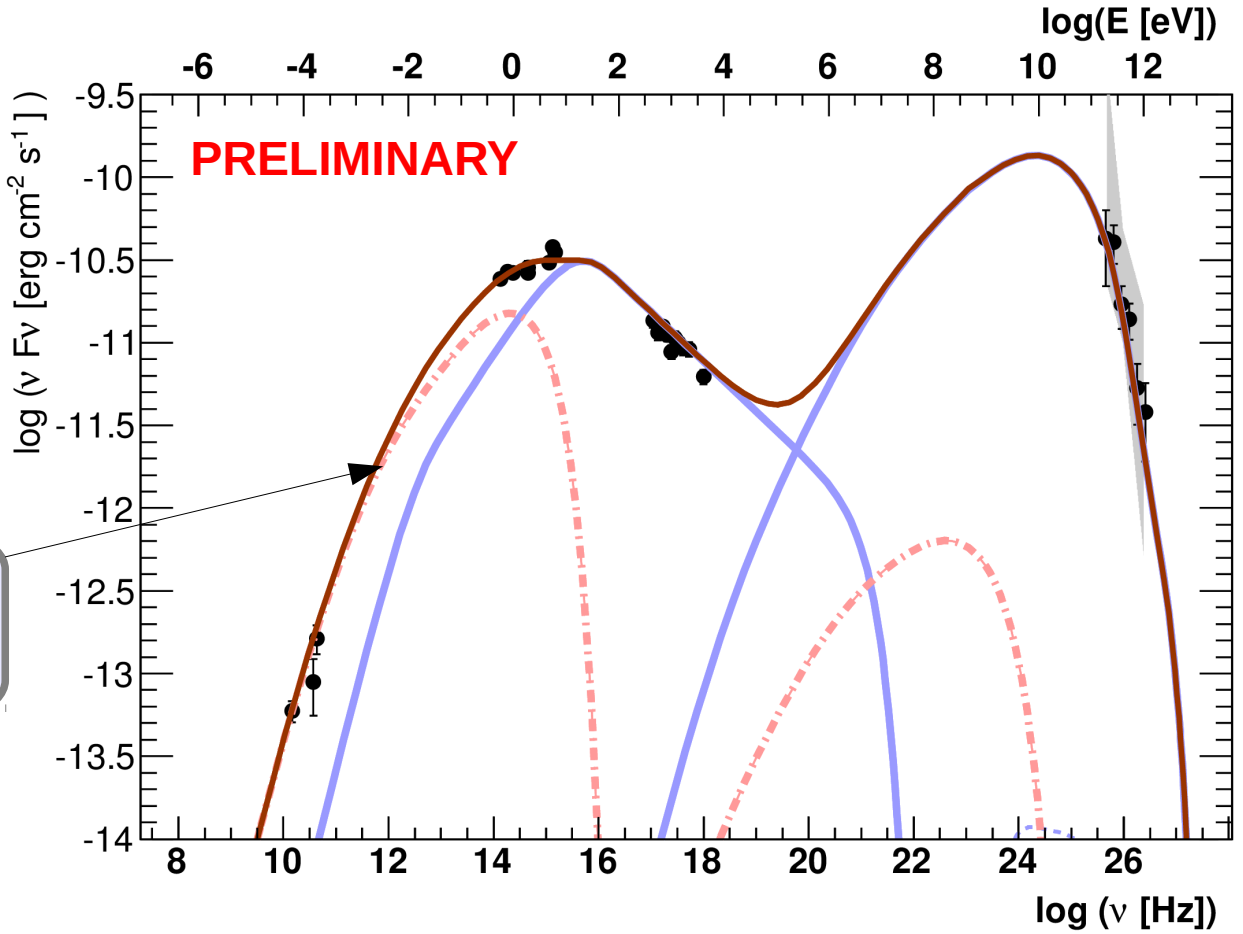
**Low energy bump highly dominated by the synchrotron jet**

Jet-blob interaction not necessary here

SSC blob farther in the jet ?

# W Comae

**High state**
2008 June 7–8




Constant jet emission

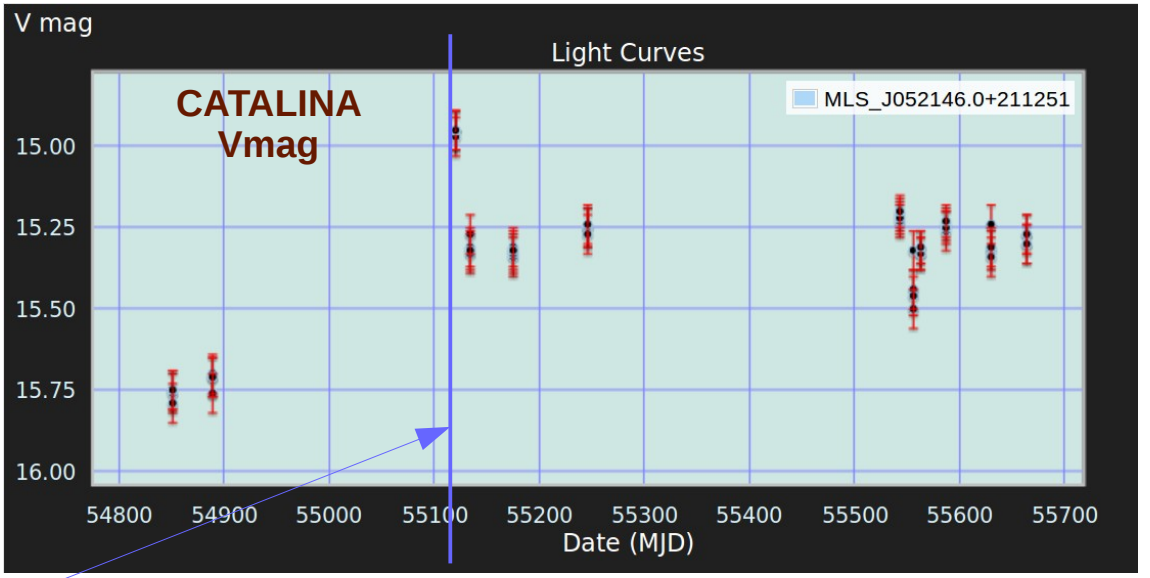
Quasi-simultaneous data : VERITAS Collaboration (2009)

**High energy blob overtakes the jet**

# VER J0521+2011

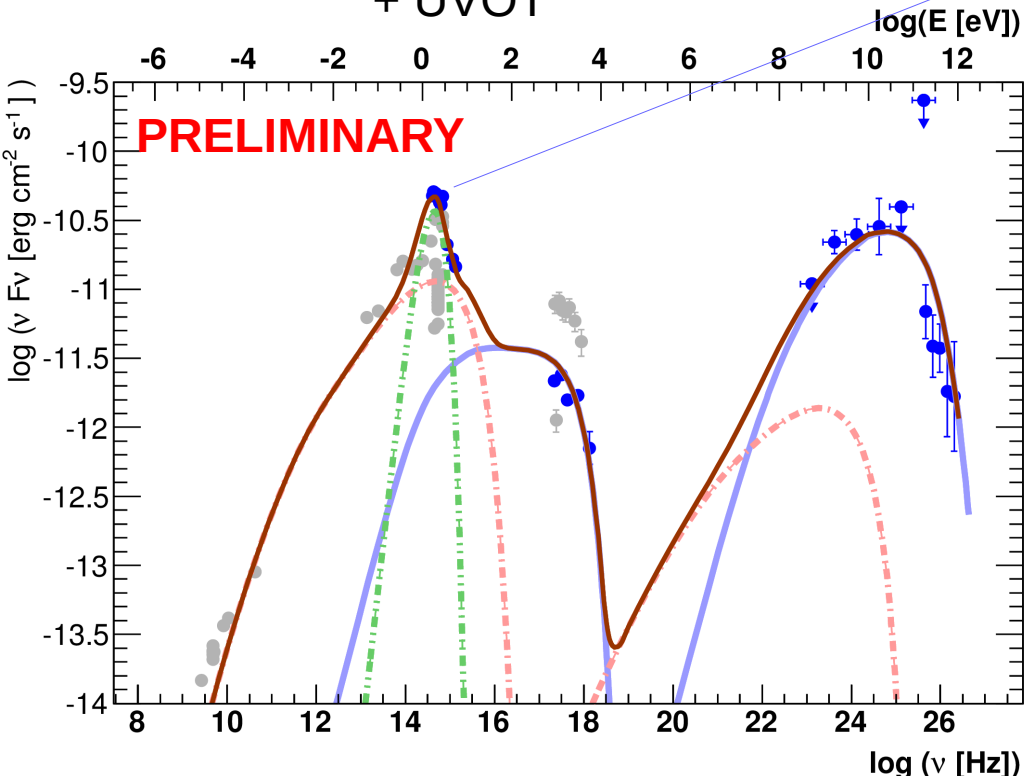
**Low state**

2009 oct 22-30




Quasi-simultaneous data :
VERITAS Collaboration (2013)

+ UVOT



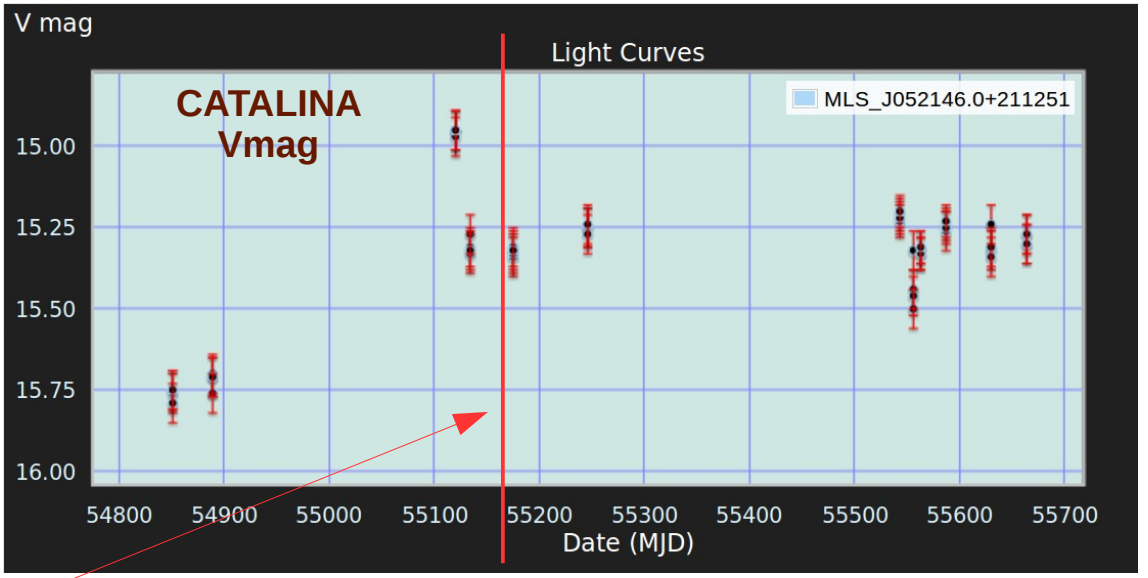

High state in optical

**Could require a strong accretion disk emission**

# VER J0521+2011

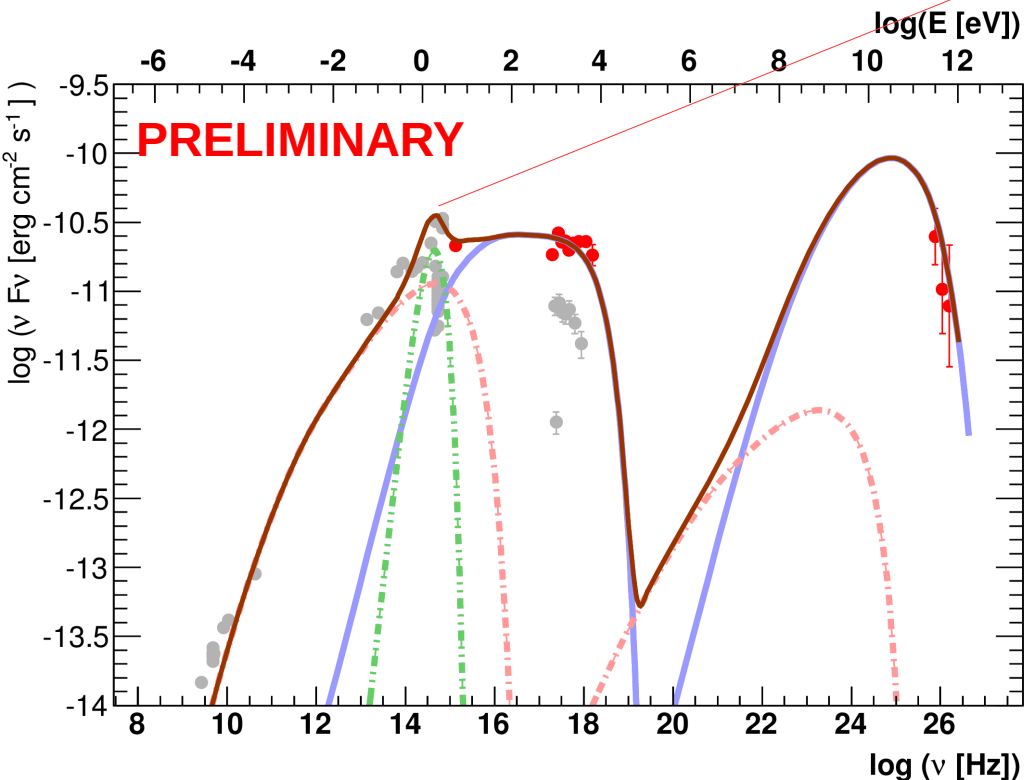
## High state

2009 Nov 27




Quasi-simultaneous data :
VERITAS Collaboration (2013)

+ UVOT




Standard state in optical

Seems that an accretion disk flare happend one month before the high energy flare

**High energy blob overtakes the jet**

# Conclusion

- TeV IBLs/ LBLs show various SEDs
- A three components (blob, jet, disk) scenario is relevant to describe these sources, including various states
- Jet-blob Compton interaction necessary when positive X-ray slope (Ap Lib, Bl Lac)

**The Low SED component peak is not enough to characterise these sources**

Can be due to various components:

- Sychrotron from a compact zone (blob)
- Sychrotron from an extended zone (jet)
- Accretion disk emission)

**And the dominant component depends on the activity state !**

**These sources provide the key to improve the blazar unification scheme**