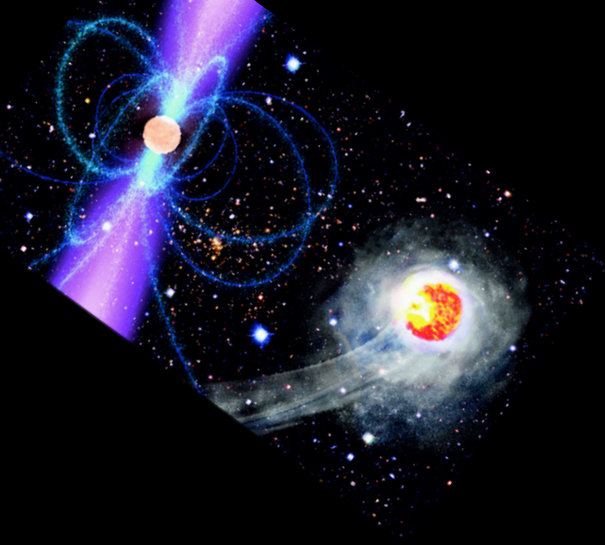
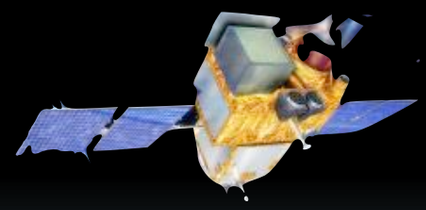
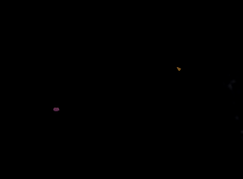




GALACTIC TRANSIENTS

JÉRÔME RODRIGUEZ / CHRISTIAN GOUIFFÈS (CEA/SAP)



Summary

- What do we call Galactic X-ray transients?
- How? from the discovery to the broad band studies
- Why? from astronomy to astrophysics model independent approach and physics of some sources
- Today/Tomorrow: large flows of data (radio, optical). What strategies, organization (to be discussed during this workshop)

Galactic Transients

- Magnetically active stars (RS CVn) also > 20 keV emitters (Swift, INTEGRAL, Maxi)
- Supernovae : optical-X-ray-neutrinos-GW(?); Rare events: 1-3 ev/century (?!!), none during the 20th century. Closer to 0.1-0.01/century
  - type II, Ib/c <=> Collapse massive star
  - Type Ia <=> Thermonuclear, white dwarf
- WD, isolated neutron stars: radio, optical, X/γ-rays
  - incl. SGR and AXPs giant flares and bursts
- X/γ-ray Binaries/CVs: full em spectrum; neutrinos(?), GW (?)
  - CV (IP) are > 20 keV emitters ; Fermi detection of HE flare from novae
  - Hadronic models for jets : VHE (TeV) emission, and neutrino production (pp interaction, and pions decay)
- Galactic Centre (Sgr A*): Radio, Optical/IR, Soft X-rays
  - Quasi periodic flares
  - TDEs

Galactic Transients

- WD, isolated neutron stars : pure physics of compact objects (no accretion / companion evolved)

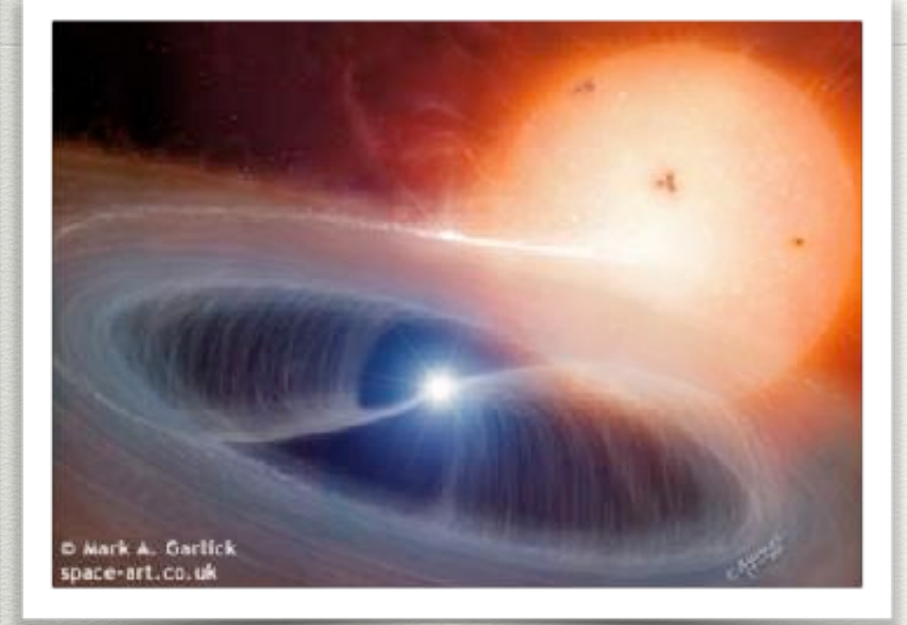
  - Crustal quake => size of NS
  - WD as SN progenitors of type Ia

- X/gamma-ray Binaries/CVs : compact source as a central engine for accretion and related processes

  - BH « visible » => access to mass ans spin
  - Transient vs persitent sources : outbursts vs flares
  - Numerous tools (timescale, multi-lambda)

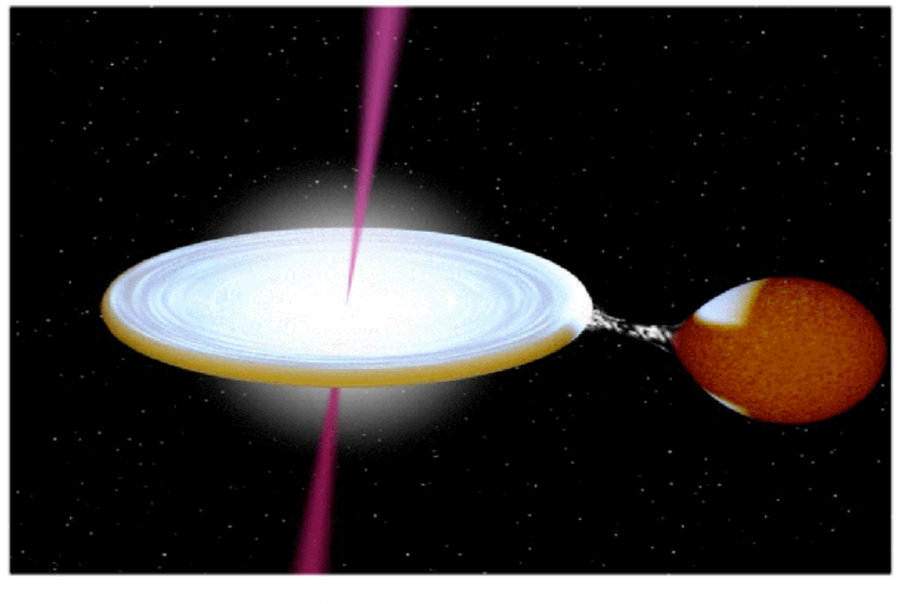
Zoology of X-ray emitting binaries

Cataclysmic variables (jet/no jet)



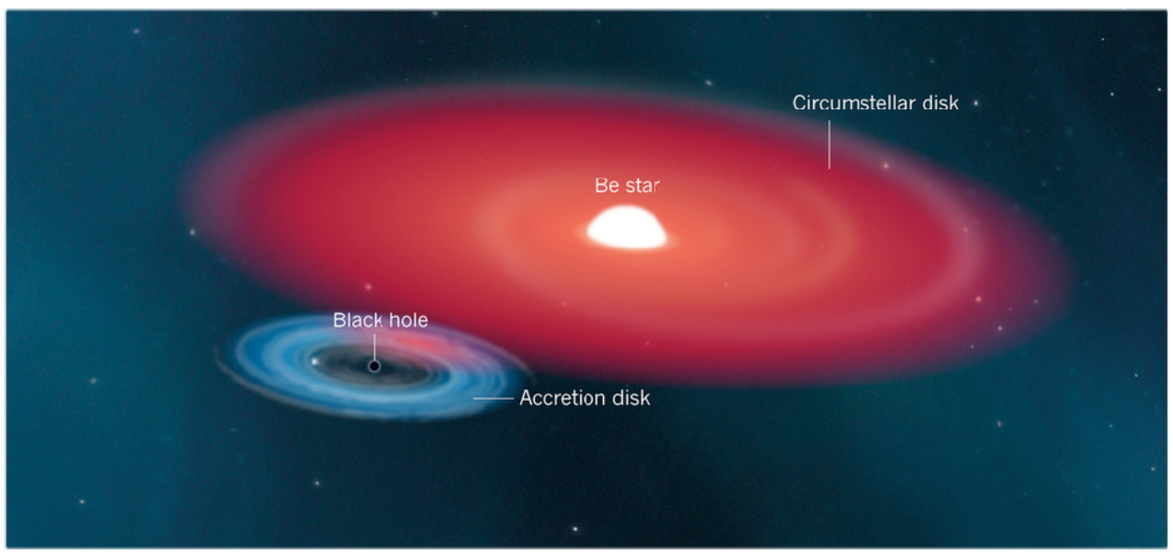
WD+star: Polar, IP, Novae

X-ray Binaries (jet/no jet)

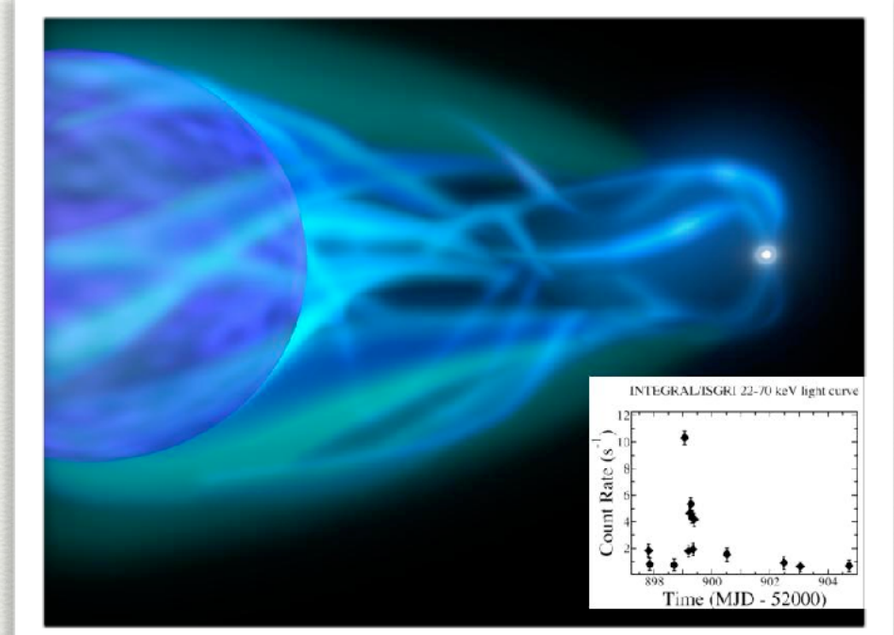


NS/BH+low mass stars: LMXB, microquasars

γ-ray Binaries (no jet)

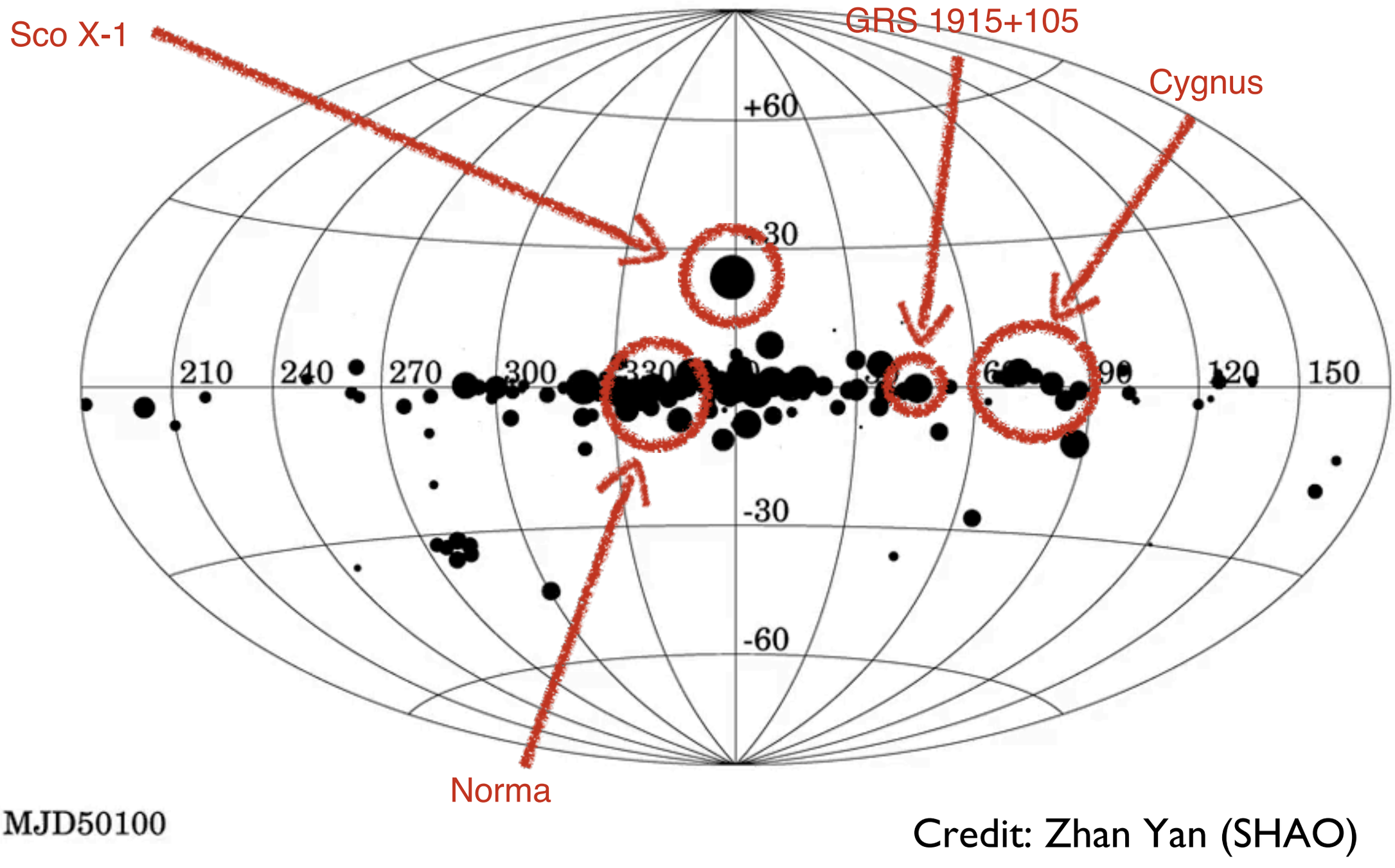


Pulsar+Be stars: a few objects (Fermi-HESS-Magic)



NS/BH+high mass stars: HMXB, microquasars

RXTE ASM (1.2-12 keV): 16 years of monitoring (1995-2012)

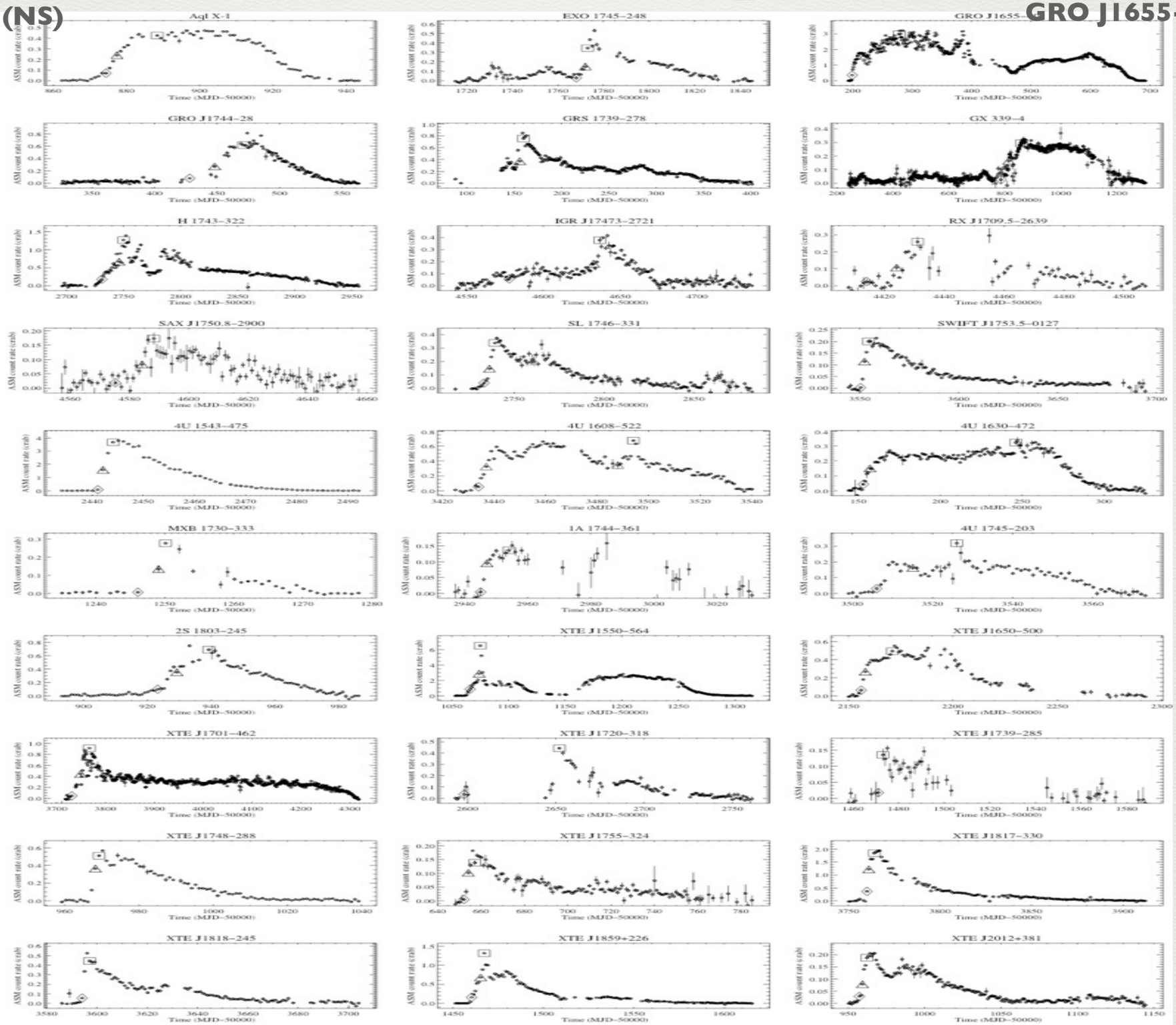


Credit: Zhan Yan (SHAO)

Outbursts and profiles

Aql X-1 (NS)

GRO J1655-40 (BH)



ASM data

Yan & Yu 2015

Potentiality brought by a wide band mission: the SVOM view

Thermal emission black body: soft X-rays ~1keV

MXT

GFT/GWAC/VT

Jet emission: radio to IR/ Optical

(External) disc/companion: IR – Visible

ECLAIRS

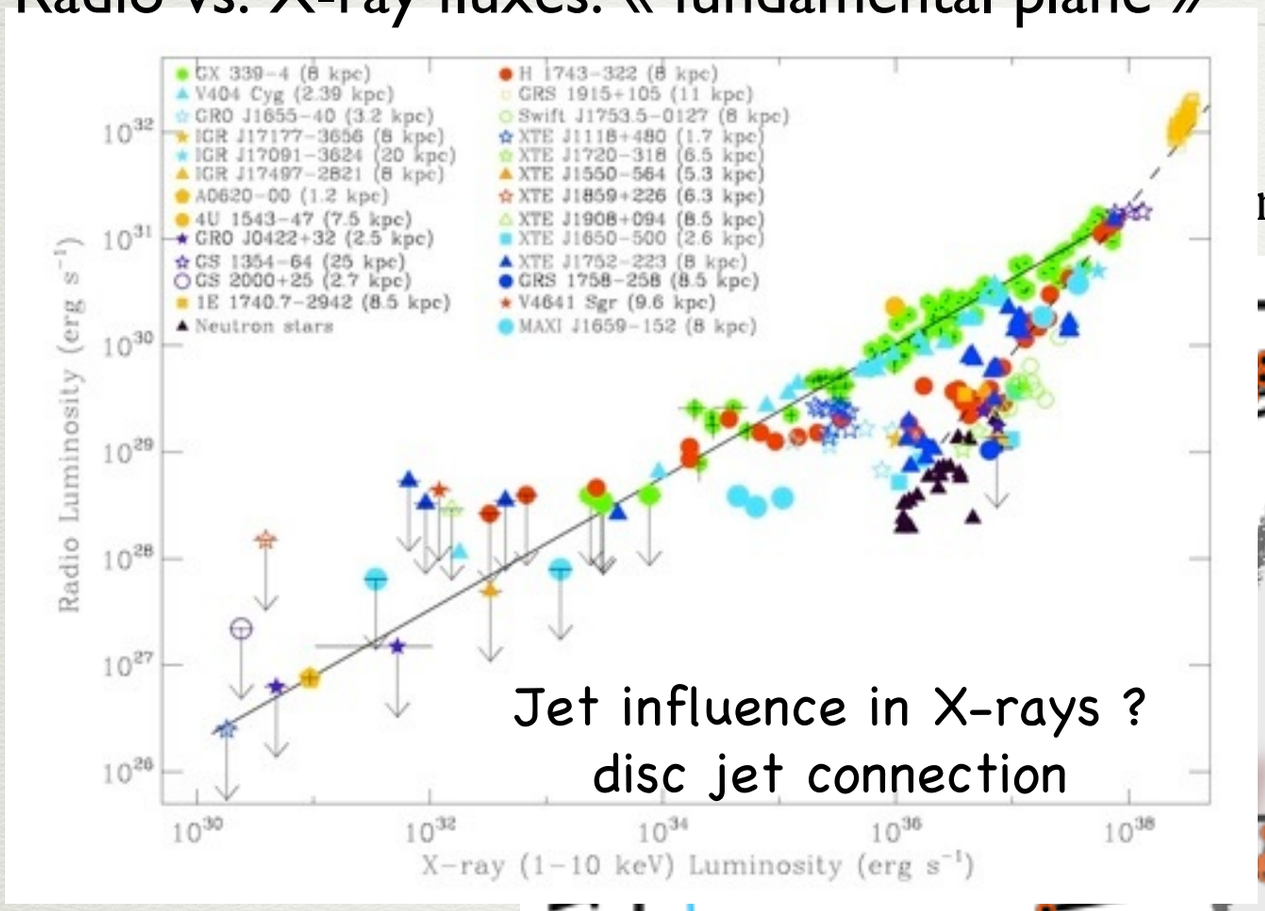
Hard X-ray (10-200 keV): « Corona »

GRM

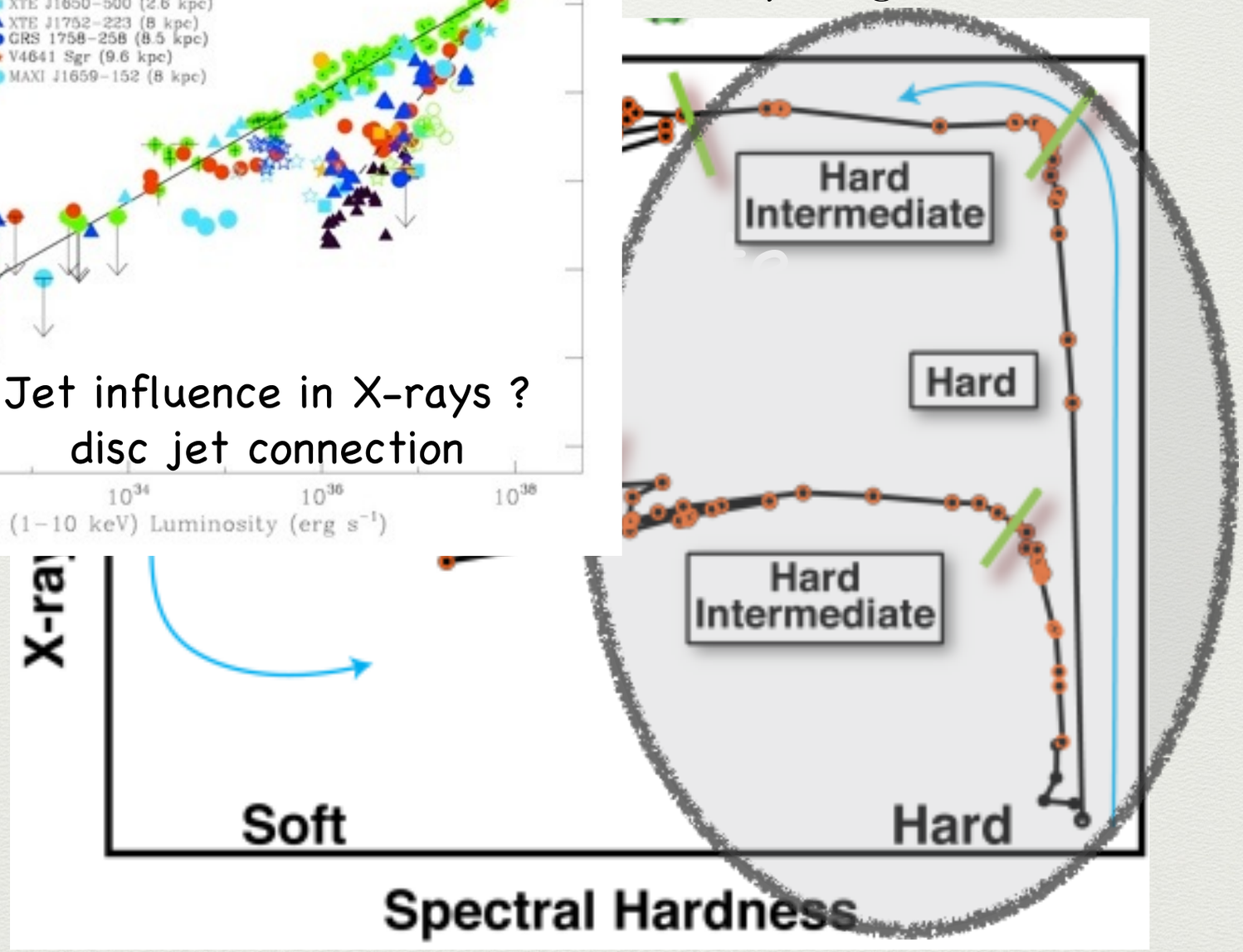
γ-ray emission 0.2-10 MeV: Origin?

Phenomenological approach

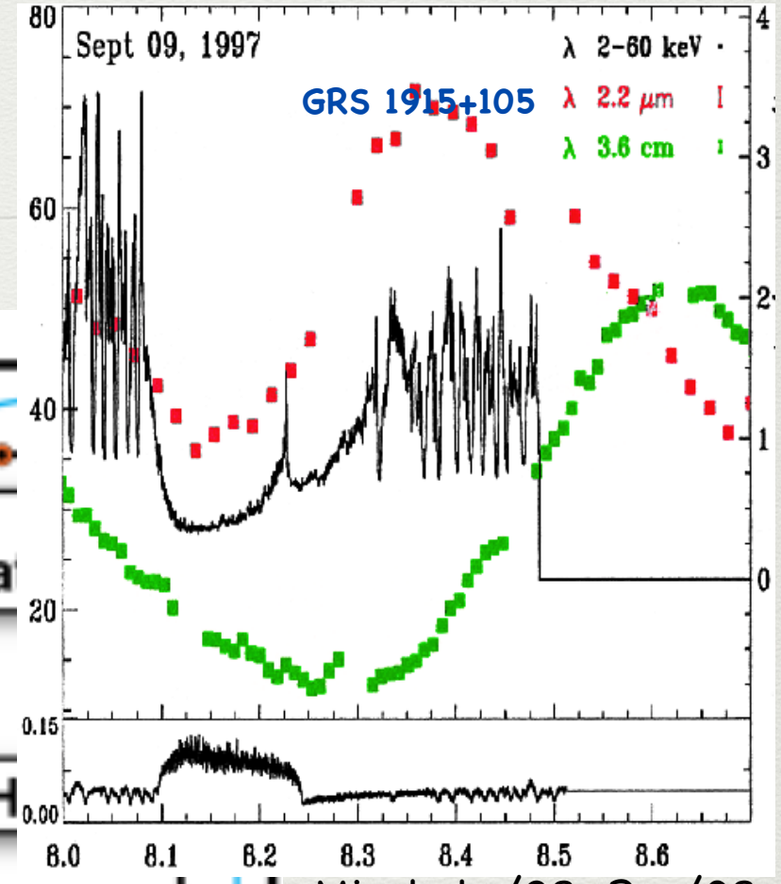
Radio vs. X-ray fluxes: « fundamental plane »



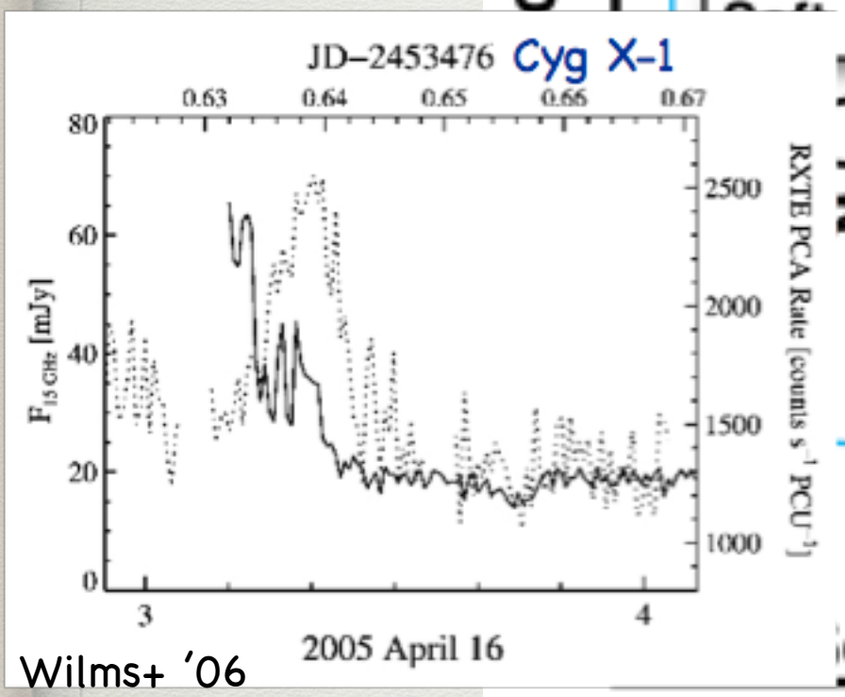
ntensity diagram



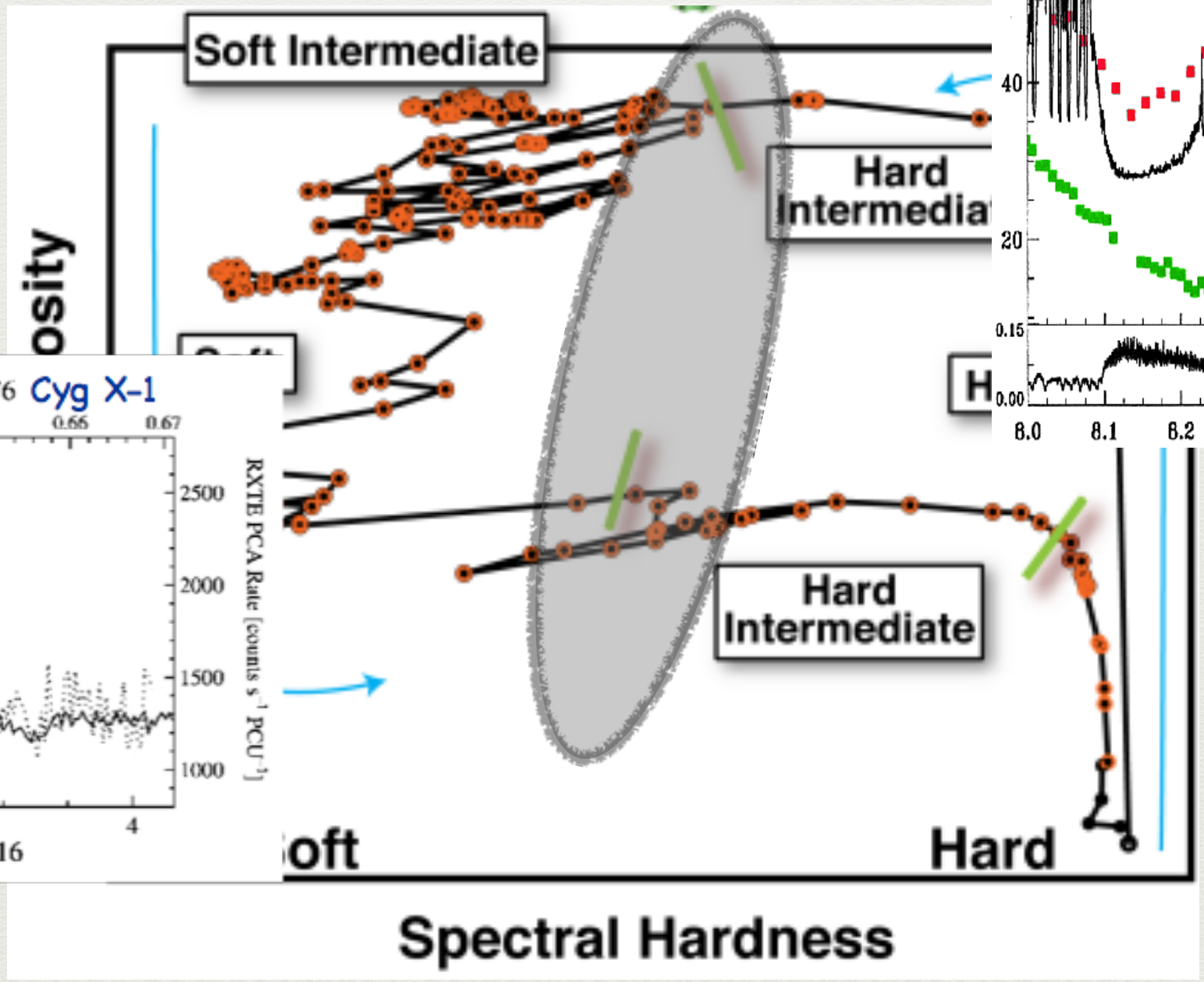
The « Jet line »



Mirabel+ '98; R.+ '08



Wilms+ '06



Physics of/from X-ray transients

Different families/sources => large number of key scientific questions (multi-λ and multi-instr. obs.)

- XRBs & CVs: physics of accretion (DIM, outburst mechanisms, state transitions,…) and links with jets/winds (energetic budget, particle acceleration, ISM feedback), plasma physics and MHD, GR=> multi lambda

- NS & WD: B topology, magnetic reconnection mechanisms and NS-quake (glitches), thermonuclear burning/explosions (feedback), crustal cooling, EOS => Timing

- Gamma-Ray Binaries & VHE emitters: Leptonic vs. hadronic models (HE-VHE), interaction with secondary, particle physics, shocks =>HE,VHE

Constraining the physical processes: spectral diagnostics

(need for day/month basis observations – depending of the spectral state)

=> Accretion geometry

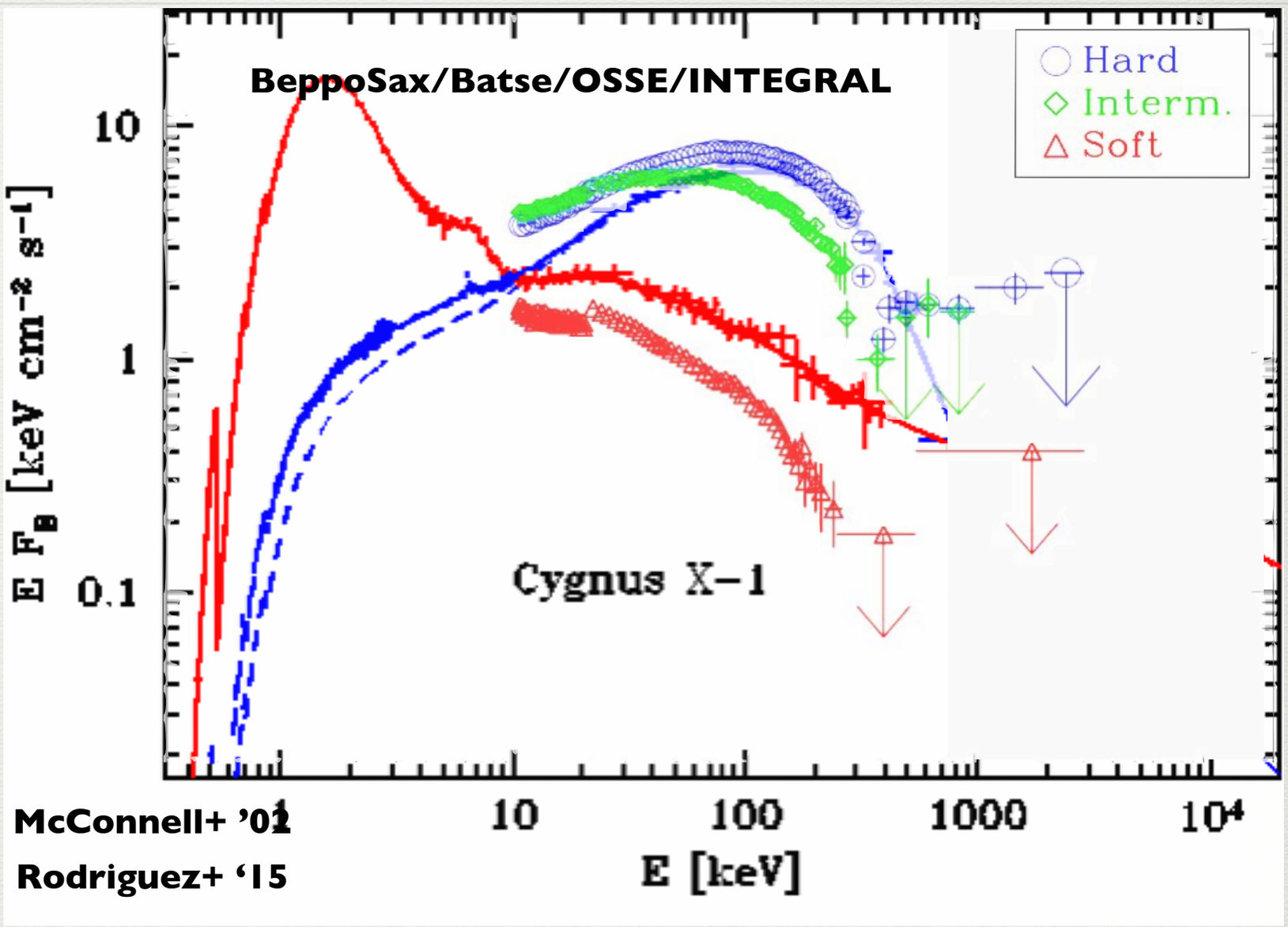
=>Origin of spectral components

=>(fast – *sec scale*) Variability

=>Disk-jet coupling (multi-λ)

=>Spin and parameters of CO

=>B of NS



Diagnostics (2): Timing

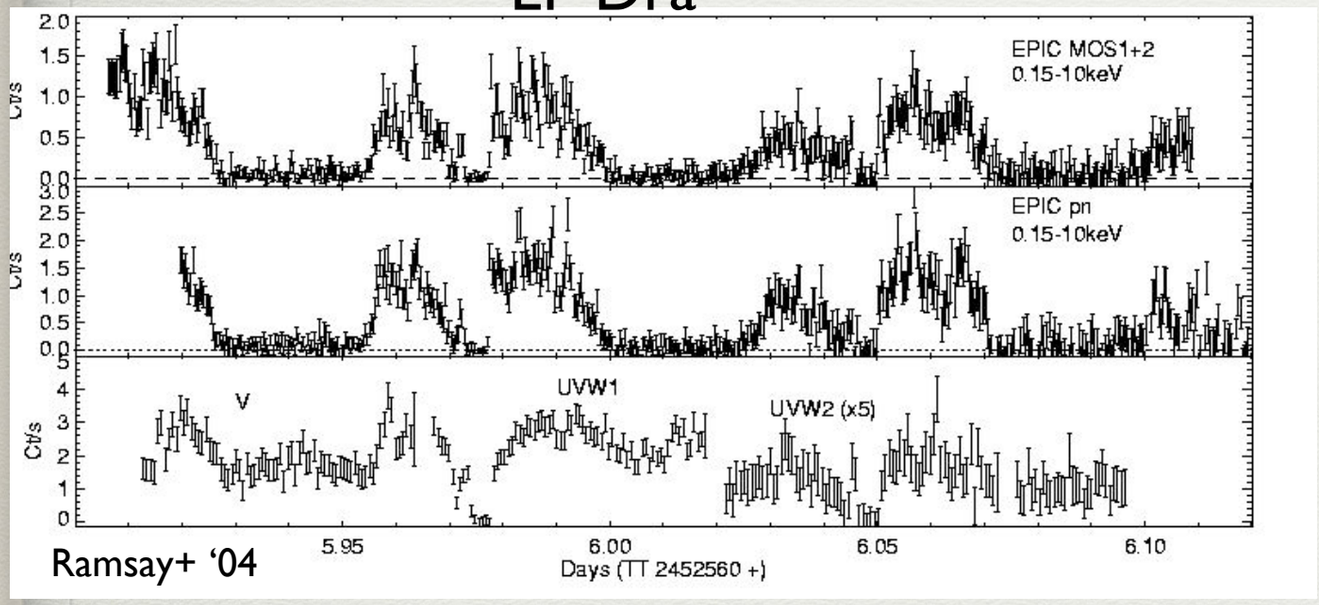
$$\tau_{\rm dyn,Kepler} \sim \sqrt{\frac{r^3}{GM_{OC}}} \qquad \tau_{\rm dyn,Kepler} \sim 2\ {\rm ms}(1\ {\rm M}_\odot, 100\ {\rm km})$$

$$1\ {\rm hr} \lesssim {\rm P_{orb}} \lesssim 100\ {\rm j}$$

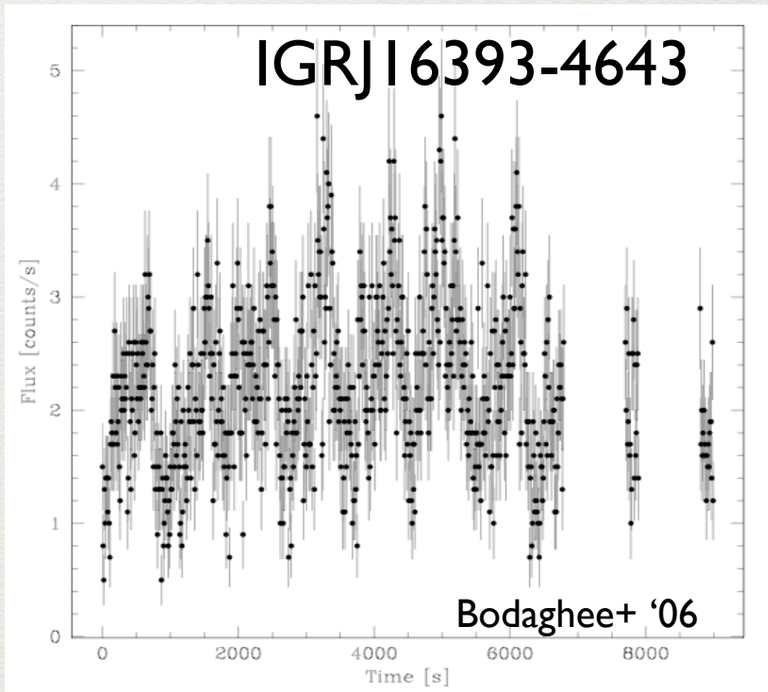
$$\text{Spin of neutron stars} : 1\ {\rm ms} \lesssim P \lesssim 1{\rm hr}$$

Some typical periods (isolated / binaries)

EP Dra



Ramsay+ '04



Bodaghee+ '06

Occurrence of outbursts, NS-quakes, thermonuclear bursts ?

Serendipitous activity <=> Needs large field surveys/ all sky monitoring

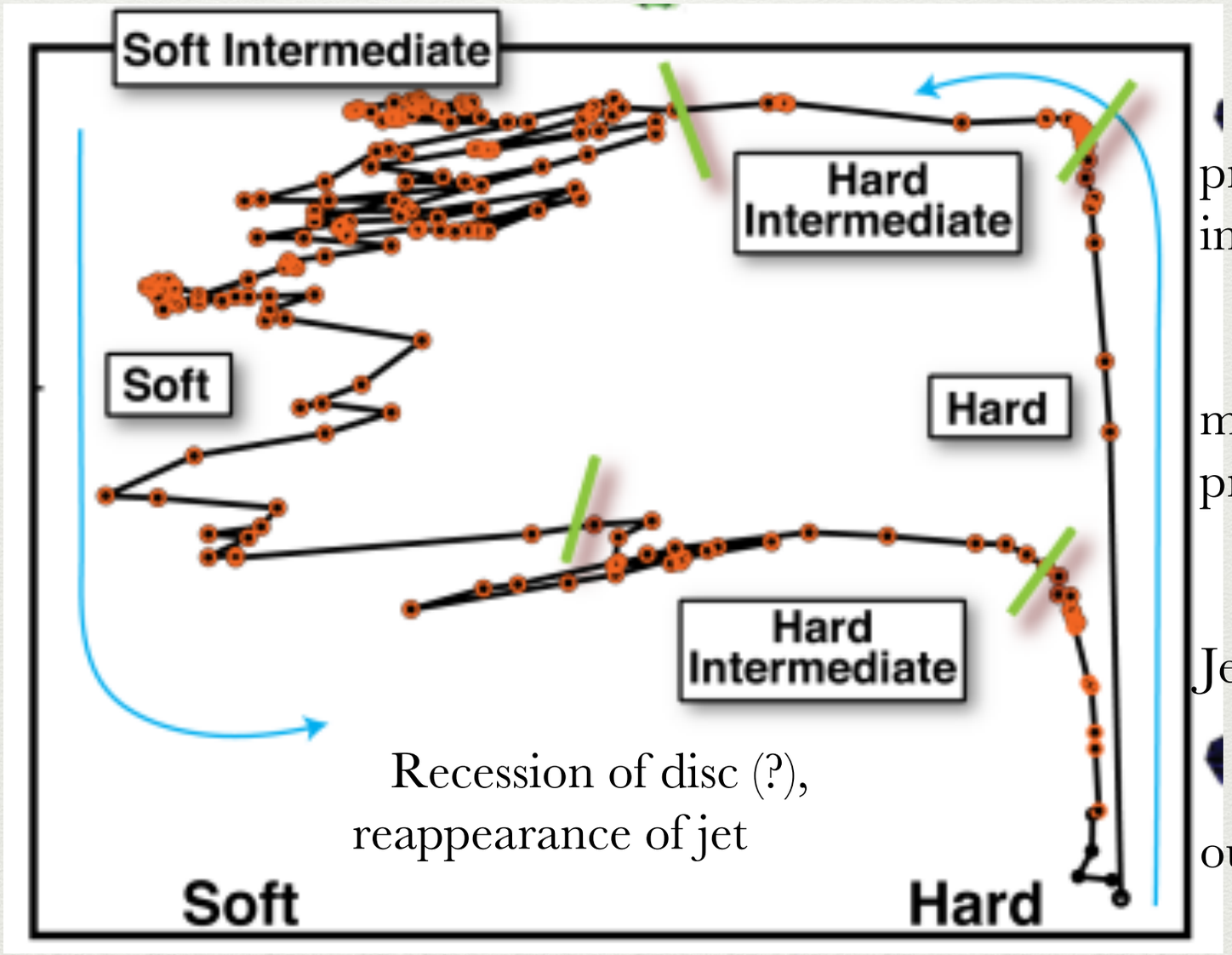
Phase dependent diagnostics

Fine spectral analysis: line/reflection/link with jet-external disk, γ-ray flares and connections to accretion

High fluxes

Disk @ LSO: line, inner radius => spin of BH?

Outflows (wind), suppression of jets? Energetic feedback in ISM



Recession of disc (?), reappearance of jet

X: Approach of disk, properties of corona, interplay

QPO

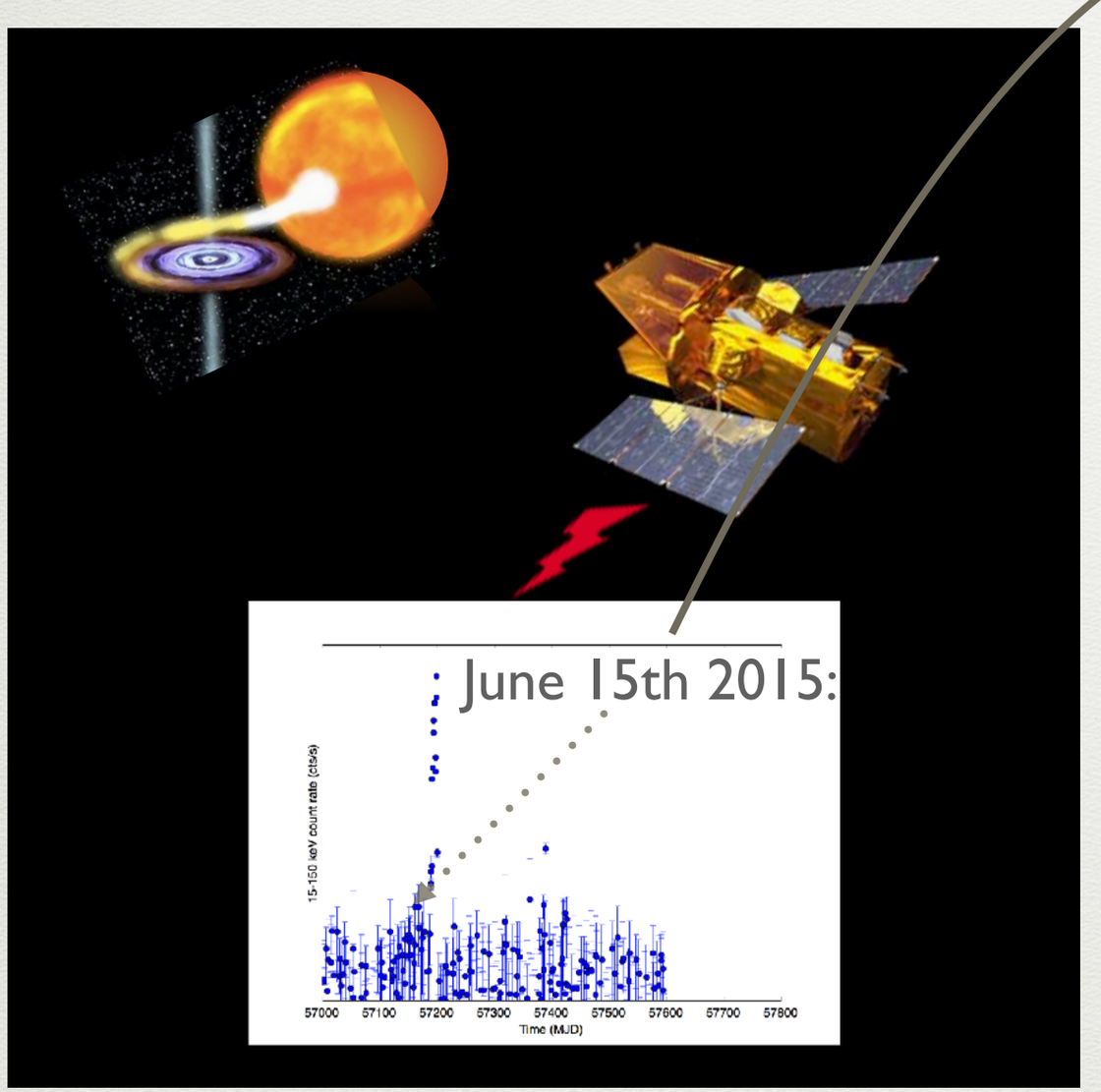
γ: jet composition, models of jet production/acceleration

Radio-Opt. : Jet behaviour, energetic

=> trigger of outburst?

Example: (re)activity to a specific transient

V404 Cygni




```
TITLE:   GCN CIRCULAR
NUMBER:  17929
SUBJECT: Swift trigger 643949 is V404 Cyg
DATE:    15/06/15 18:55:32 GMT
FROM:    Scott Barthelmy at NASA/GSFC  <scott@milkyway.gsfc.nasa.gov>

S. D. Barthelmy (GSFC), A. D'Ai (INAF-IASFPA), P. D'Avanzo (INAF-OAB),
H. A. Krimm (CRESST/GSFC/USRA), A. Y. Lien (GSFC/UMBC),
F. E. Marshall (NASA/GSFC), A. Maselli (INAF-IASFPA) and
M. H. Siegel (PSU) report on behalf of the Swift Team:

At 18:31:38 UT, the Swift Burst Alert Telescope (BAT) triggered and
located V404 Cyg.  Swift slewed immediately to the source.
The BAT on-board calculated location is
RA, Dec 306.020, +33.850 which is
   RA(J2000) = 20h 24m 05s
   Dec(J2000) = +33d 50' 59"
with an uncertainty of 3 arcmin (radius, 90% containment, including
systematic uncertainty). As is usual with an image trigger,
the available BAT light curve shows no significant structure.

The XRT began observing the field at 18:34:37.3 UT, 179.1 seconds after
the BAT trigger. Using promptly downlinked data we find an X-ray source
with an enhanced position: RA, Dec 306.0162, 33.8673 which is
equivalent to:
   RA(J2000)  = 20h 24m 03.89s
   Dec(J2000) = +33d 52' 02.4"
with an uncertainty of 2.4 arcseconds (radius, 90% containment). This
location is 63 arcseconds from the BAT onboard position, within the BAT
error circle. This position may be improved as more data are received;
the latest position is available at http://www.swift.ac.uk/sper. This
position is 0.8 arcseconds from that of a known transient low-mass X-ray
binary V* V404 Cyg.

A power-law fit to a spectrum formed from promptly downlinked event
data gives a column density consistent with the Galactic value of 8.10
x 10^21 cm^-2 (Willingale et al. 2013).

UVOT took a finding chart exposure of 150 seconds with the White filter
starting 183 seconds after the BAT trigger. No credible afterglow candidate has
been found in the initial data products. The 2.7'x2.7' sub-image covers 100% of
the XRT error circle. The typical 3-sigma upper limit has been about 19.6 mag.
The 8'x8' region for the list of sources generated on-board covers 100% of the
XRT error circle. The list of sources is typically complete to about 18 mag. No
correction has been made for the large, but uncertain extinction expected.
```

[Previous | Next | ADS]

MAXI/GSC detection of a new outburst from the Galactic black hole candidate GS 2023+338 (V* V404 Cyg)

ATel #7646; *H. Negoro, T. Matsumitsu (Nihon U.), T. Mihara, M. Serino, M. Matsuoka (RIKEN), S. Nakahira, S. Ueno, H. Tomida, M. Kimura, M. Ishikawa, Y. E. Nakagawa (JAXA), M. Sugizaki, M. Shidatsu, J. Sugimoto, T. Takagi (RIKEN), N. Kawai, T. Yoshii, Y. Tachibana (Tokyo Tech), A. Yoshida, T. Sakamoto, Y. Kawakubo, H. Ohtsuki (AGU), H. Tsunemi, R. Imatani (Osaka U.), M. Nakajima, K. Tanaka (Nihon U.), Y. Ueda, T. Kawamuro, T. Hori (Kyoto U.), Y. Tsuboi, S. Kanetou (Chuo U.), M. Yamauchi, D. Itoh (Miyazaki U.), K. Yamaoka (Nagoya U.), M. Morii (ISM)*
*on **17 Jun 2015; 03:20 UT***
Credential Certification: Hitoshi Negoro (negoro@phys.cst.nihon-u.ac.jp)

Subjects: X-ray, Binary, Black Hole, Transient, Variables

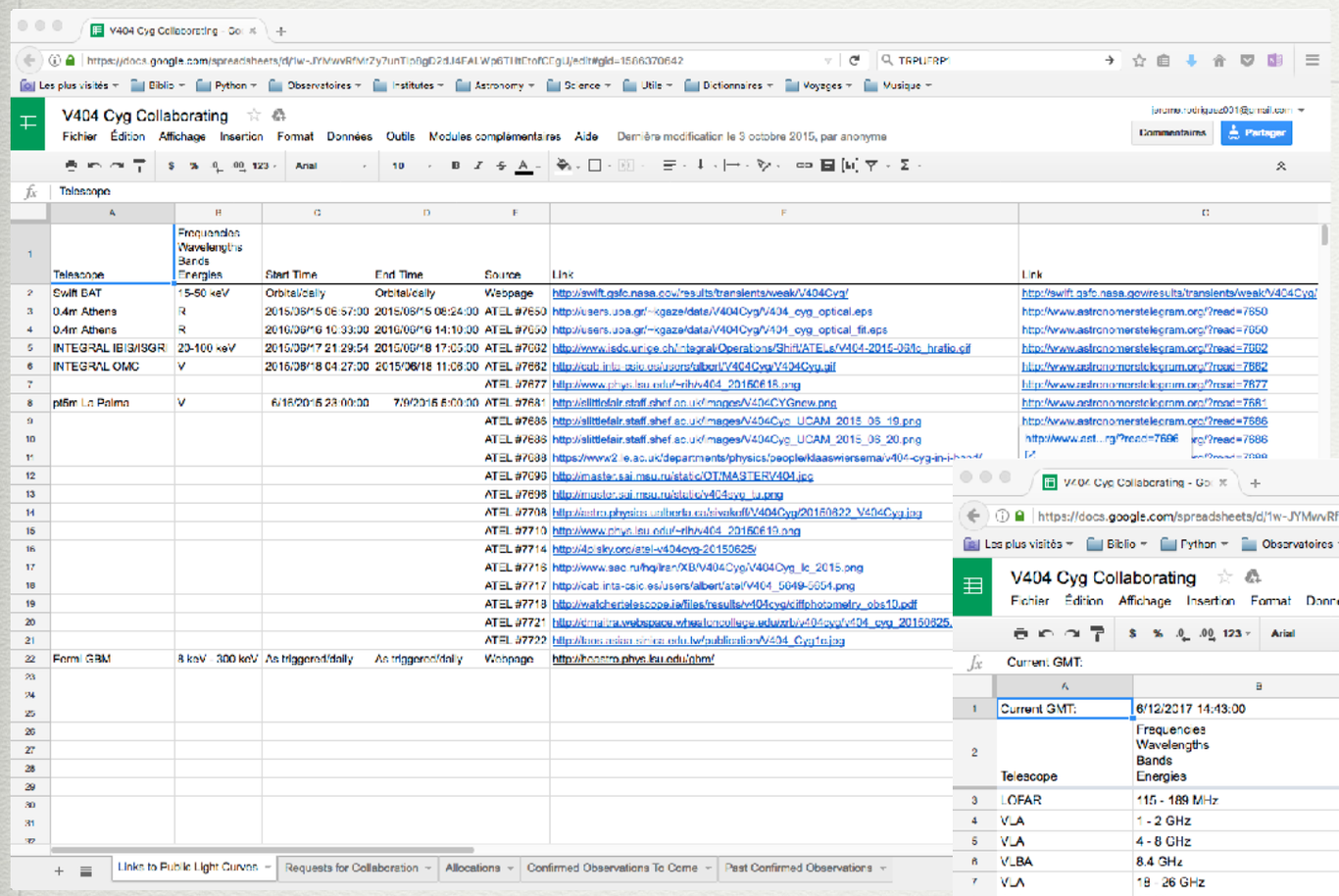
Referred to by ATel #: 7647, 7655, 7659, 7661, 7662, 7663, 7667, 7669, 7671, 7674, 7677, 7681, 7686, 7693, 7695, 7701, 7702, 7708, 7709, 7717, 7718, 7720, 7721, 7722, 7729, 7734, 7740, 7755, 7772, 7959

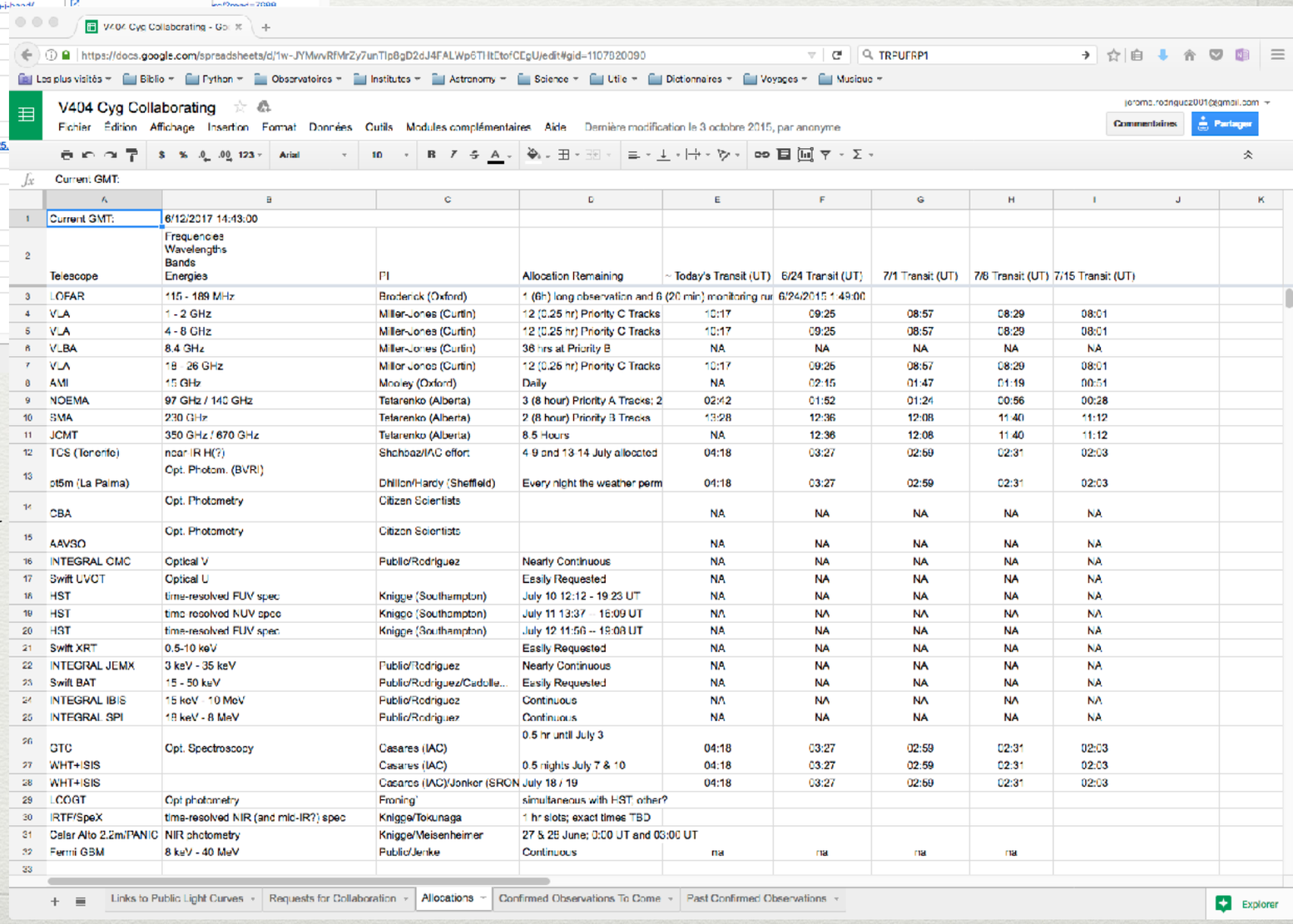
On 2015 June 16 (MJD 57189), the MAXI/GSC nova alert system detected burst-like activities from the position consistent with the Galactic black hole candidate GS 2023+338 (V404 Cyg, Makino et al. IAUC. #4786). This renewed activity from the source was first detected by Swift/BAT at 18:31 on June 15 (Barthelmy et al. GCN #17929). Currently, MAXI observed the region with the degraded and uncalibrated counter, GSC3. The GSC3 clearly detected bright X-ray flare(s) from the source in the scan transits at 18:48 and 20:21 on June 16. The 4-10 keV fluxes were roughly 500-600 mCrab. In the following scan transits at 21:53 and 23:26 on June 6 and 00:59 on June 7, however, the flux decreased again to ~100 mCrab or less. Note that the detection limit in a single scan transit with the GSC3 is roughly 100 mCrab.

Such sporadic flare activities of this source were often observed in the previous outburst in 1989 (Terada et al. 1994, PASJ 46, 477; Oosterbroek et al. 1997, A&A 321, 776). We strongly encourage multi-wavelength followup observations to observe this unique black hole candidate.

Related
8531 Multicolour Optical Photometry of V404 Cyg
8520 e-MERLIN detection of compact radio emission from V404 Cyg
8516 INTEGRAL/OMC optical photometric observations of V404 Cyg during its last outburst
8515 V404 Cyg was in optical quiescence from mid October to mid December 2015
8512 INTEGRAL observations of V404 Cyg (GS 2023+338): further public data products
8510 INTEGRAL and Swift observations of V404 Cyg: going back to quiescence?
8509 T100 Observations of V404 Cyg during quiescence
8507 A Faint X-ray Dust Scattering Echo from V404 Cyg in Response to Recent Flares
8501 Recent Optical Observations of V404 Cyg
8500 INTEGRAL observes a bright flare and spectral changes in V404 Cyg: possible hard to soft transition ahead?
8499 Sub-millimetre Detection of V404 Cygni During December-2015 Outburst
8494 MAXI/GSC detection of a recent low-level X-ray activity and a bright hard X-ray flare from V404 Cyg
8489 Rapid Bright X-ray Flares from V404 Cyg During December-2015 Outburst
8482 The RATAN-600 monitoring of the V404 Cyg
8475 INTEGRAL/Swift observations of V404 Cyg back in outburst
8466 Observation of V404 Cyg in quiescence in 2015 November
8462 X-ray re-brightening of V404 Cyg observed by Swift.
8459 MASTER dwarf nova outbursts
8458 INTEGRAL IBIS/ISGRI confirms renewed activity of V404 Cyg
8457 GBM observations of V404 Cyg outburst
8455 Swift triggers on V404 Cyg
8454 Detection of the new activity in V404 Cyg with RATAN-600

The largest multi-λ worldwide effort for a XRB outburst (strong french implication)





- Tens of multi-λ ToOs :

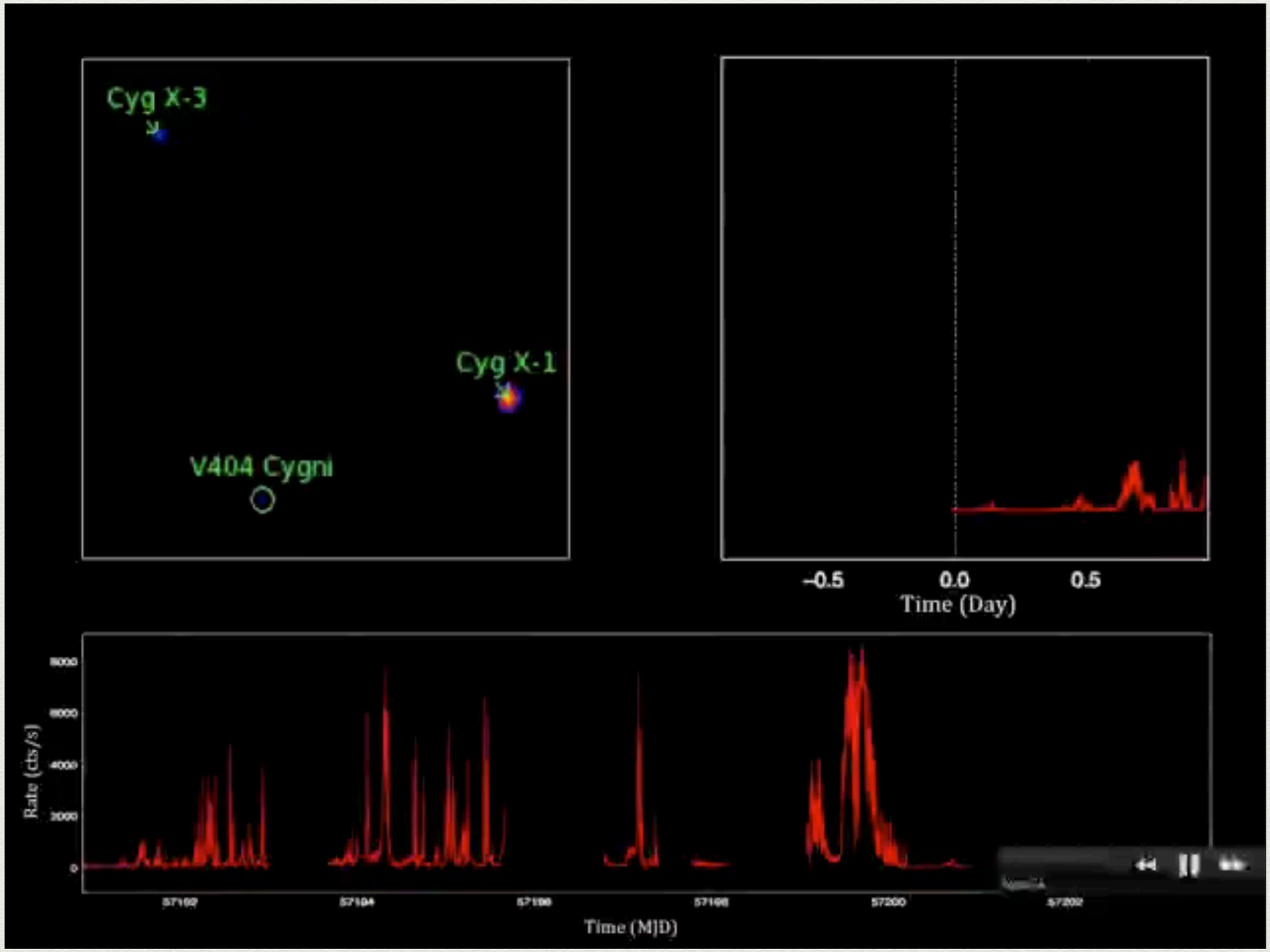
=>50 ATELs published on June 30th (2 weeks of outburst)

=> Another 15 in the first week of July, while the source was already entering into quiescence

Tentative federation of the community

Early alerts permit fine monitoring

FOV



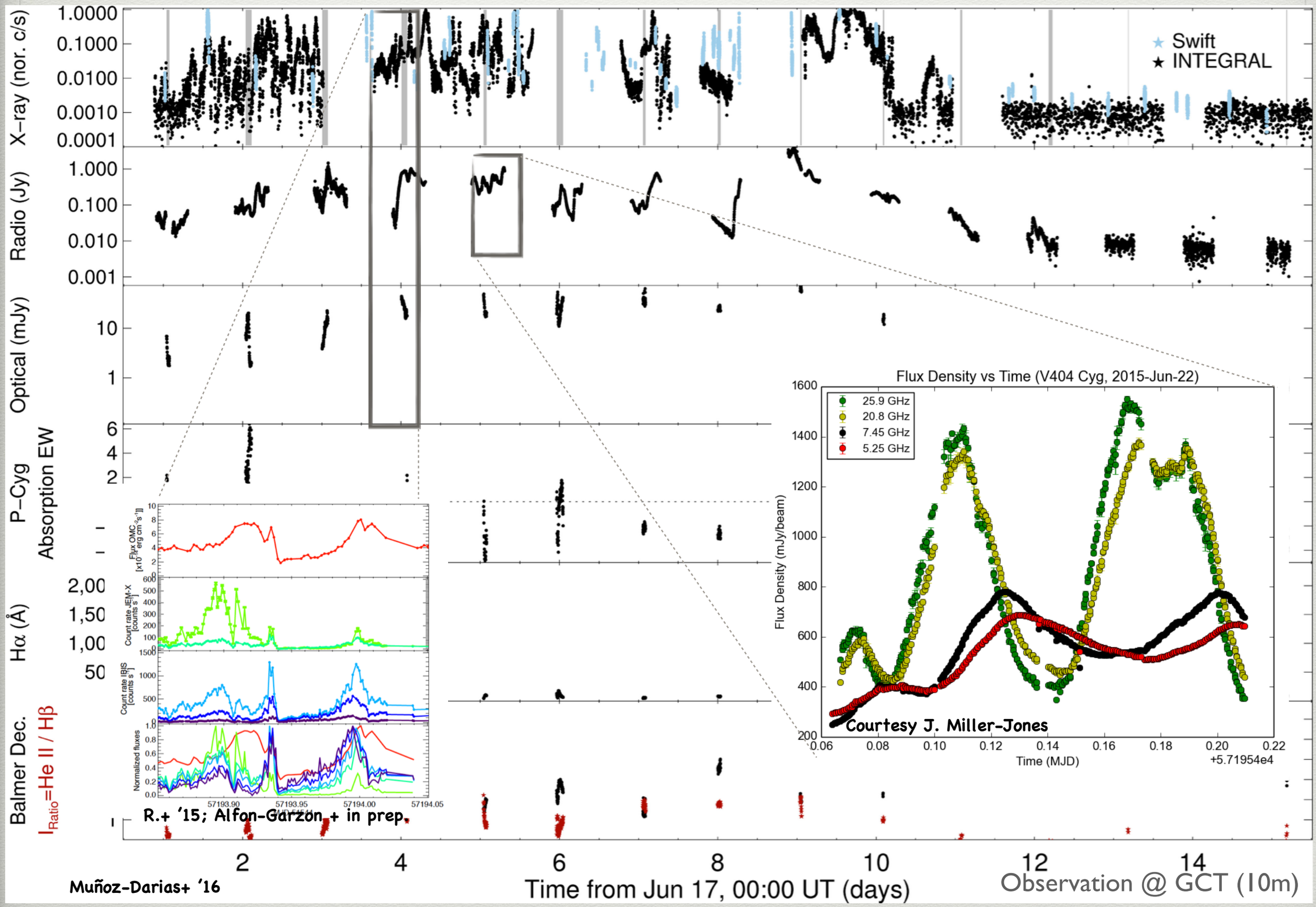
Timing

Temporal coverage

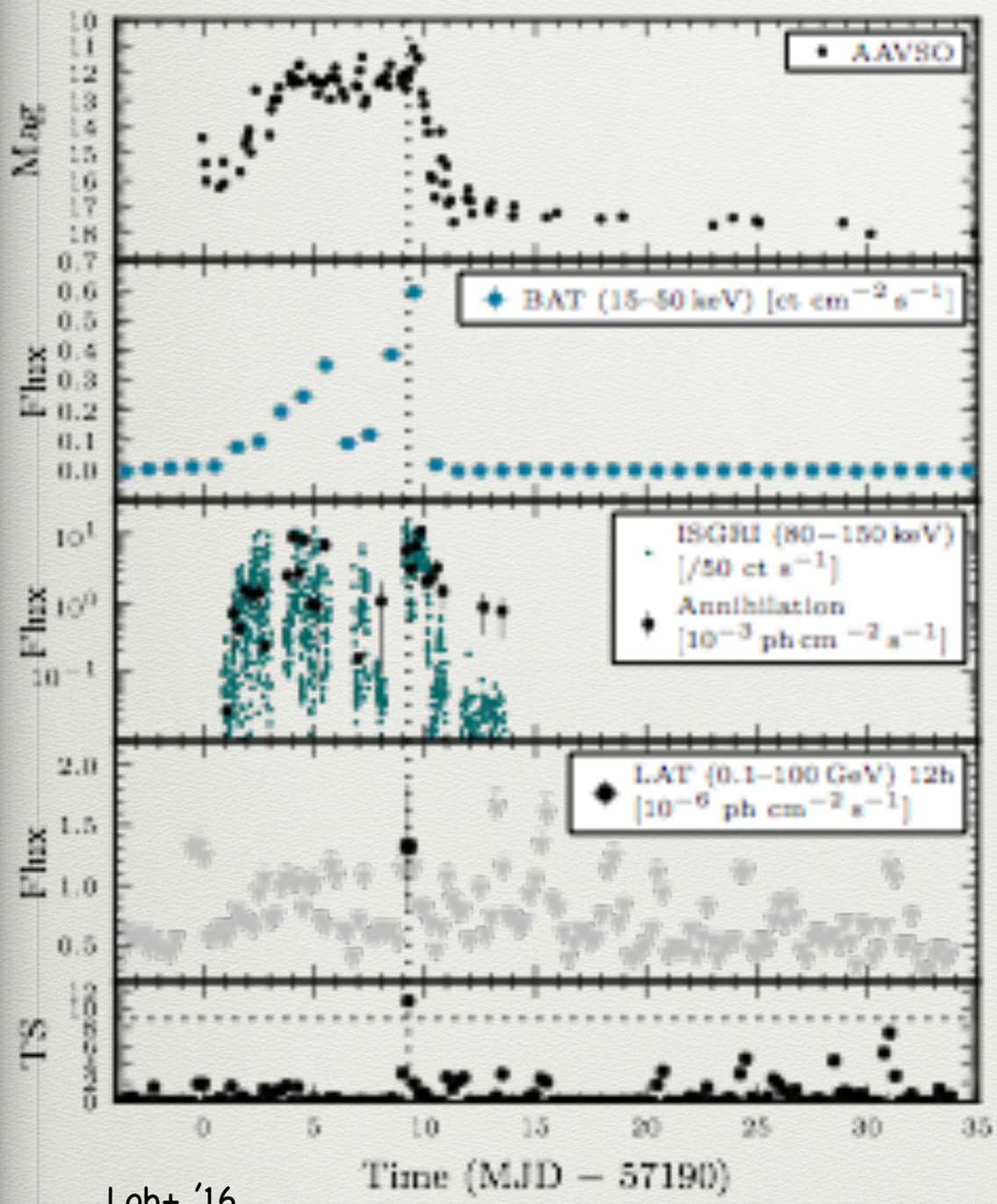
+spectra

Credit: Vincent Chambouleyron (CEA)

And specific focus on peculiar transitions



Few selected results



Loh+ '16

- 50 Crab flares at 20 keV: brightest X-ray source, > 20 keV spectra have similar shape (R.+ '15)
- Detection of a variable 511 keV line (Siegert+ '16): e-/e+ jet, pair plasma production
- Detection with Fermi @ GeV + 511 keV line => origin related to jet (Loh+ '16)
- Multi-λ flaring activity => evacuation of inner accretion disc before ejection (Radhika+ '16)
- Optical analysis => a sustained disc wind regulating the outburst (Muñoz-Darias+ '16) but flares due to disk reprocessing (Kimura +'16)

Take away message

- High throughput/ narrow field instruments (VLA, ALMA, VLT, HST, Chandra, XMM, et al…) => deeper into the physics of accreting sources/ Several important results over the past 20 years

- This would have **not** been **possible without alerts** on outburst / state transitions / flares / unpredictable behaviour **from wide field/all sky monitors**

- 2020 is the era of large radio array and sky surveys / alerts in radio/optical with a very high expected discovery space

  => Need for all sky monitor at X/gamma rays ASM type monitor

  => Need for the possibility to quickly react to alerts mission design

  => Need to federate over common/automatized strategies given the expected high number of alerts (SKA, LSST, multi-messengers, …) selection of alerts required, criteria?

Take away message (2)

- Transients phenomena cover different time scales : long declining ourburst (days to weeks) to fast events (SN, magnetars flares or Fast Radio Burts)

- => Good/very good time resolution necessary (not to be neglected in the instrument definition/data storage/alert system/follow-up strategy)

- => Alerts/strategy

- => HTRA (High Time Resolution Astrophysics) domain

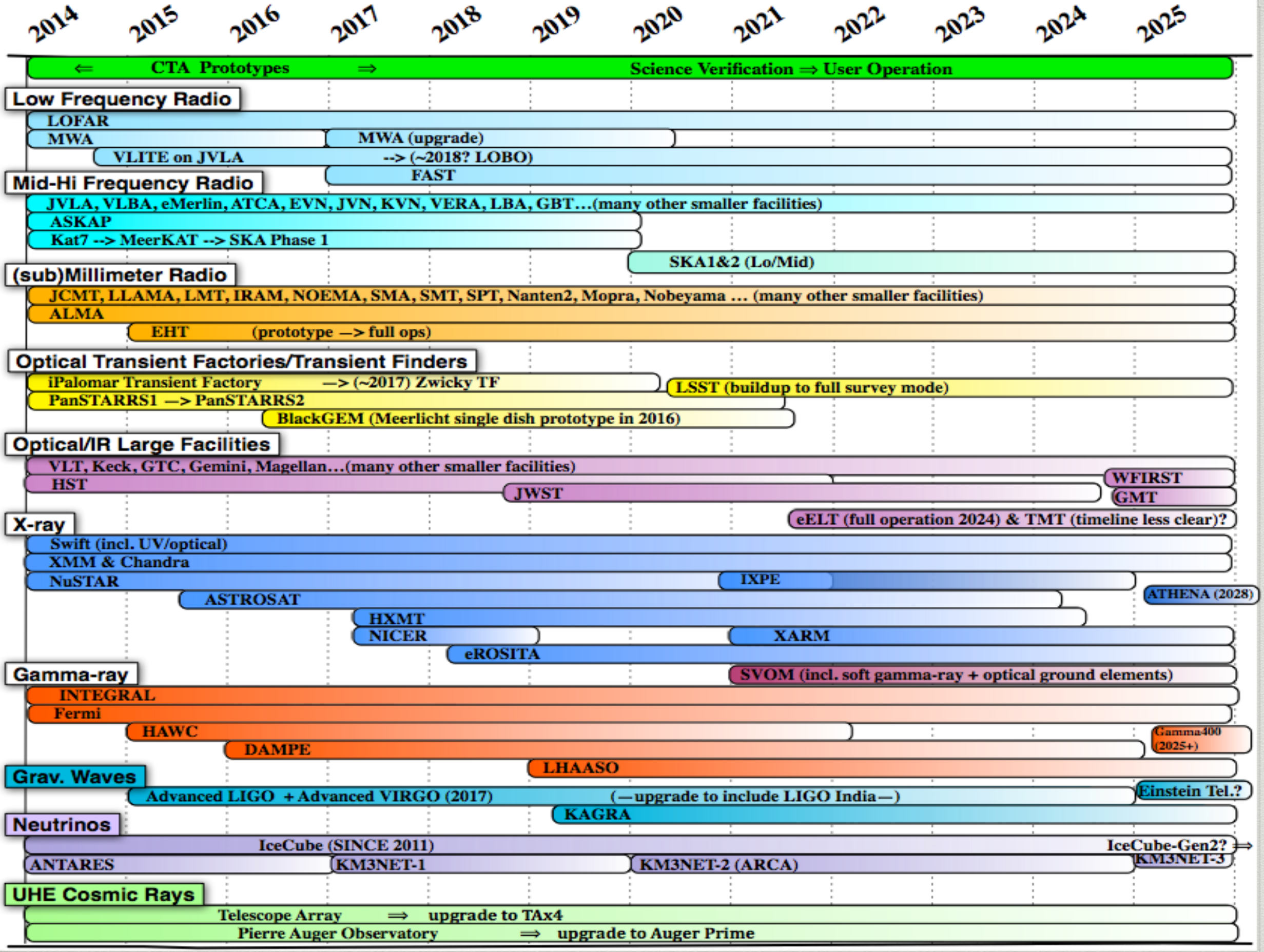
- => Performant/dedicated instruments needed

NICER on ISS

NICER : Neutron star Interior Composition ExploreR

2017, June 14th

https://heasarc.gsfc.nasa.gov/docs/nicer



Happily stolen from S. Markoff (UvA)