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## The puzzling thermonuclear burst behaviour of IGR J17473-2721

Chenevez, Jérôme

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# Puzzling thermonuclear bursts from the transient low-mass X-ray binary IGR J17473-2721

Jérôme Chenevez

Diego Altamirano

Duncan Galloway

Jean in 't Zand

Erik Kuulkers

Nathalie Degenaar

Maurizio Falanga

Ettore Del Monte

Y. Evangelista

M. Feroci

E. Costa

$$f(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(x)}{n!} (x-x_0)^n$$

$$\Delta \int_a^b \varepsilon \Theta_{\infty}^{\sqrt{17}} + \Omega \int \delta e^{i\pi} = (2.7182818284)$$

$$\chi^2 \sum \gg \ddot{}$$

# A paper submitted to MNRAS



## Puzzling thermonuclear burst behaviour from the transient low-mass X-ray binary IGR J17473-2721

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Complete List of Authors:	Chenevez, Jerome; Technical University of Denmark, National Space Institute Altamirano, Diego; University of Amsterdam, Astronomical Institute Galloway, Duncan; Monash University, School of Physics and School of Mathematical Sciences in 't Zand, Jean; SRON Kuulkers, Erik; ESA/ESAC Deqenaar, Nathalie; University of Amsterdam, Astronomical Institute "A. Pannekoek" Falanga, Maurizio; ISSI Del Monte, Ettore; INAF, IASF Evangelista, Yuri; INAF, IASF Feroci, Marco; INAF, IASF Costa, Enrico; INAF, IASF
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# Nuclear burning regimes

## Theoretical thresholds:

- $\dot{m} < 900 \text{ g/cm}^2/\text{s}$  : Mixed H/He burning triggered by thermally unstable H ignition. Long burst duration ( $> 100\text{s} - 1000\text{s}$ ) due to rp- process.  $\alpha \approx 150$ .

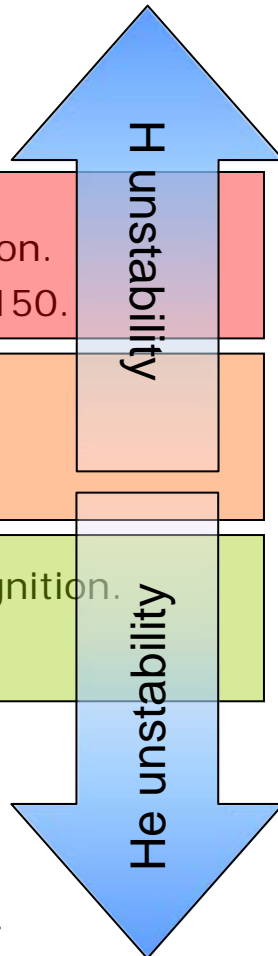
- $900 < \dot{m} < 2000 \text{ g/cm}^2/\text{s}$  : H stable burning (hot CNO cycle) to He  $\Rightarrow$  Pure He flash ( $3-\alpha$ ). Frequent PRE.  $\alpha \approx 200$ .

- $2000 \text{ g/cm}^2/\text{s} < \dot{m} < \dot{m}_{Edd}$ : Mixed H/He burning triggered by thermally unstable He ignition. Burst duration  $> 10\text{s}$  due to rp- process.  $\alpha \sim 20-100$ .

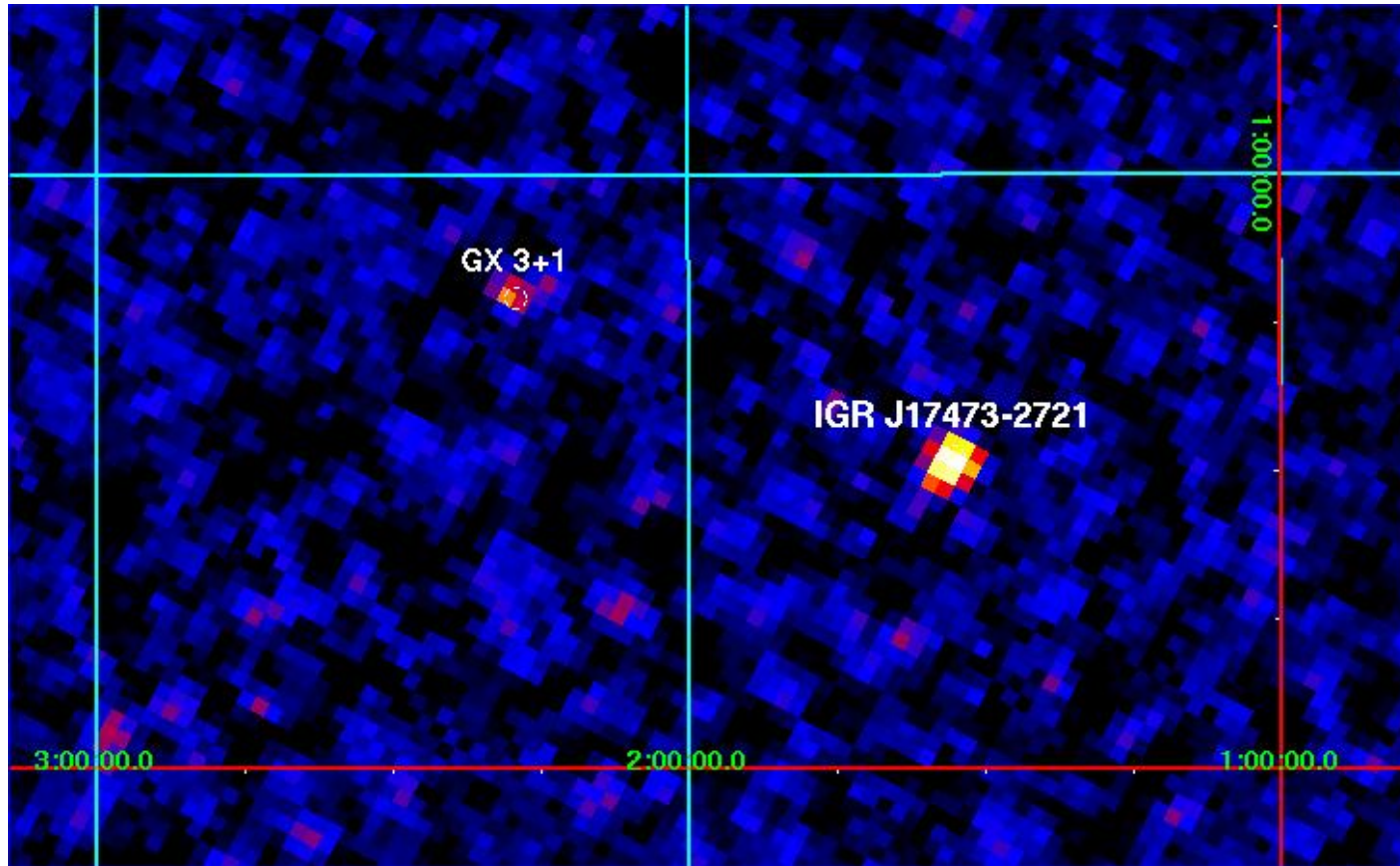
- $\dot{m} \geq \dot{m}_{Edd}$  : No bursts (e.g. pulsars).  $\dot{m}_{Edd} = 10^5 \text{ g/cm}^2/\text{s}$

- Thick He burning (e.g. pure He accretion in UCXB)  $\Rightarrow$  Long He bursts ( $\sim 10^{41}$  ergs).

- Deep Carbon burning in superbursts (duration  $\sim$ hours, released energy  $\sim 10^{42}$  ergs).



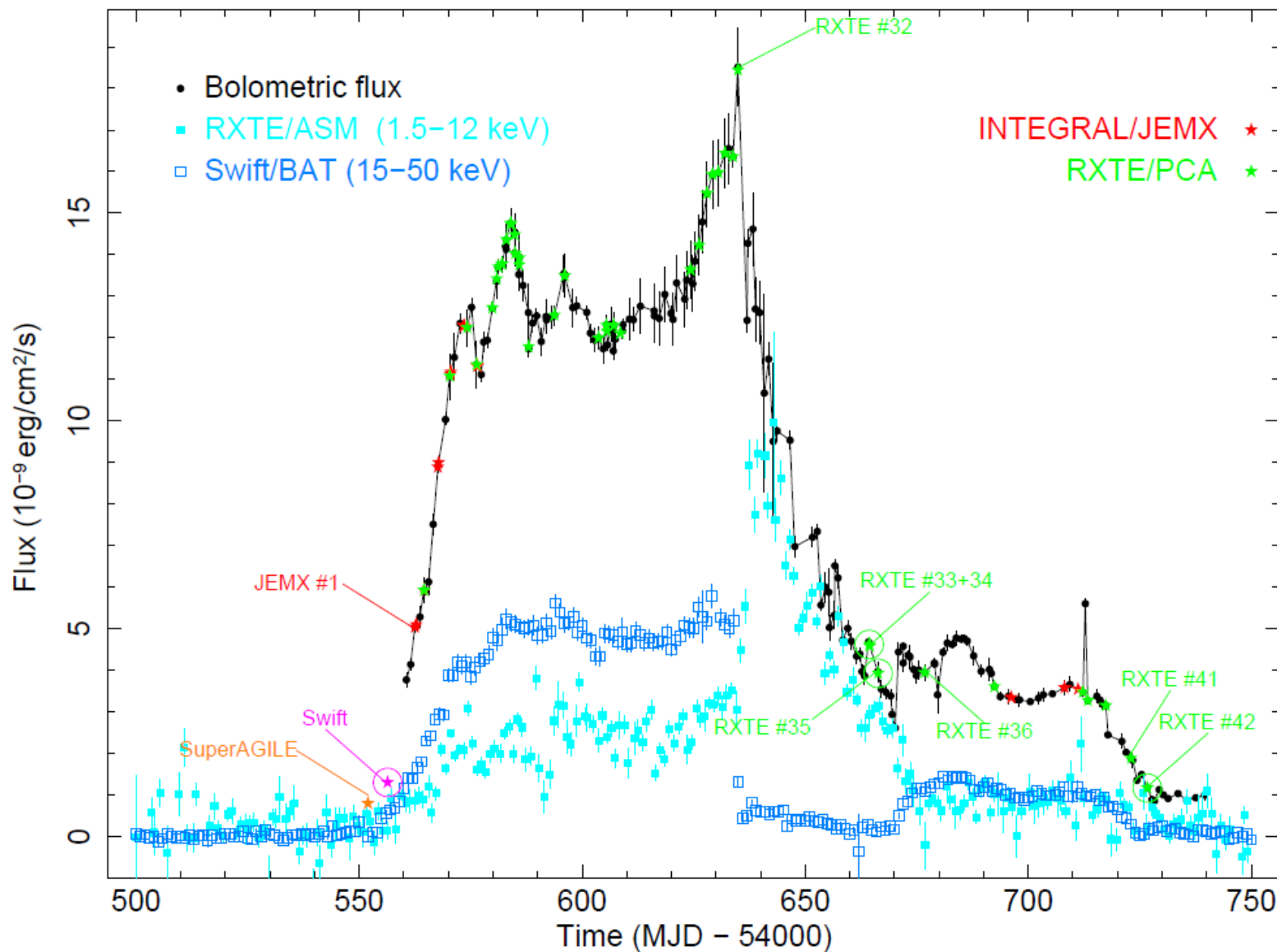
# IGR J17473-2721 aka XTE J1747-274



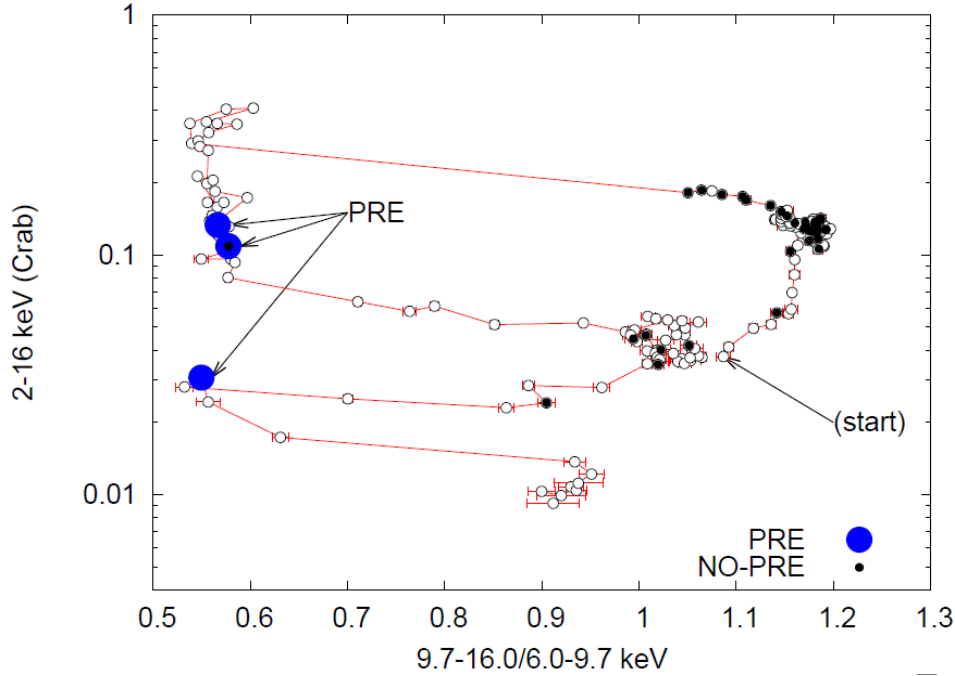
- Located in the Galactic Bulge,  $0.8^\circ$  from GX 3+1
- Transient X-ray source, discovered in 2005 (Grebenev et al., ATel 467)  
NIR counterpart (ATels 521, 634) - 2 (unpublished) X-ray bursts in RXTE
- 2<sup>nd</sup> outburst March – September 2008 (ATels 1445, 1459, 1460, 1461, 1468, 1651)  
INTEGRAL + RXTE + Swift coverage (57 X-ray bursts)

# Outburst with sudden spectral transition

IGR J17473-2721 outburst 2008 and burst times



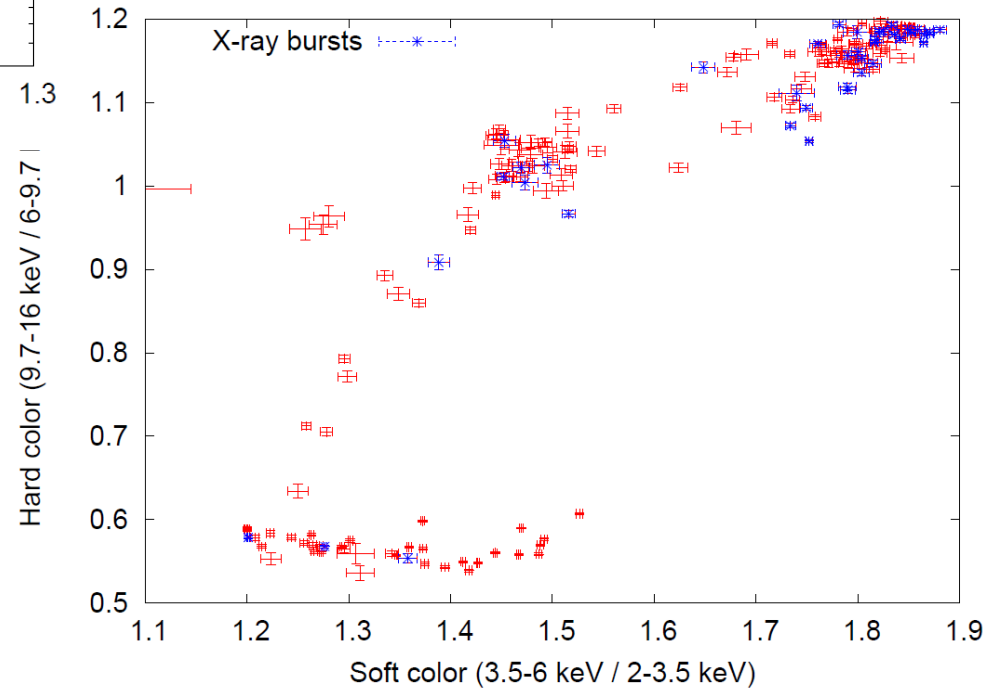
# Diagrams of the 2008-outburst



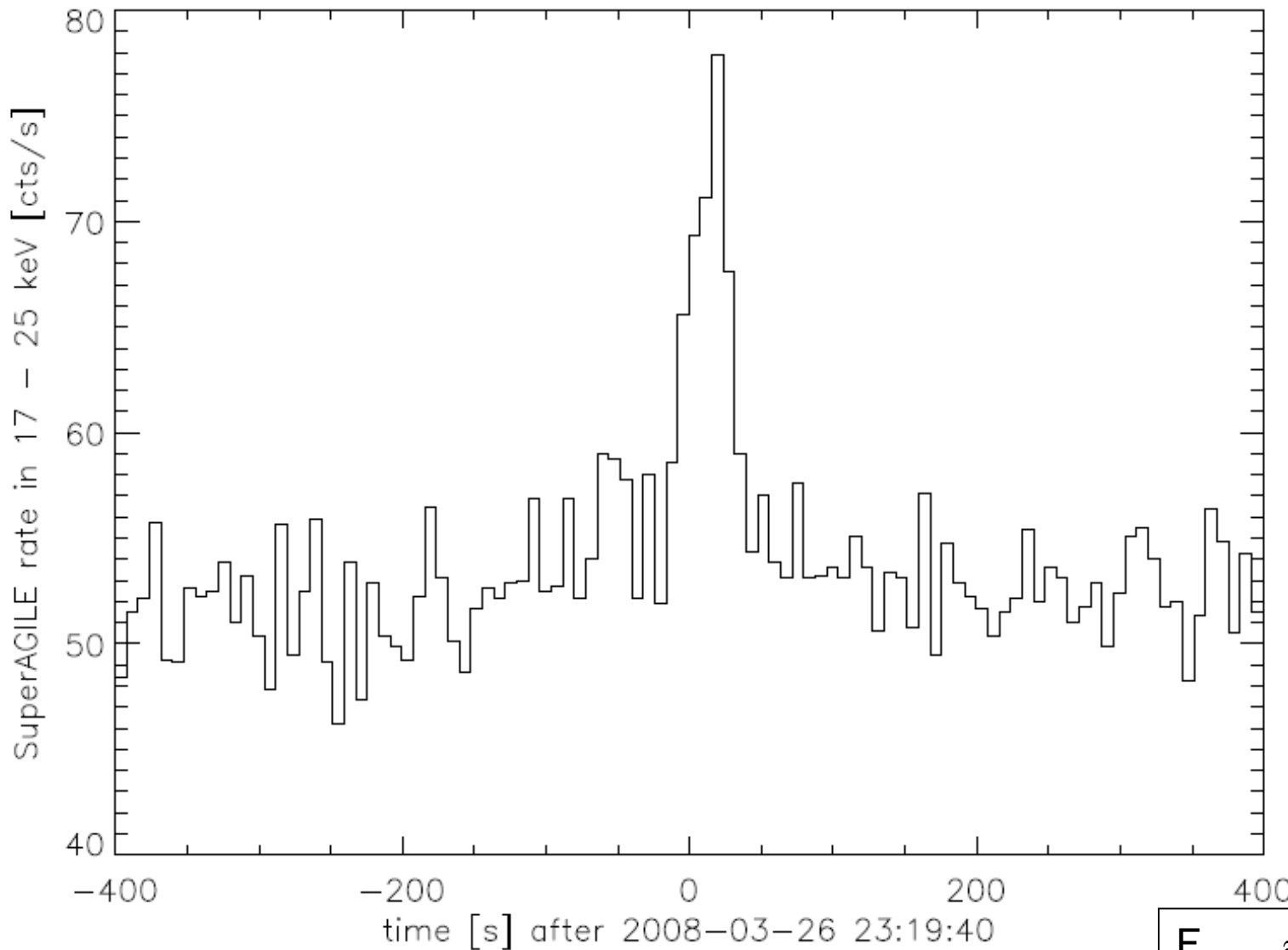
**HID**

From RXTE/PCA measurements

**CCD**



# Burst as precursor of outburst?

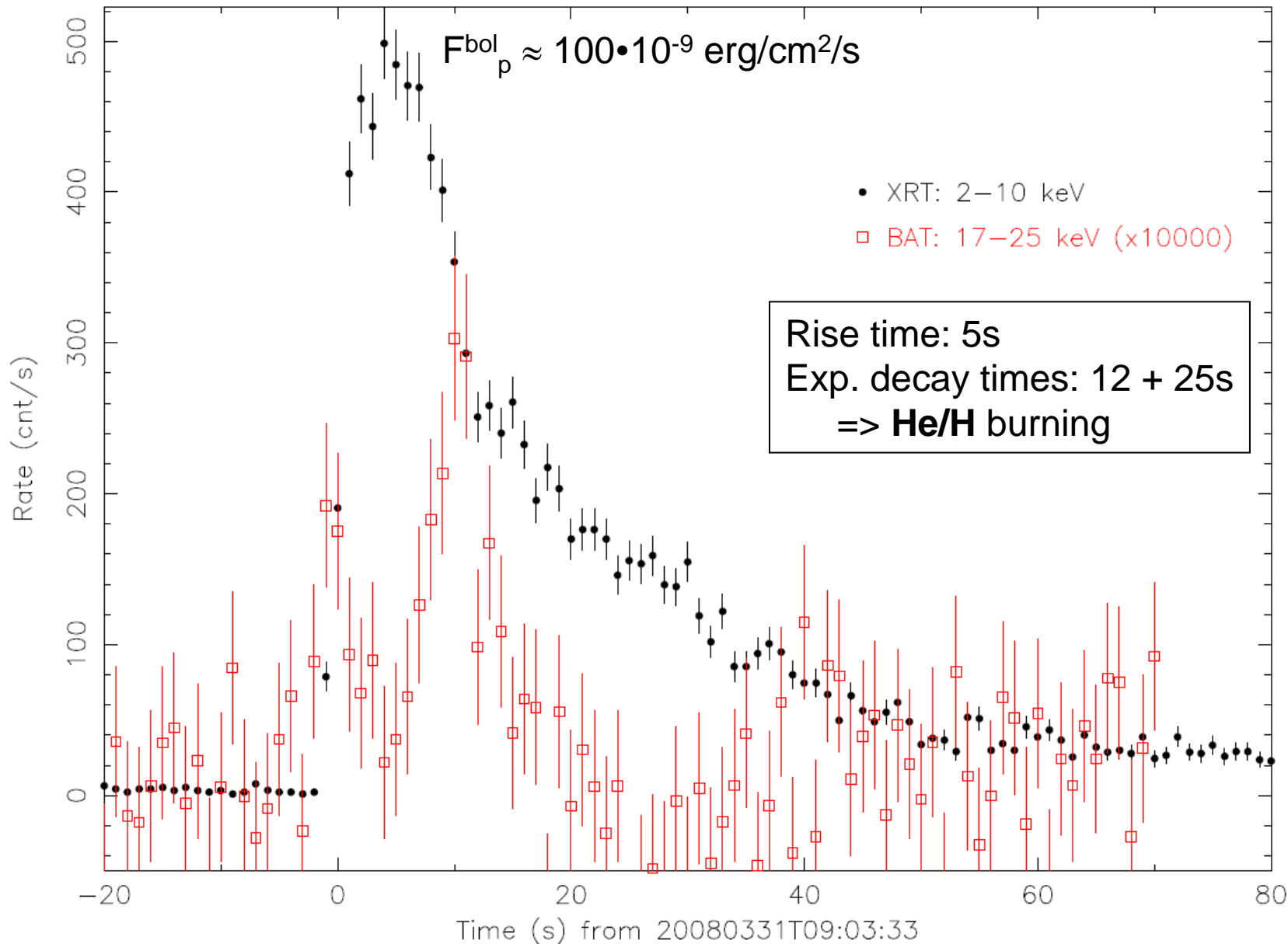


$F_{\text{pers}} \sim 10^{-10} \text{ erg/cm}^2/\text{s}$

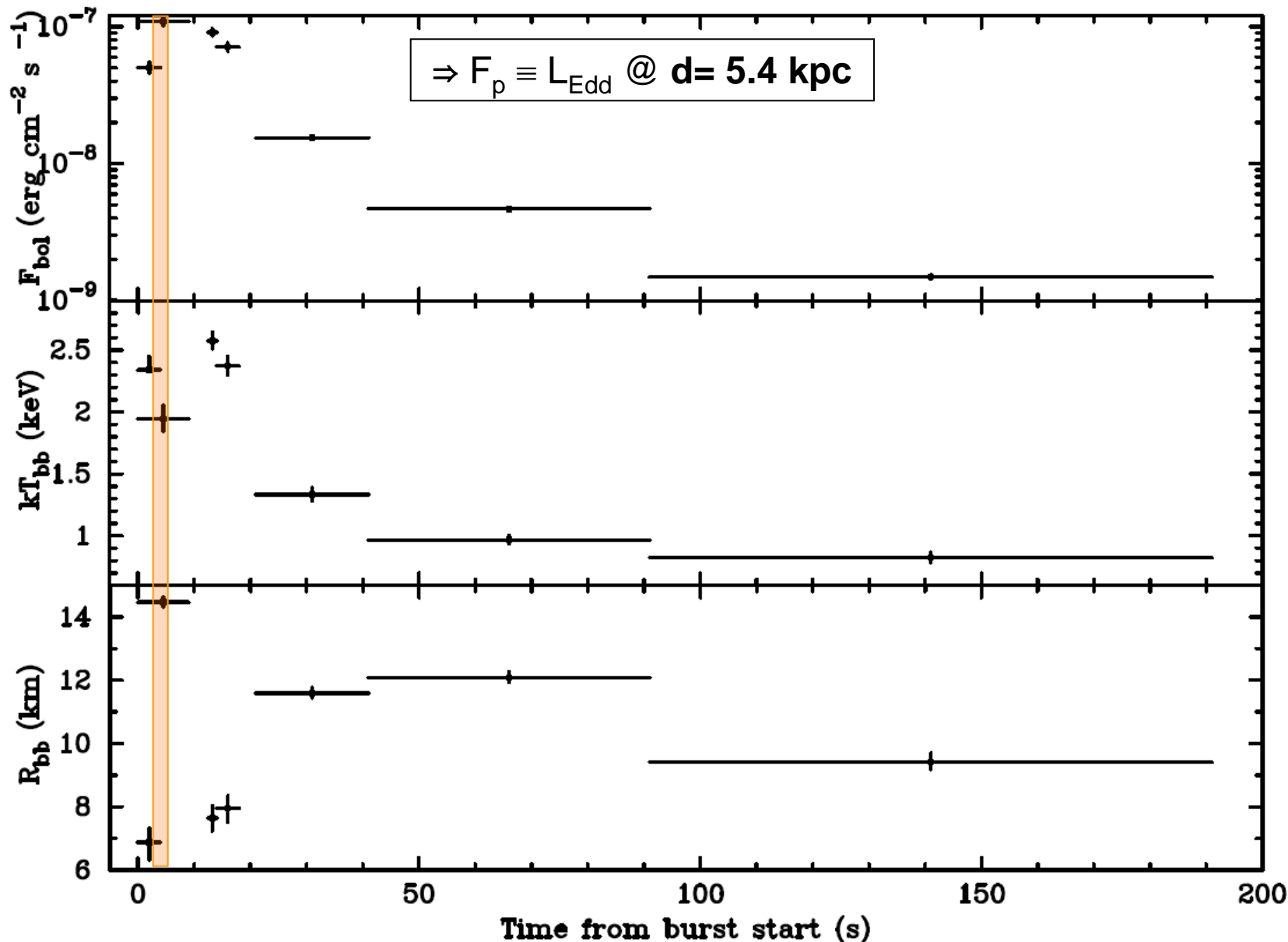
$F_{\text{peak}} \approx 0.5 \text{ Crab}$   
Duration  $\approx 44\text{s}$



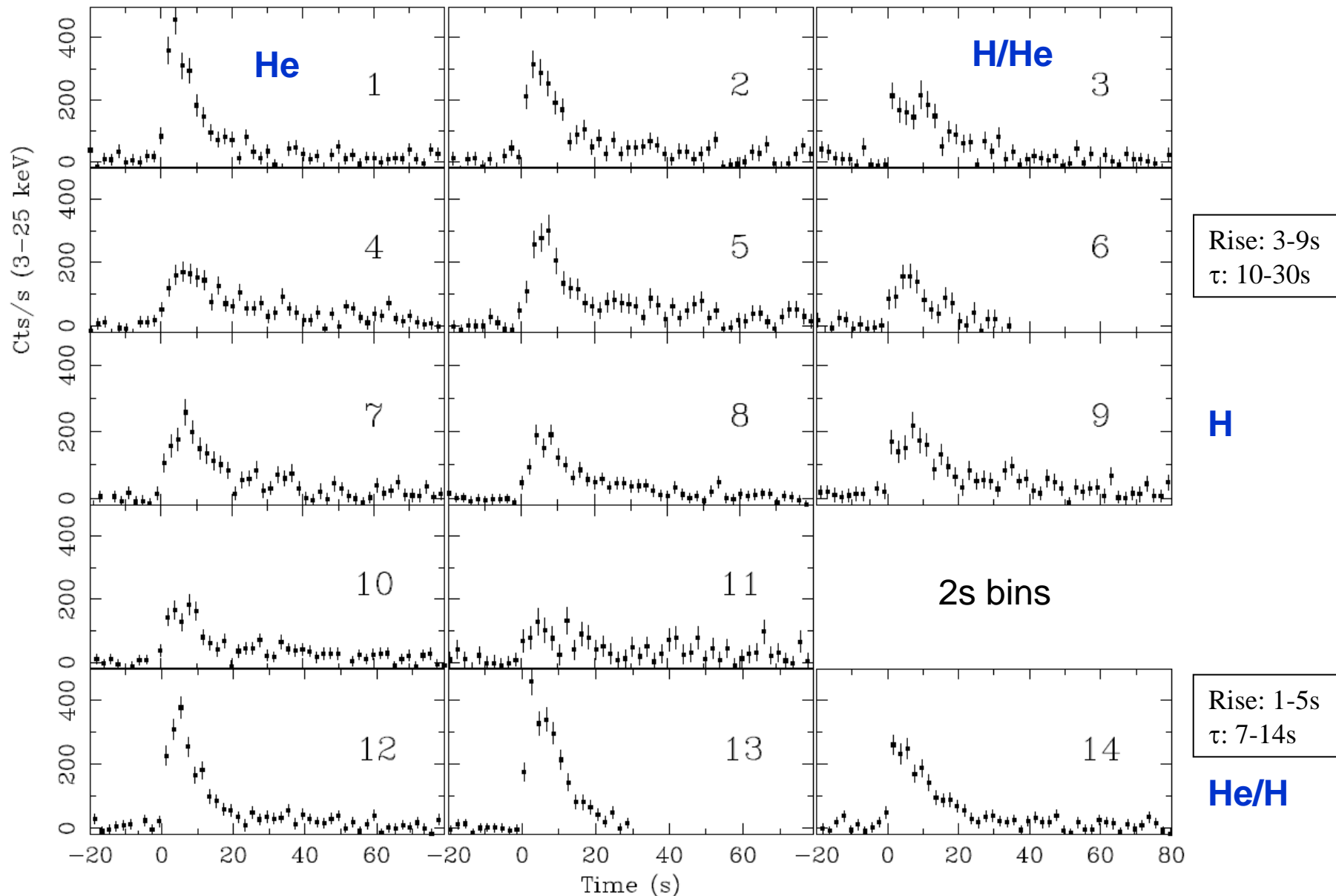
# The burst observed by *Swift*



# Time-resolved spectral analysis of the *Swift* burst

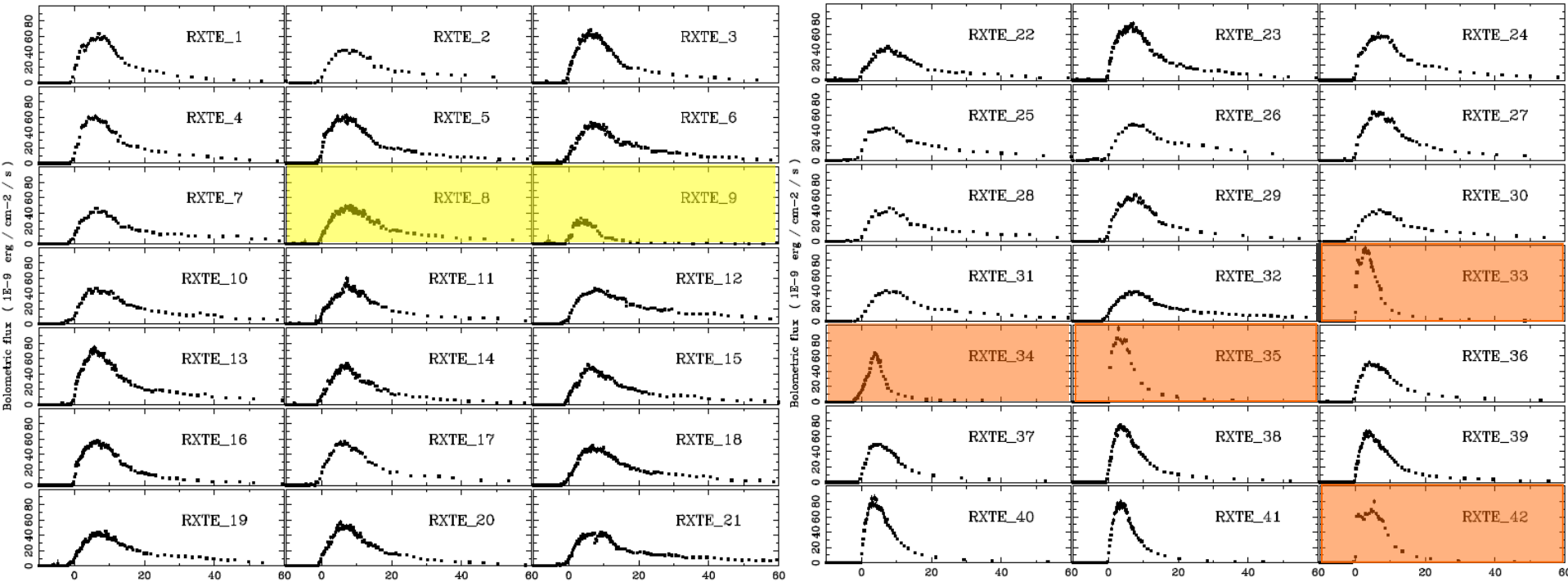


# JEM-X bursts



# 42 RXTE/PCA bursts

He/H (stable H)



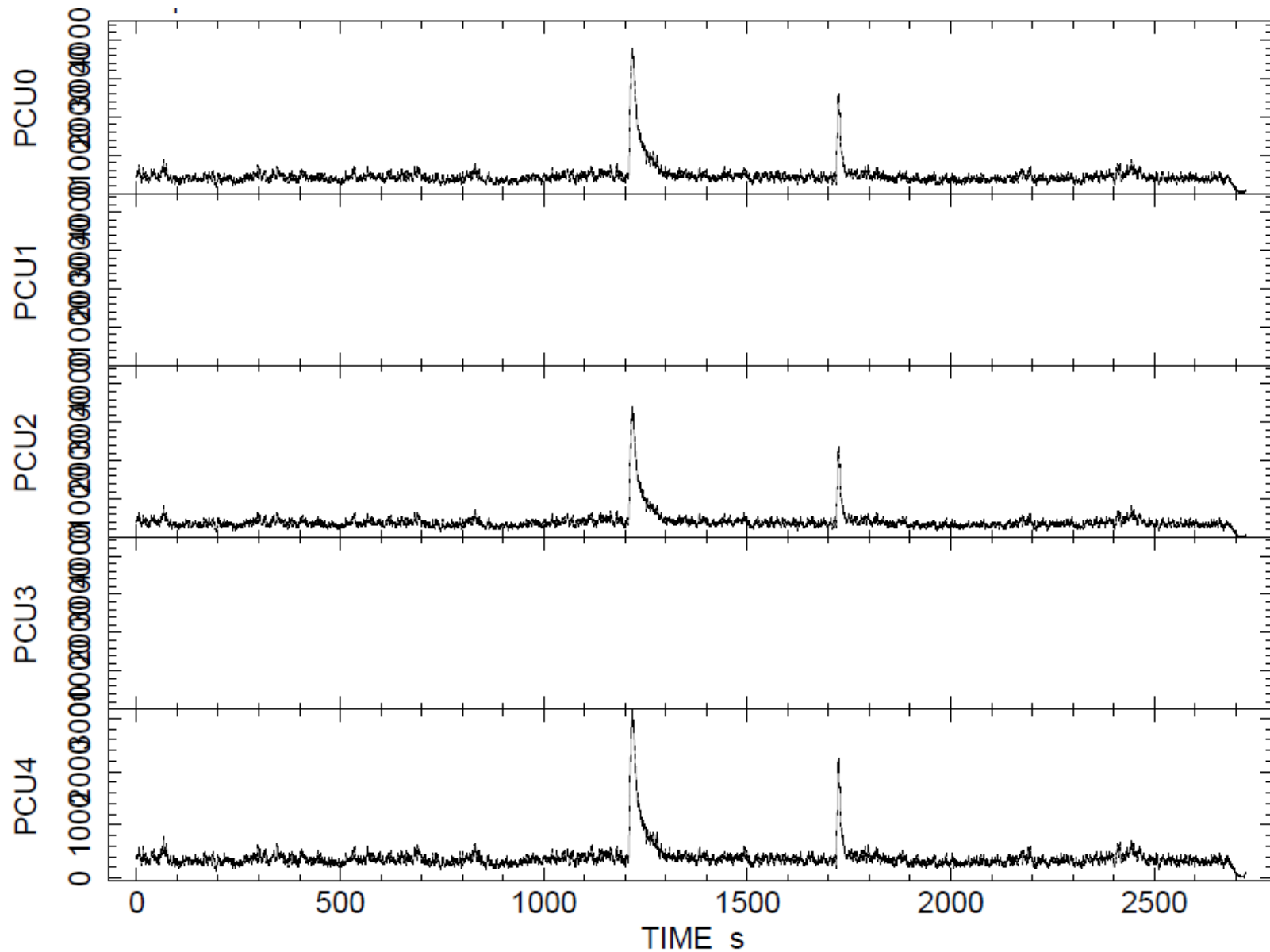
**H/He**

Rise: 6-9s  
 $\tau$ : 10-18s

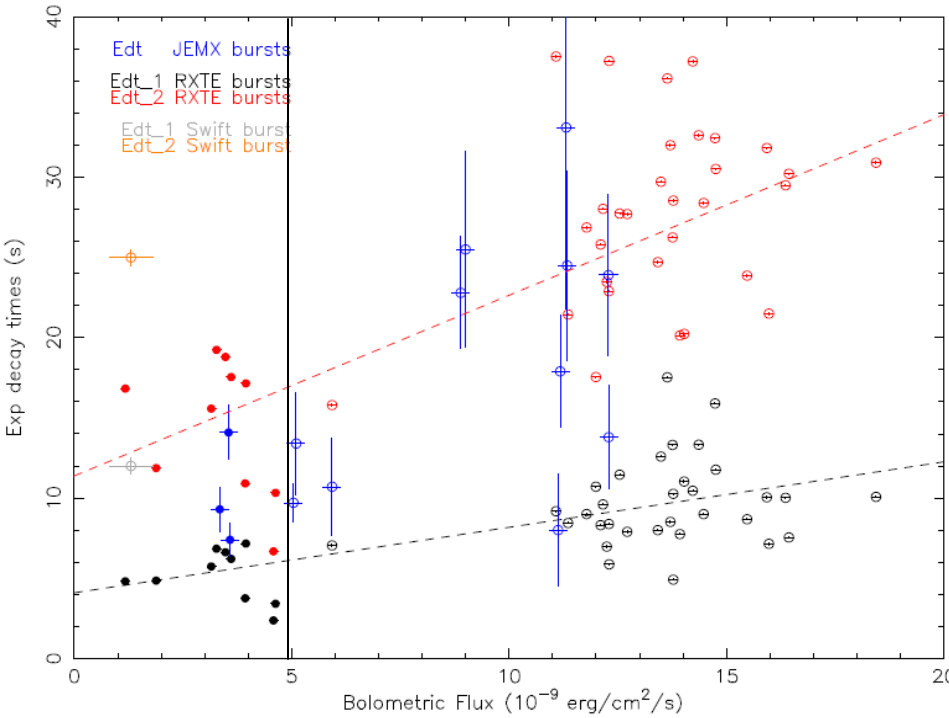
(stable He) **He**

Rise: 2-5s  
 $\tau$ : 8-16s

# A double burst observed by *RXTE/PCA*

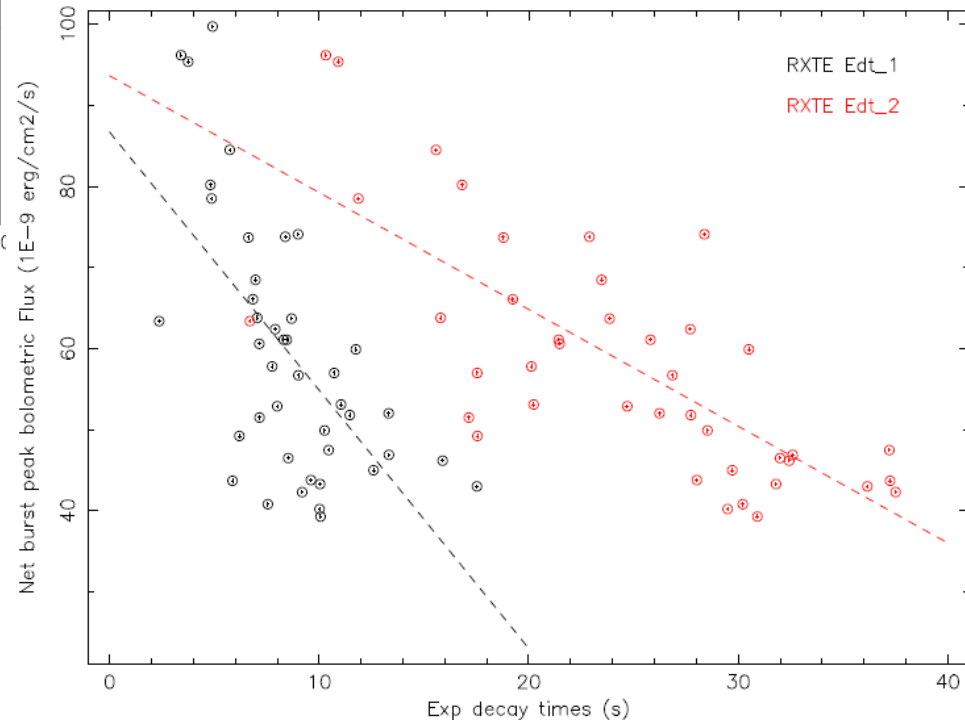


# Burst properties



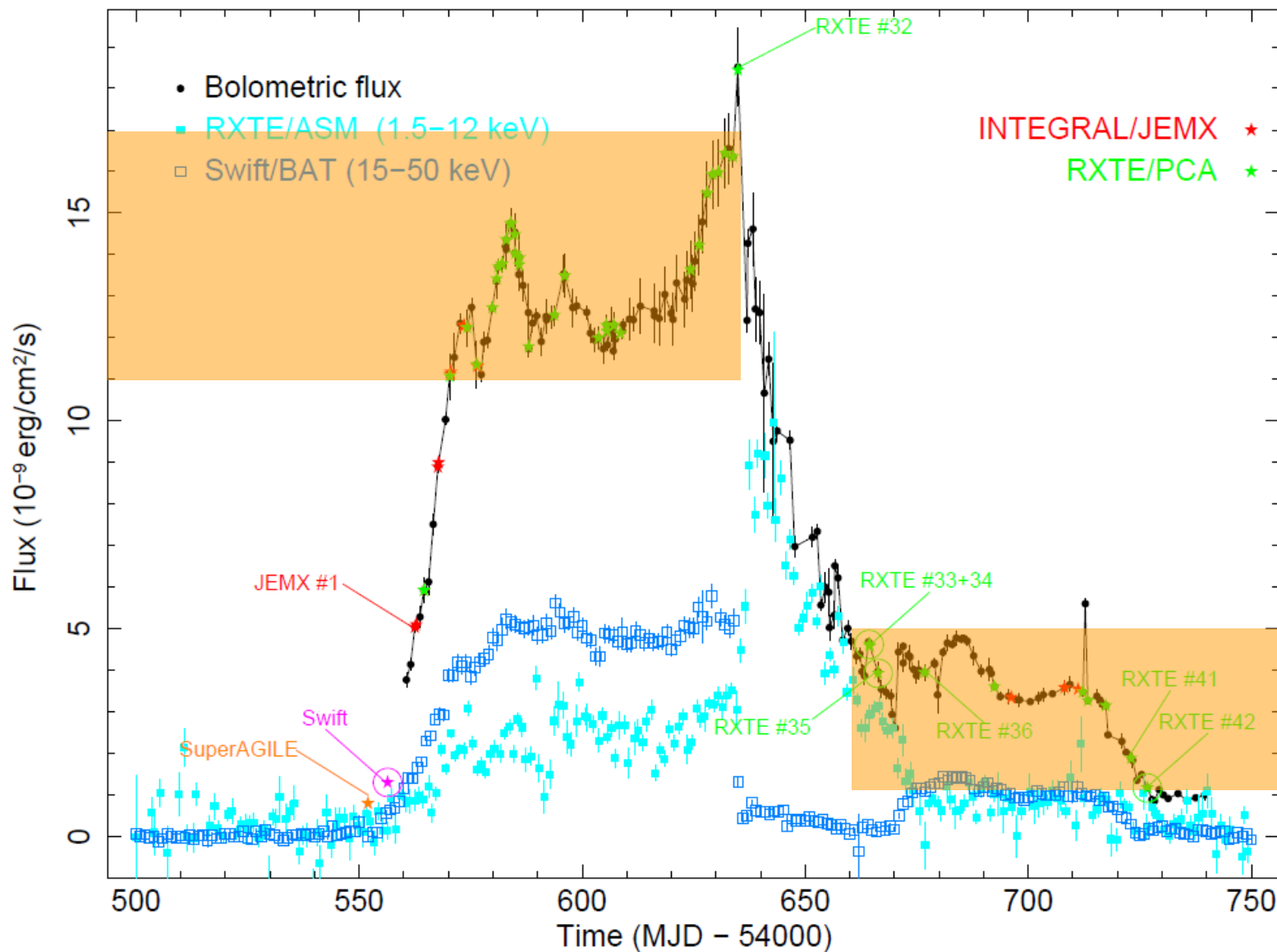
Burst decays vs. emission intensity

## Burst intensity vs. decays

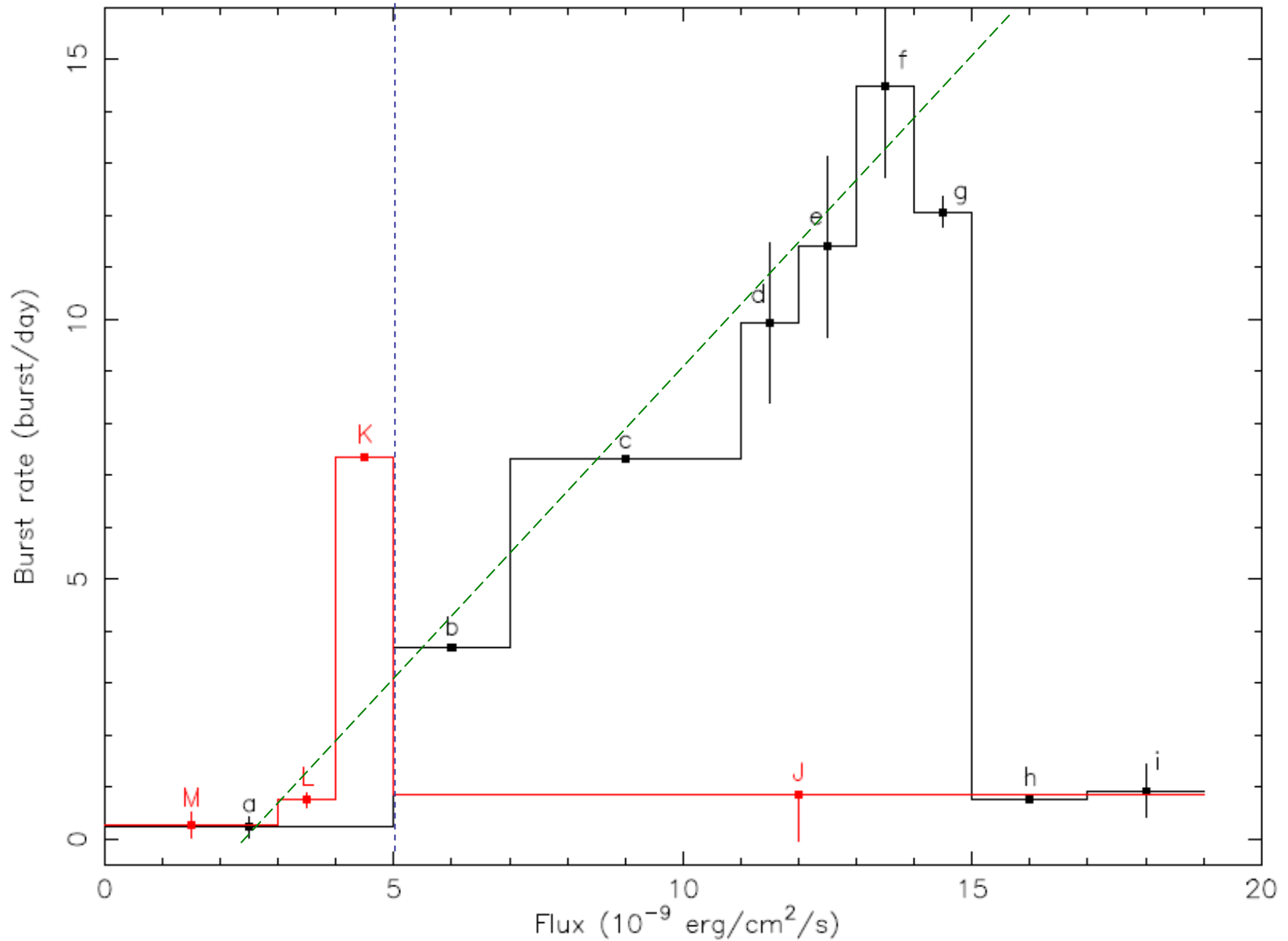


# Outburst with sudden spectral transition

IGR J17473-2721 outburst 2008 and burst times



# Burst rate vs. accretion rate





# SUMMARY



- Identification of IGR J17473-2721 as a transient NS –LMXB source
- Dramatic spectral transition simultaneous with burst intermission at outburst peak.
- Distance  $\approx 5.5$  kpc derived from Eddington-limited PRE bursts
- 57 X-ray bursts  $\Rightarrow$  7 different regimes identified:
  1. Hard He bursts at outburst onset (very low accretion rate)
  2. He-trig. H/He bursts in hard state (short recurrence times)
  3. He/H bursts with H & He stable burning at high accretion rate
  4. No burst activity at soft-high state (due to a **SUPERBURST?**)
  5. Pure He bursts (with PRE) at soft-low state
  6. Mixed He/H burning at hard-low state
  7. Last He burst at low accretion rate in soft state
- Rising bursting rate  $< 15\%$  Eddington accretion rate and **hysteresis**