STATES AND STATE-TRANSITIONS IN BLACK HOLES AS SEEN BY RXTE

TEO MUÑOZ DARIAS
Osservatorio Astronomico di Brera

MYSELF

- I was born in La Gomera (CI, Spain) in 1981

- Degree in Physics/Astrophysics at University of La Laguna (Tenerife, CI, Spain)

- Observer at the solar laboratory at Teide Observatory

- PhD. at Instituto de Astrofísica de Canarias, supervised by Casares and Martinez-Pais

Istanbul, network meeting 2010

Black Hole Universe

OSSERVATORIO ASTRONOMICO DI BRERA (MERATE)

- Group led by Tomaso
- Two Postdocs: Holger and myself
- PhD Student: Sara Motta
- M.Sc. Student: Dario Carbone

Istanbul, network meeting 2010

Black Hole Universe

OUTLINE

- Black Holes in outburst: the complex outburst evolution of H1743-322

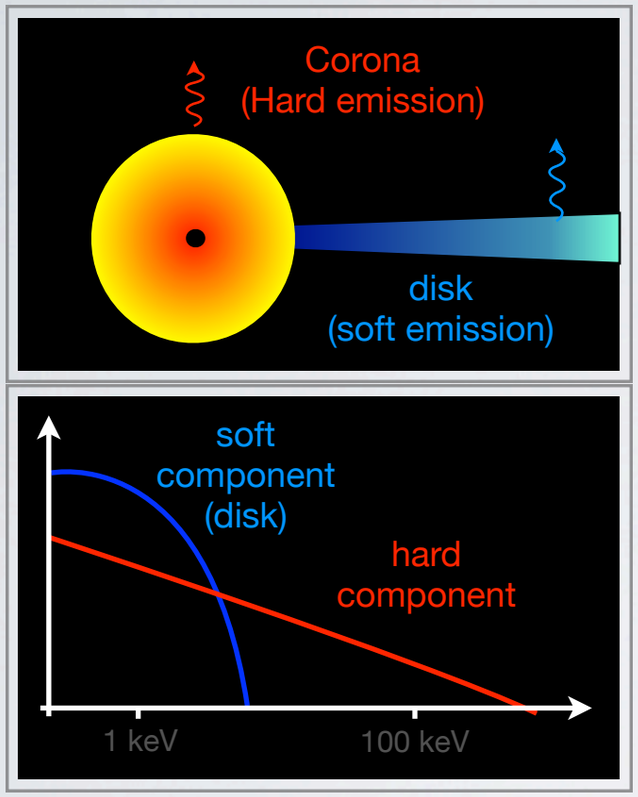
- A new tool: the VARIABILITY diagram

- XTE J1752-223: studying the hard state in detail

Istanbul, network meeting 2010

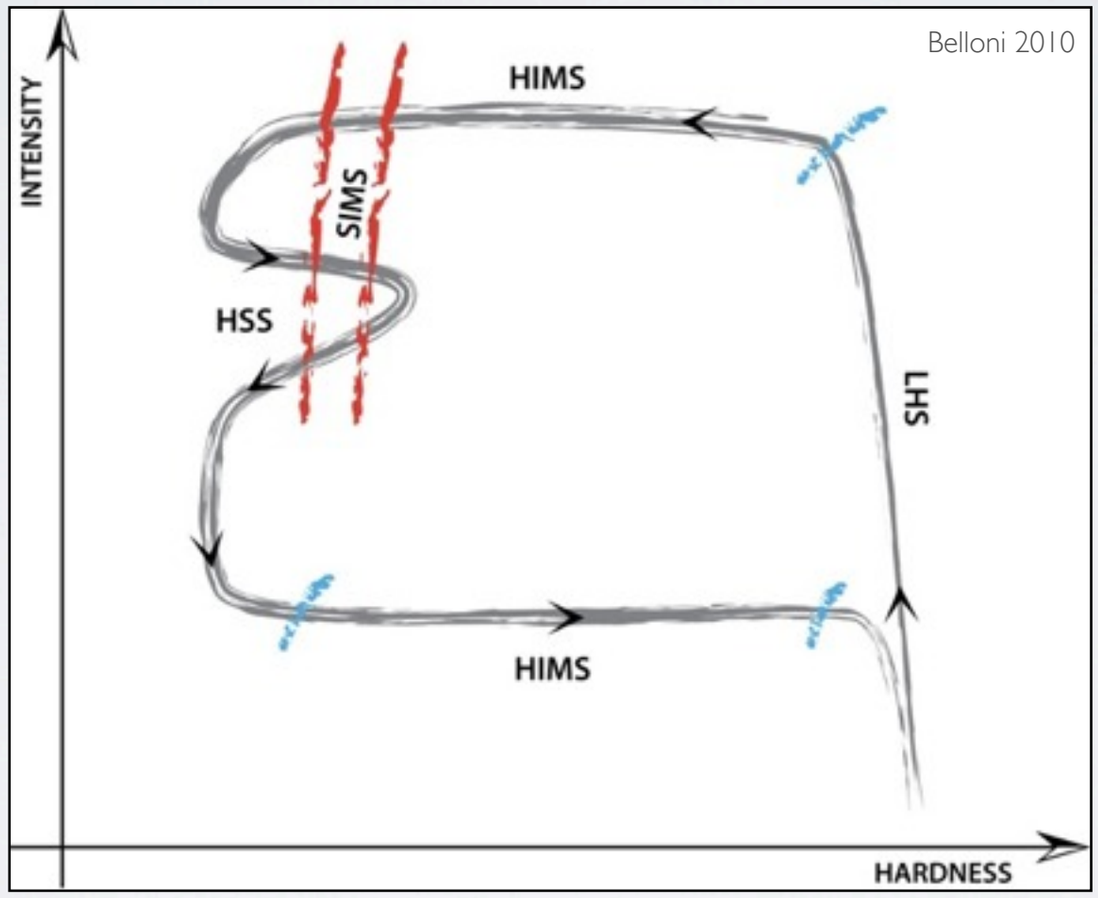
Black Hole Universe

BLACK HOLES IN OUTBURST



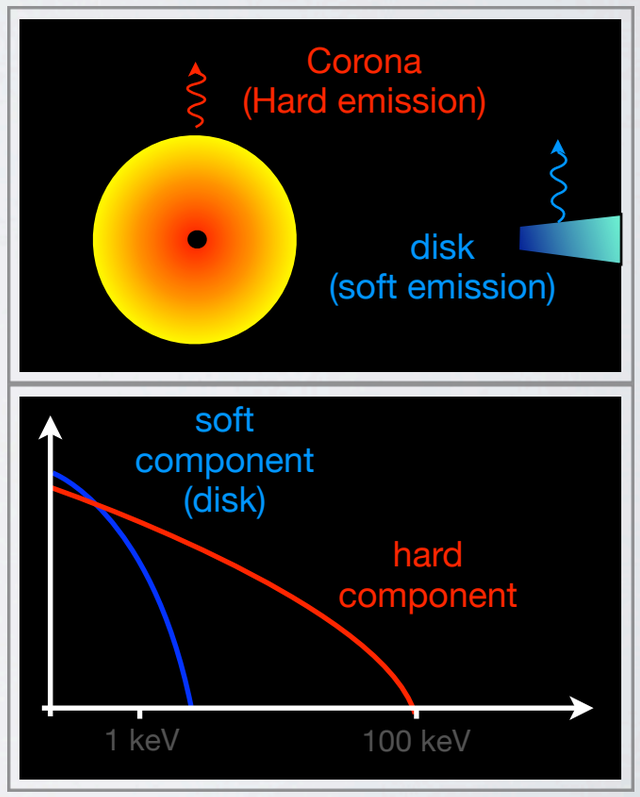
High Soft state:

- hot corona (different geometry?)
- hot disk, small inner radius?



Low hard state:

- hot corona
- cold disk, large inner radius?



Istanbul, network meeting 2010

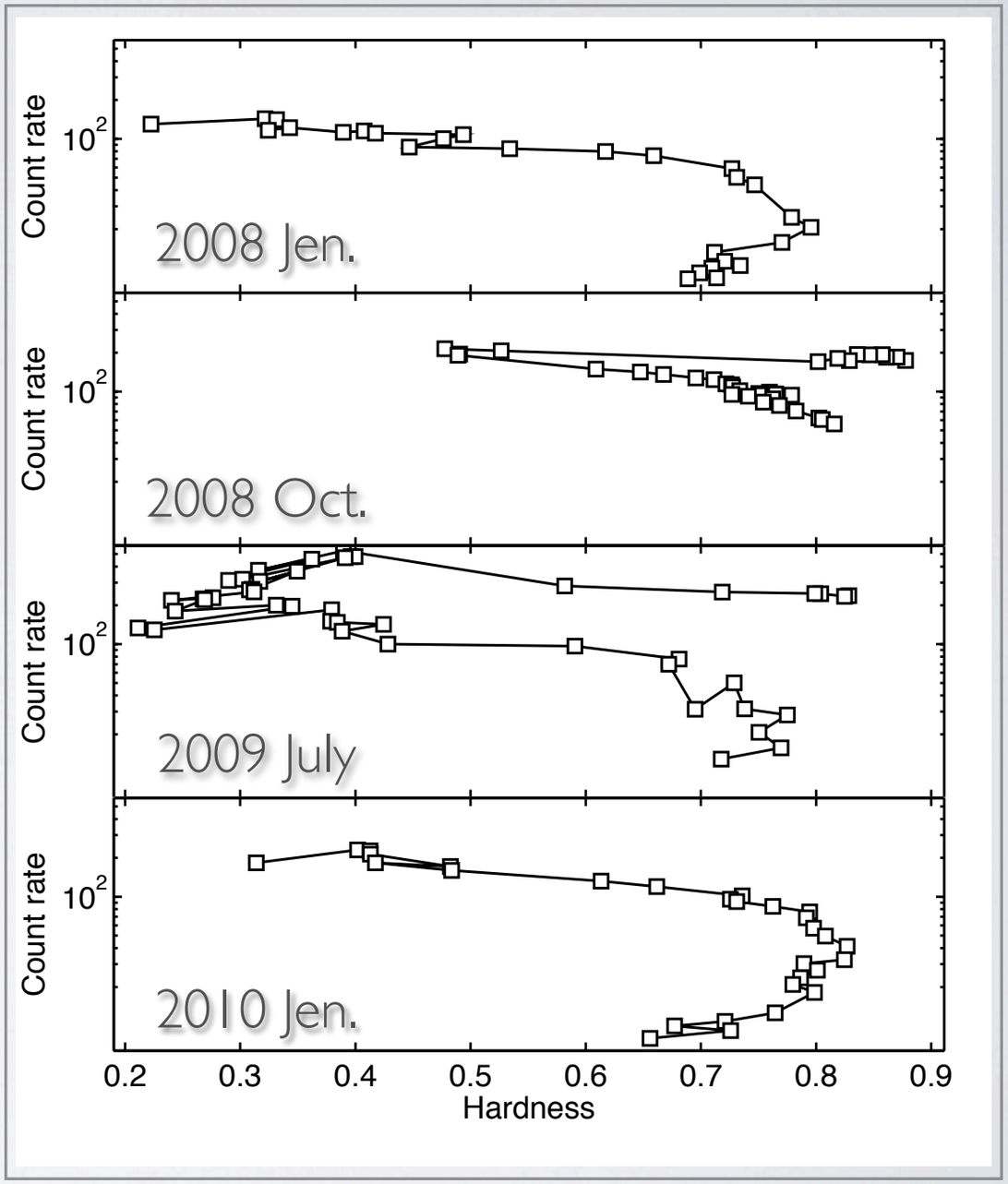
Black Hole Universe

H1743-322

and the transition mechanism

Motta, Muñoz-Darias, & Belloni, MNRAS, 2010

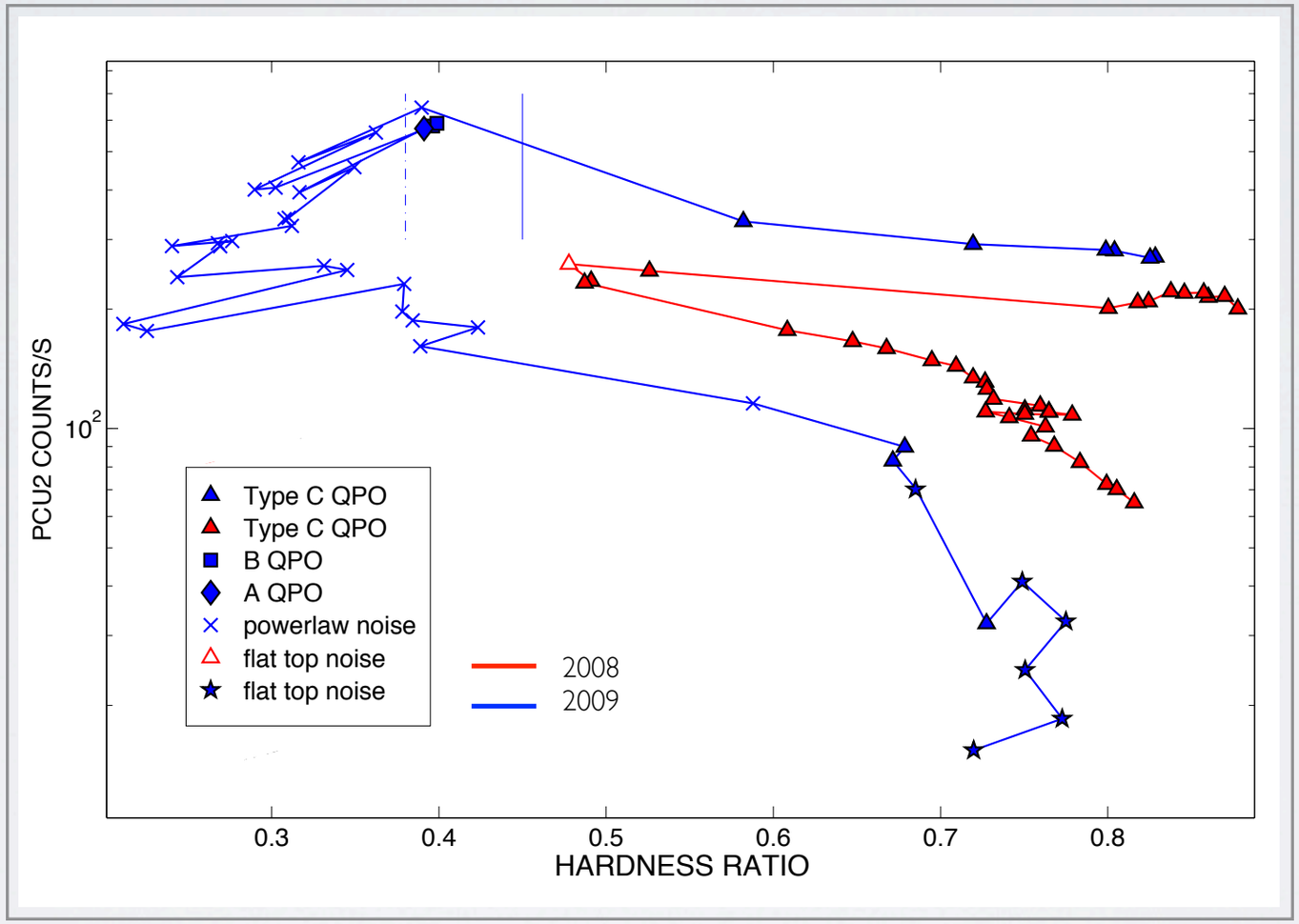
H1743-322: last outbursts



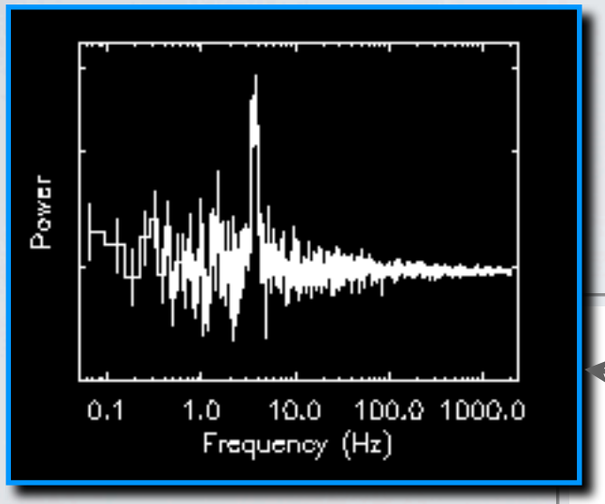
Istanbul, network meeting 2010

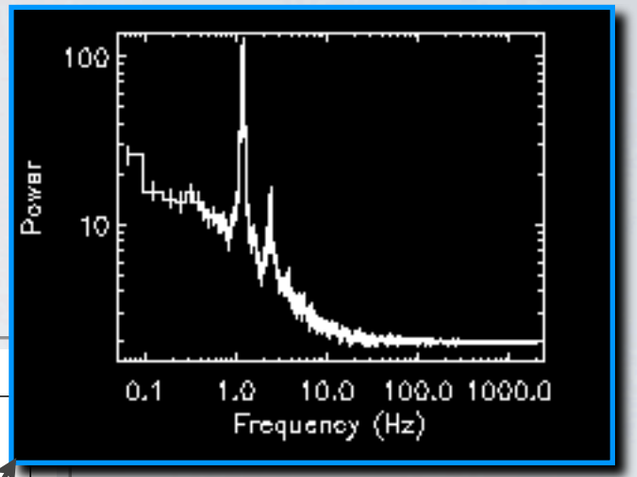
Black Hole Universe

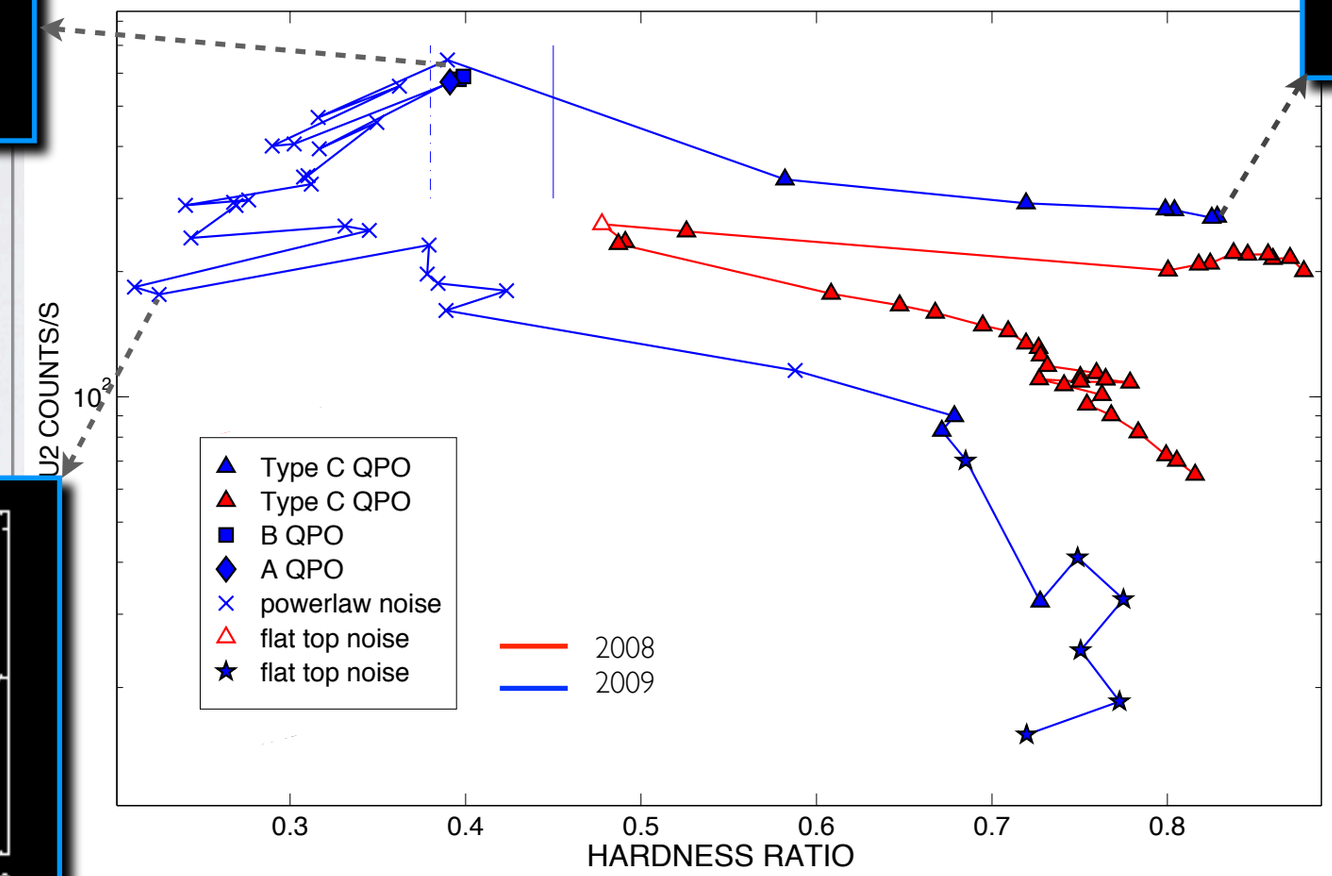
OUTBURST EVOLUTION: 2008/2009

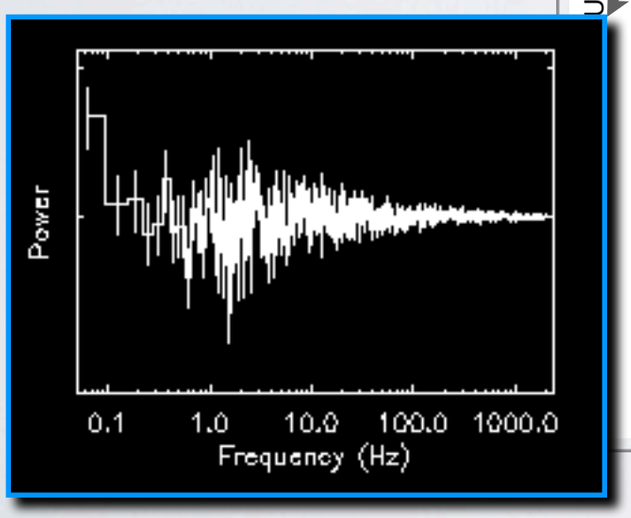


OUTBURST EVOLUTION: 2008/2009

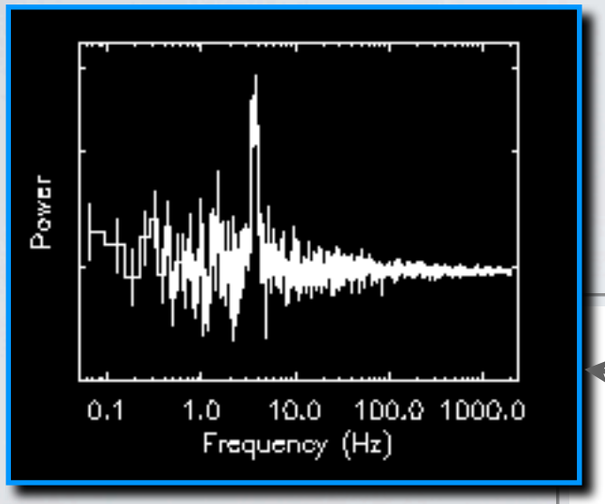


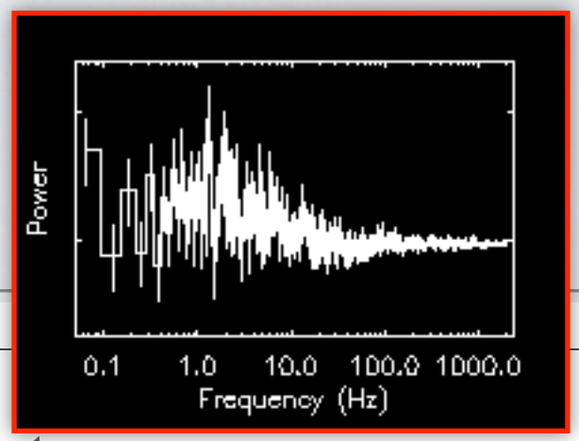


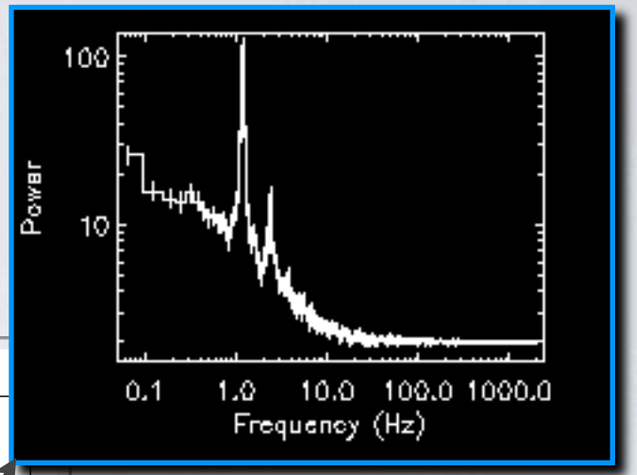


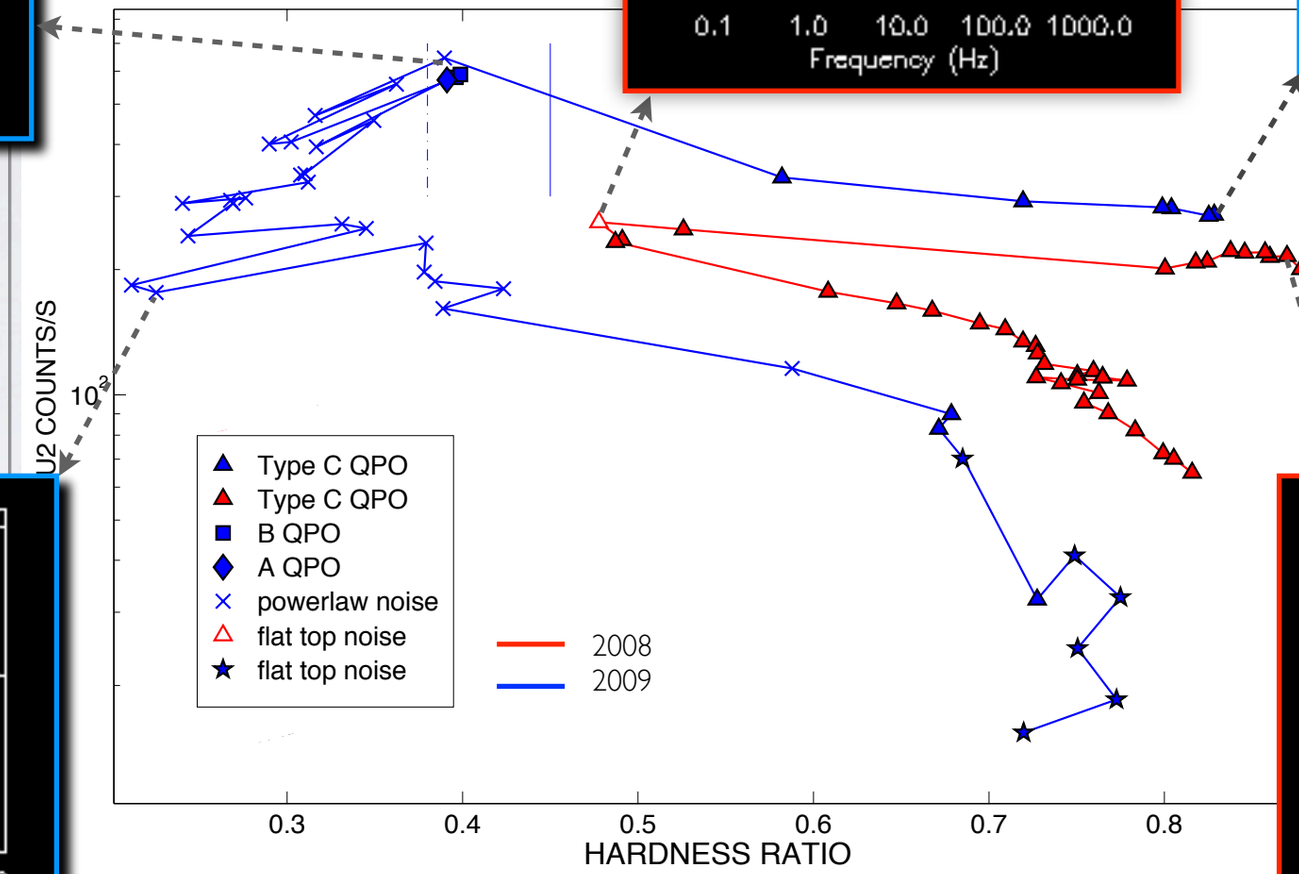


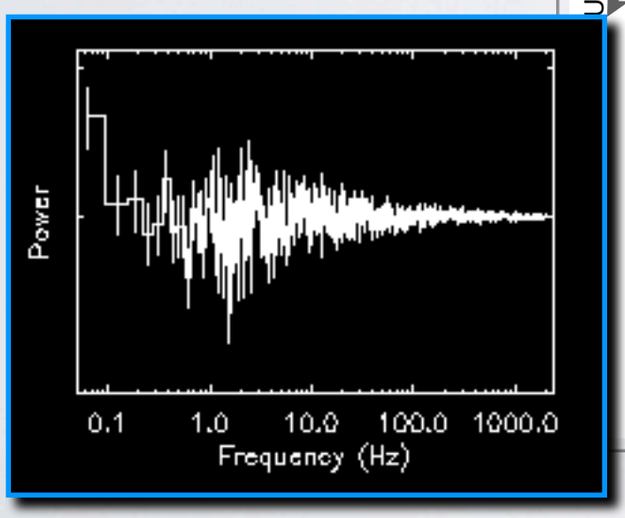
OUTBURST EVOLUTION: 2008/2009

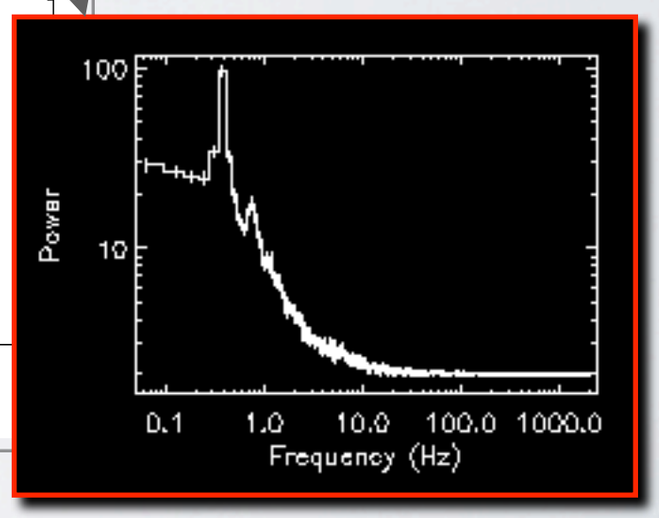












Istanbul, network meeting 2010

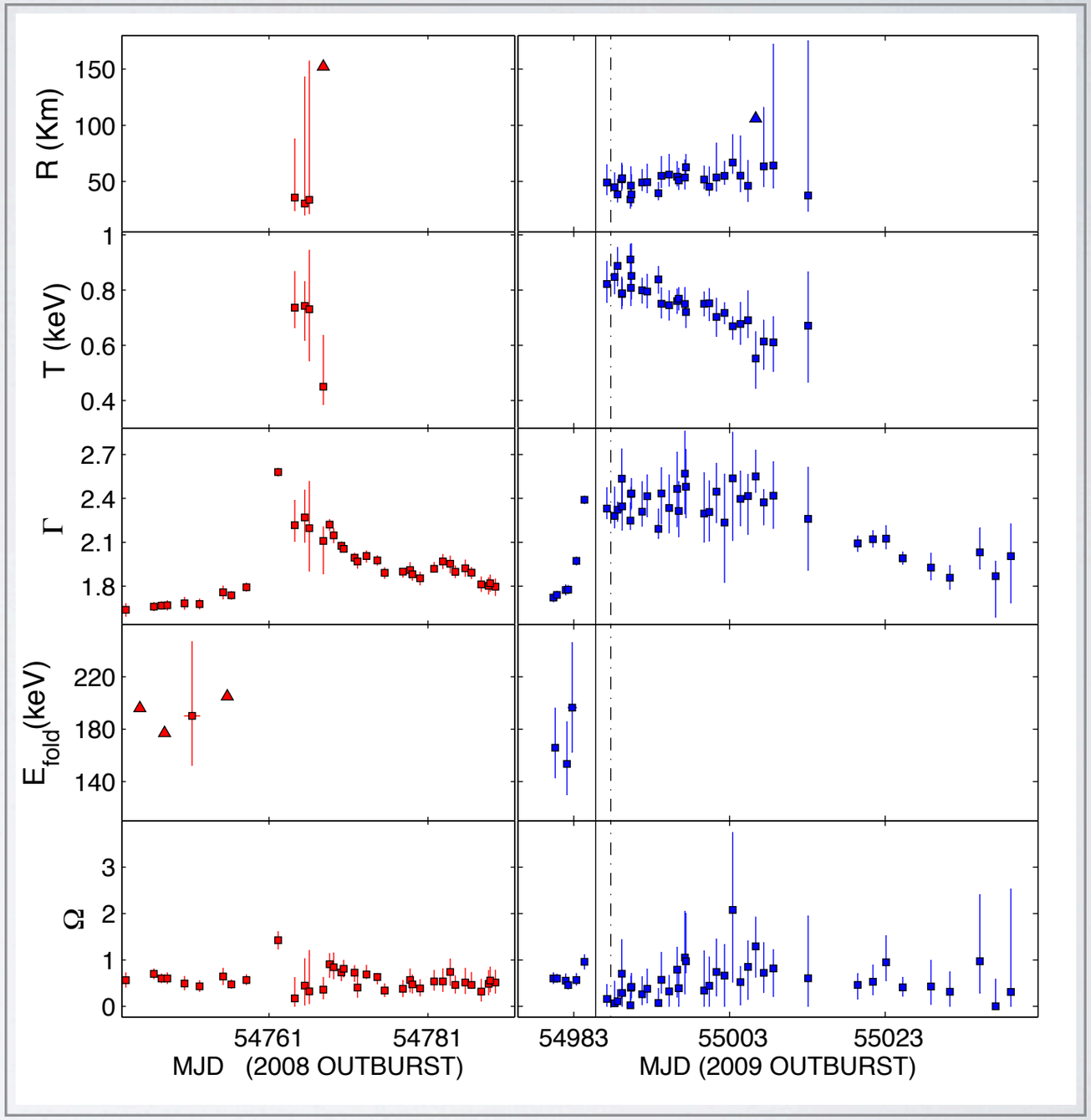
Black Hole Universe

SPECTRAL ANALYSIS

- no dependence between initial spectral parameters and subsequent evolution

- Just a matter of accretion rate?

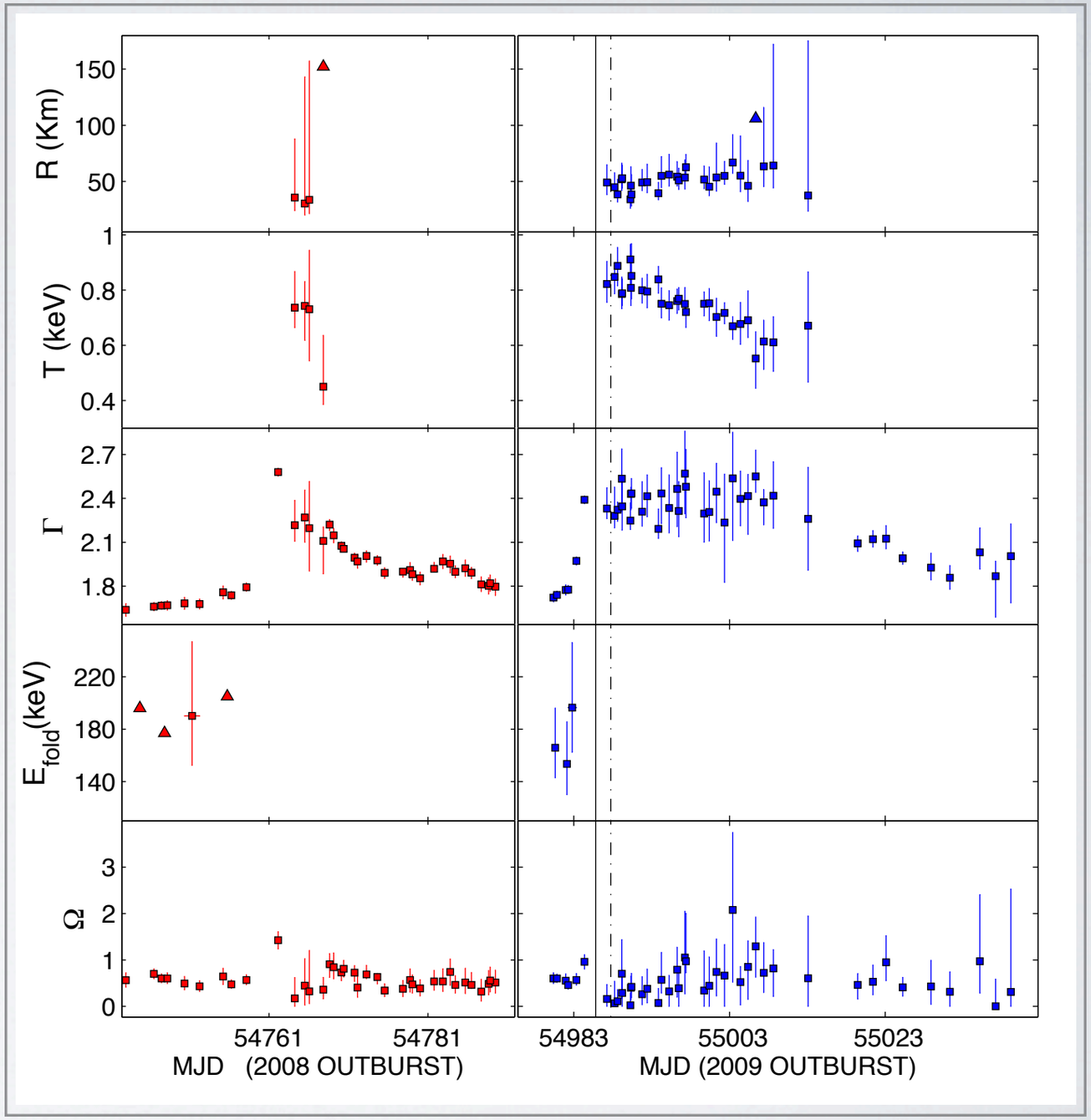
XSPEC model:
wabs*(gauss + diskbb + pexrav)



SPECTRAL ANALYSIS

➡ no dependence between initial spectral parameters and subsequent evolution

➡ Just a matter of accretion rate?



TIMING ANALYSIS IN PREPARATION

Istanbul, network meeting 2010

Black Hole Universe

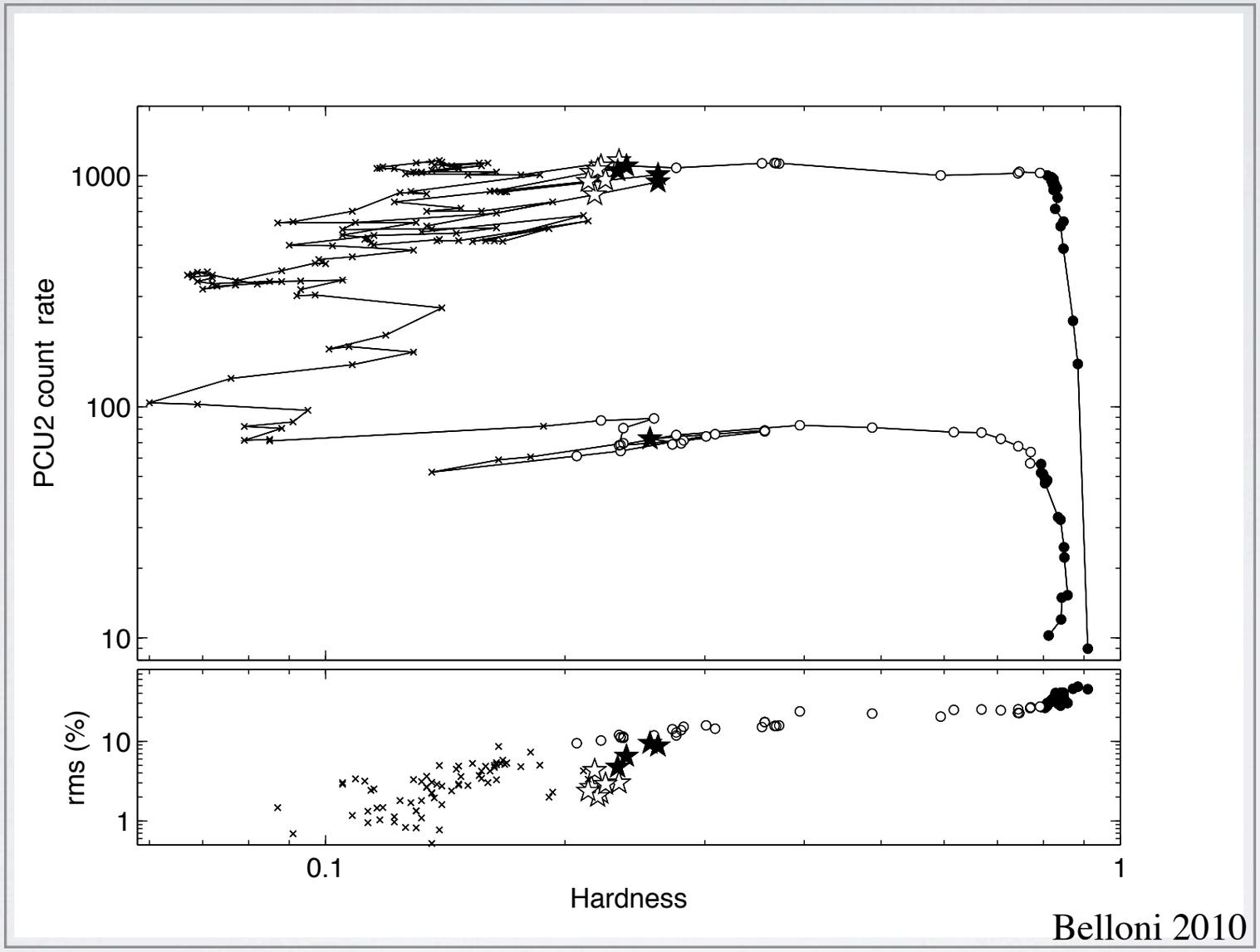
THE VARIABILITY DIAGRAM

the case of GX339-4

Muñoz-Darias, Motta, & Belloni, MNRAS, 2010

GX 339-4: STANDARD DIAGRAMS

Hardness-Intensity Diagram

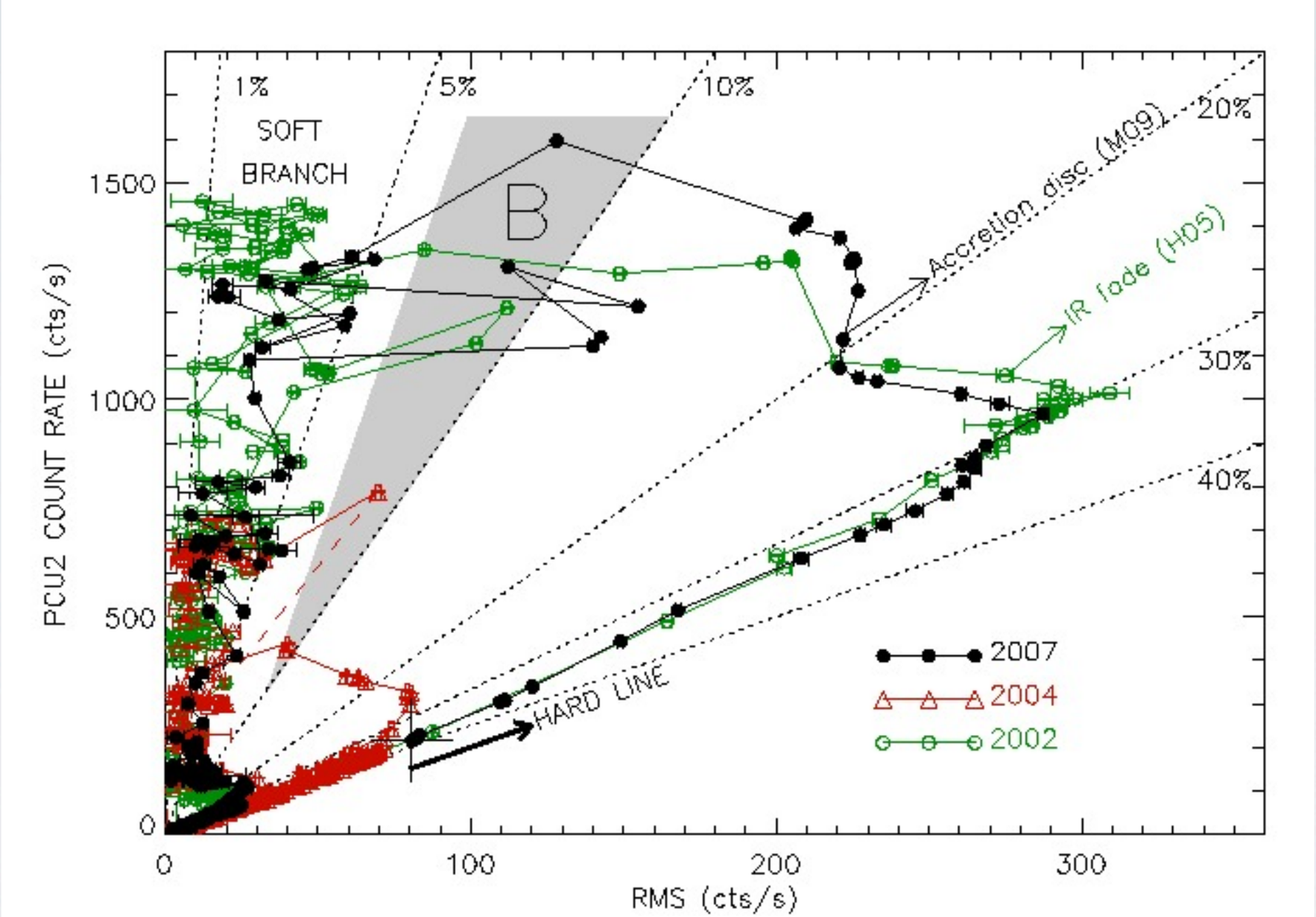


Hardness-rms Diagram

Istanbul, network meeting 2010

Black Hole Universe

THE RMS-INTENSITY DIAGRAM

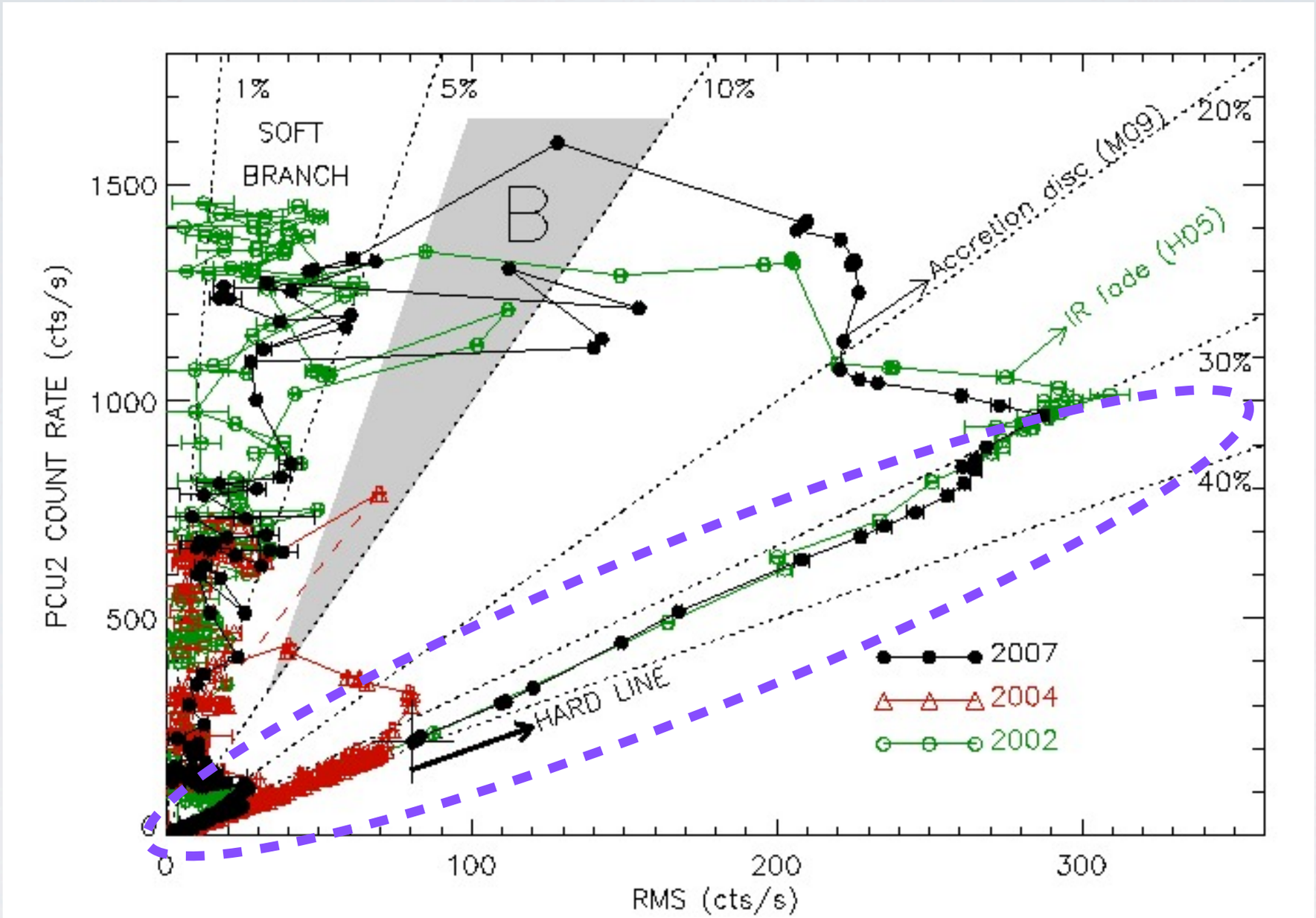


Istanbul, network meeting 2010

Black Hole Universe

THE RMS-INTENSITY DIAGRAM

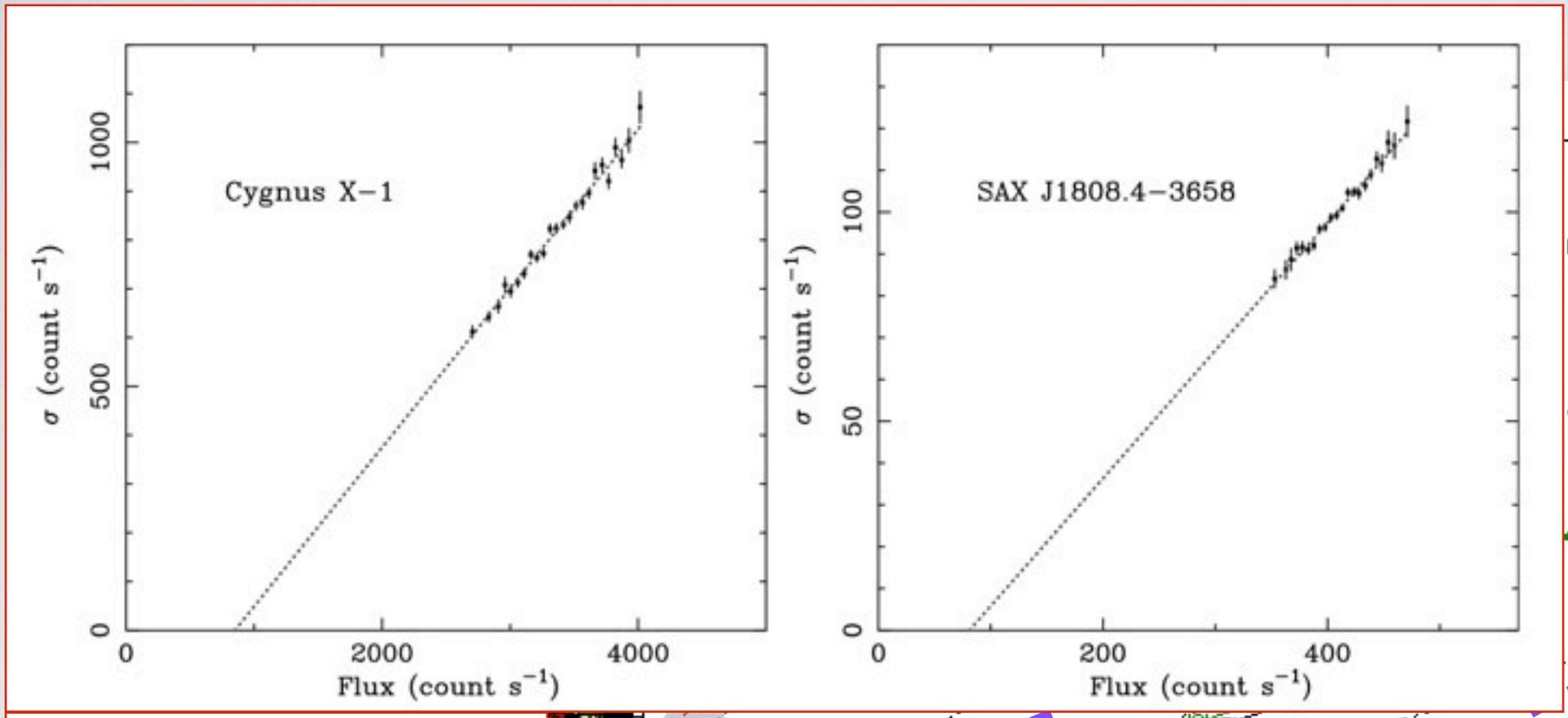
Hard line



Istanbul, network meeting 2010

Black Hole Universe

THE RMS-INTENSITY DIAGRAM

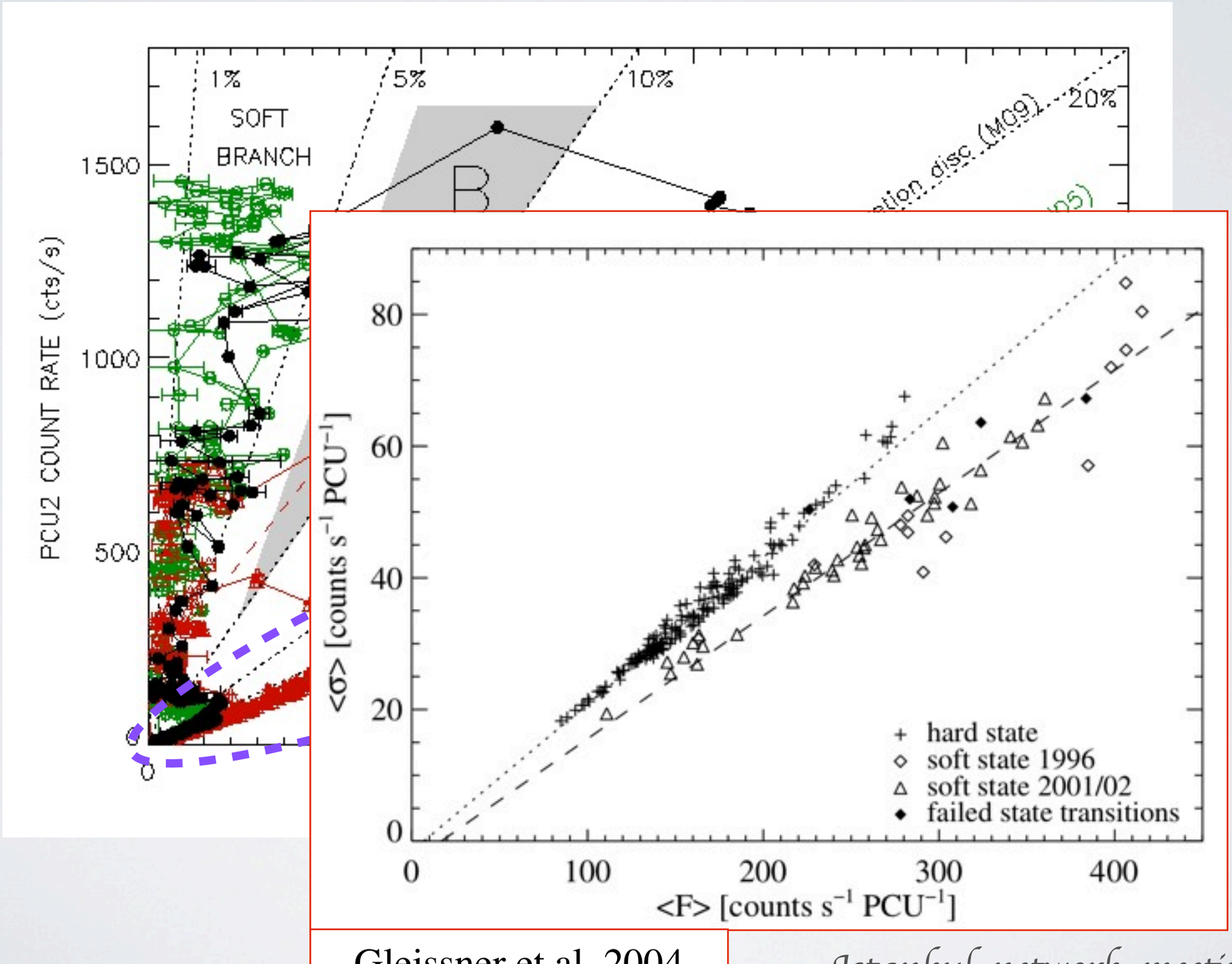


Uttley & McHardy 2001

Hard line

THE RMS-INTENSITY DIAGRAM

Hard line



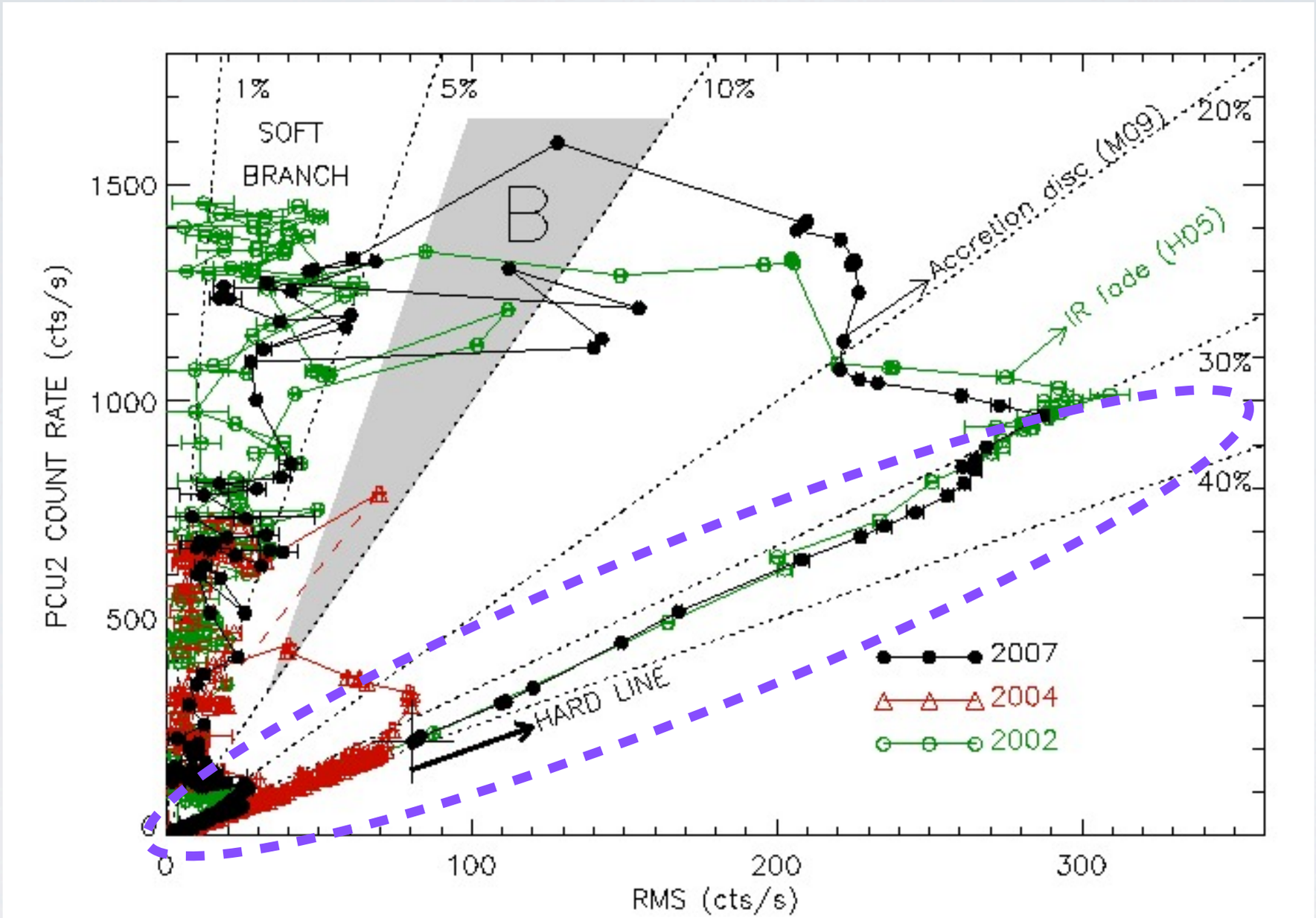
Gleissner et al. 2004

Istanbul, network meeting 2010

Black Hole Universe

THE RMS-INTENSITY DIAGRAM

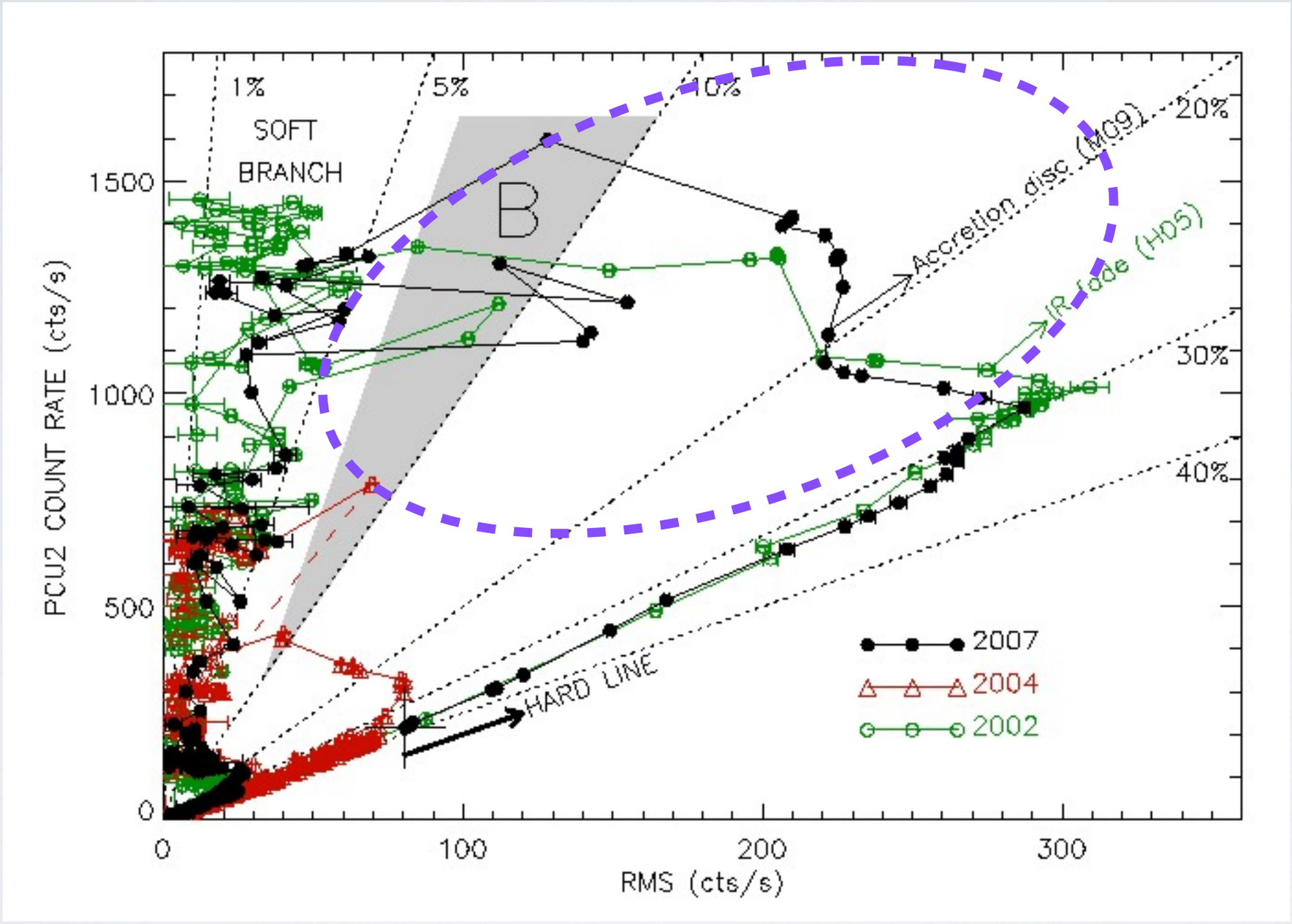
Hard line



Istanbul, network meeting 2010

Black Hole Universe

THE RMS-INTENSITY DIAGRAM

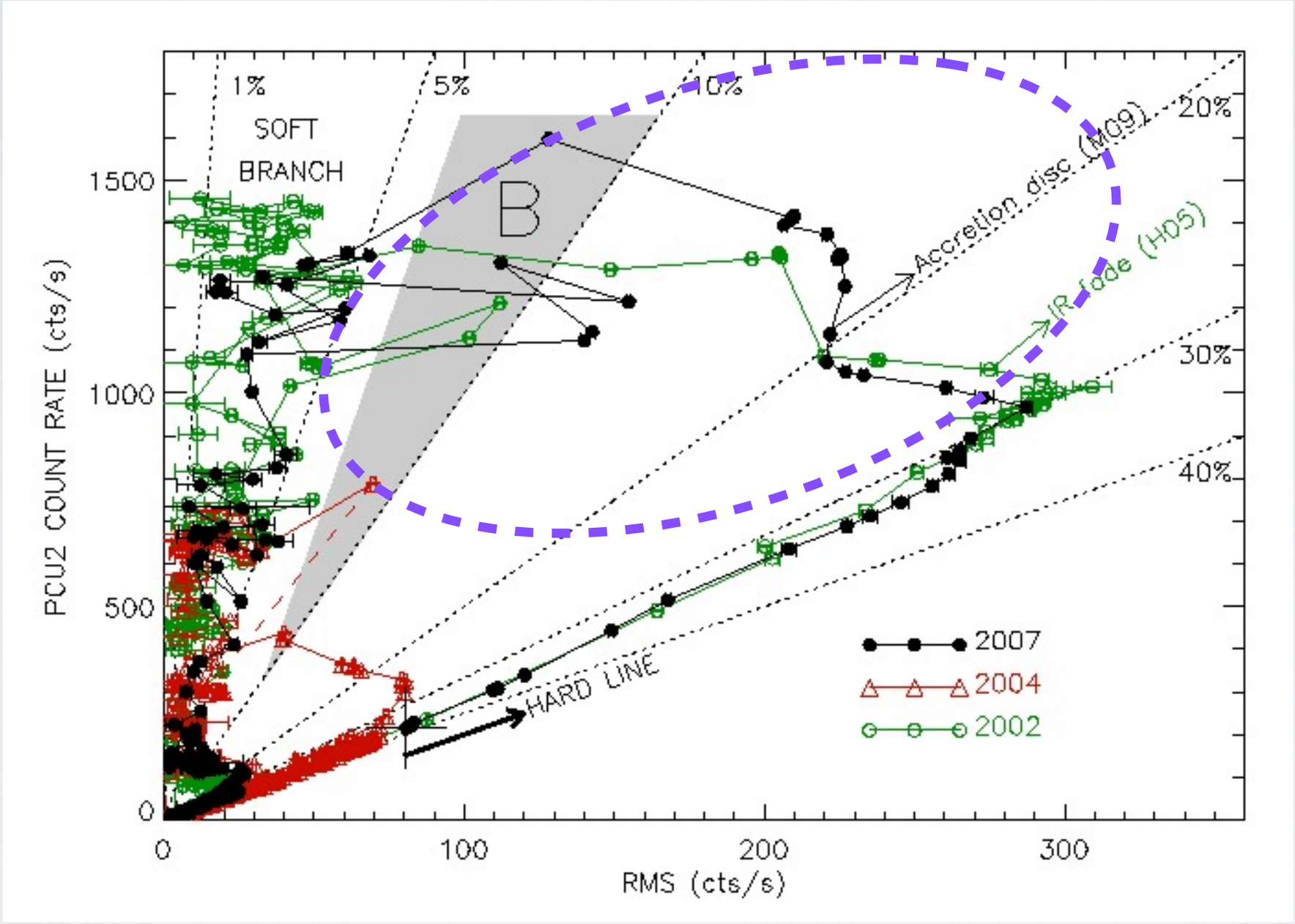


Istanbul, network meeting 2010

Black Hole Universe

THE RMS-INTENSITY DIAGRAM

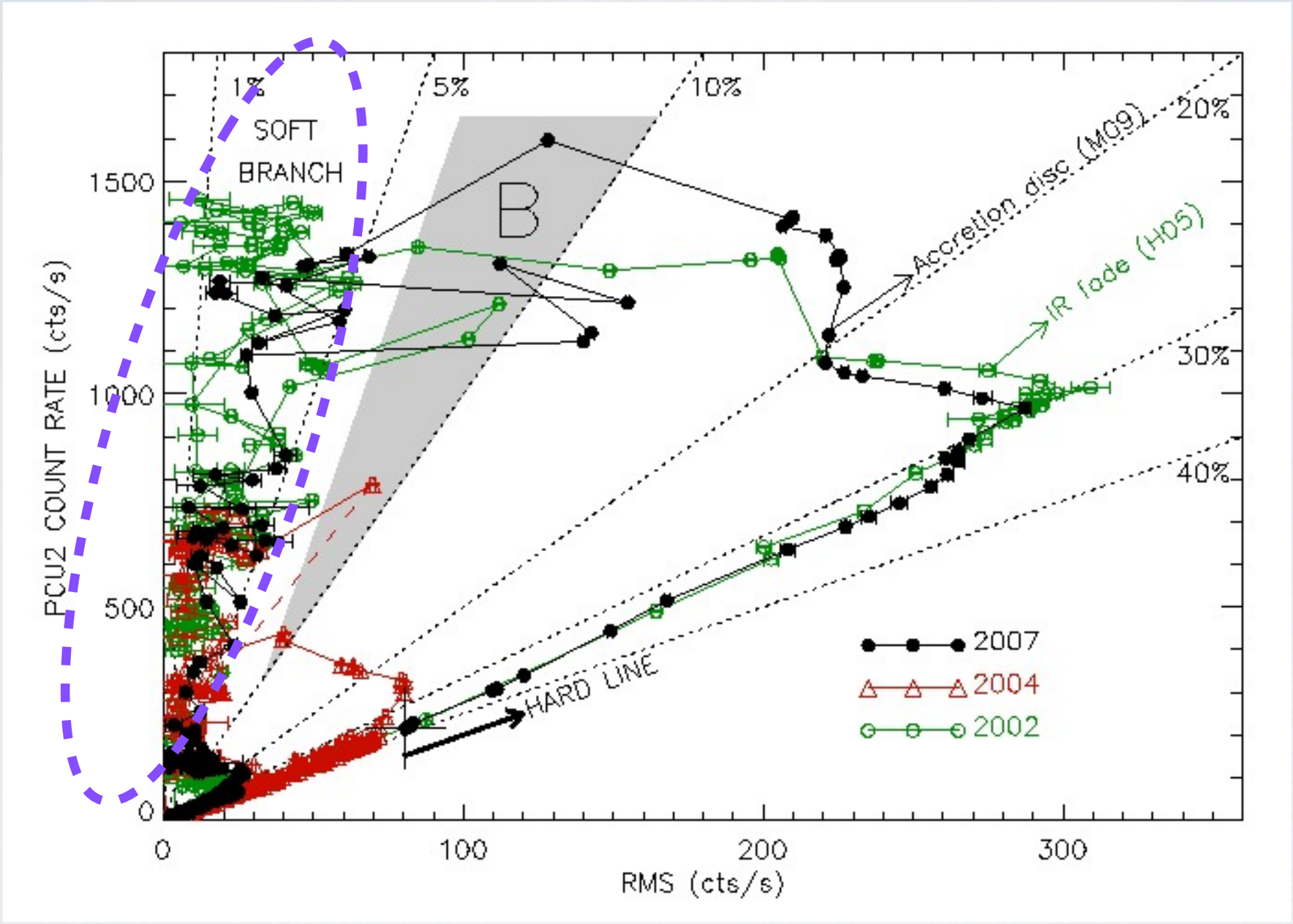
Hard-to-Soft transition



Istanbul, network meeting 2010

Black Hole Universe

THE RMS-INTENSITY DIAGRAM

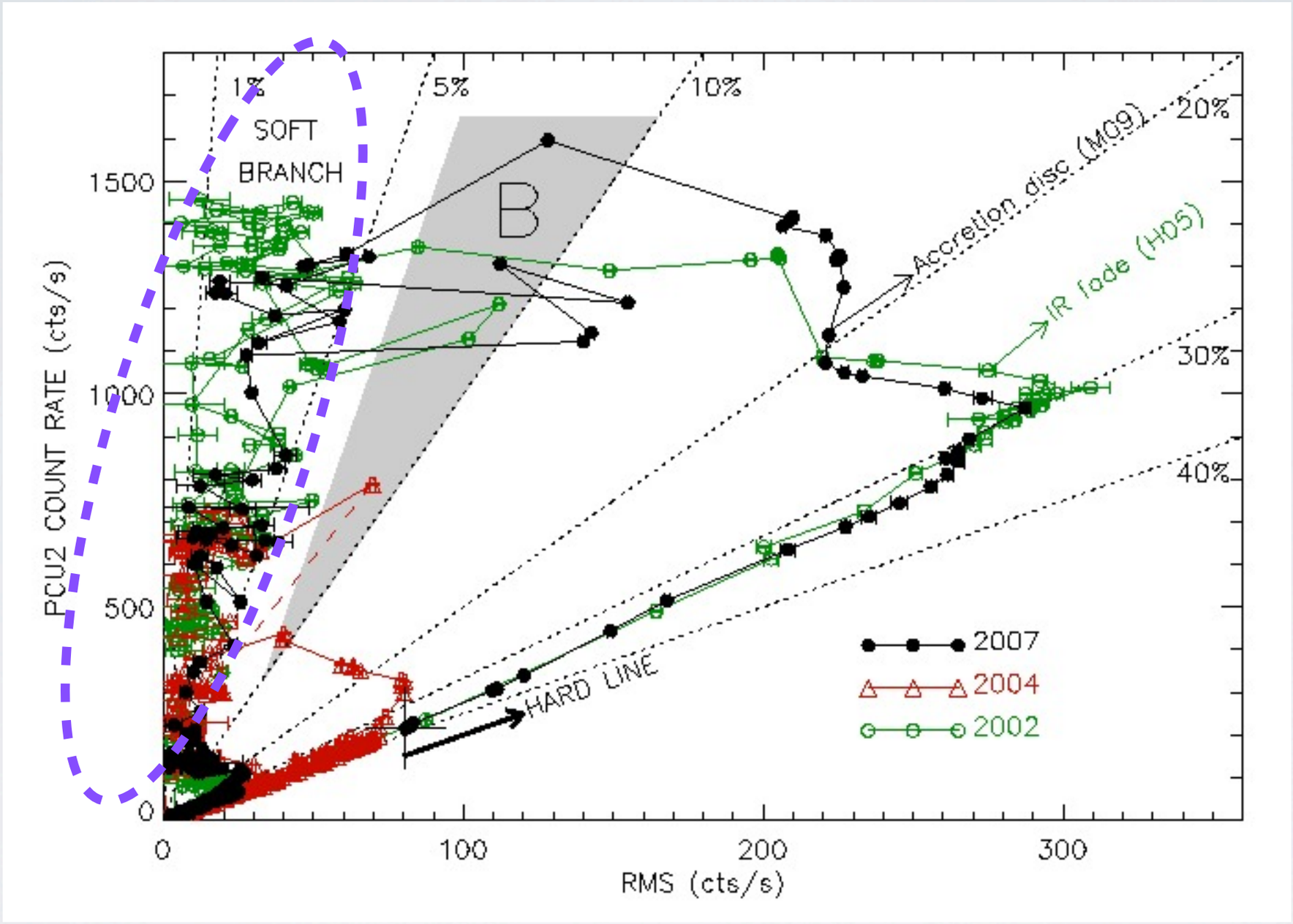


Istanbul, network meeting 2010

Black Hole Universe

THE RMS-INTENSITY DIAGRAM

Soft Branch

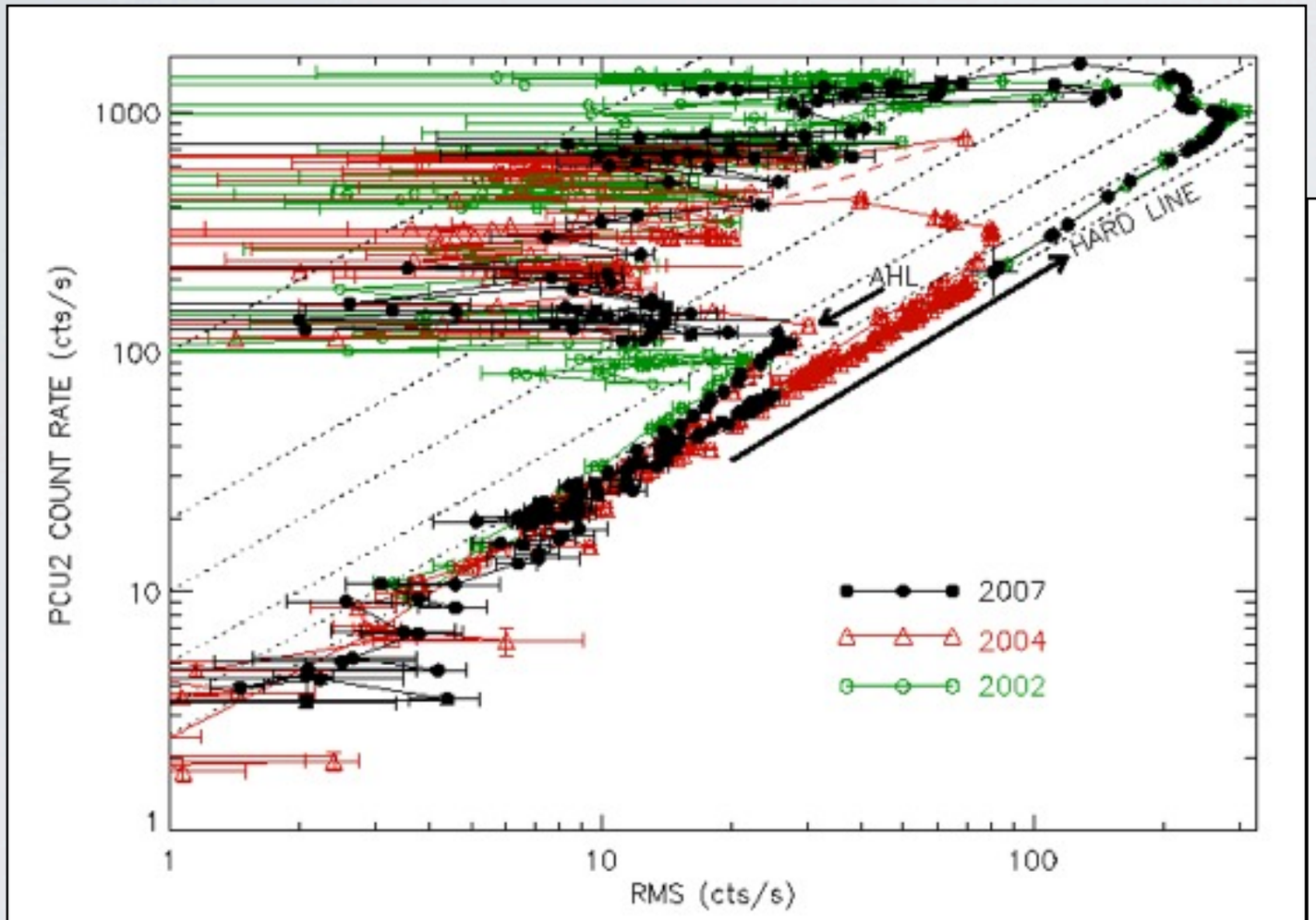


Istanbul, network meeting 2010

Black Hole Universe

THE RMS-INTENSITY DIAGRAM

Adjacent Hard Line



- Hard line across 3 orders of magnitude
- Presence of an Adjacent Hard Line
- No evidence for extra-component at low count-rates

Istanbul, network meeting 2010

Black Hole Universe

XTE J1752-223

the hard state of a new discovered black hole binary

Muñoz-Darias et al., MNRAS Lett., 2010

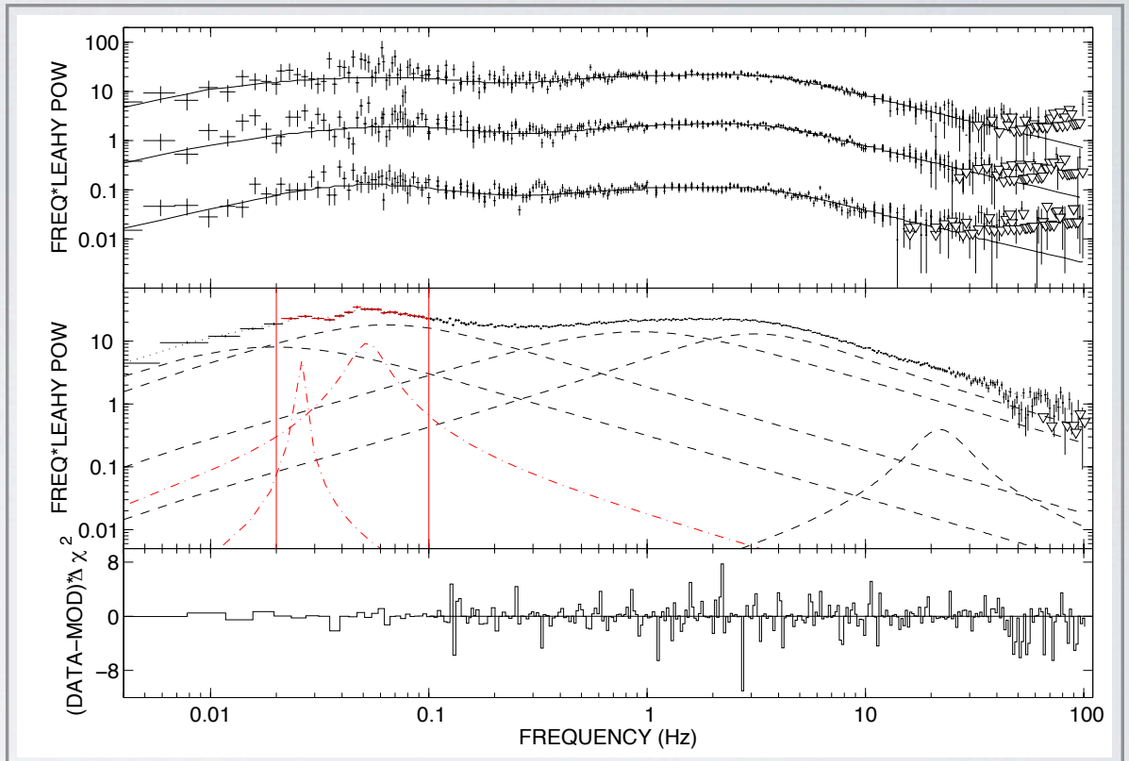
XTE J1752-233 IN HARD STATE

- **Discovered by RXTE**
  23/09/2009; Markwardt et al. 2009
- **Infrared/optical counterparts**
  Torres et al. 2009
- **Radio counterpart**
  Brocksopp et al. 2009

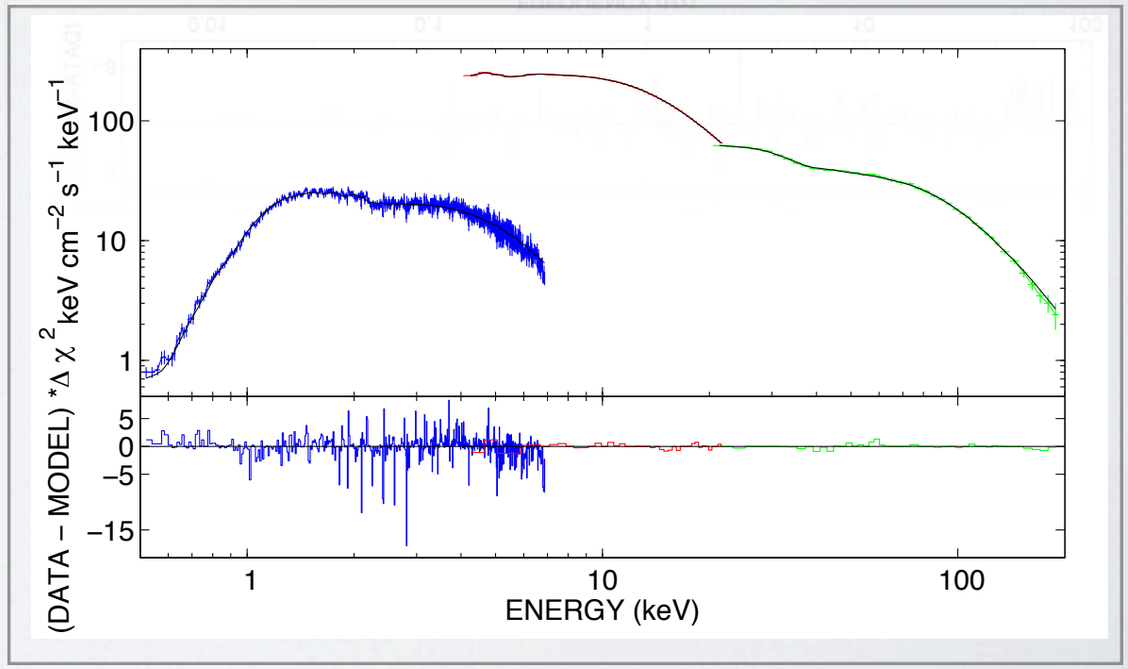
★Long (~116 ks) RXTE observation and simultaneous SWIFT data taken during 26-29 October, 2009

single orbits PDS

2 days average PDS



swift/XRT+PCA+HEXTE energy spectrum

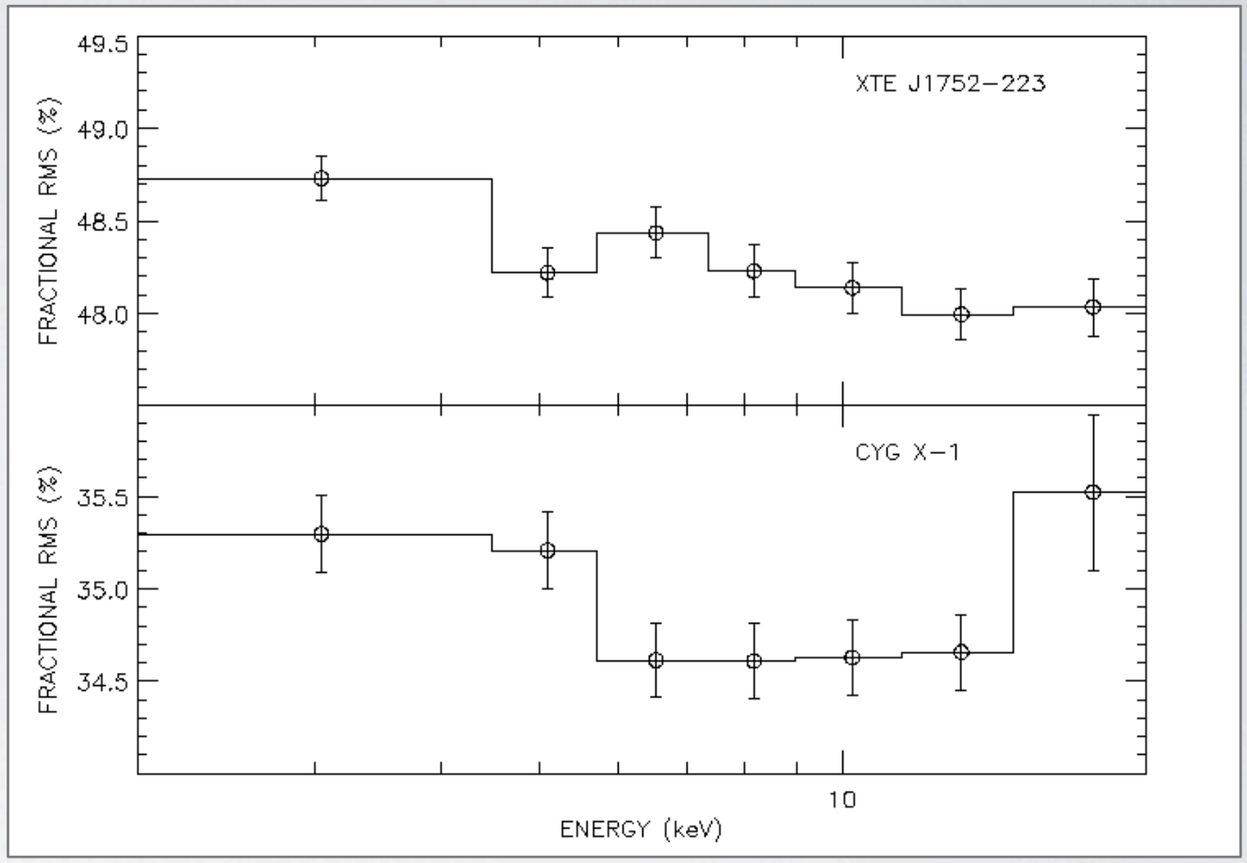


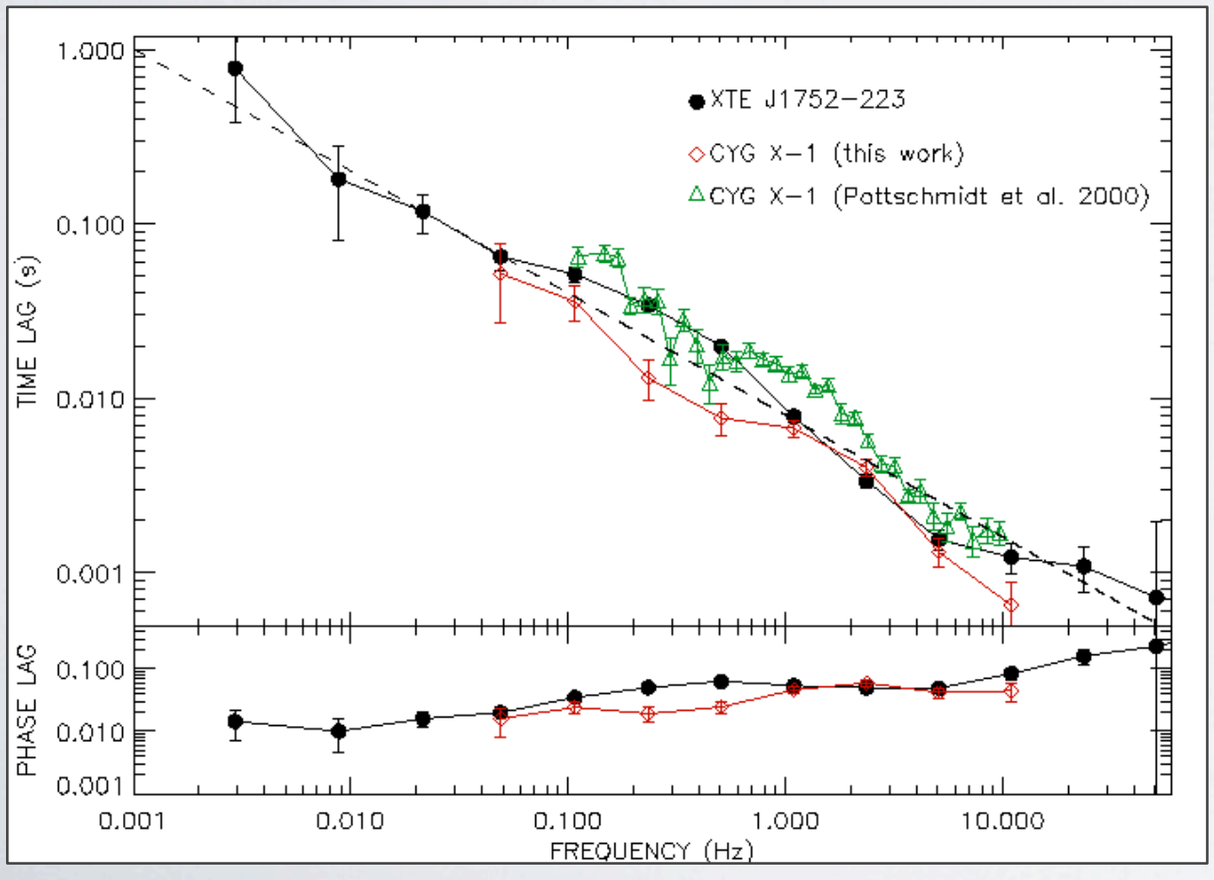
Istanbul, network meeting 2010

Black Hole Universe

XTE J1752-233 IN HARD STATE

- Very similar to **Cyg X-1** in hard state
- Black Hole candidate



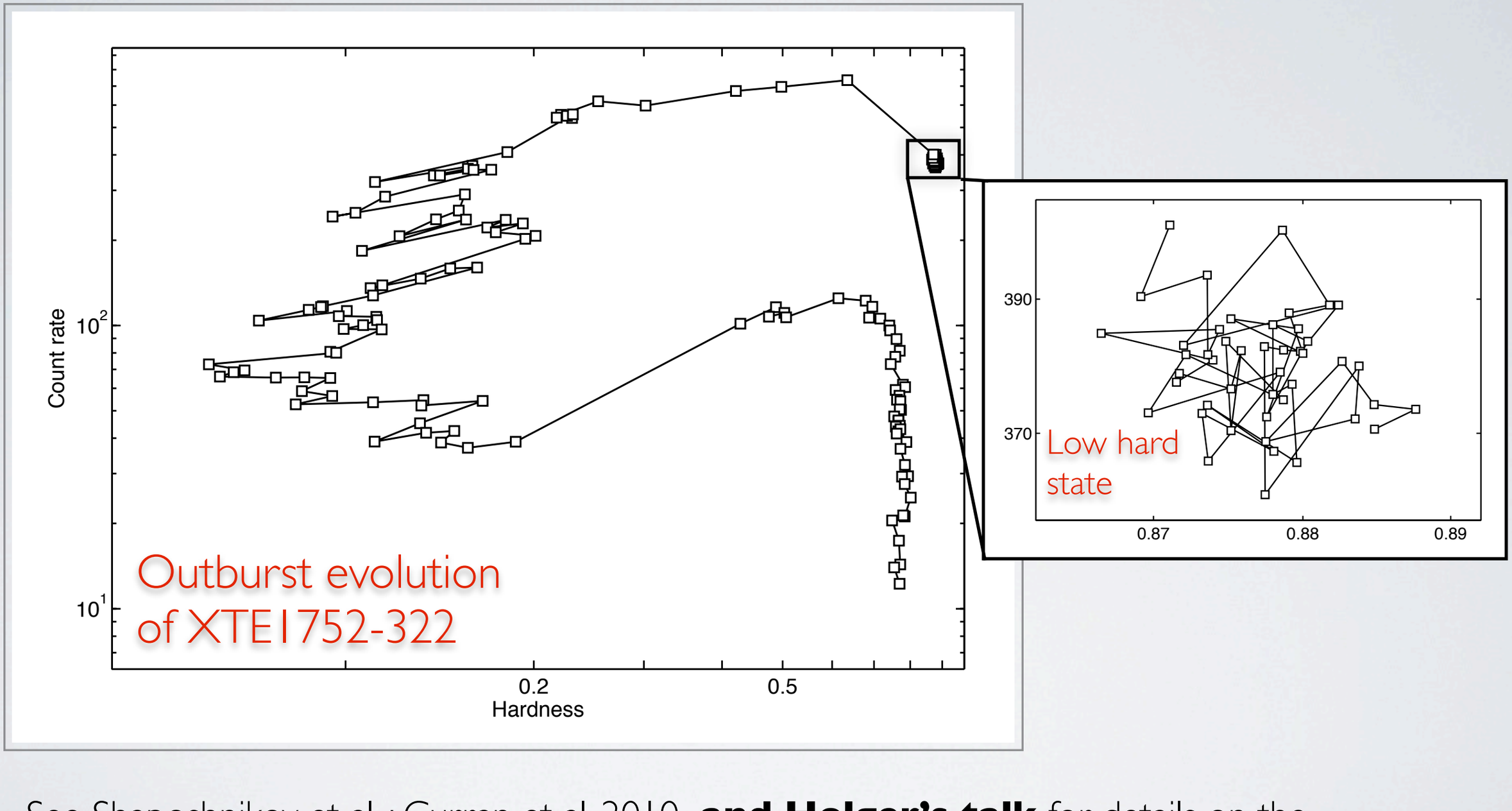


Time-lags difficult to be explained by Comptonization processes.

Istanbul, network meeting 2010

Black Hole Universe

XTE J1752-223: OUTBURST EVOLUTION



See Shaposhnikov et al. ; Curran et al. 2010 **and Holger's talk** for details on the outburst evolution

Istanbul, network meeting 2010

Black Hole Universe

SUMMARY

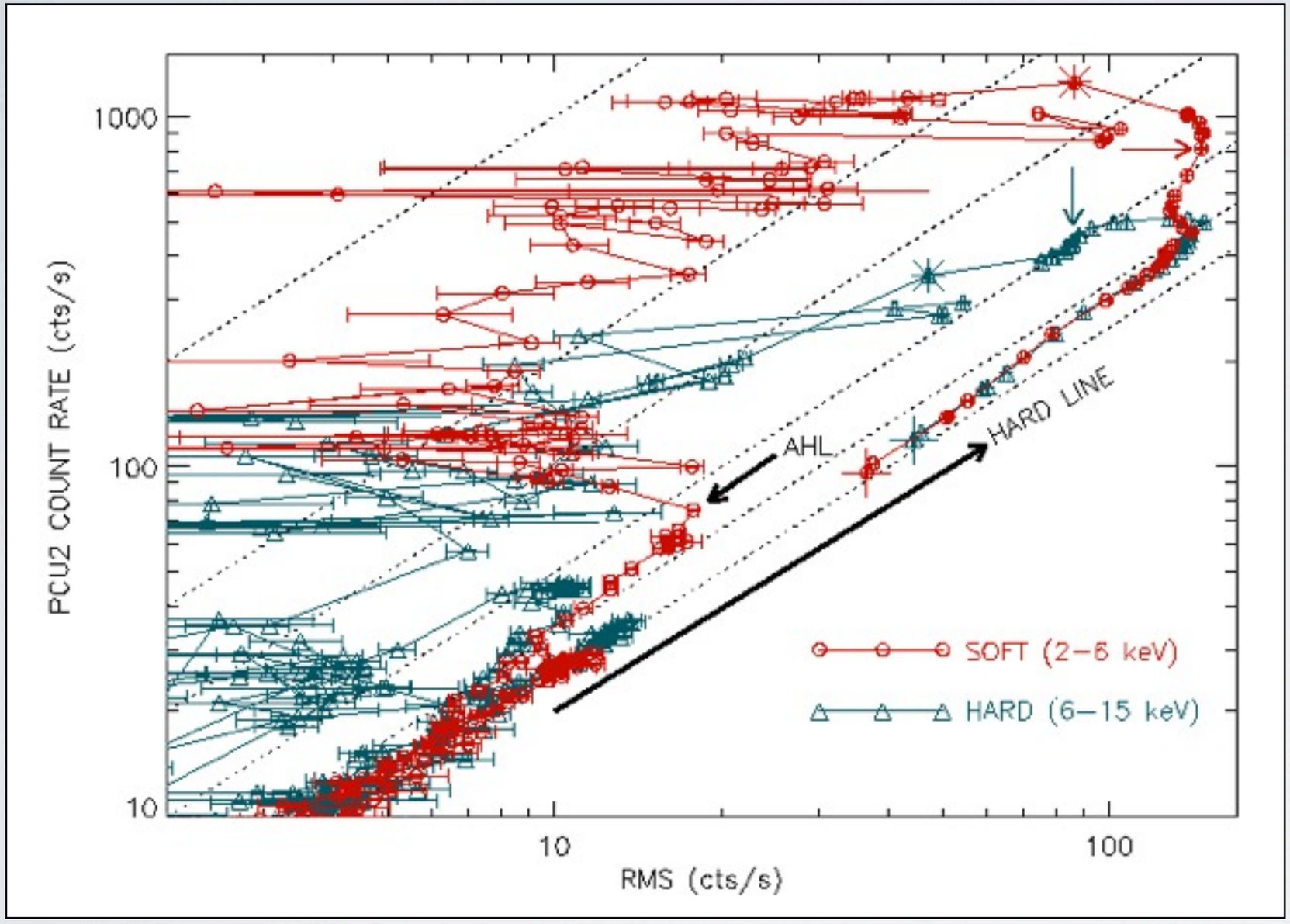
- **H1743-322**
  - Complex Outburst behavior
  - Spectral analysis during LHS is not enough to predict a subsequent transition
  - Timing study on progress
- **GX 339-4 and the variability diagram (RID)**
  - Diverse rms-flux relations outside the hard state
  - Sharp state transitions. Useful for studies in other sources.
  - No evidence for disc variability
- **XTE J1752-223**
  - First published paper on this source
  - Hard state analysis thanks to a long RXTE observation
  - Time-lags not consistent with (purely) Comptonization origin
  - See Holger's talk for outburst evolution

Istanbul, network meeting 2010

Black Hole Universe

THANKS

SOFT/HARD RID



- Flat rms spectrum during the hard line
- More hard variability in soft and intermediates states
- Adjacent hard line present in soft and hard RIDs

Istanbul, network meeting 2010

Black Hole Universe

H1743-322

and the transition mechanism

Motta, Muñoz-Darias, & Belloni, MNRAS, 2010