



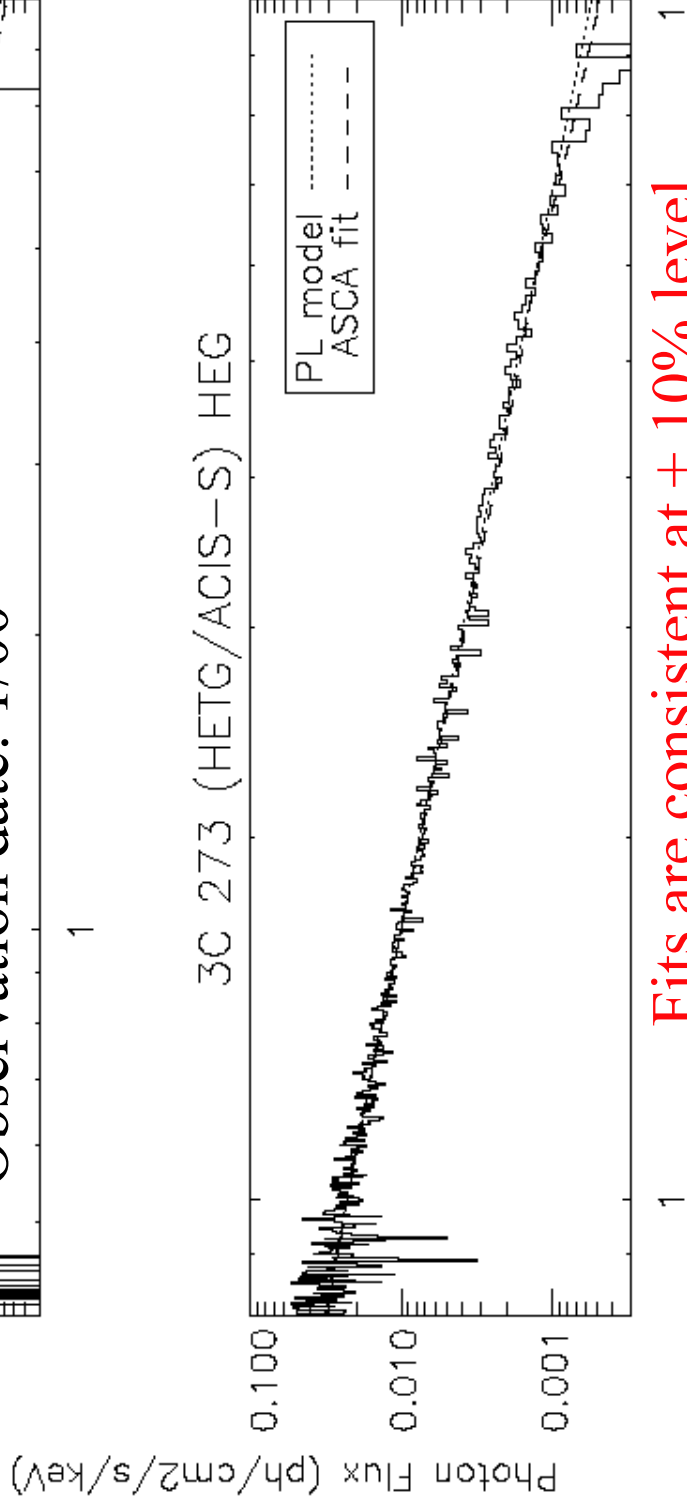
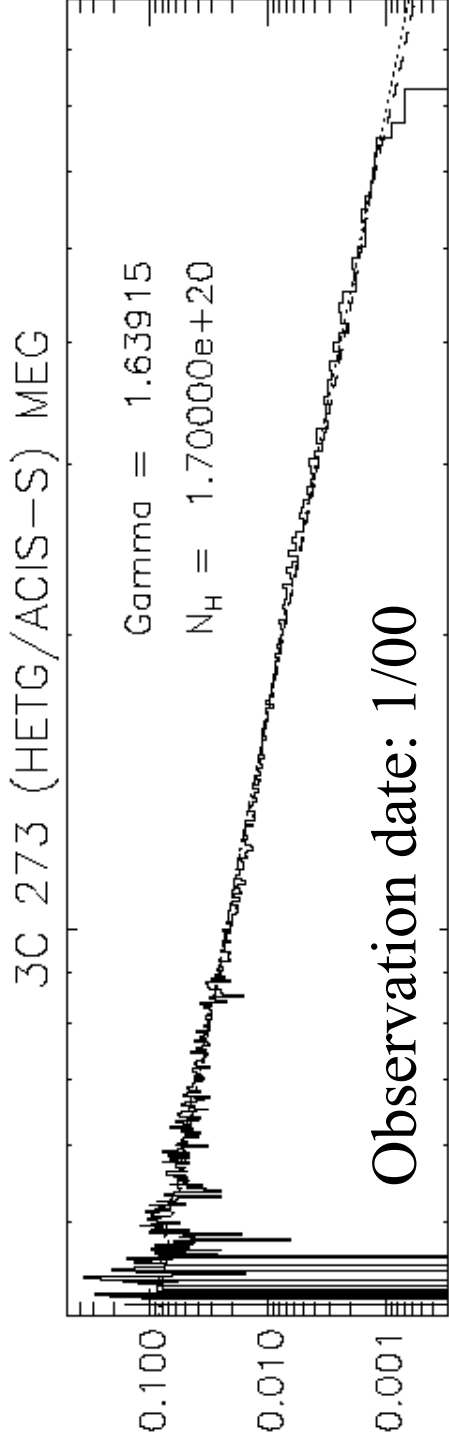
# Cross-Calibrating Chandra HETGS and LETGS with XMM

With material from

J. W. den Herder (SRON)



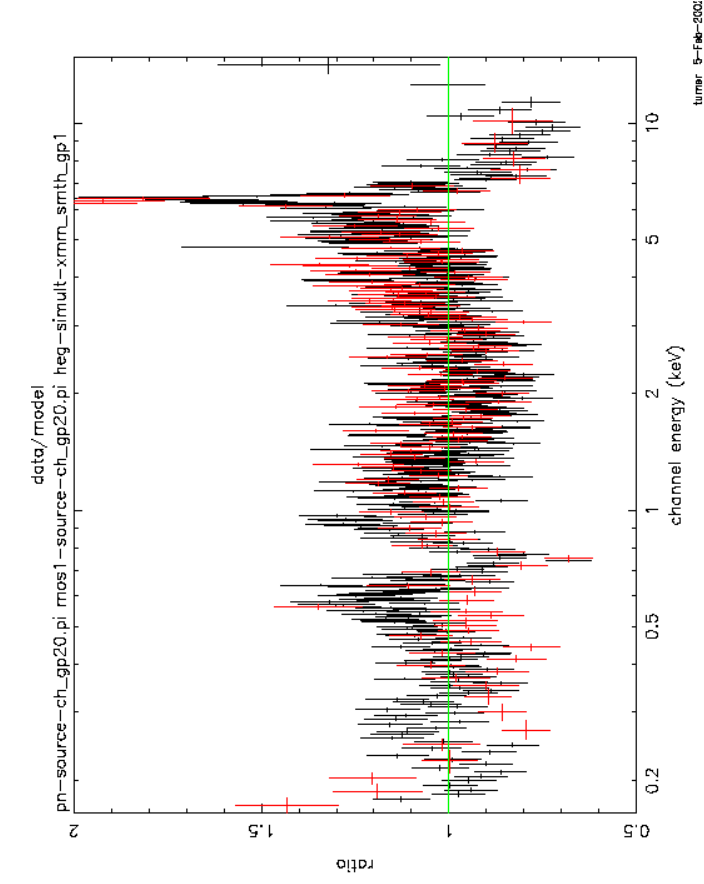
# Cross-Calibration with ASCA



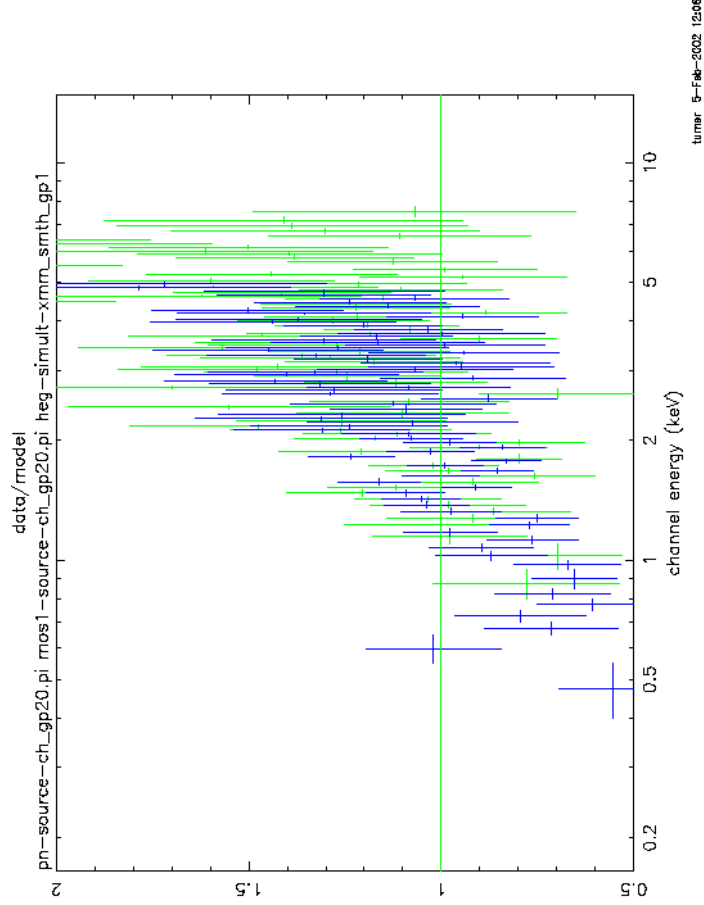
**Fits are consistent at  $\pm 10\%$  level**



# Comparing XMM & HETGS



XMM data (PN, MOS)



Chandra data (HEG, MEG)

- J. Turner provided figures comparing HETGS and simultaneous XMM data
- HETGS data appear to be low by  $\sim 40\%$  relative to MOS & EPIC PN



# Cross-Calibration with XMM

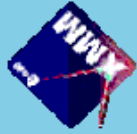
- PKS 2155-304 was observed jointly twice
  - May 2001 and Nov./Dec. 2001
  - J.W. den Herder (SRON) has analyzed XMM data, performed some comparisons to Chandra
  - CXC received data only in July 2002 due to proprietary nature of data
- Developed plan for joint fitting in collaboration with SRON
  - Each instrument data set is fit optimally using internal calibrations and effective energy ranges set
  - Fits are characterized numerically, then compared to create a single reference model
  - All groups recalibrate to reference model



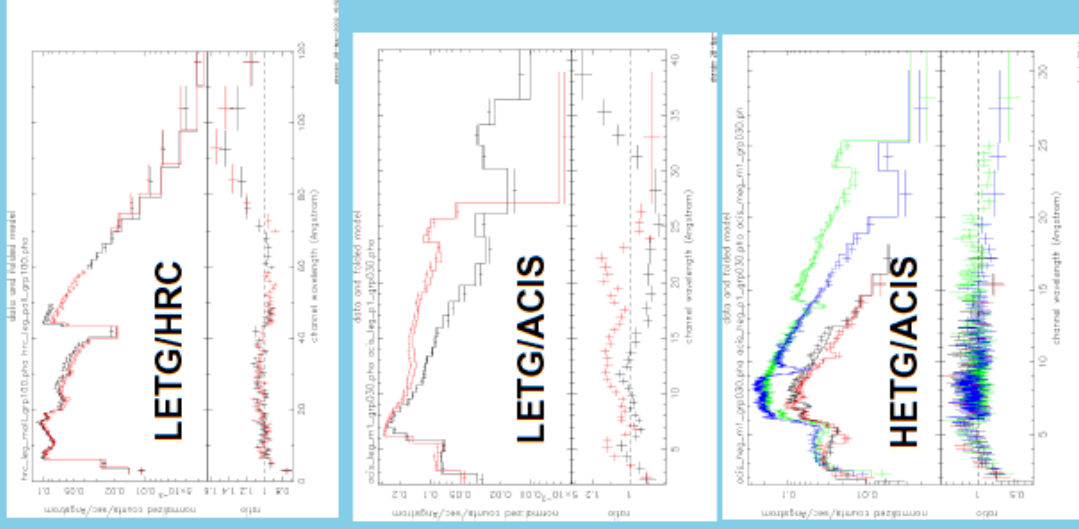
Courtesy J.W. den Herder (SRON)

# All spectra (orbit 362)

- All data are shown with optimal fit



8-4-02



Nov. 7, 2002

CXC Calibration Workshop

21

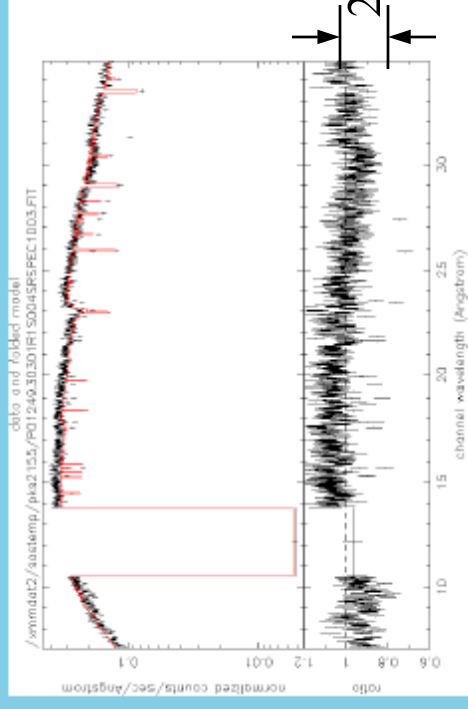
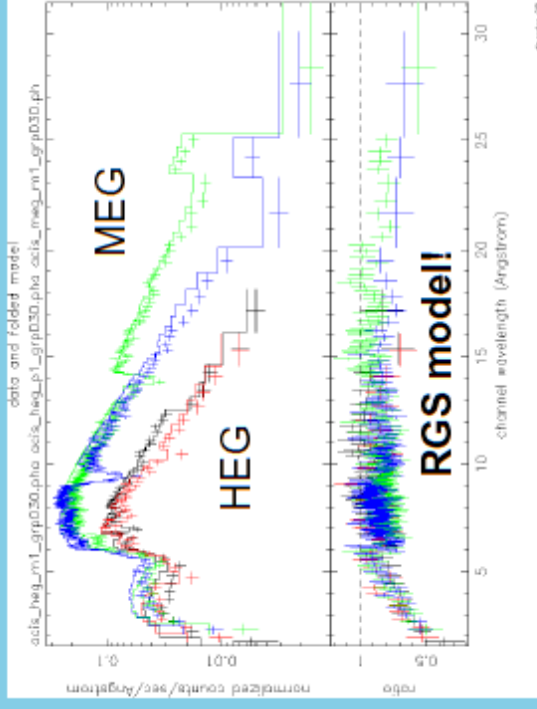
CXC



Courtesy J.W. den Herder (SRON)

## RGS - HETG/ACIS comparison

- Normalisation difference of about 15%, RGS and HEG in better agreement (5%) than with MEG
  - We agree: HEG is “better”
- PL index RGS and MEG in good agreement ( $< 0.03$ ), difference with HEG larger ( $\sim 0.2$ )
  - MEG bandpass matches RGS
- Residuals in RGS above 7 Å smaller than for HEG/MEG combination
  - Correct MEG, then HETGS will agree with XMM RGS to  $\pm 5\%$





Courtesy J.W. den Herder (SRON)

## RGS - LETG/ACIS comparison

Photon Norm  
index (x 10<sup>4</sup>)

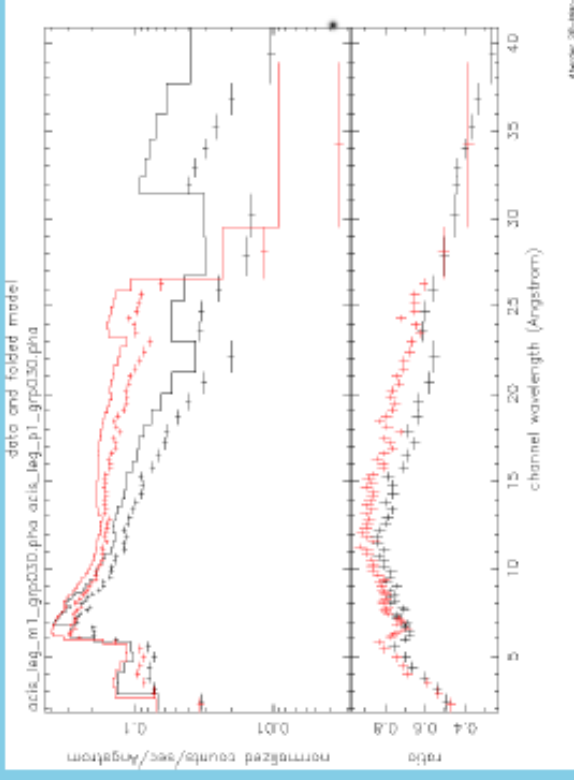
- **Chandra results**
  - 0.335-1.75 2.659(20) 617(4)
  - 0.3- 6 keV 2.714(10) 617(6)

- **RGS results**
  - RGS 2.363(3) 650(3)

- **Differences:**
  - normalisation ~ 5%
  - PL ~ 0.3

➤ LETG/ACIS agrees with XMM RGS to ±5%

➤ LETG/ACIS EA should be corrected for deeper contamination, changing slope





# Summary of HETGS Cross Calibration Work

- HETGS agrees with ASCA to  $\pm 10\%$
- RGS analysis indicates agreement to 5-15%
  - HEG: 5%
  - MEG: 15% (likely due to MEG efficiencies)
  - LETGS: 5%
- RGS has some internal systematic errors to resolve
- Cross-calibrate by comparing models after each calibration team works out internal inconsistencies