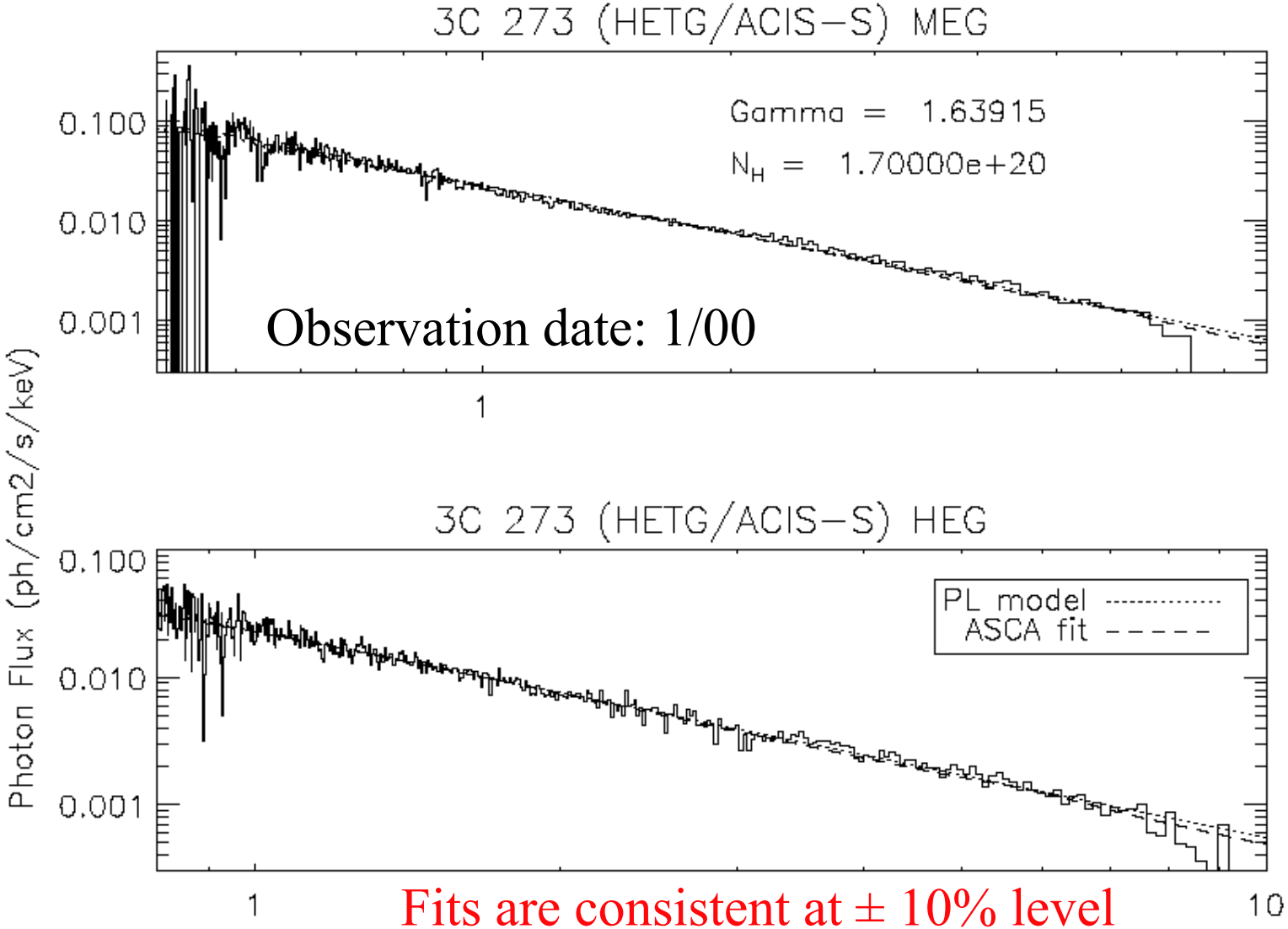
# Cross-Calibrating Chandra HETGS and LETGS with XMM

With material from

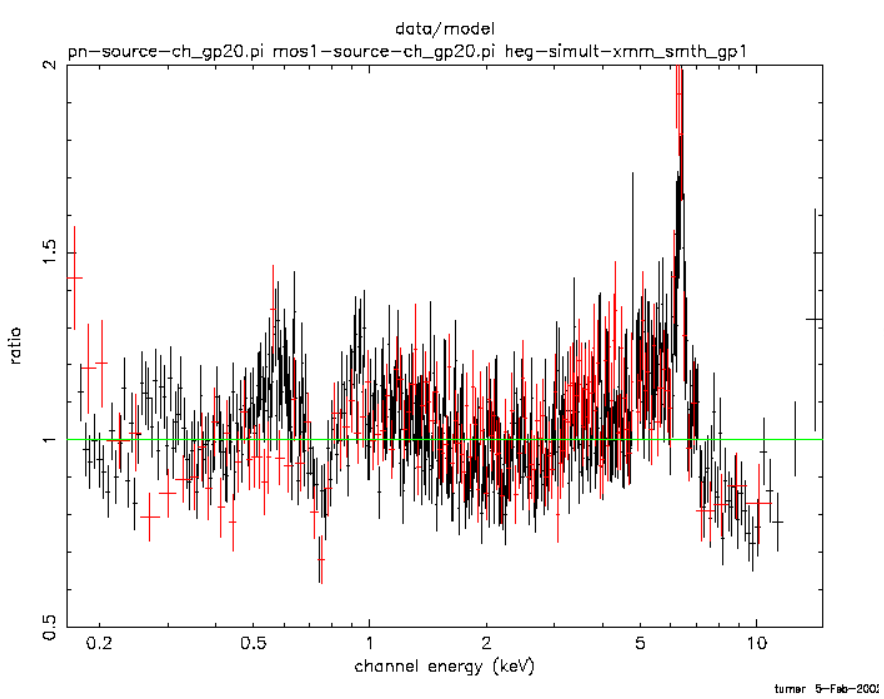
J. W. den Herder (SRON)

# Cross-Calibration with ASCA

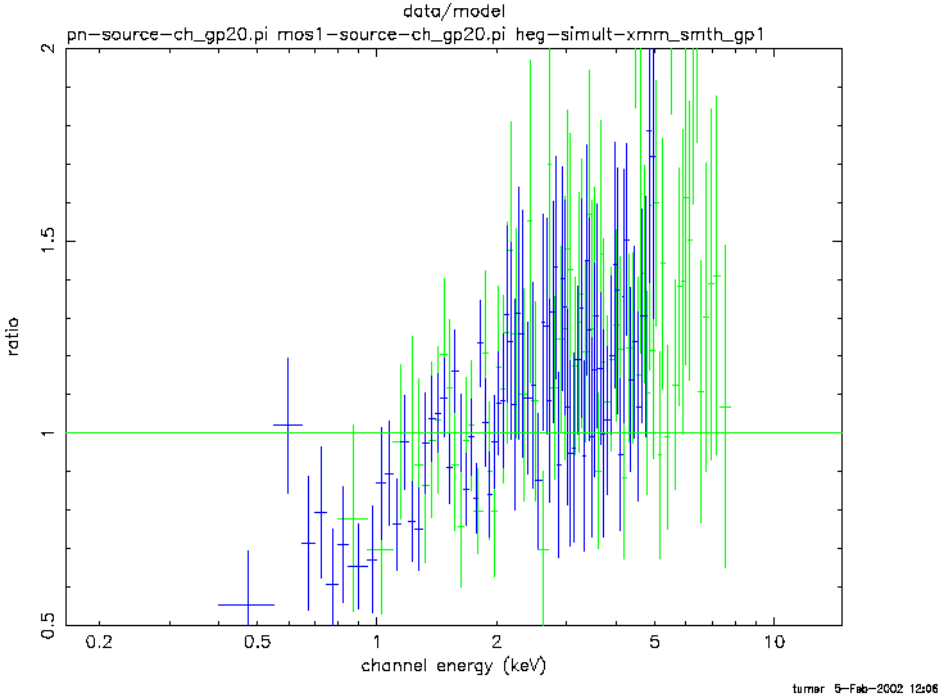



Fits are consistent at ± 10% level

# 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 ~40% relative to MOS & EPIC PN

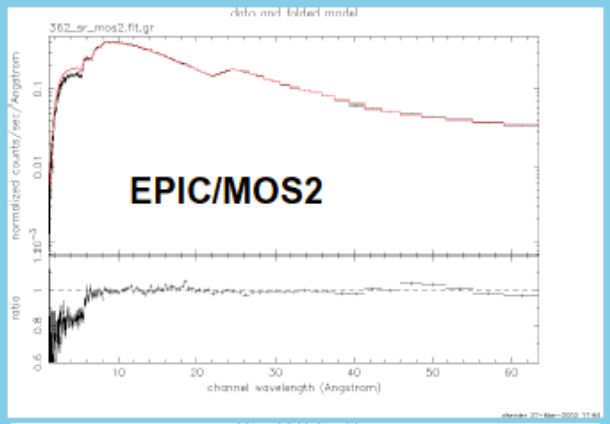
# Cross-Calibration with XMM

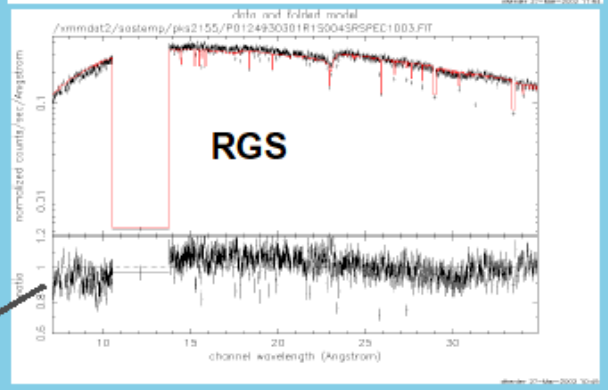
- PKS 2155-304 was observed jointly twice
  - May 2001 and Nov./Dec. 2001
  - J.W. den Herder (SRON) has analyzed XMM data, performed some comparisons to Chandra
  - CXC received data only in July 2002 due to proprietary nature of data
- Developed plan for joint fitting in collaboration with SRON
  - 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

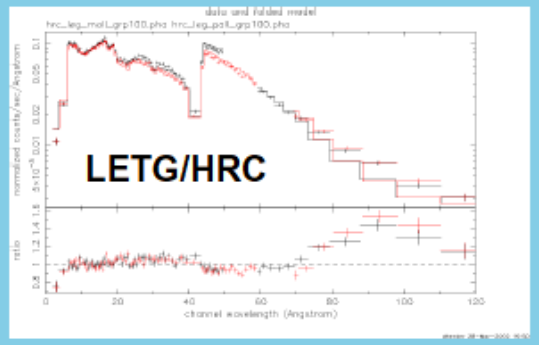
Courtesy J.W. den Herder (SRON)

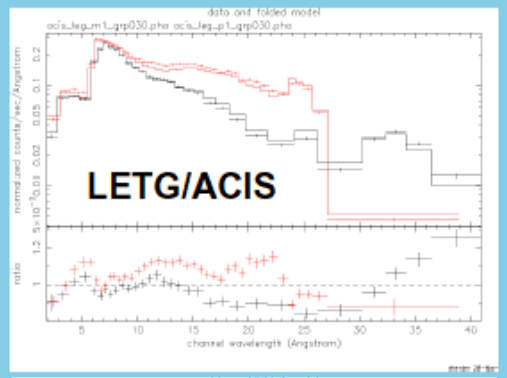
# All spectra (orbit 362)

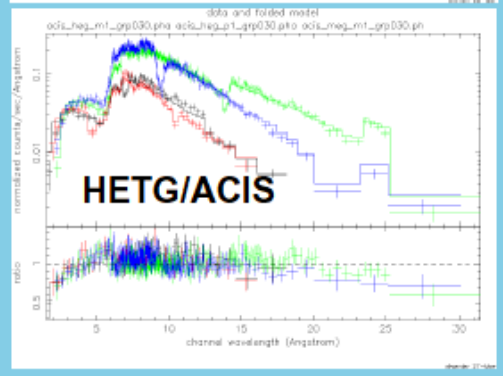
- All data are shown with optimal fit



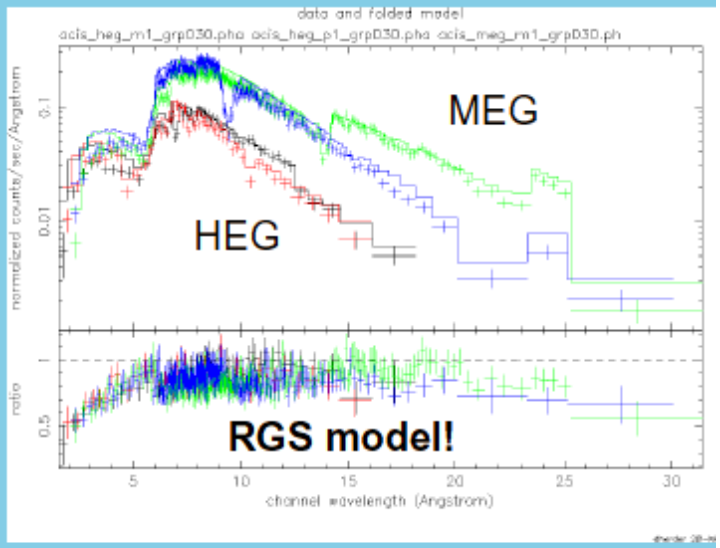

8-4-02

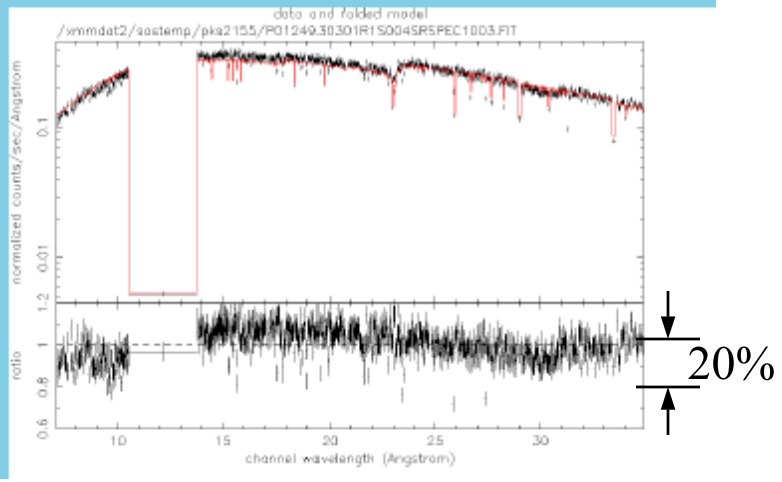
Courtesy J.W. den Herder (SRON)

# 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 (~ 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 ±5%

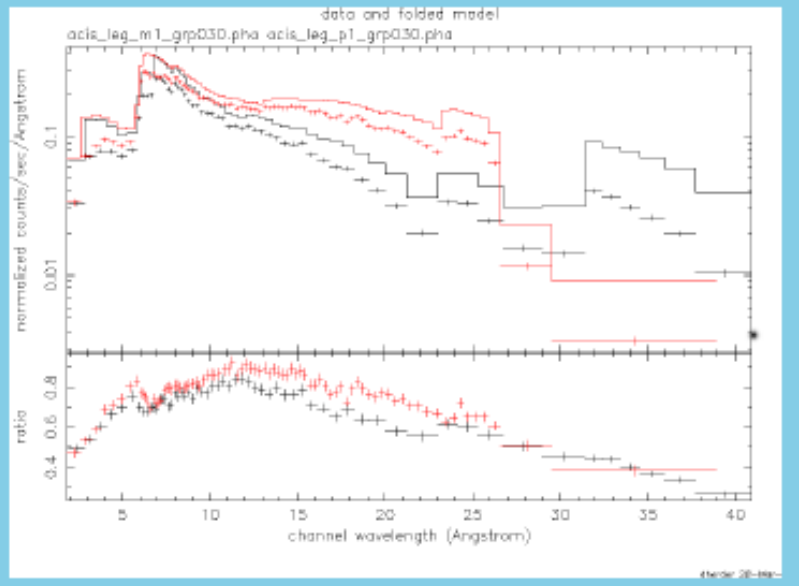


Courtesy J.W. den Herder (SRON)

# RGS - LETG/ACIS comparison

| | Photon index | Norm ($\times 10^4$) |
|---|---|---|
| **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 ±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