Modelowanie widm SphinX'a i ich interpretacja „od podszewki"

Synteza widm CHIANTI

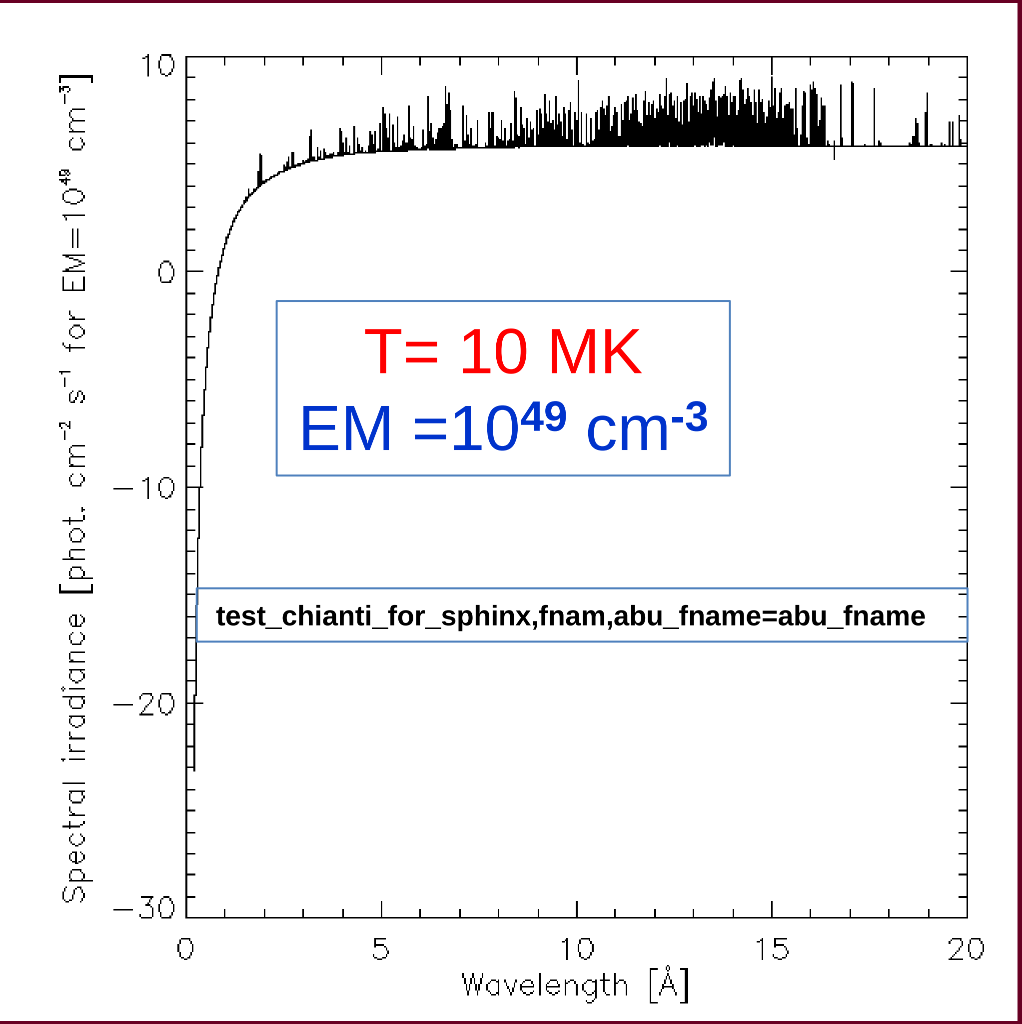
Rola procesów

Modelowanie DEM

Rola „niepewnosci" skladu chemicznego

Seminarium heliofizyczne Prof. Jakimca 5 grudnia 2011

Input spectra: CHIANTI code (6.01) v. 7.01 is available 2 weeks ago



- Inputs:
  - plasma composition i.e. elemental abundances
  - T & EM
- Plasma assumed thermal
  - Maxwellian distribution
  - Ionisation equilibrium
  - Free-free
  - Free-bound
  - Two-photon
  - & line emission

CHIANTI calling keys

- **ch_synthetic**, ; **calculates LINE EMISSION for unit abundances**
  - 2.d-1,6.5d1, limiting wavelengths ~10000 lines
  - **output=output** ,
  - pressure=1.e+15,
  - /photons, ; forces output in photons
  - /all, ; includes all lines in repository
  - ioneq_name=concat_dir(concat_dir(!xuvtop,'ioneq'),'**bryans_etal_09.ioneq**'),
  - logt_isothermal=alog10(temprob) ; picks the temperature
  - ,logem_isothermal=**22.650149d0 ; for EM=10^49**

- The output is incorporated into **make_chianti_spec**: ff,fb,2p and adds lines for assumed abundances
    - Maxwellian distribution
    - Ionisation equilibrium
  - Free-free
  - Free-bound
  - Two-photon
  - & line emission: **thermal widths incorporated Ti=Te**

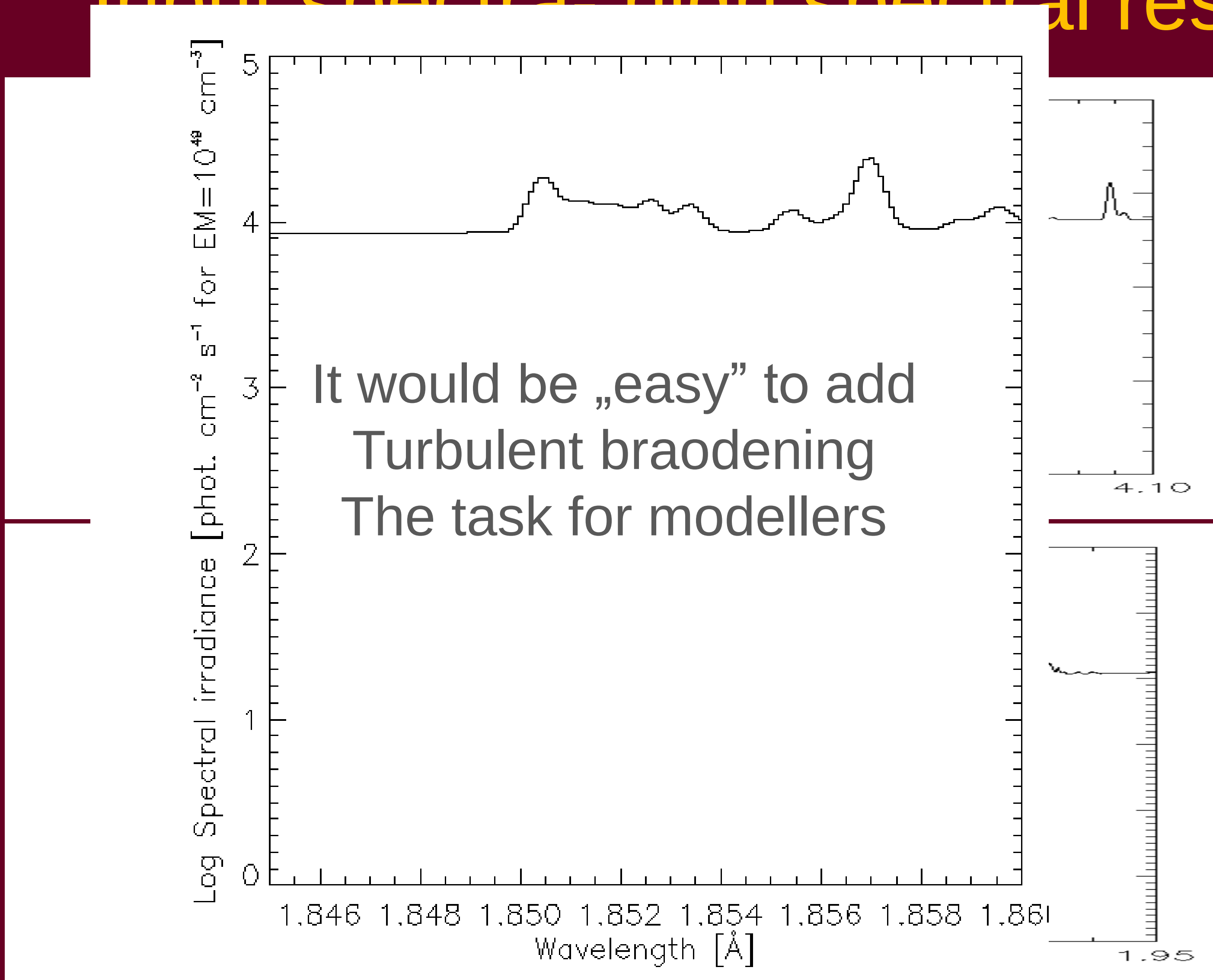
This procedure belo, I rewrote in order to see individual contributions

make_chianti_spec, output, wlambda, spectrump,aff,afb,a2p,lspec,
/CONTINUUM,/verbose,/photons,temperature=temprob,$

BIN_SIZE=1.d-4, WRANGE=[0.2,20.]*1.d0,$

abund_name= abu_name

Input spectra- high spectral resolution



It would be „easy” to add
Turbulent braodening
The task for modellers

101 T

1-100 MK

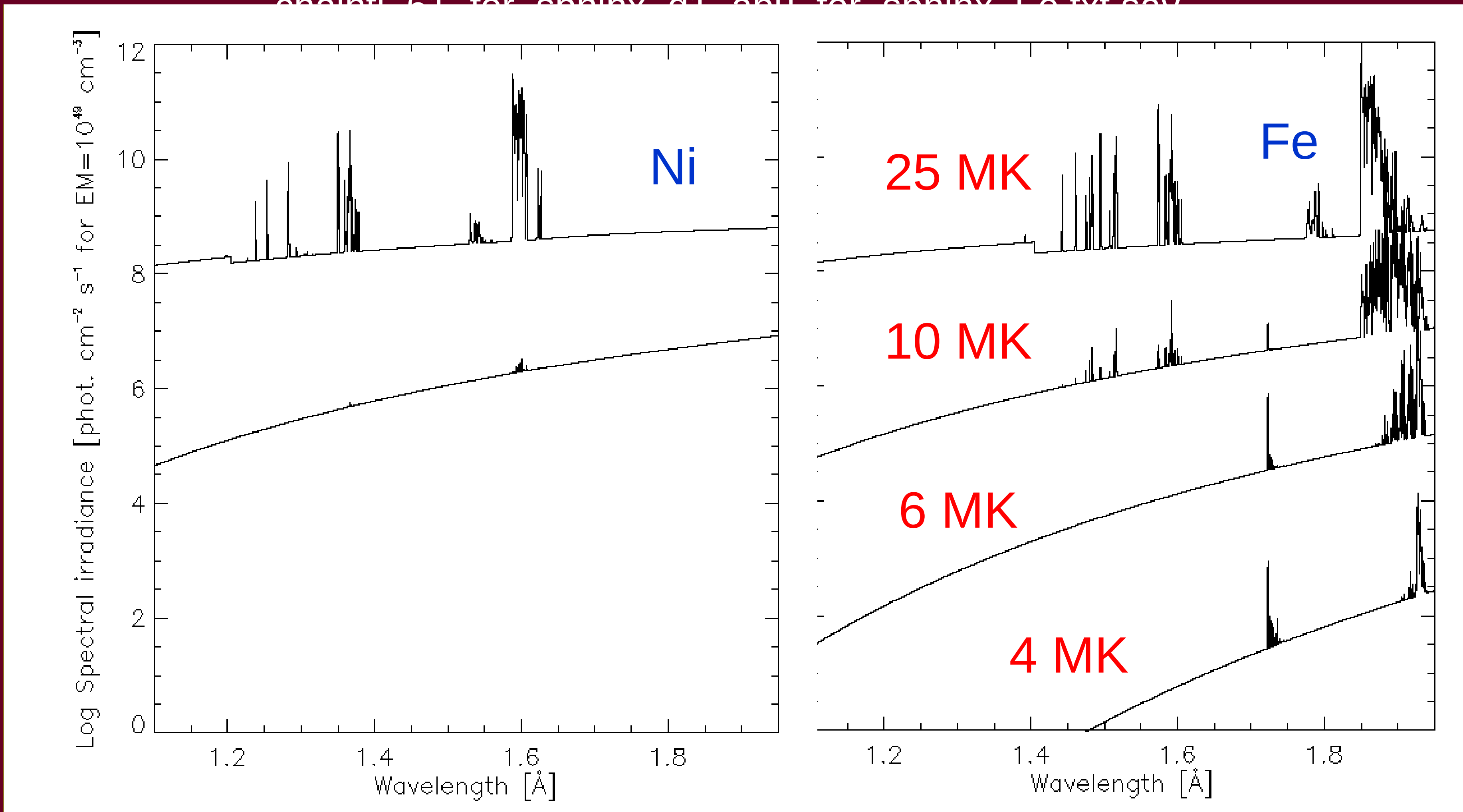
dlogT=0.02

Each

0.0001 Å

spectra are available for plasmas where H and He abundances are as in the corona, but abundance of selected element=12

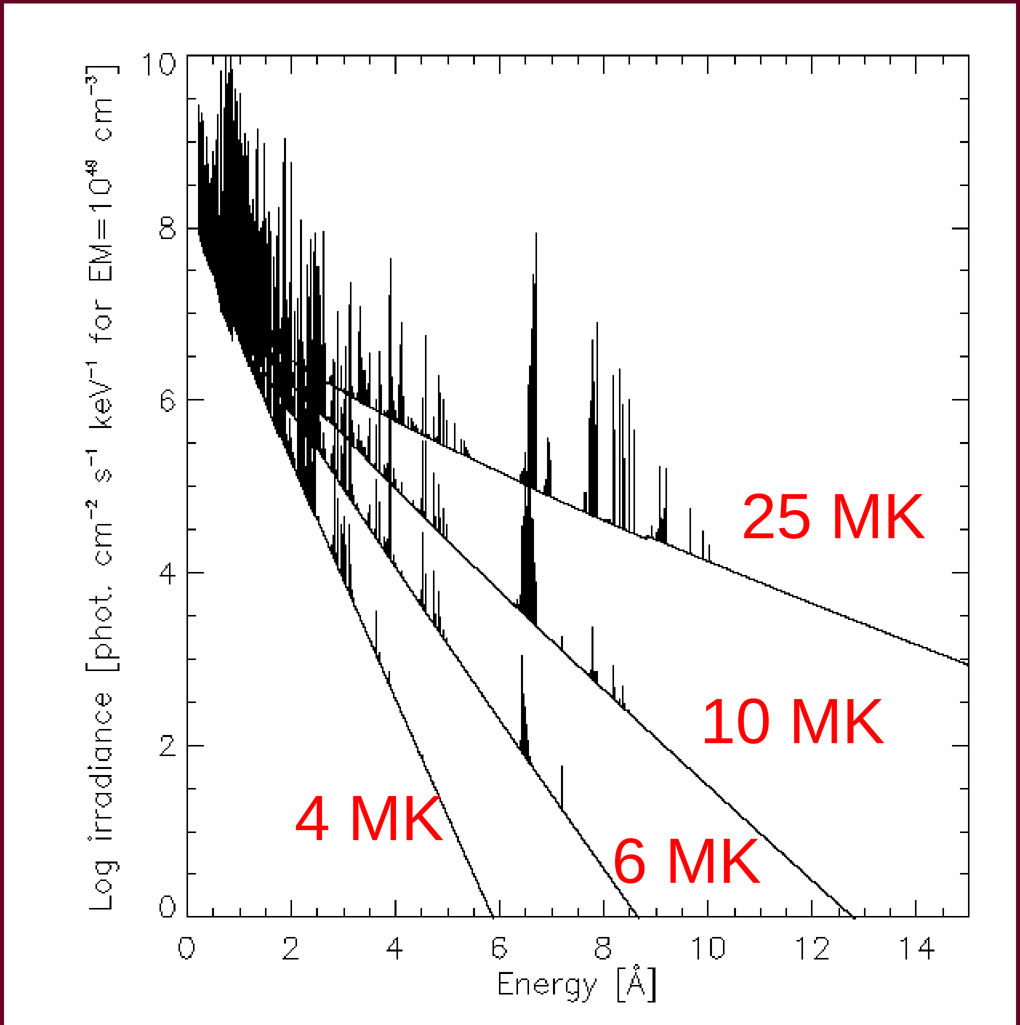
chainti 61 for sphinx d1 abu for sphinx Fe.txt.sav



CHIANTI allows also for a direct calculations of spectra vs Energy

- **make_chianti_spec**, output, elambda, pspectrum,aff,afb,a2p,lspec, /CONTINUUM,**/kev**,/verbose,/photons,temperature=temprob,BIN_SIZE=1.d-3, WRANGE=[0.2,20.]*1.d0,   abund_name= abu_name

Example of spectra vs. energy

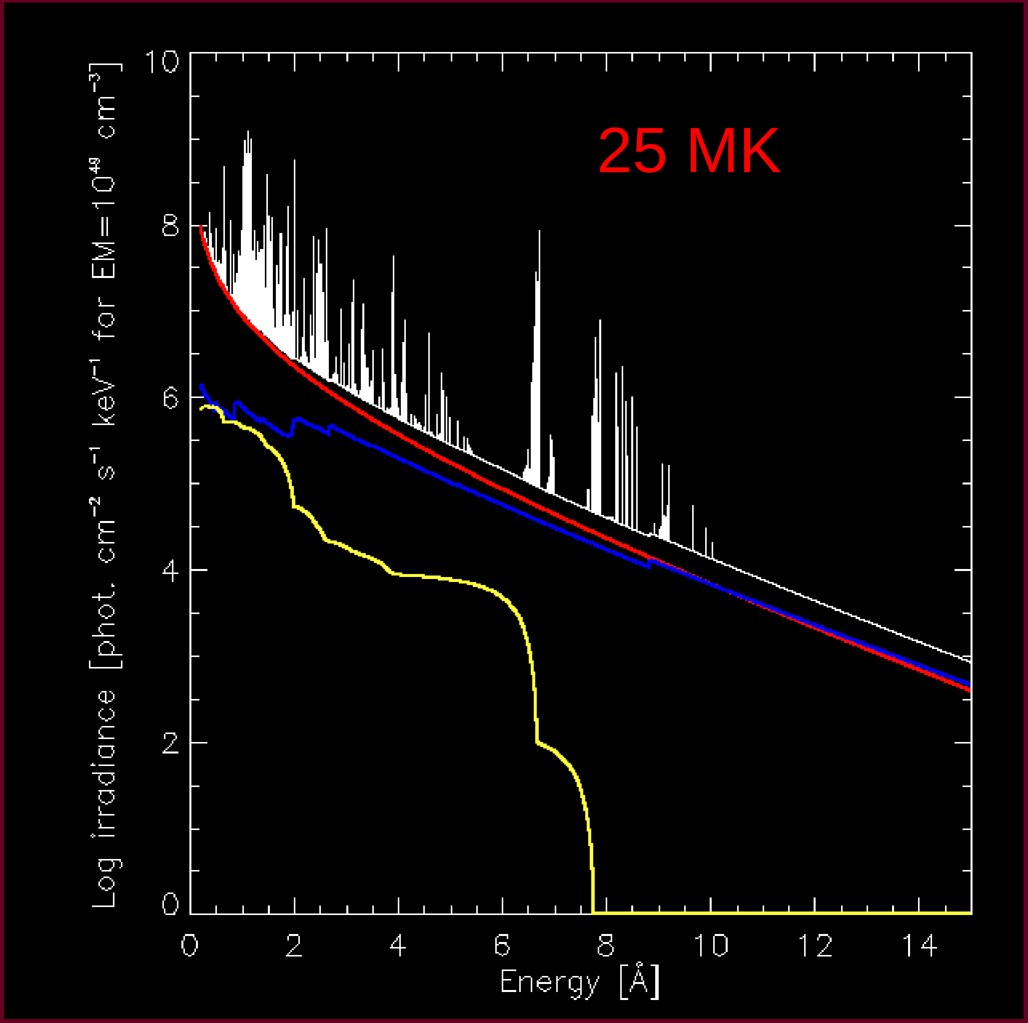


- Each

1 eV

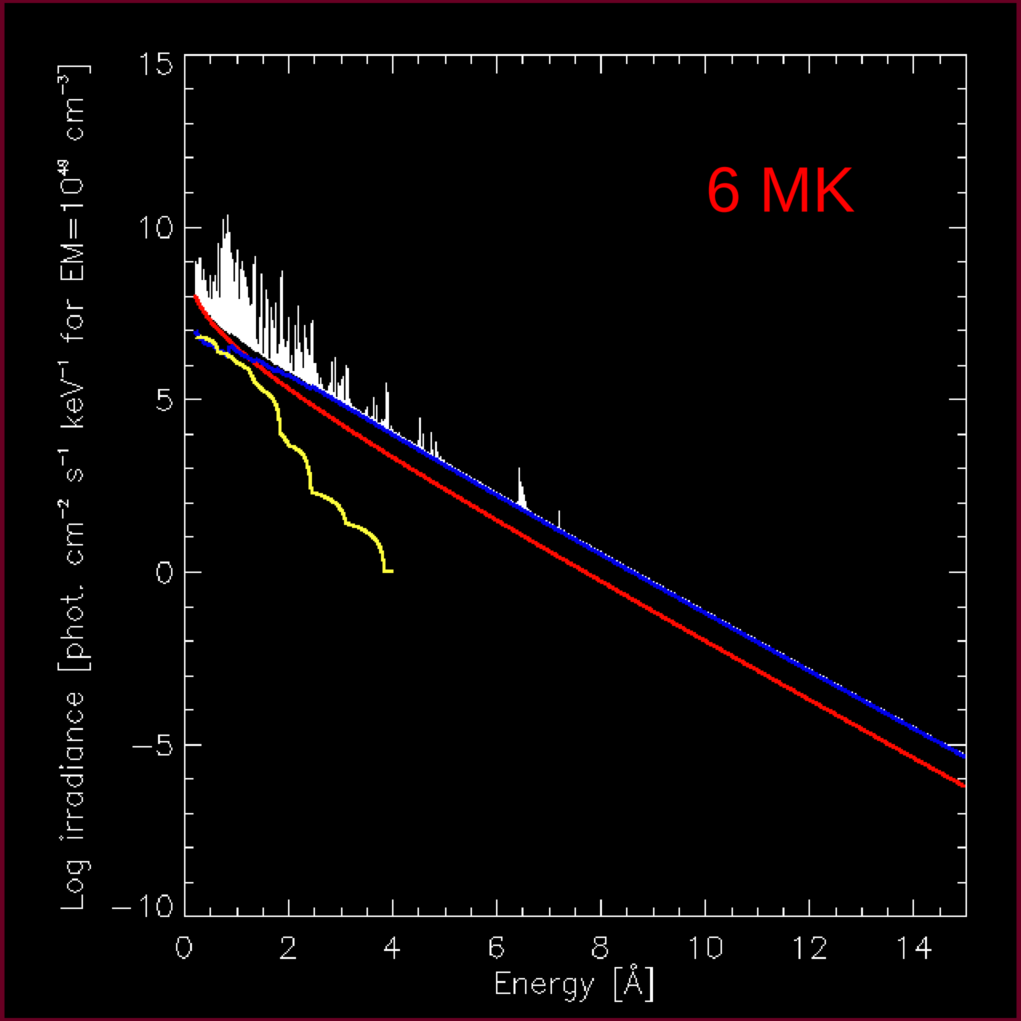
101 T

Role of contributing processes



- Lines
- f-f
- f-b
- Two-phot

Role of contributing processes

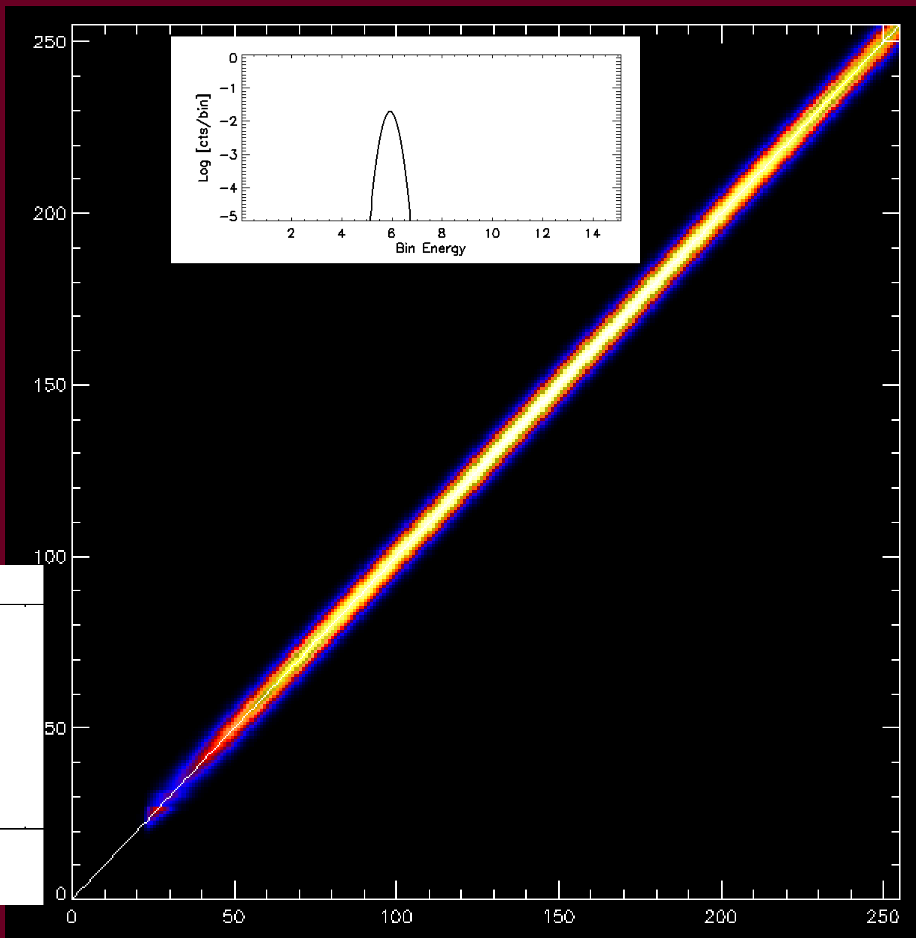


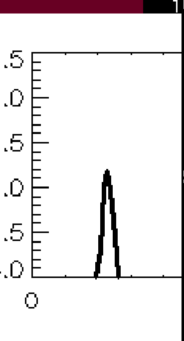
- Lines
- f-f
- f-b
- Two-phot

Instrument response matrix

http://156.17.94.1/sphinx_l1_catalogue/CALIB_SOFT_GUIDE/SPHINX_RSP_256_nom_D1.fts

DRM = mrdfits('SPHINX_RSP_256_nom_D1.fts',1,hdr)





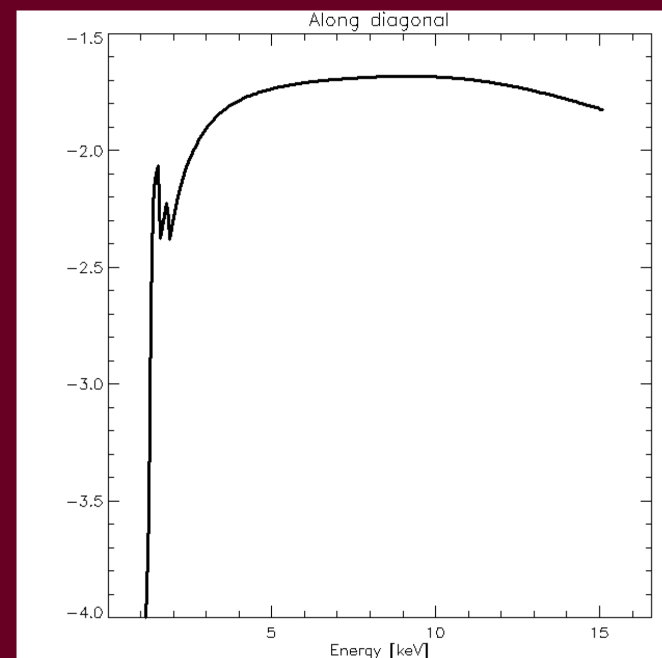
; dispersion:

d_ene=drm.energ_hi-drm.energ_lo

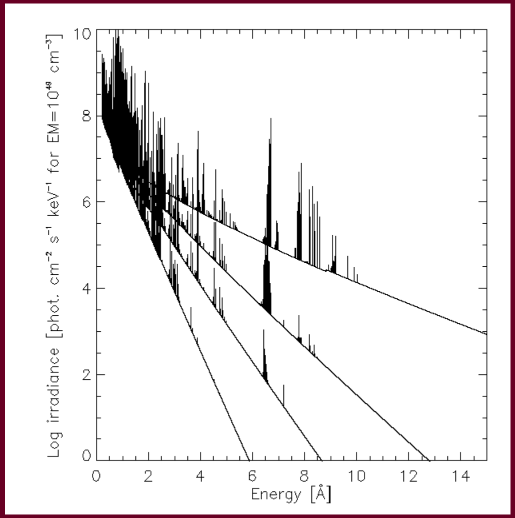
; average bin energy:

e_bin=0.5*(drm.energ_hi+drm.energ_lo)

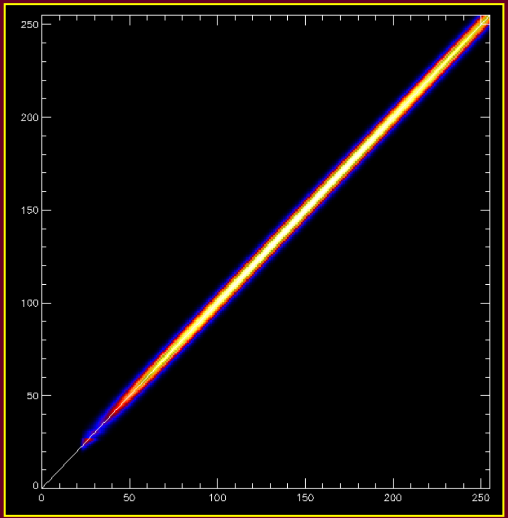
Obs= drm.matrix # (theory*dispersion)



How the instrument sees spectra?



X



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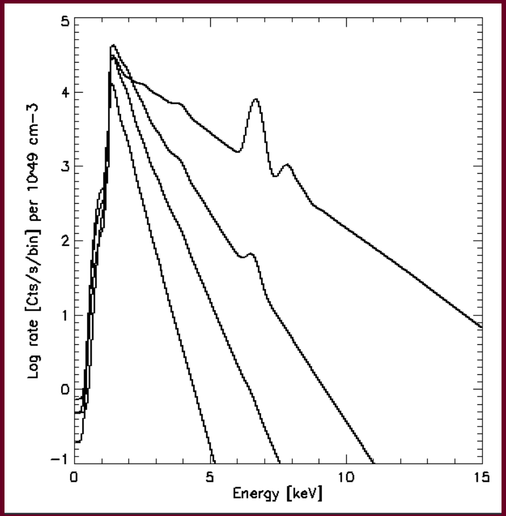
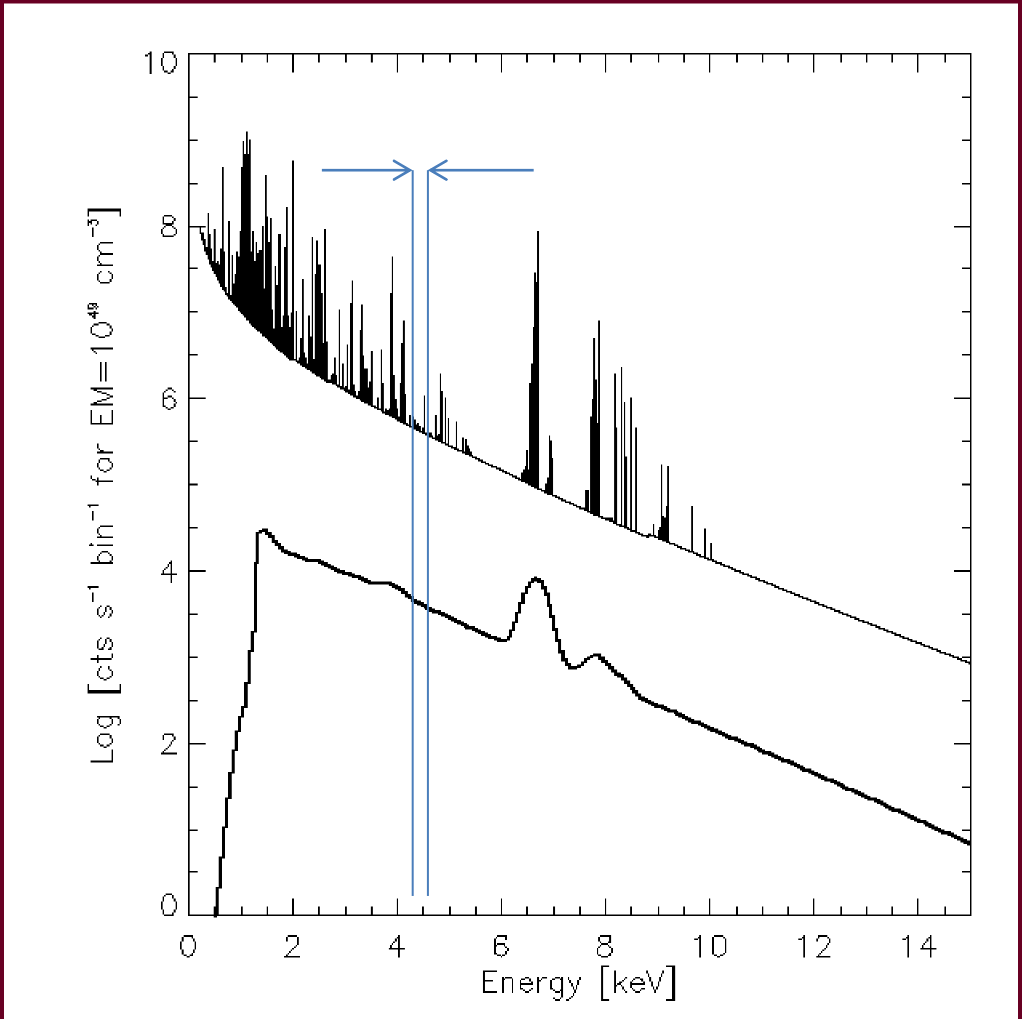


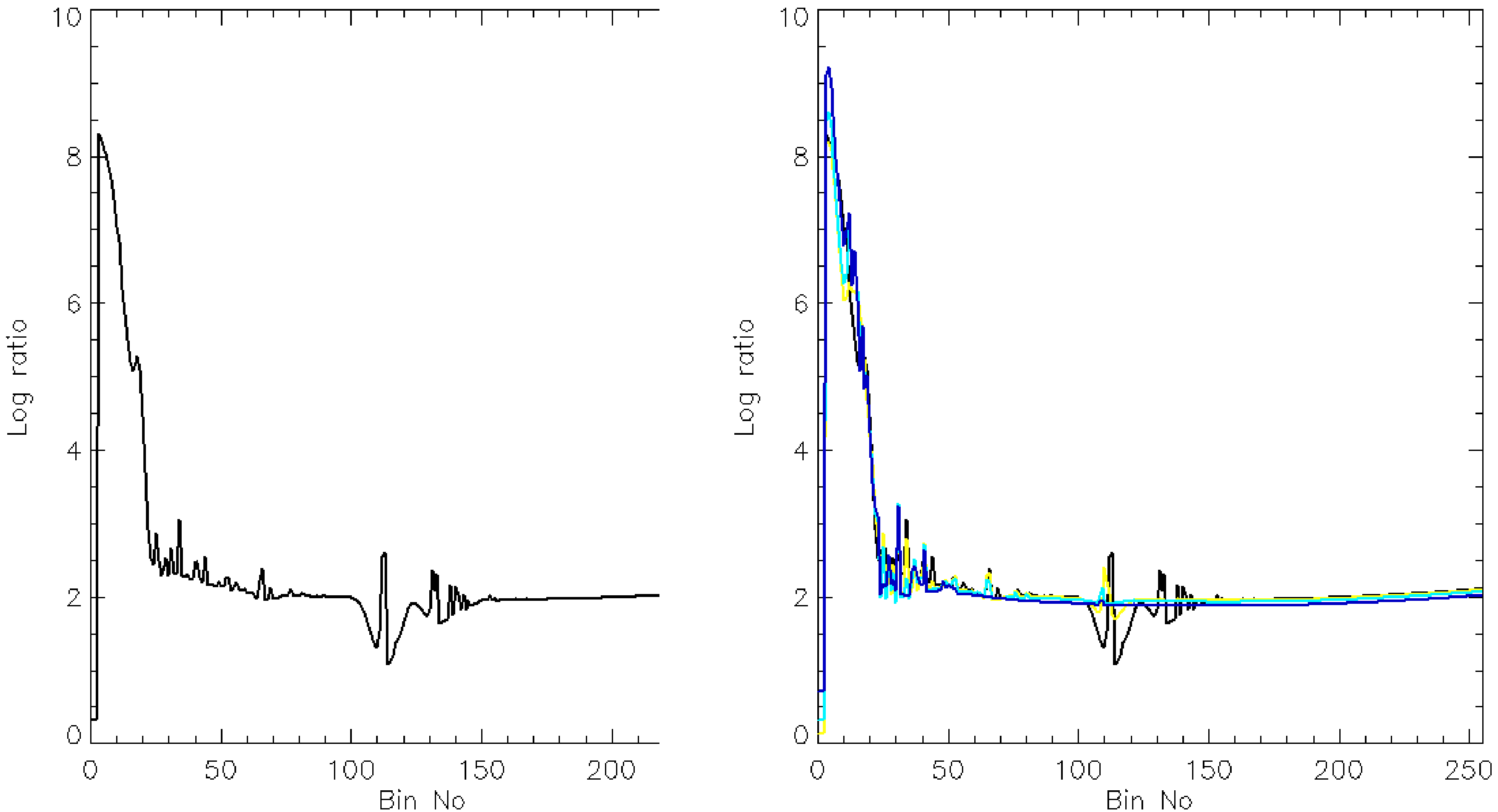
Input and measured spectra D1



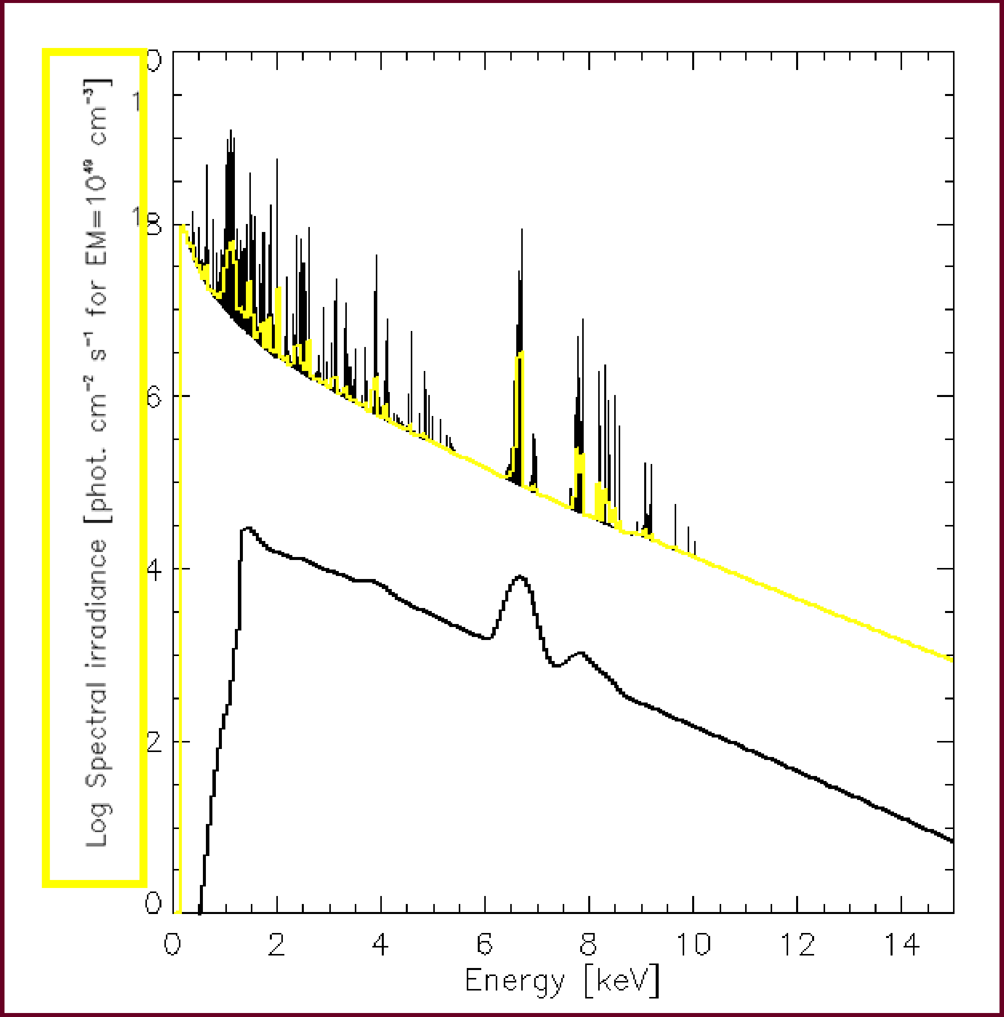
- The input spectum is summed for en. Ranges of bins → ratio is the

Experimental Inversion Matrix EIM

Shape of EIM



Input and measured spectra D1



Input→

observed→

„converted”

obtained

using

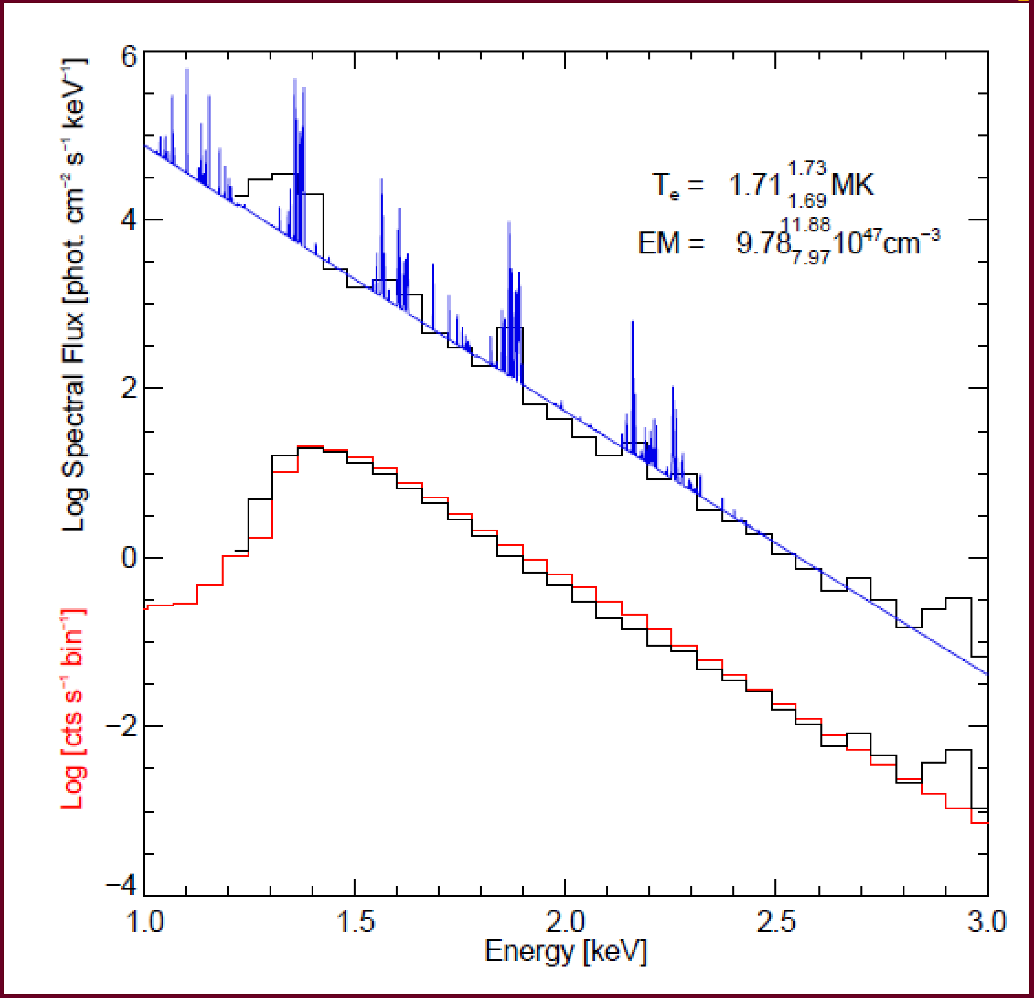
Experimental

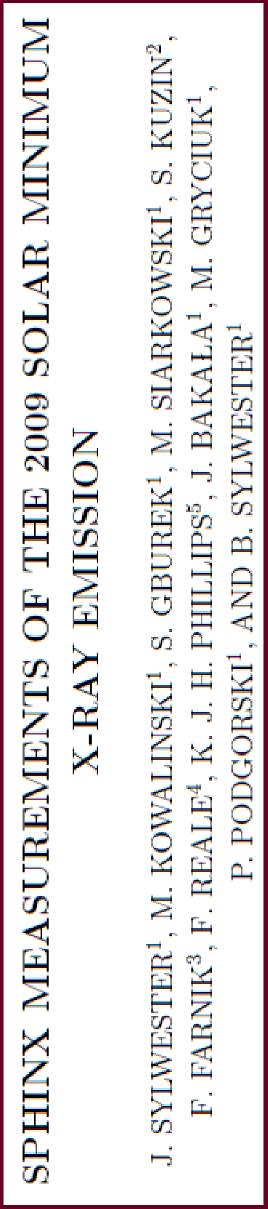
Inversion

Matrix EIM

Be carefull, model dependen t!!!!!!

How this works on real data submitted to ApJ

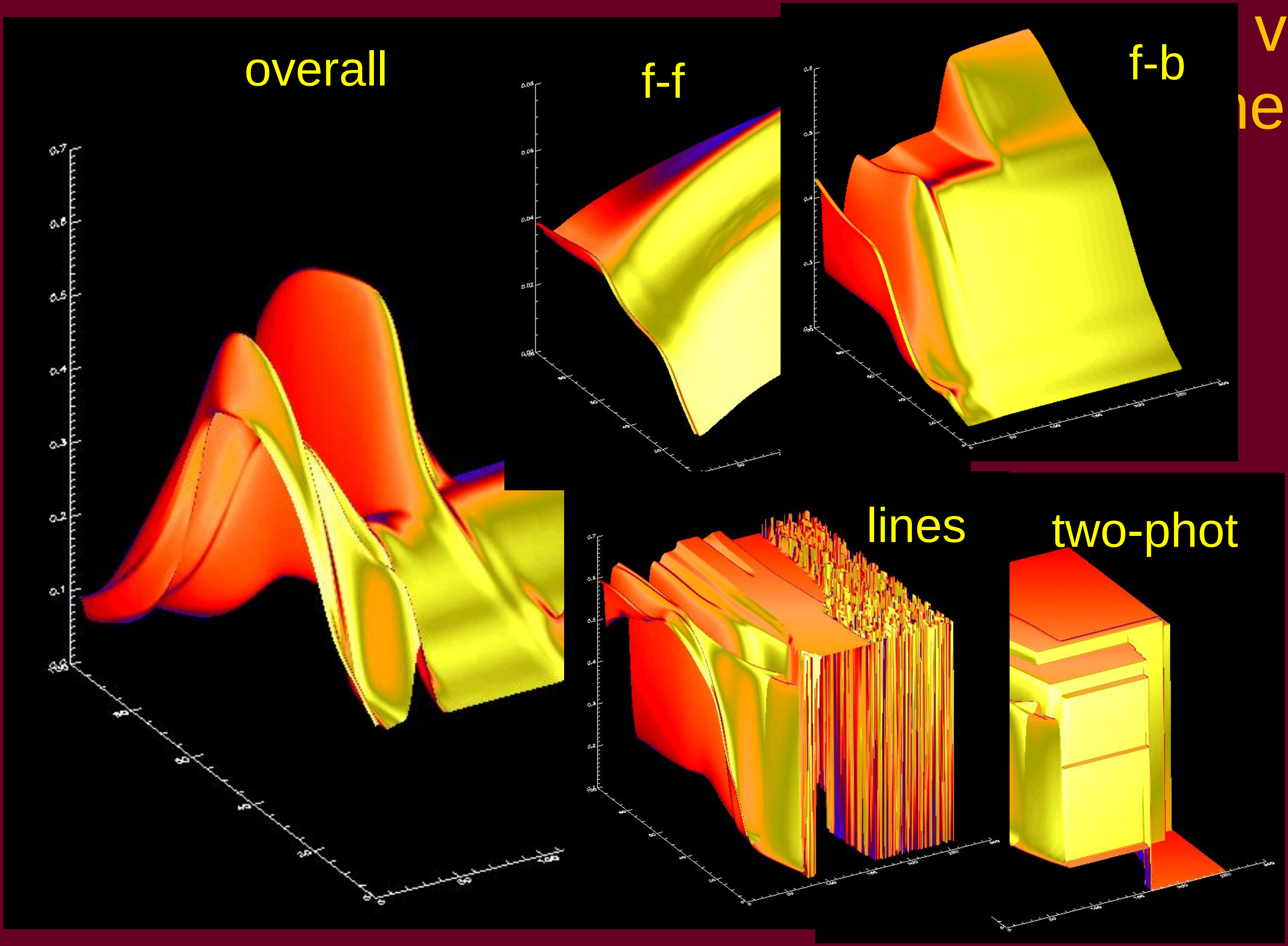




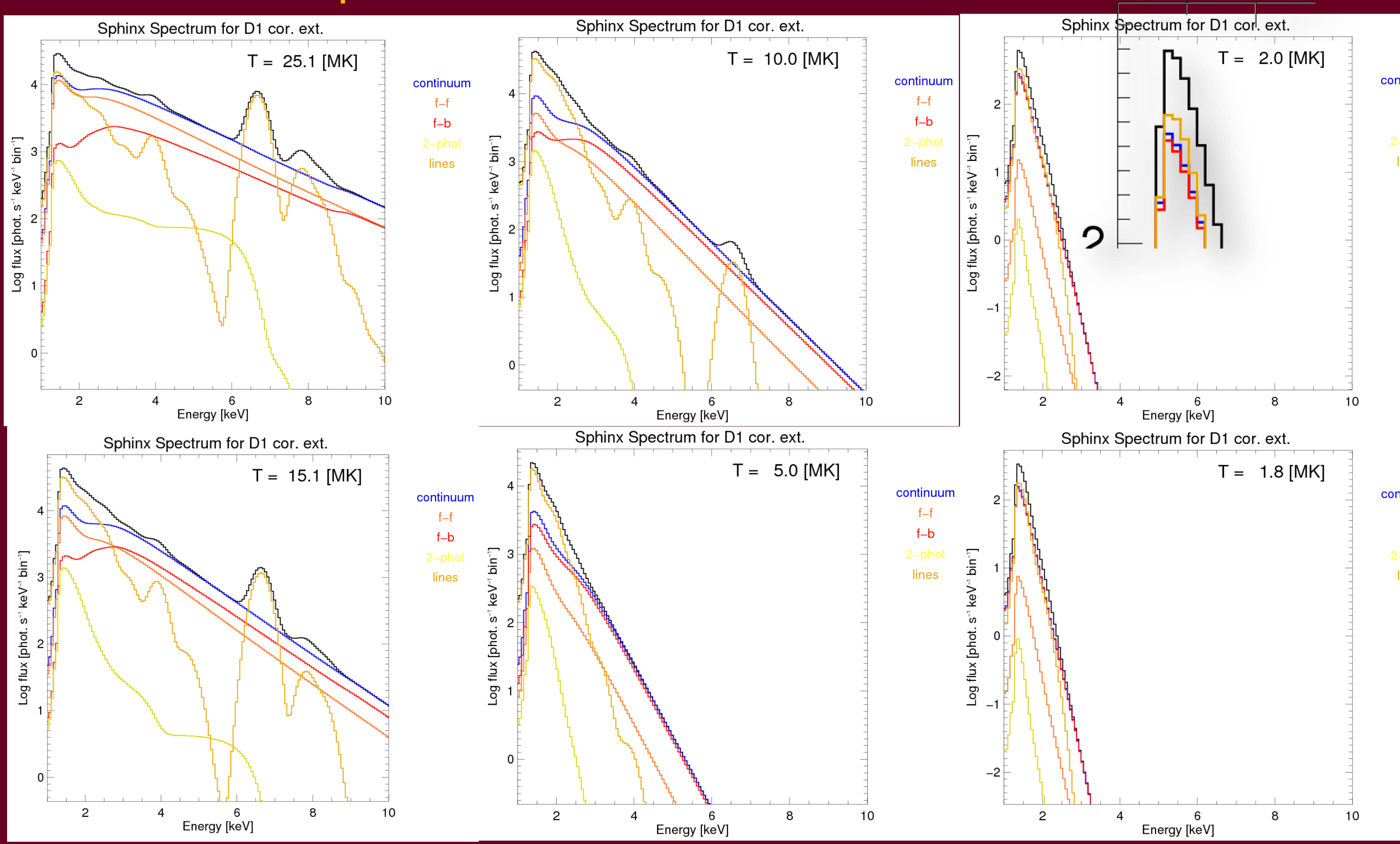
SPHINX MEASUREMENTS OF THE 2009 SOLAR MINIMUM X-RAY EMISSION

J. SYLWESTER[1], M. KOWALINSKI[1], S. GBUREK[1], M. SIARKOWSKI[1], S. KUZIN[2], F. FARNIK[3], F. REALE[4], K. J. H. PHILLIPS[5], J. BAKAŁA[1], M. GRYCIUK[1], P. PODGORSKI[1], AND B. SYLWESTER[1]

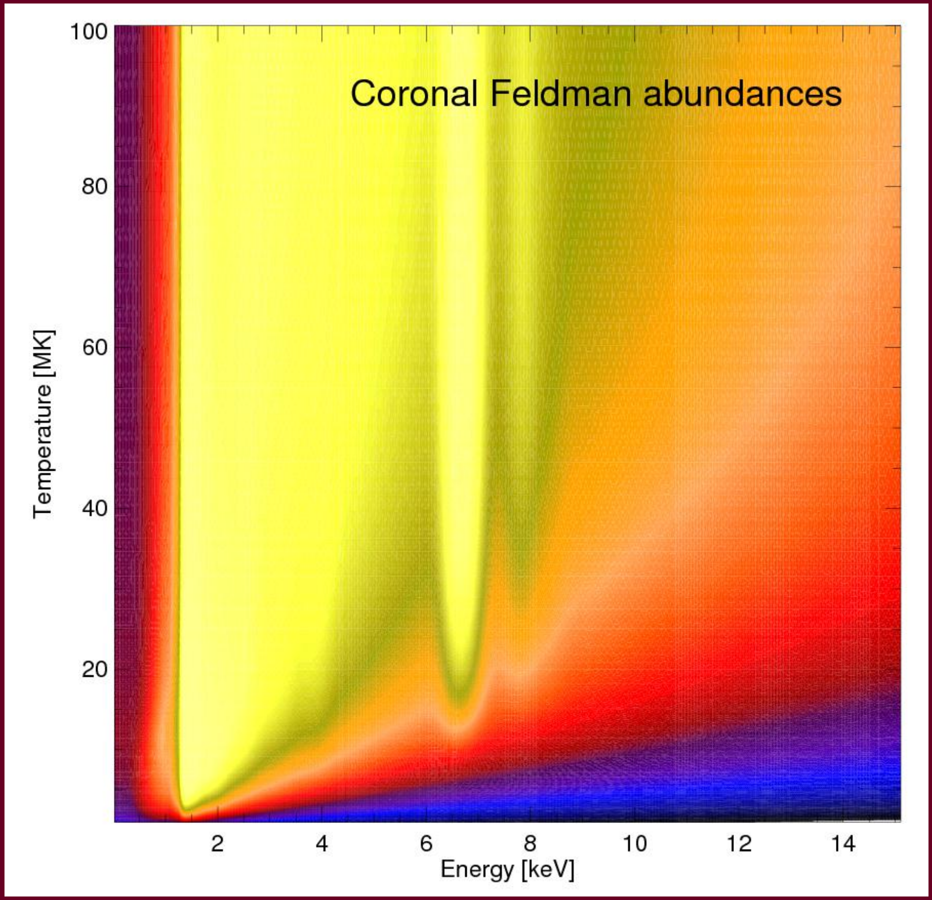
vs
eric

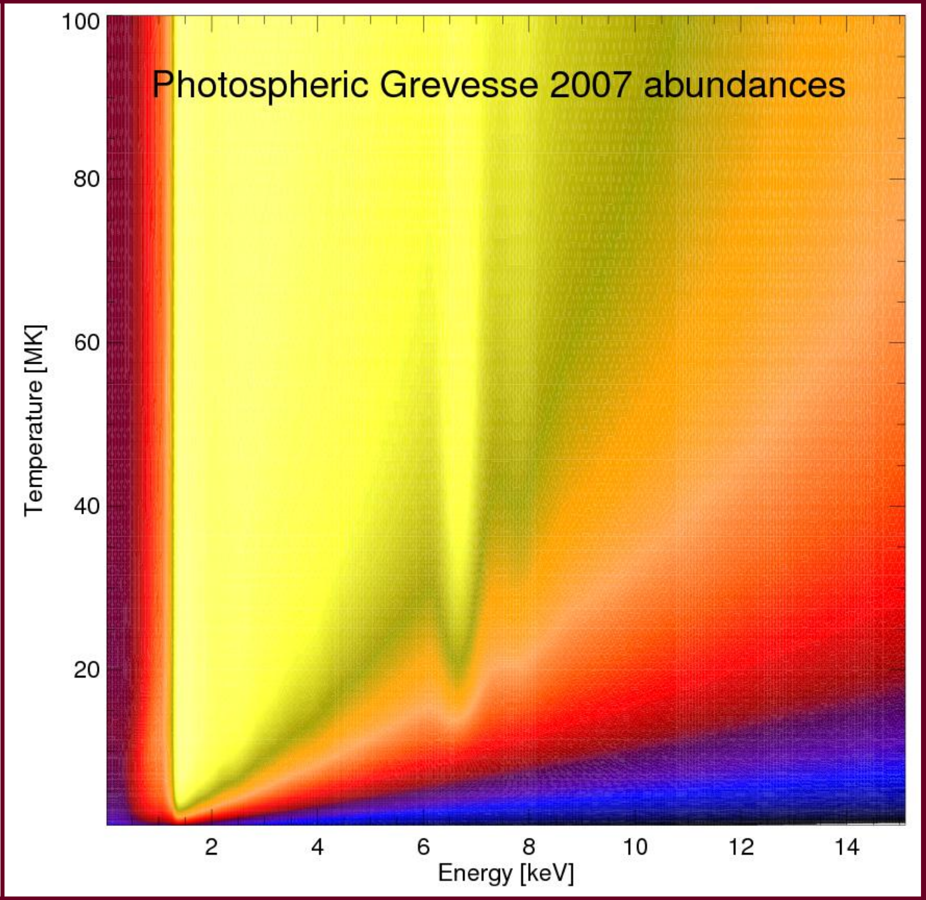


Dependence of overall spectral shape on individual processes coronal extended abu

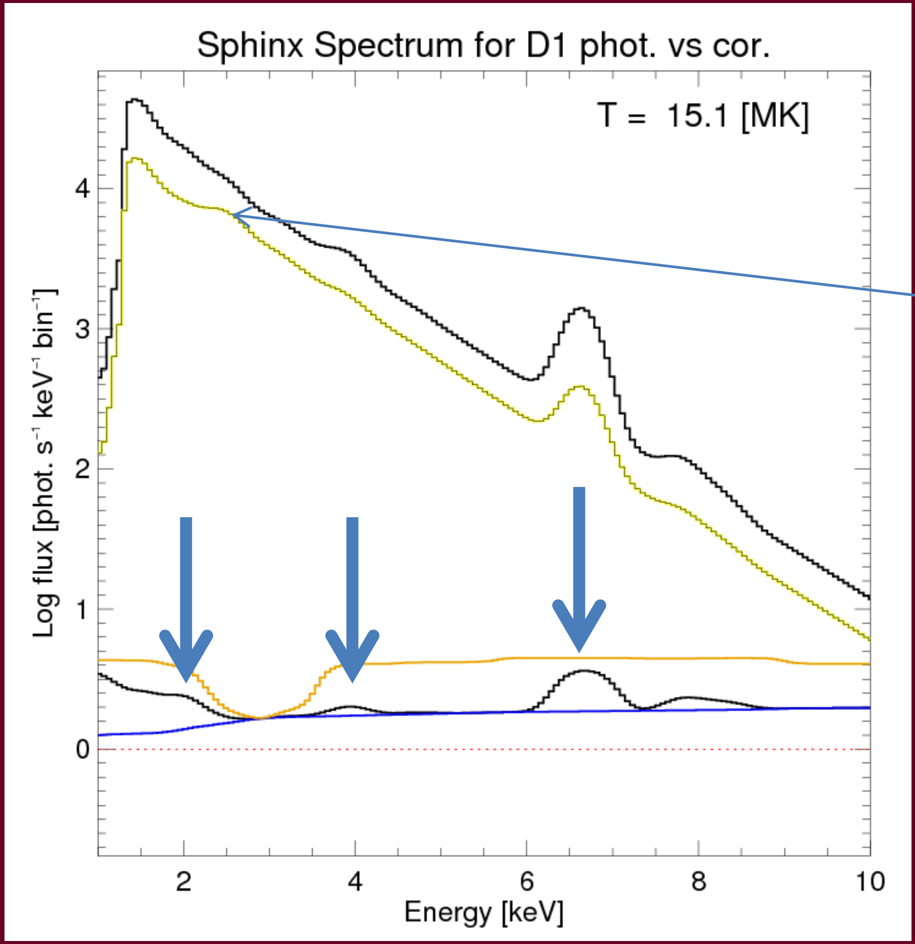


Dependence on el. Abundances qualitatively



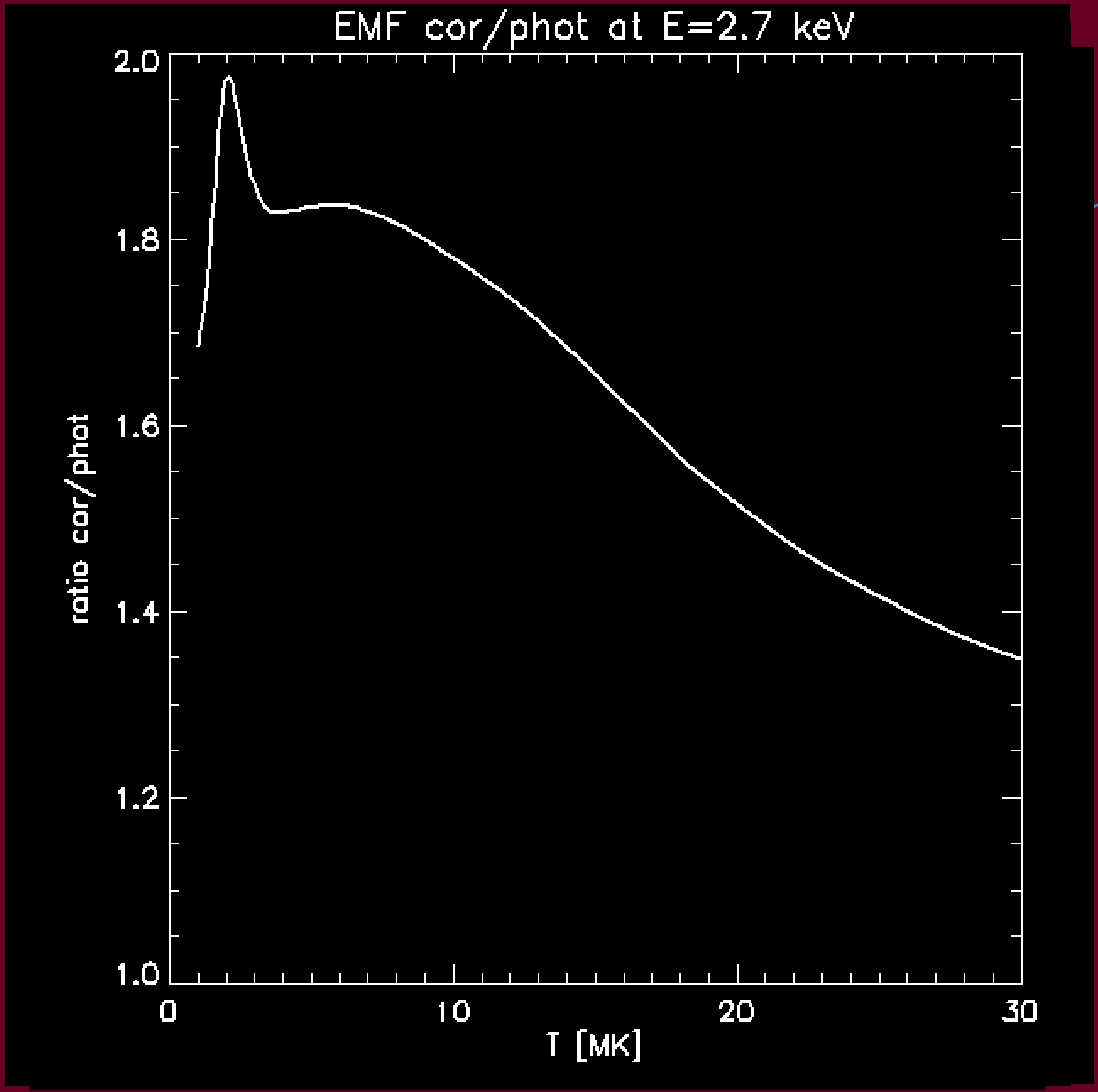


Dependence on el. Abundances quantitatively



- Cor Level is ~2 x phot.
- Line groups of elements with different abundances pronounced

Emission functions in bins

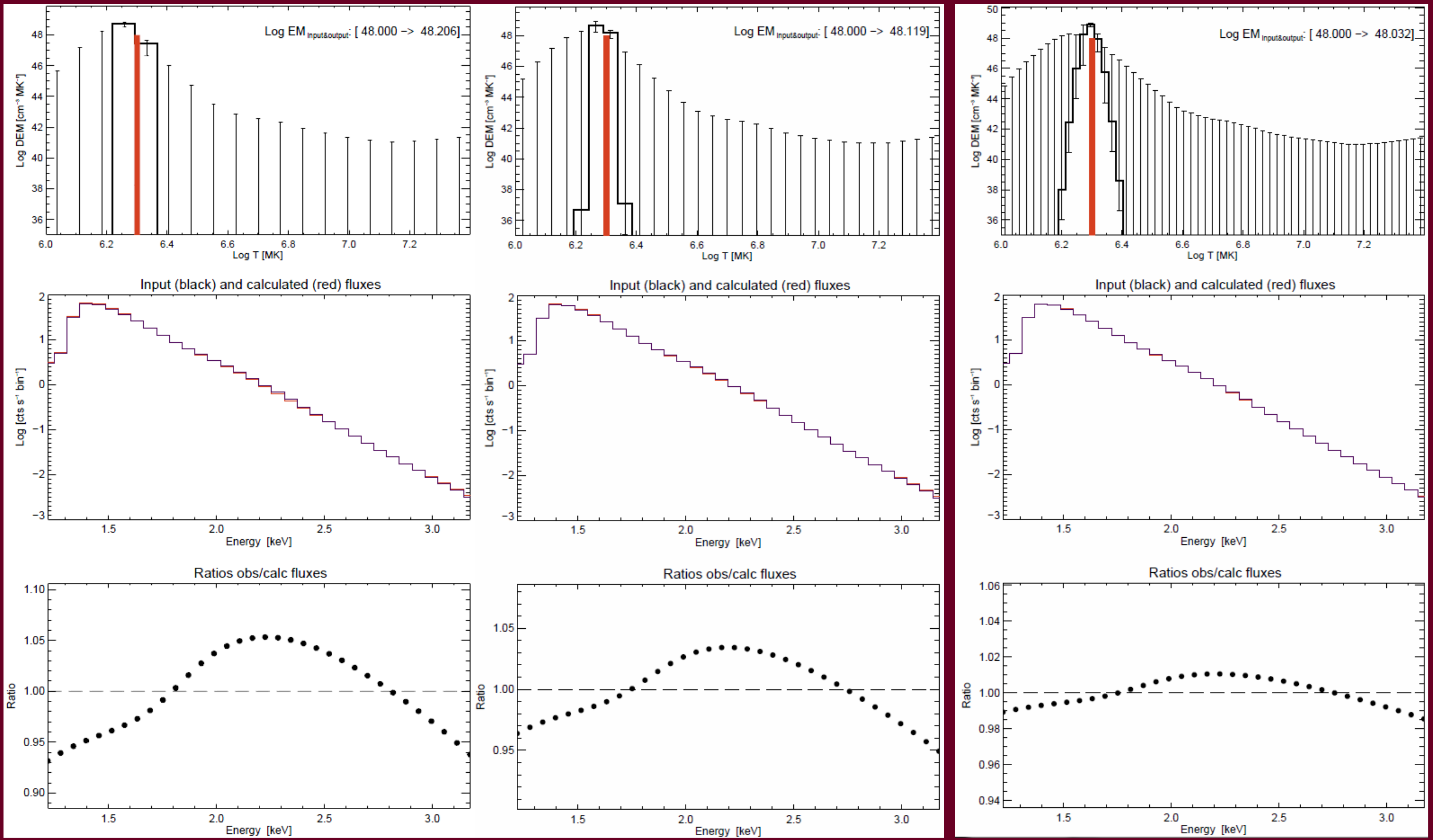


- Low E bins: important but uncertain
- For certain bins (where differences due to abundance effects strong may have very different T dependence

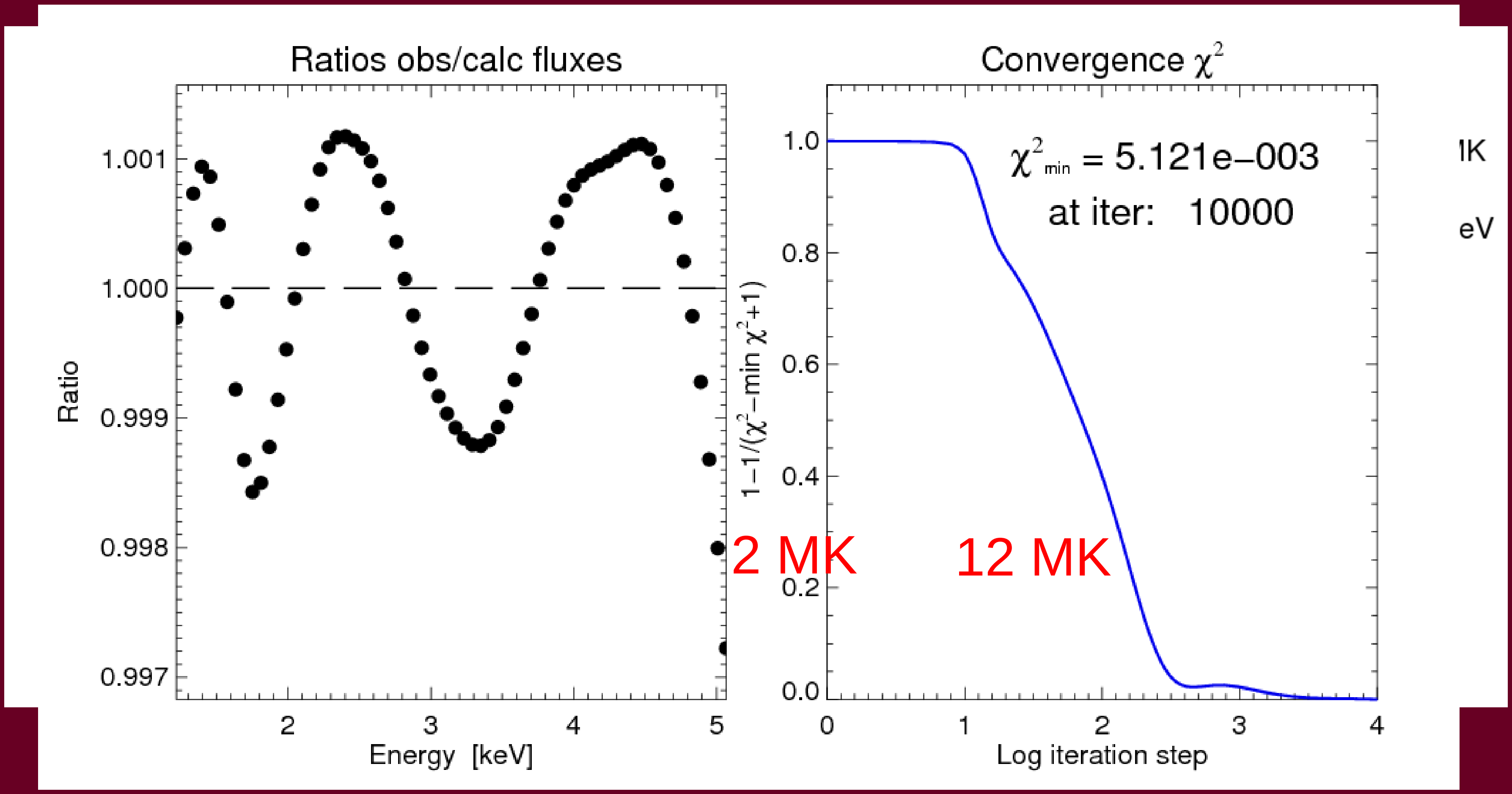
Testing of SphinX dem Reconstruction

- Just reminder of Barbara's results
- Results for Trapezoidal shapes
- Dependence on instrument effect: shift
- Dependence on elemental abundances
- Merging XRT and SphinX
  - Total fluxes

Model 1T: T=2 MK; nT= 19, 29, 59

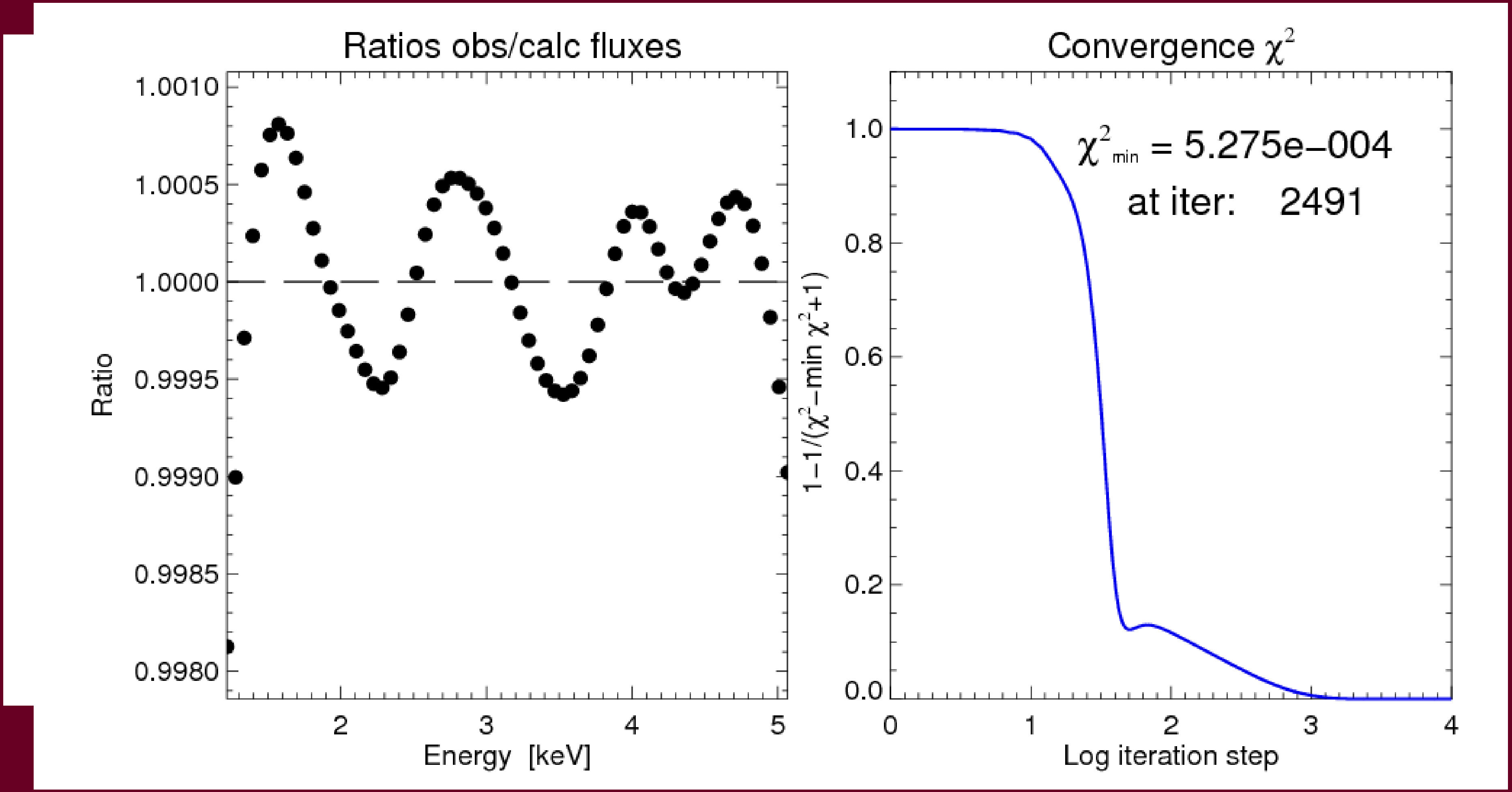


DEM inversion of SphinX cd.
Fit to continuous test distributions



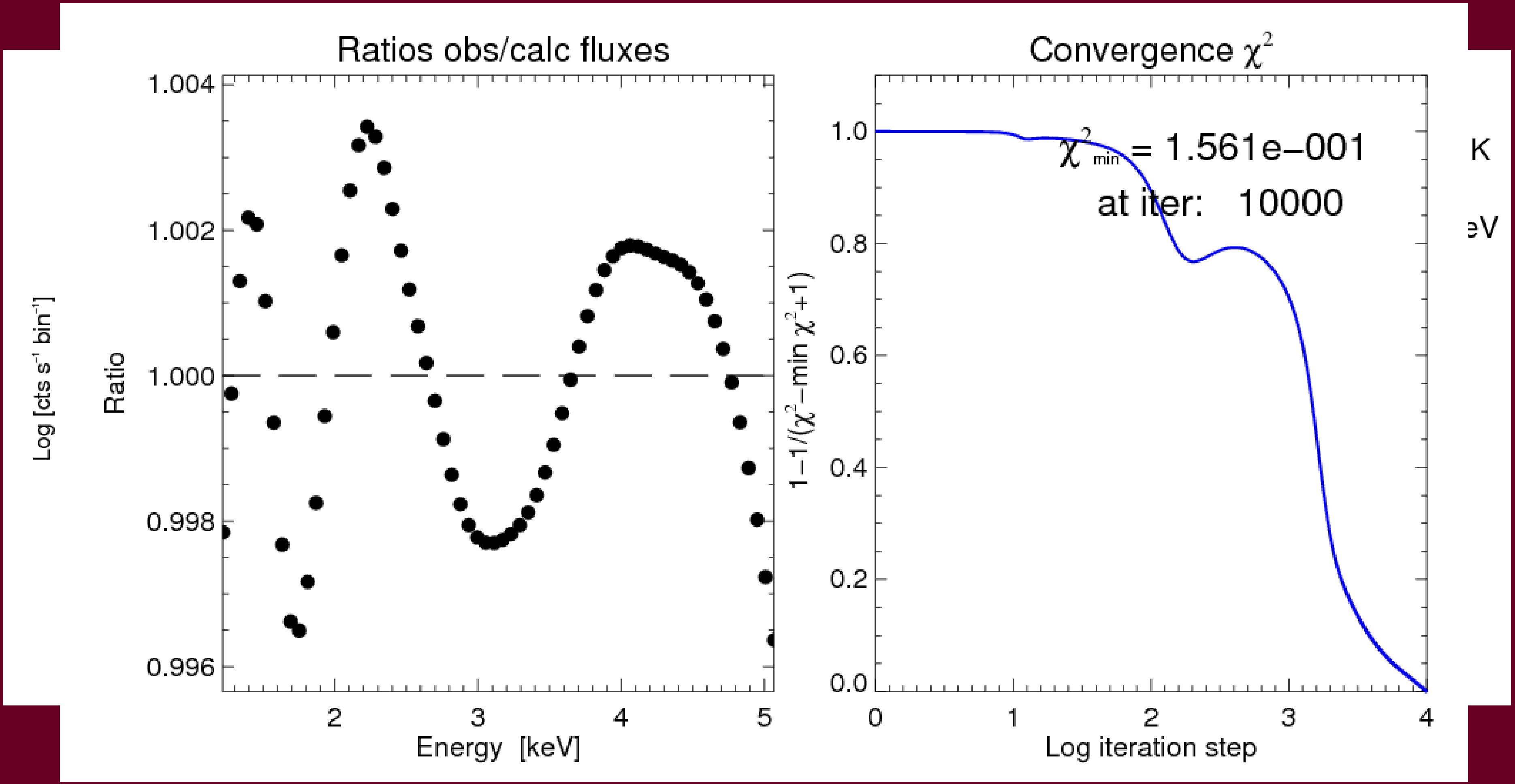
DEM inversion of SphinX cd.

Fit to continuous test distributions

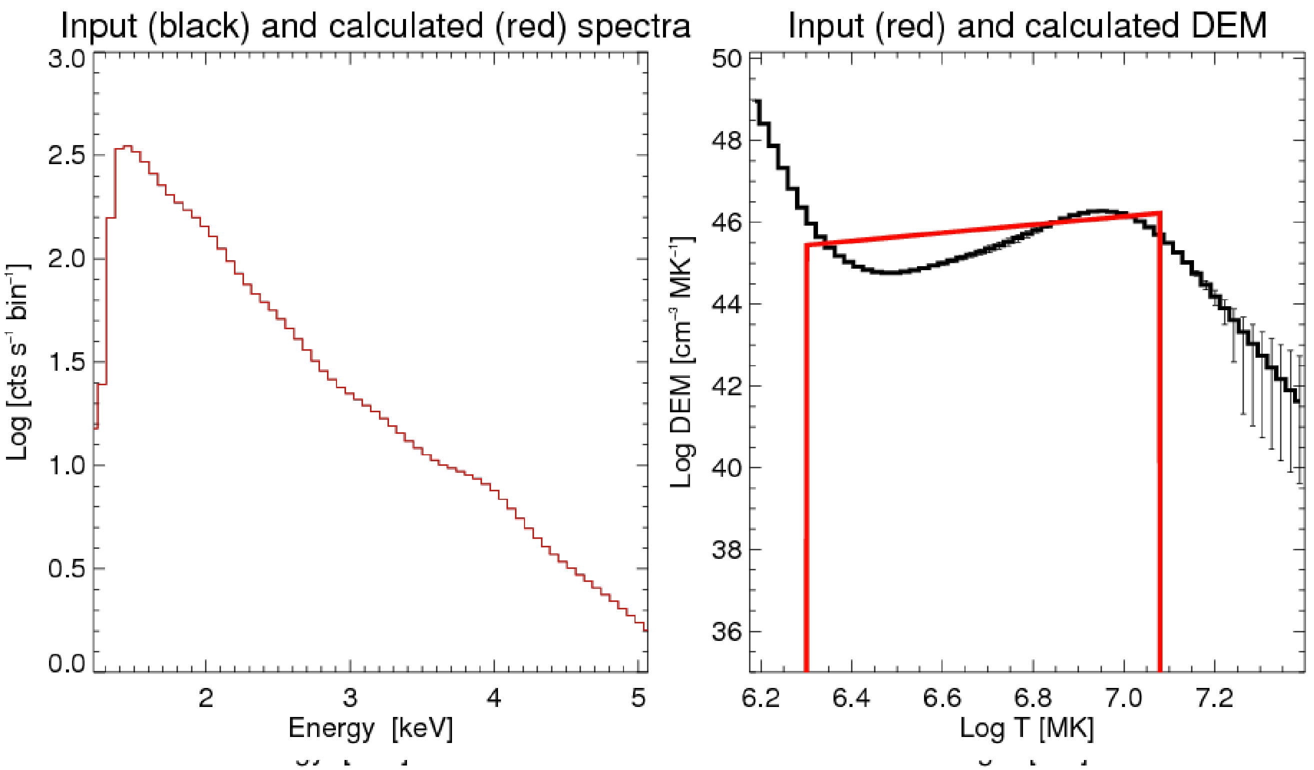


DEM inversion of SphinX cd.

Fit to continuous test distributions



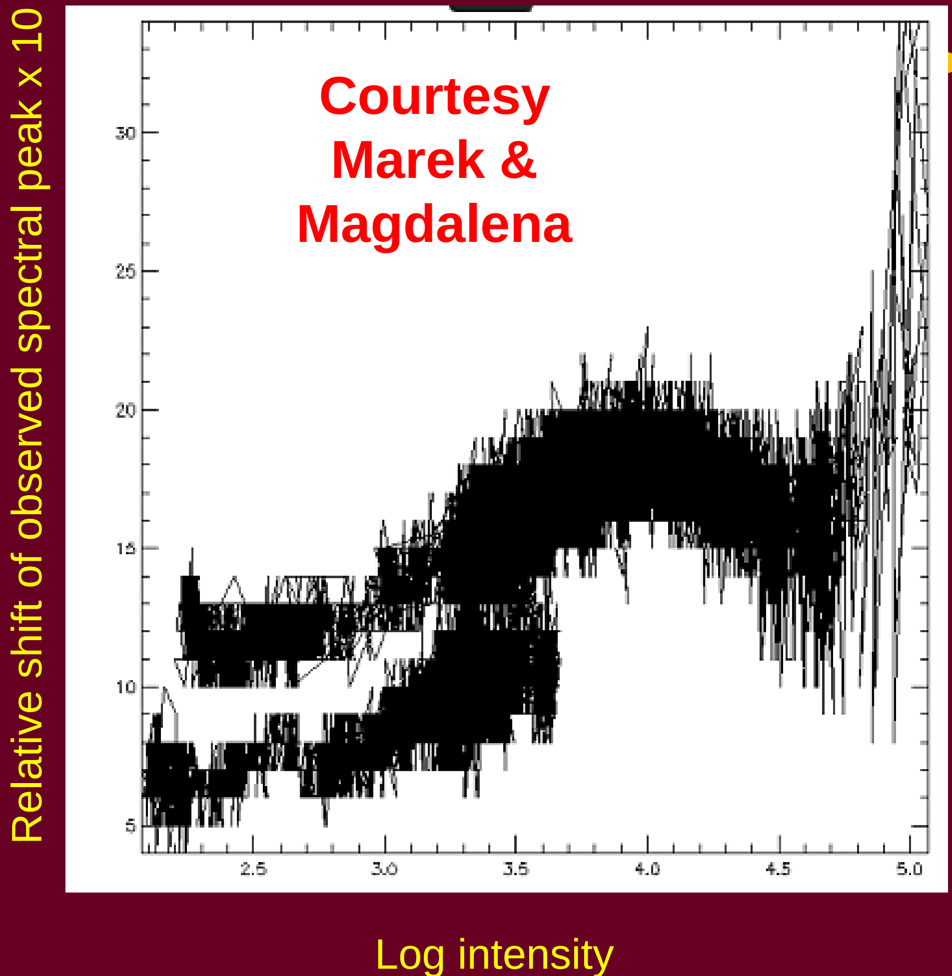
DEM inversion of SphinX cd.
Fit to continuous test distributions



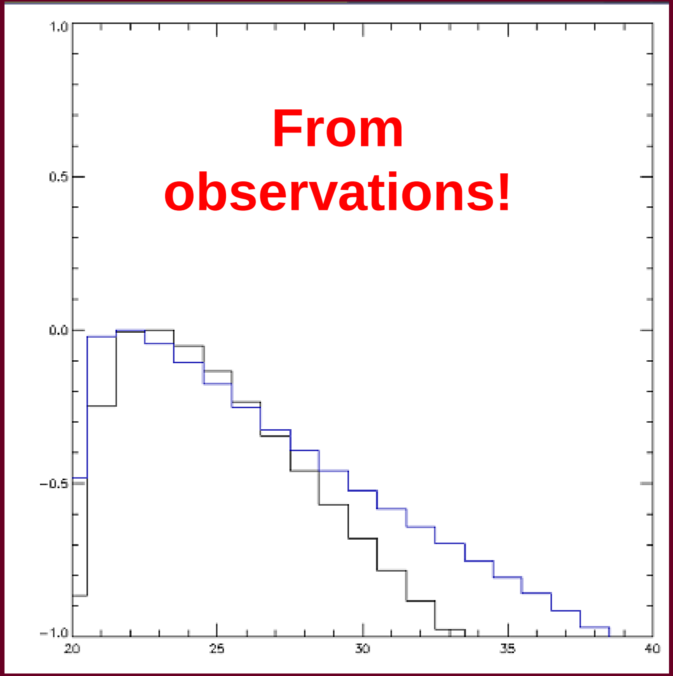
Trange: [1.5 – 25.0] MK
nTrang: 59
Erang:[1.219–5.068] keV
Log EM $_{input}$: 47.000
Log EM $_{output}$: 48.022

DGI time: 1000.0[s]

DEM inversion of SphinX cd.
Dependence on bin-energy calibration

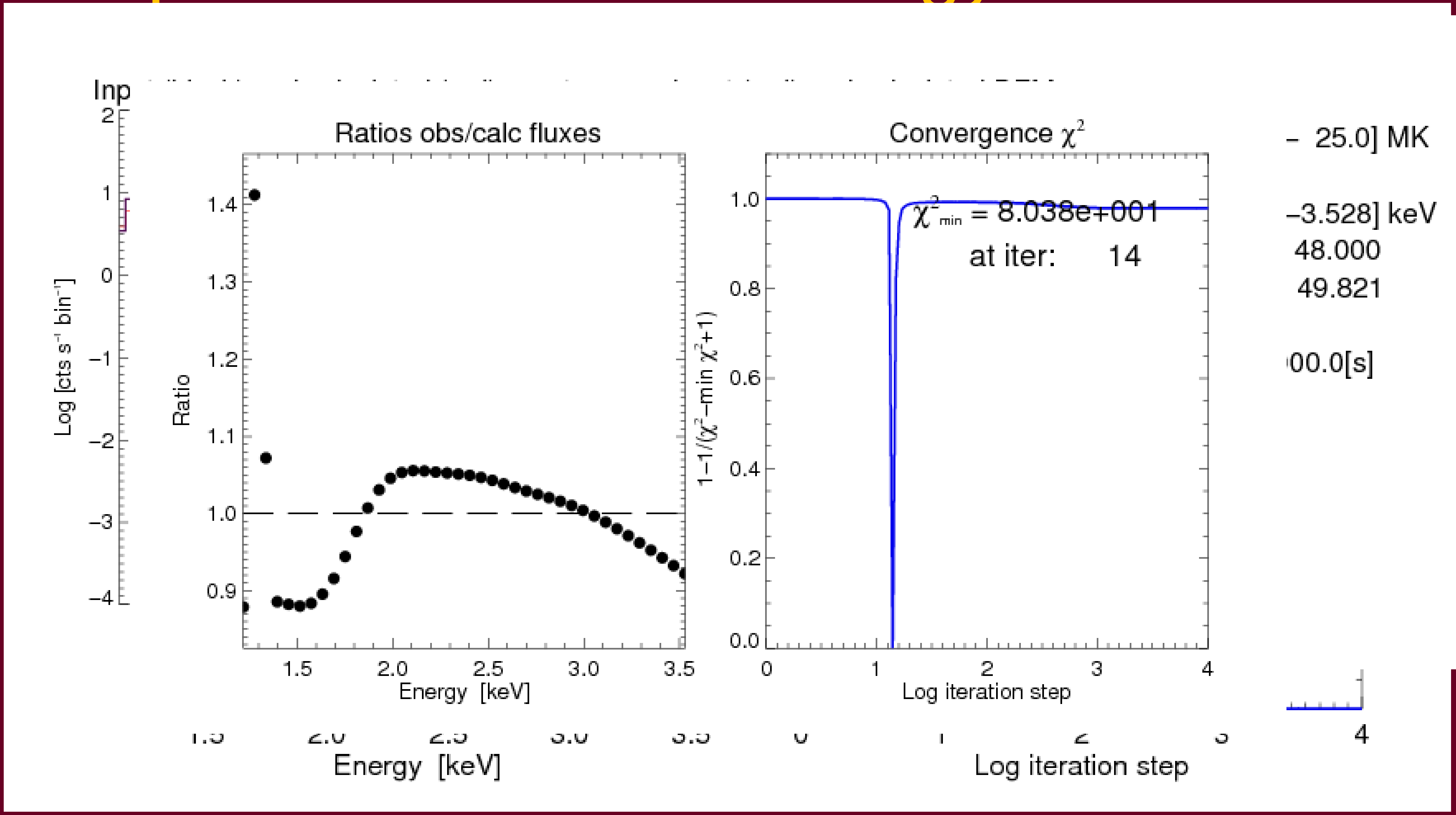


- The accuracy of shift determination is ~0.3 bin = 20 eV



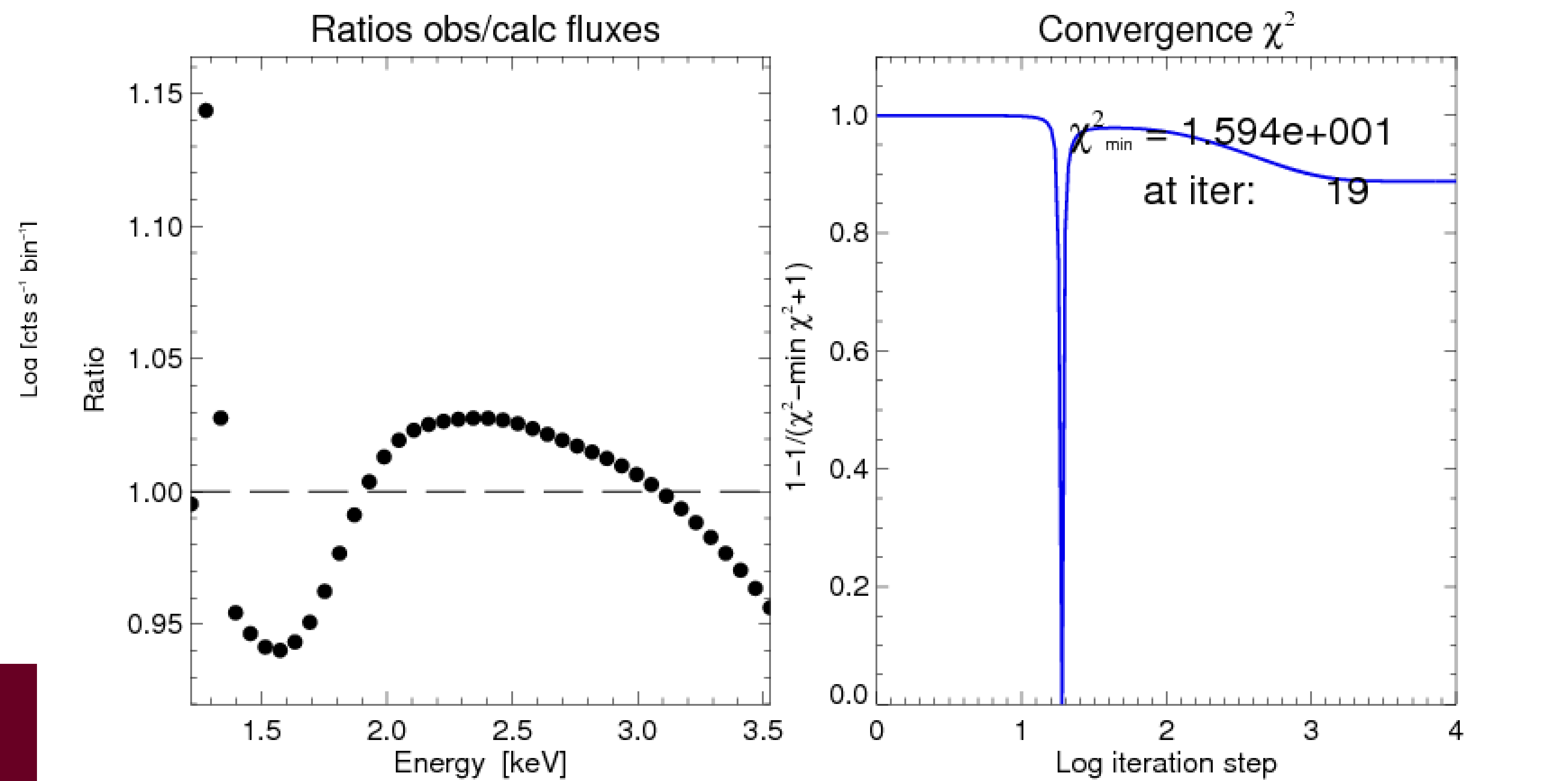
DEM inversion of SphinX cd.

Dependence on bin-energy calibration



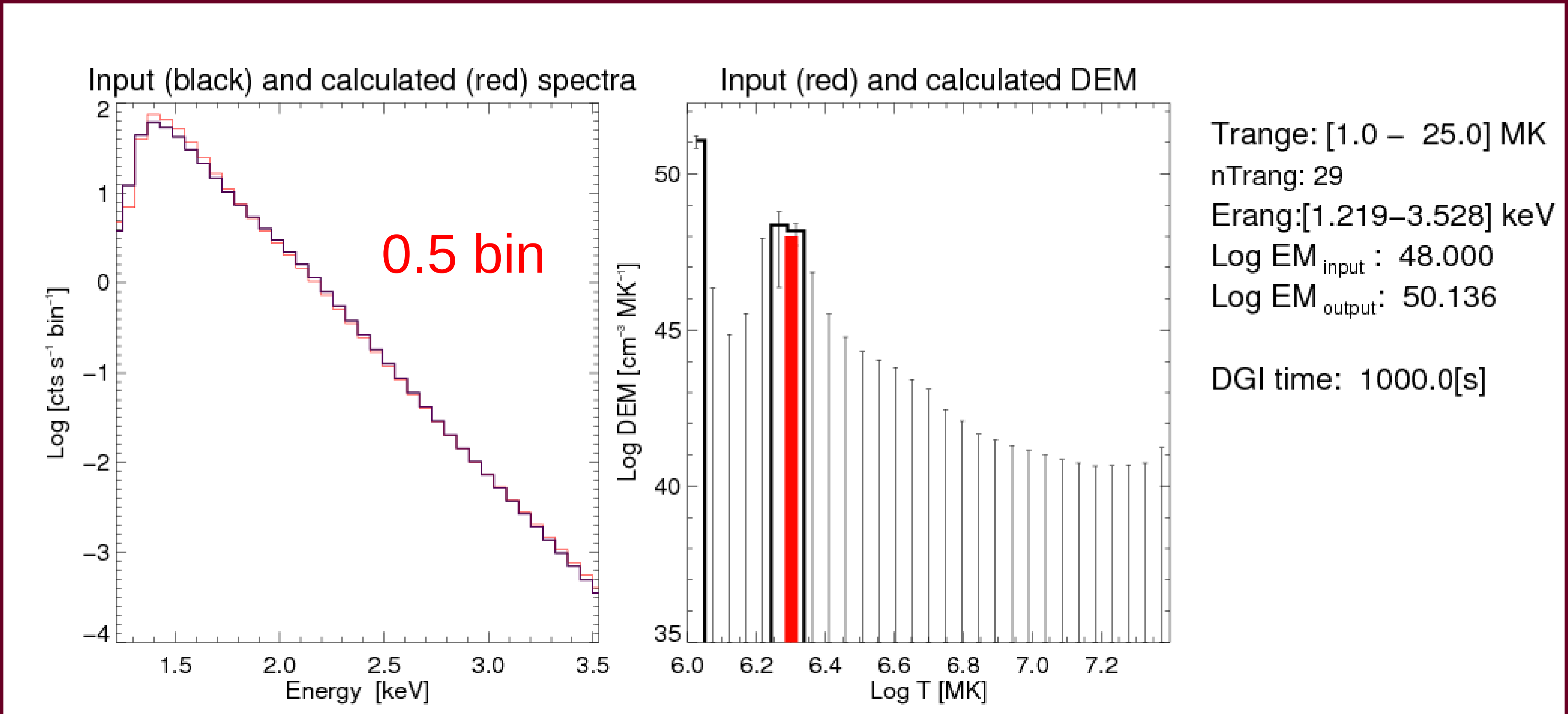
T= 2 MK

DEM inversion of SphinX cd.
Dependence on bin-energy calibration



T= 2 MK

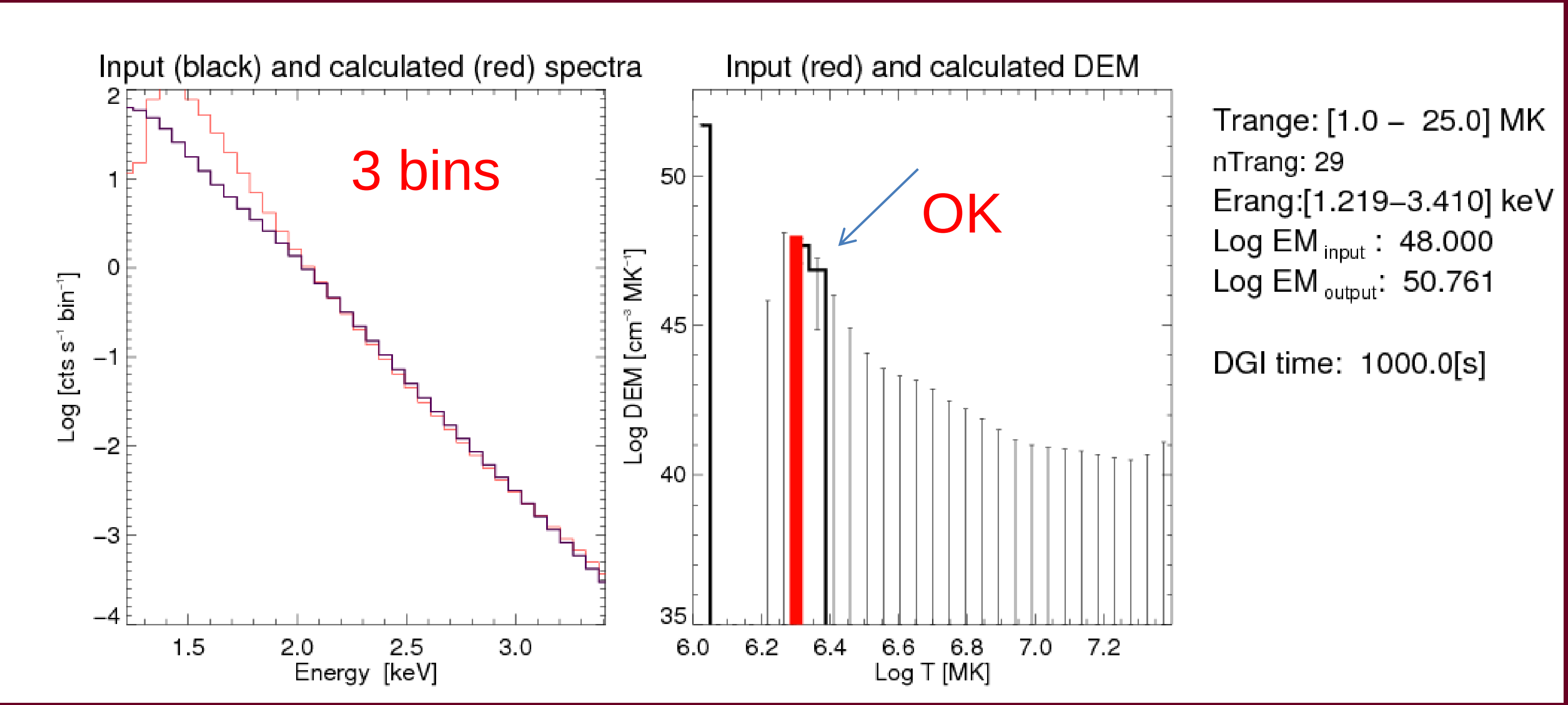
DEM inversion of SphinX cd.
Dependence on bin-energy calibration



T= 2 MK

DEM inversion of SphinX cd.

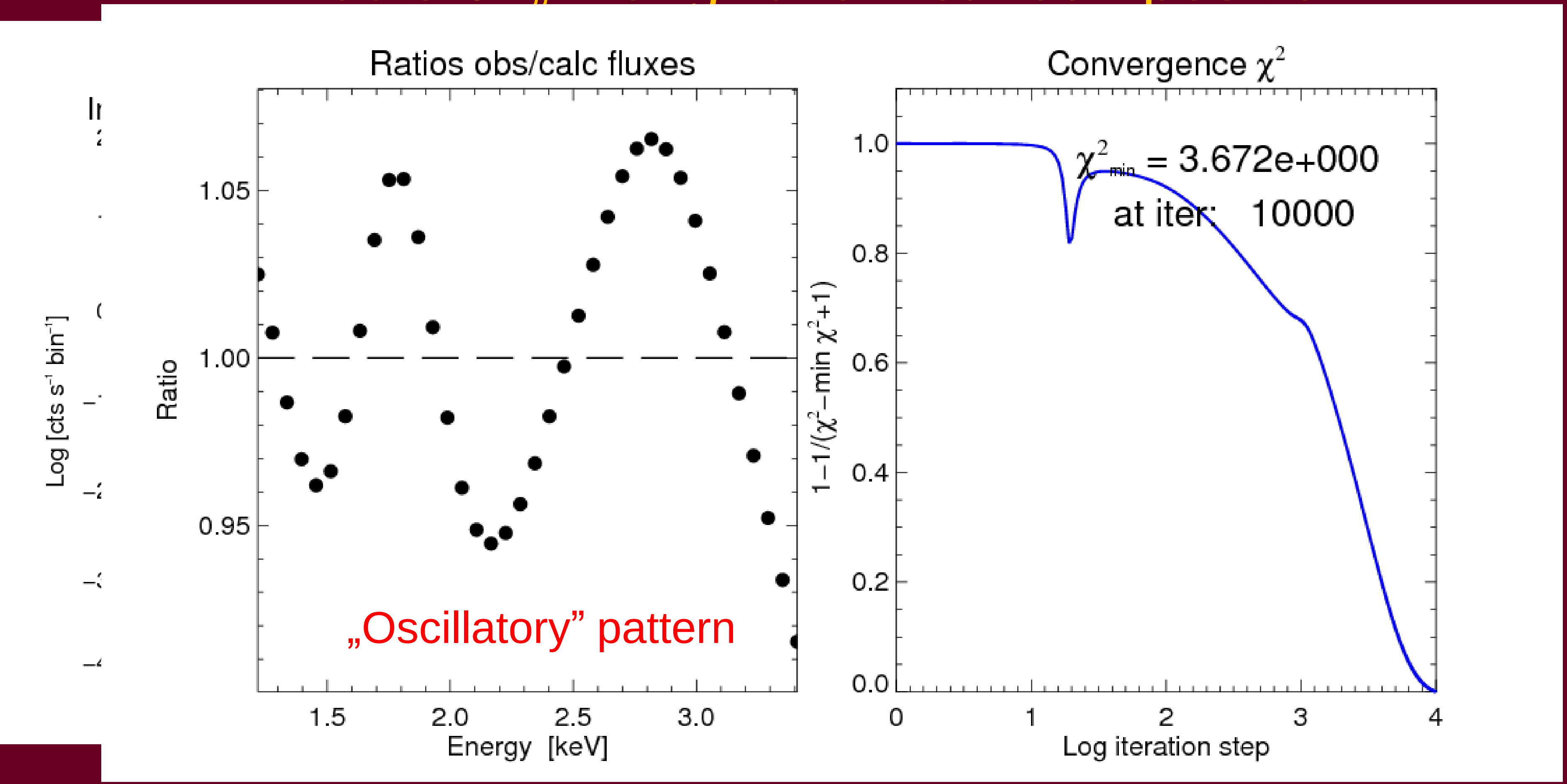
Dependence on bin-energy calibration



T= 2 MK

DEM inversion of SphinX cd.

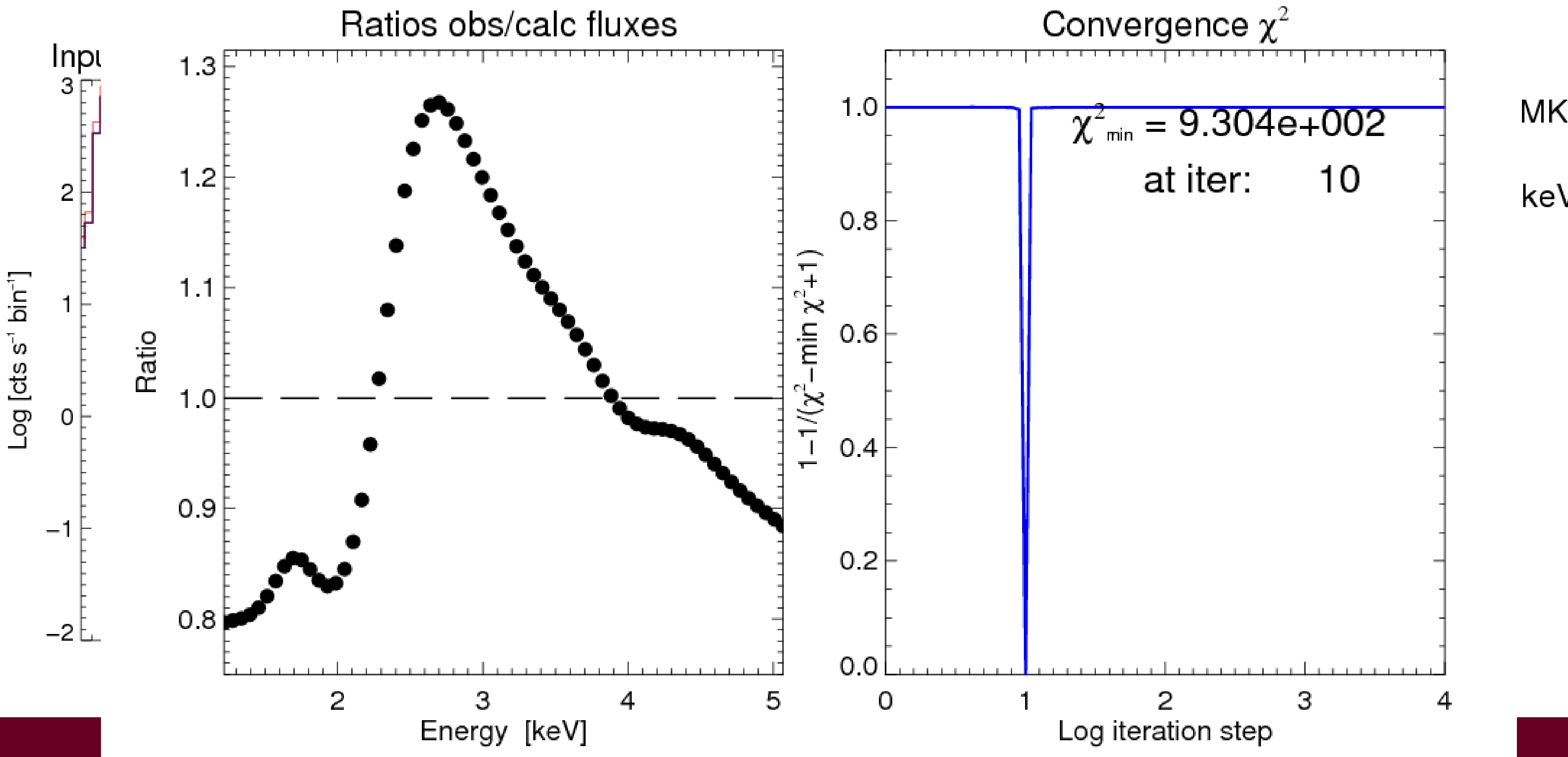
Effecte of „wrong” chemical composition



T= 2 MK

DEM inversion of SphinX cd.

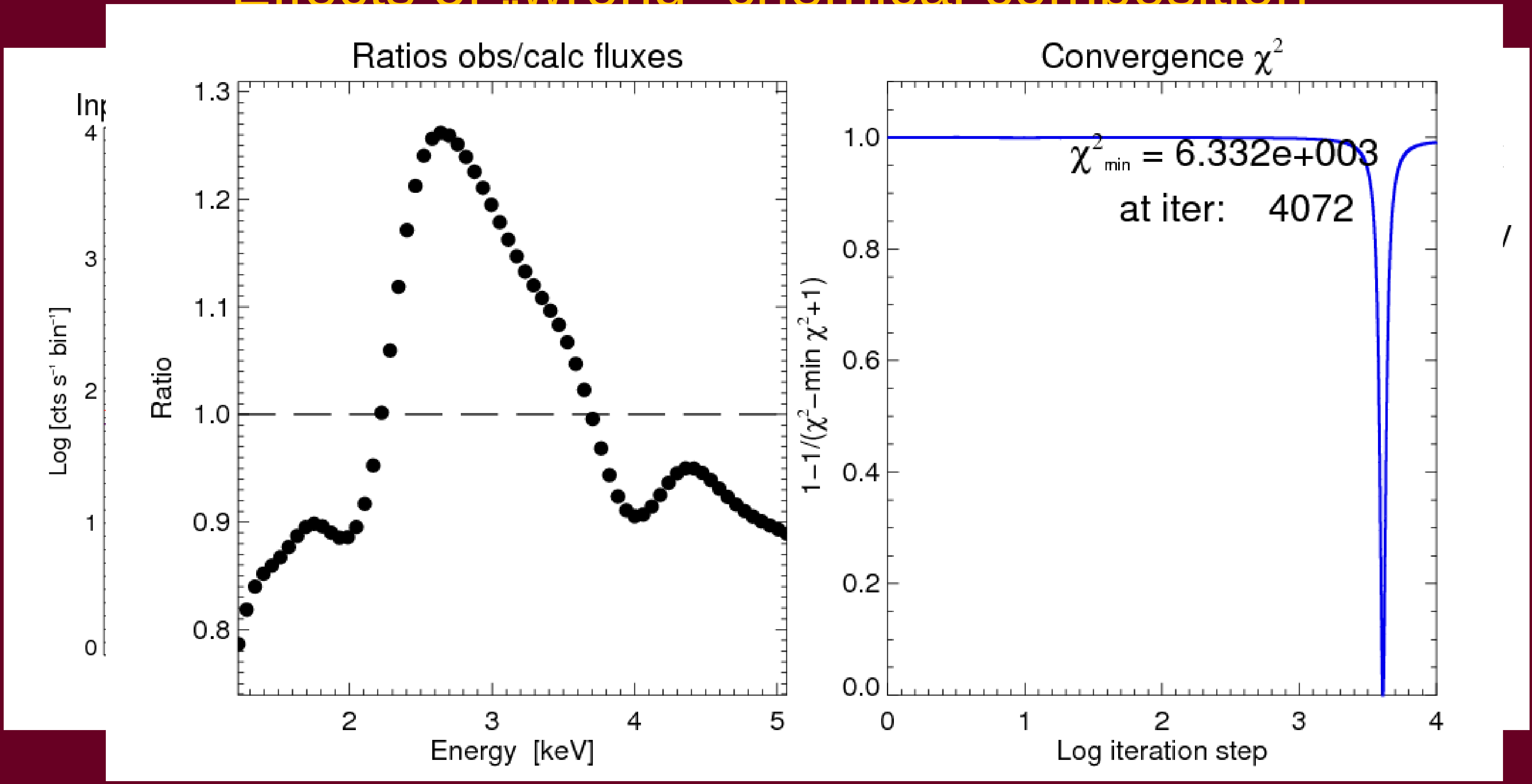
Effects of „wrong” chemical composition



T= 5 MK

DEM inversion of SphinX cd.

Effects of „wrong" chemical composition



T= 10 MK

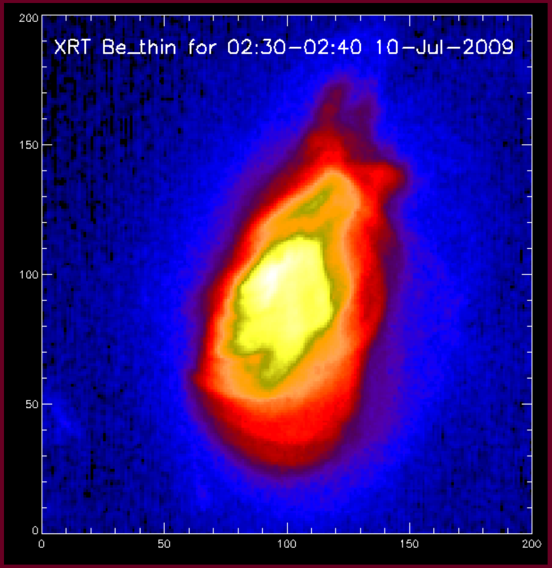
Merging SphinX and XRT data

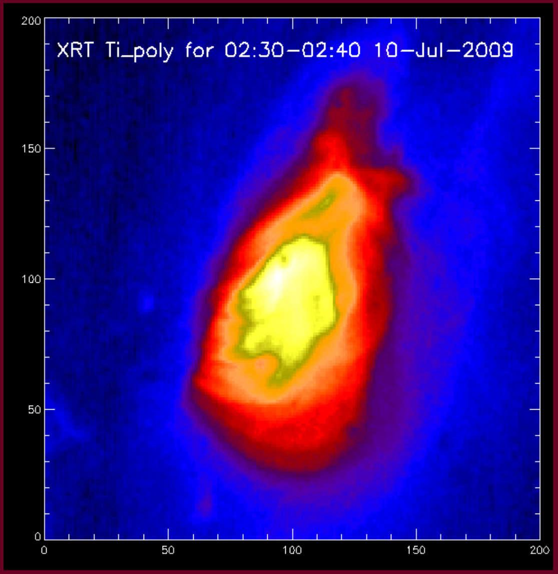
- Extend the Trange 0.3 MK-25 MK
- Uses XRT Team provided filter emissivities

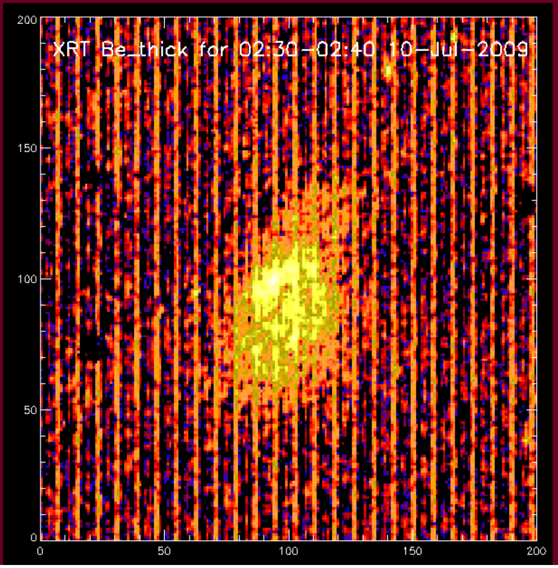
  DN/s/cm-5/pixel

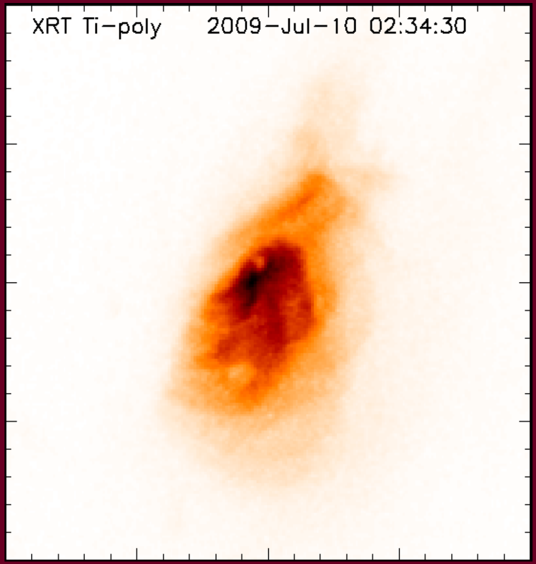
- Correct them for volumetric EM (stil guess)
  - Divide by factor **2*!pi*r0^2** -
  - Multiply by XRT pixel Nos 1024^2
  - Multiply 10^49 cm-3

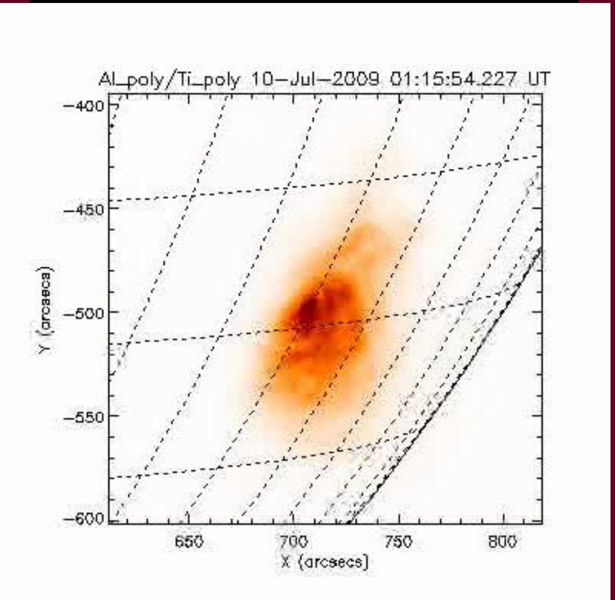
XRT images for 02:20-02:40 UT on 10-Jul-09



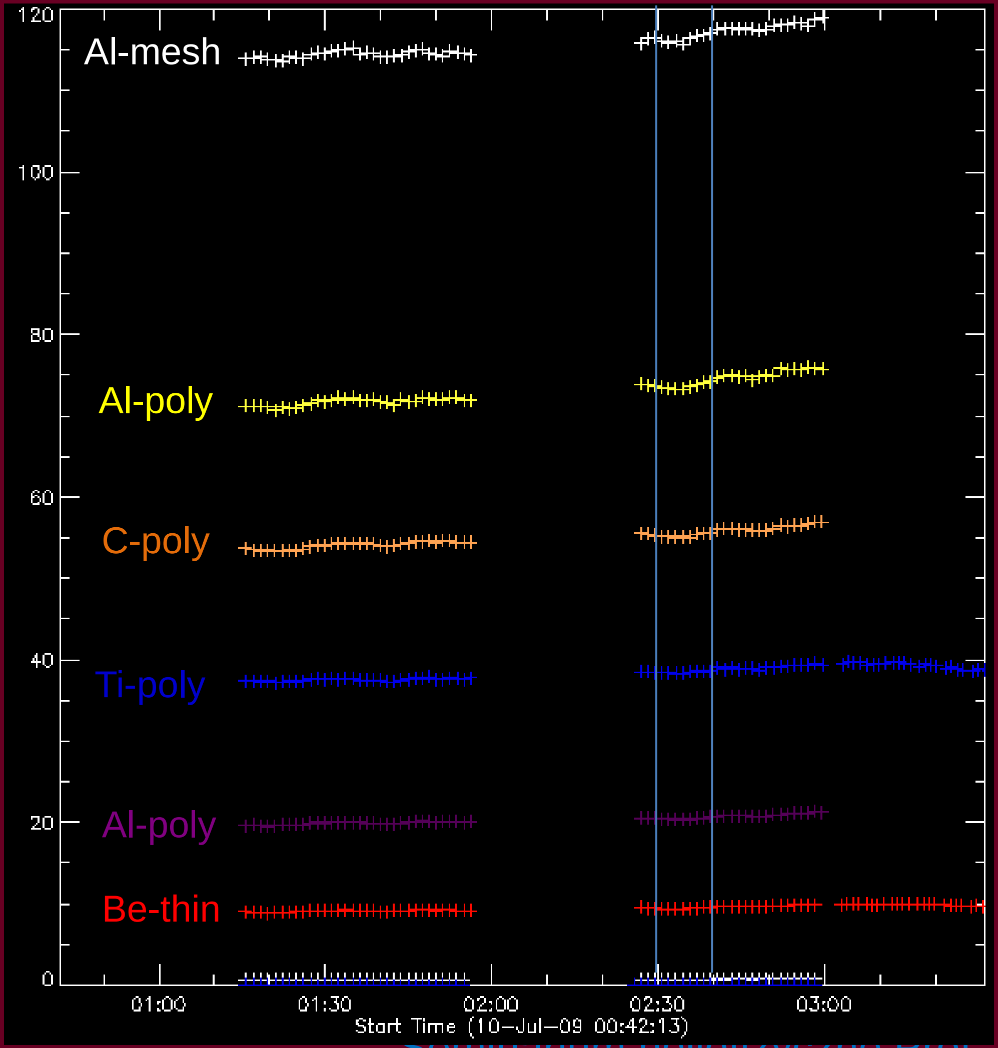


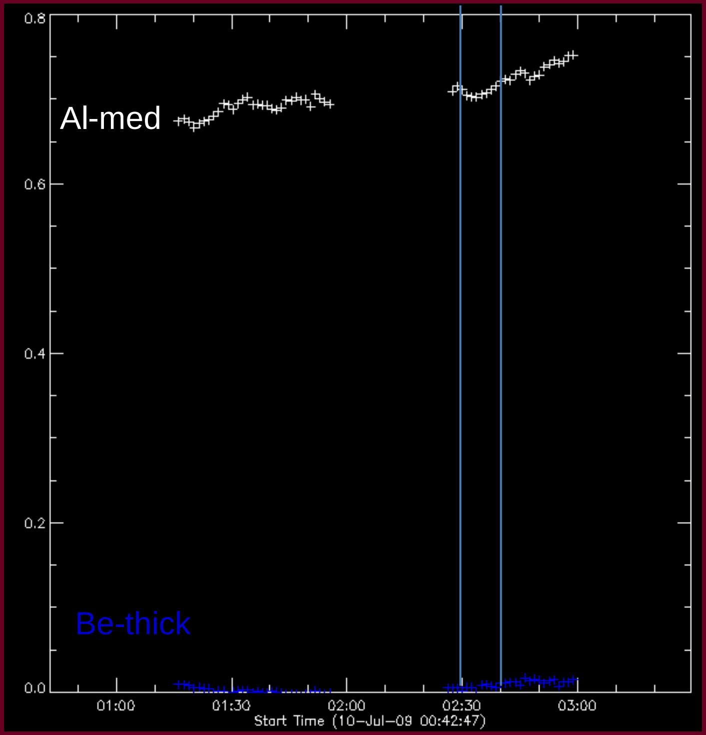






Strumienie XRT (8 filtrów)

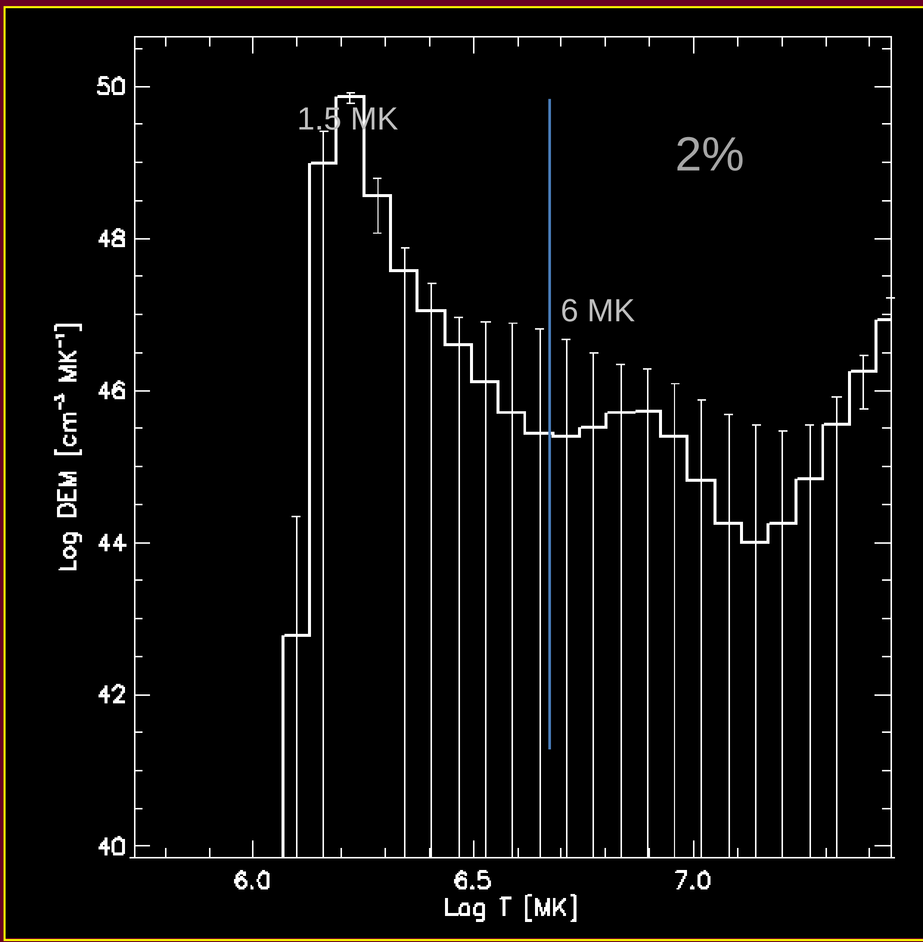


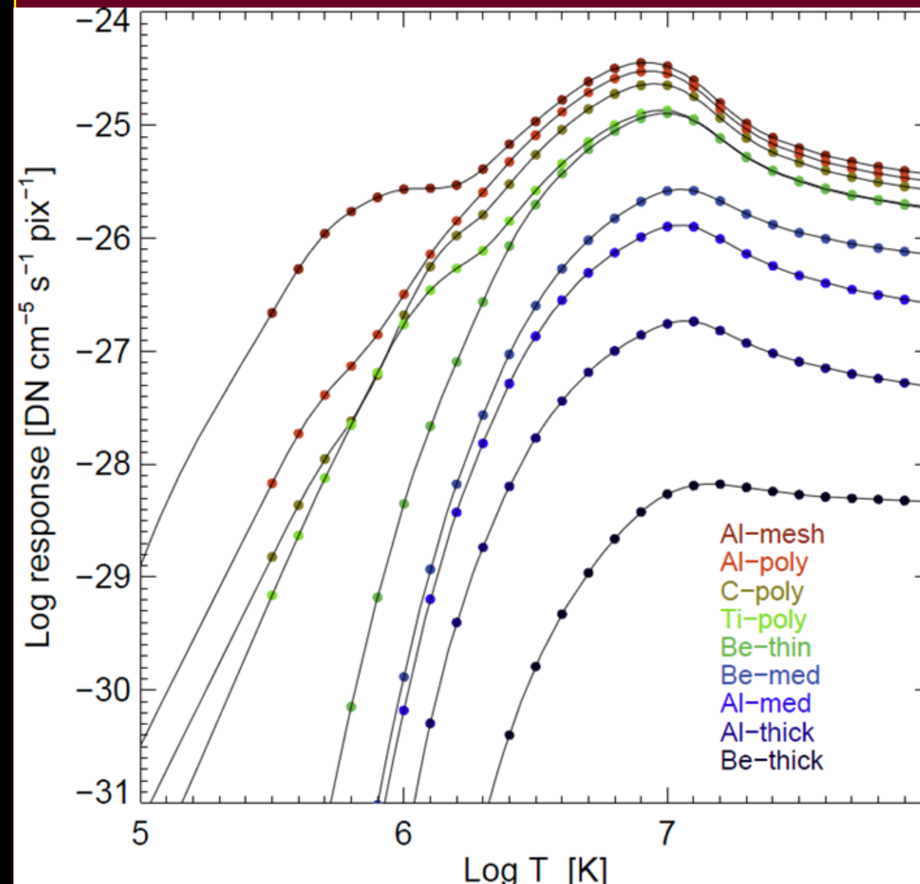


Al_poly/Ti_poly

7 filtrów do DEM

DEM model based on XRT/Hinode data (7)

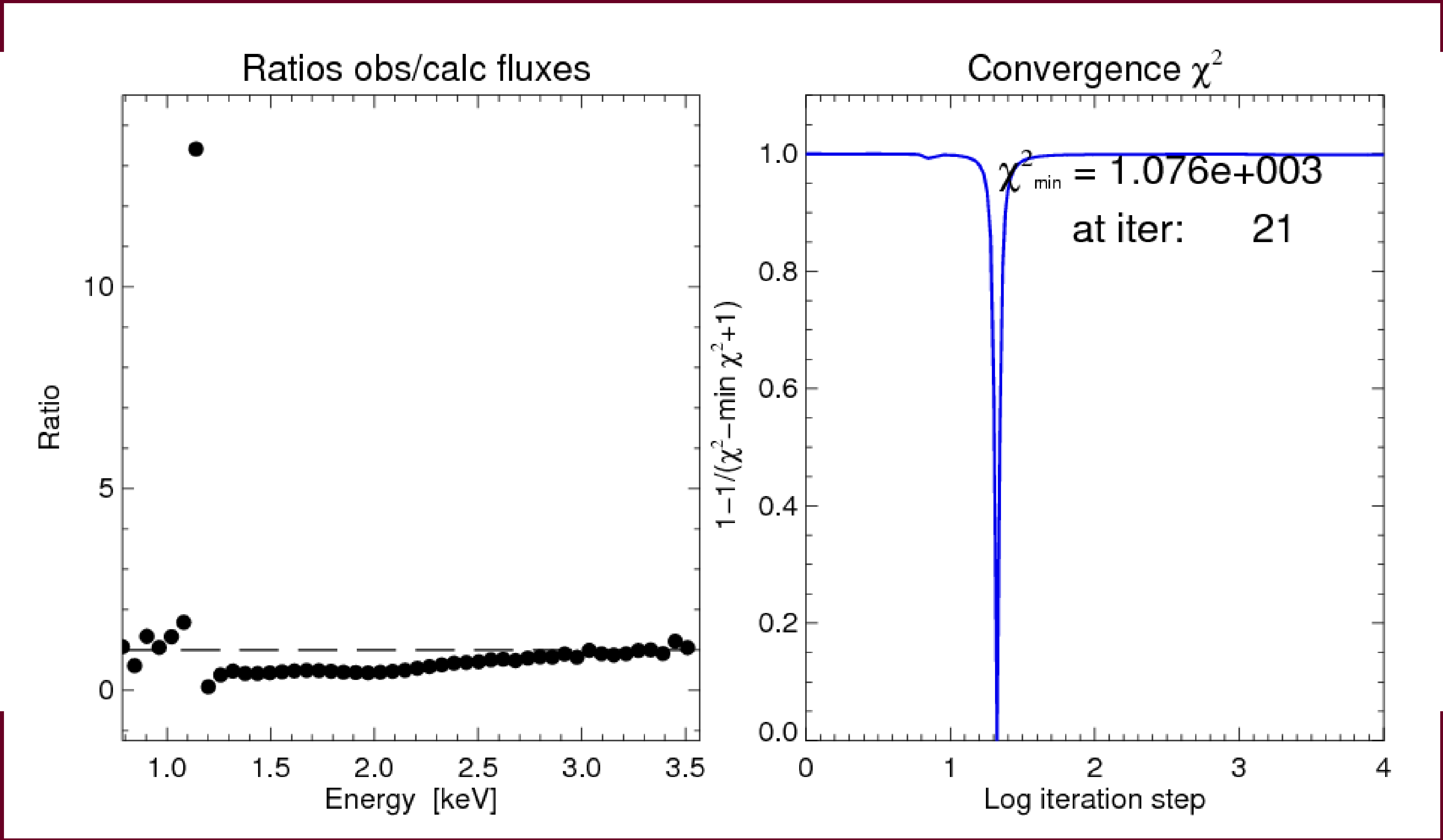




Be-med brak danych

Al-thick brak danych

Results of common analysis



Conclusions

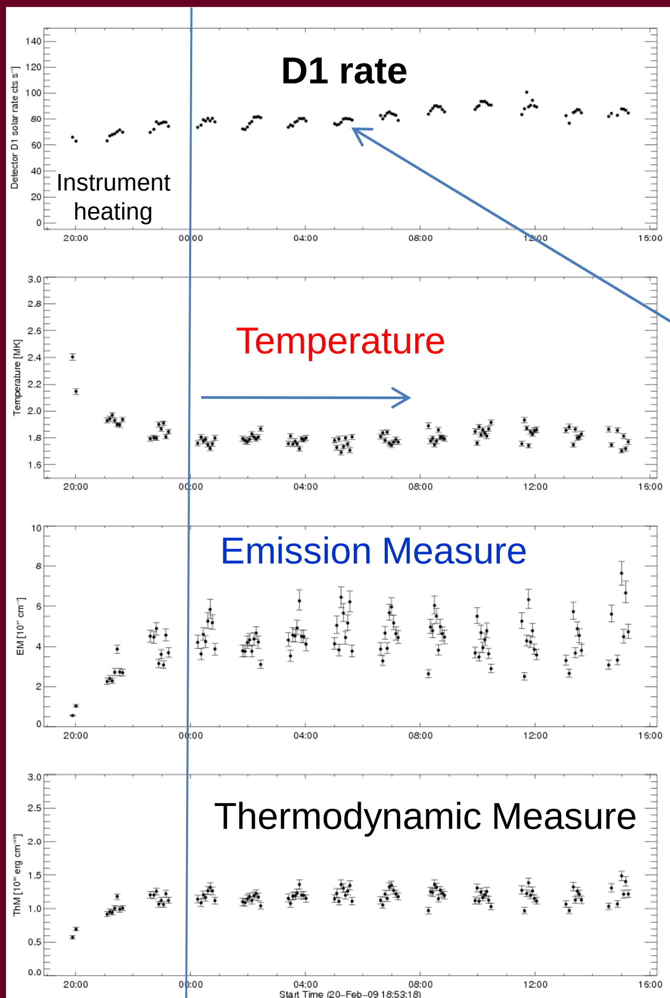
- SphinX DEM „alone” can be helpful in assesing:
  - Detailed adjustment of experimental shift
  - Iso/multitemperature character of the source plasma
  - Identification of abundance effects
    - Slight tweaking of individual abundances + Chi^2 optimization is the recommended procedure
- Sphinx+XRT DEM
  - XRT Fluxes should be „improved” to correspond to AR component („outside” emission removed)
  - Lot of experimenting with abundances…will strongly change the filter emissivities.

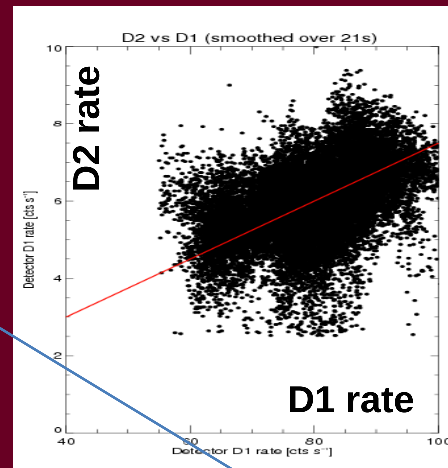
Work in progress
we are looking for enthusiasts
to join us

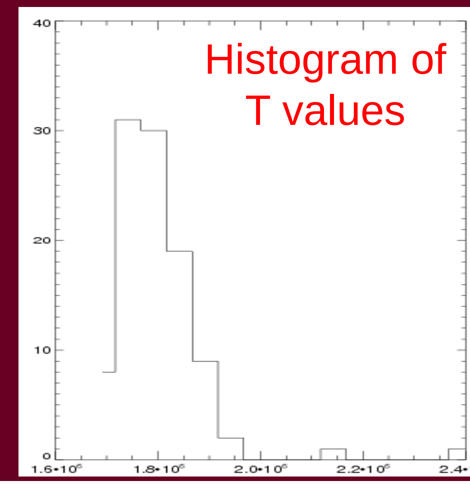
☺

Thank you

X-ray fluence at E > 1 keV







1.6 1.8 2.0 MK

Example: for data set No. 50

Te 1.71 MK [1.69, 1.72]

EM 6.2 [5.7 , 6.7] 10^{47} cm^{-3}

Flux [1 - 15 keV] 1.4 10^{-8} W/m2

Flux $_{GOES}$ [1 – 8 Å] 4.2 10^{-10} W/m2