MoCA: a Monte Carlo code for Accretion

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many thanks for the help also to: Michal Dovciak, René Goosmann and Michal Bursa

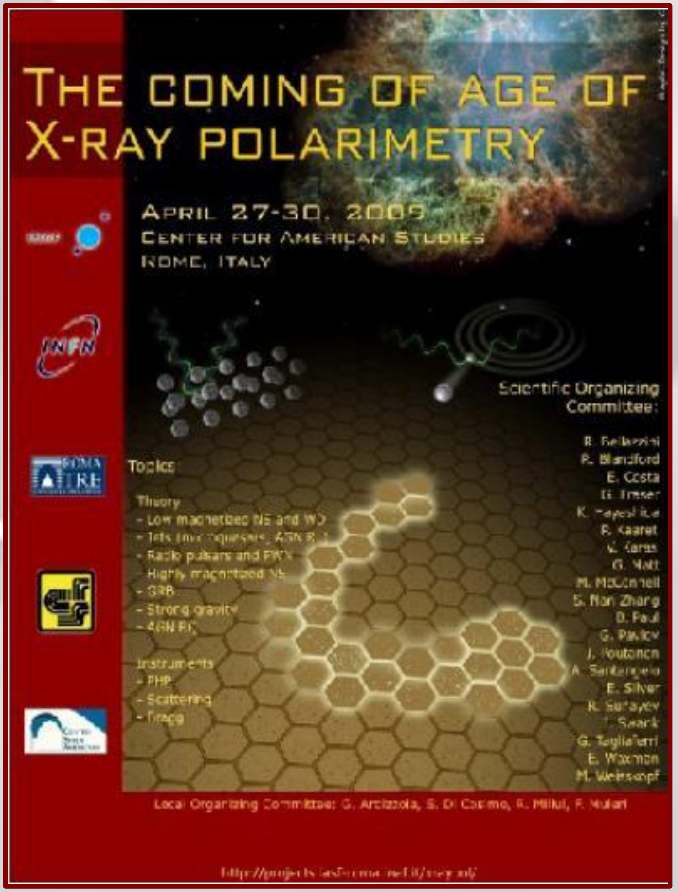
6th FERO meeting – 30th and 31st of August, Prague

Outline

- scientific motivation
- the model
- the code
- preliminary results (just the spectra)
- future developments & applications

Scientific motivation

MoCA is a fully special relativistic code for studying the spectrum and the polarization signal in accreting sources



Why polarimetry?

Since the birth of X-ray astronomy, spectral, spatial and timing observation improved dramatically, procuring a wealth of information on the majority of the classes of the celestial sources. Polarimetry, instead, remained basically unprobed. X-ray polarimetry promises to provide additional information procuring two new observable quantities, the degree and the angle of polarization. [*Enrico Costa*]

…unfortunately ALL the large and medium missions with an X-ray polarimeter on board have been cancelled or unselected.

the model
- the corona -

SPHERICAL corona parameters

R_{Cin} = 6 rg

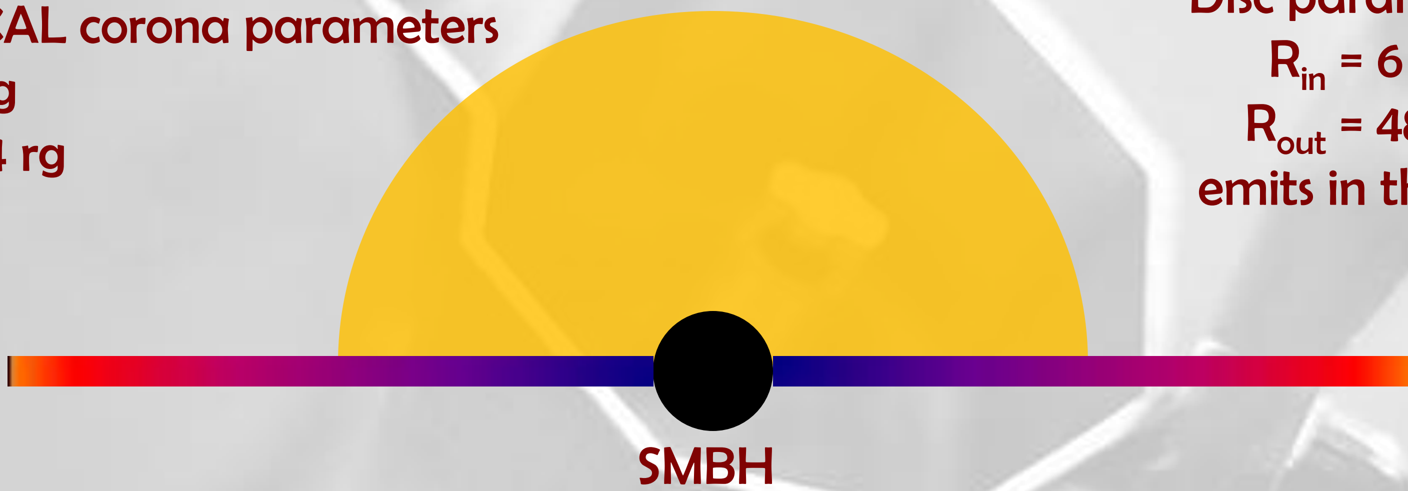
R_{Cout} = 24 rg

Disc parameters

R_{in} = 6 rg

R_{out} = 48 rg

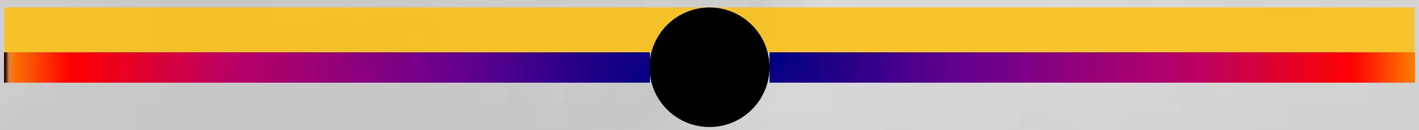
emits in the UV



SLABBY corona parameters

H_C = 6 rg

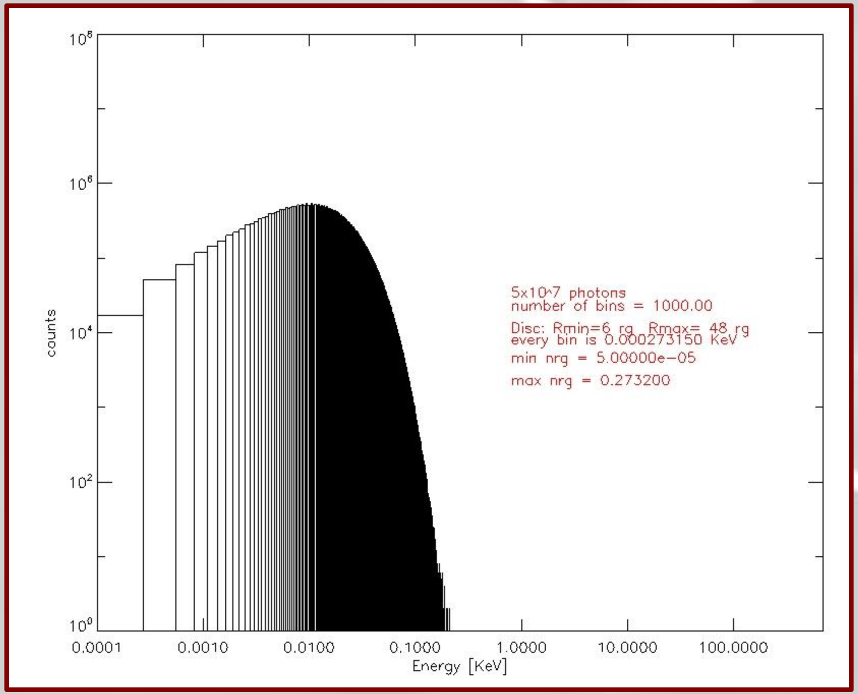
L_C = 48 rg

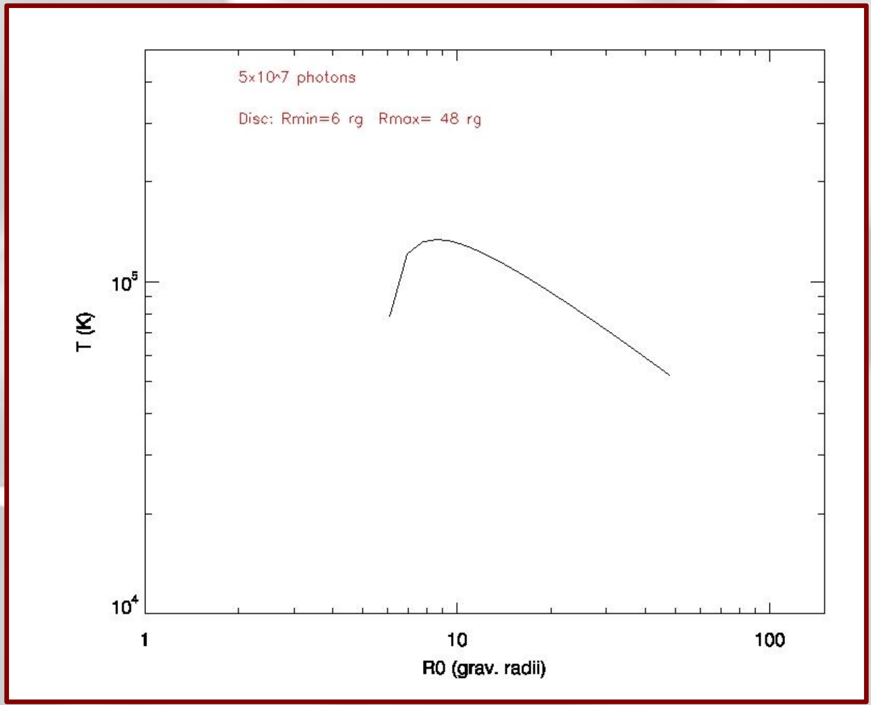


the model

- the emission -

- emission from the disc (MTBB)





for both the geometries the thermal energy of the corona is kT= 100 KeV

- Iron line @ 6.4 KeV (unpolarized)

for both the geometries the thermal energy of the corona is kT= 2,5,8 KeV

the code

The code is written in IDL, an interactive and vectorized language, and it's modular, fully special relativistic, and extremely time consuming!!

The approach is to follow every photon during its journey from the disc to the observer, switching between the RF of the Disc and the RF of the electron

INPUT: seed photon = { R_o, $\theta_d(=90°)$, φ_d, $K_d(h\nu_d)$}

$$K_{d,t} = \frac{2\pi\,\nu_d}{c}$$
$$K_{d,x} = K_{d\{0\}}\, sin(\Theta_d)\, cos(\Phi_d)$$
$$K_{d,y} = K_{d\{0\}}\, sin(\Theta_d)\, sin(\Phi_d)$$
$$K_{d,z} = K_{d\{0\}}\, cos(\Theta_d)$$

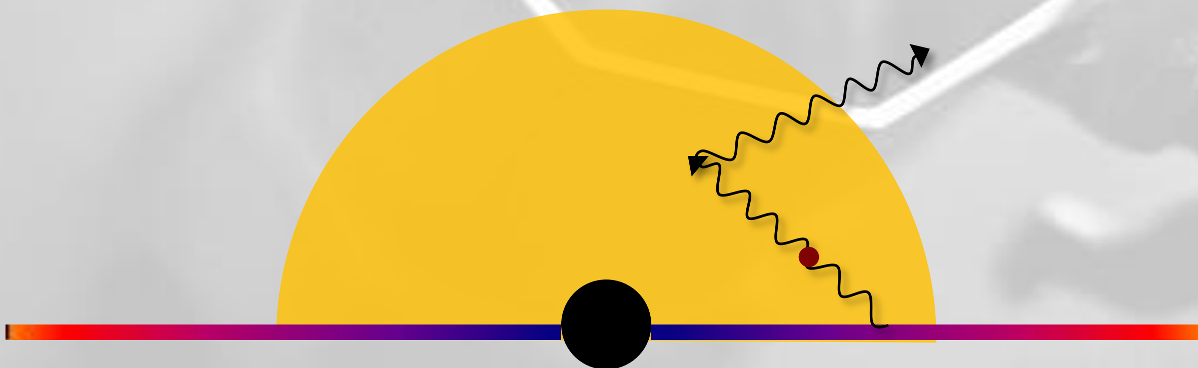
- emissivity law weighted both on $\sigma_{SB}T_D$ and on $R_o dR$ (for disc emission)
- limb darkening on Θ_d

the code

The P_d vector (electric field) of the seed photon is randomly chosen on the polarization plane for unpolarized radiation OR linearly polarized (up to 11%) on the direction parallel to the plane of the disc (Chandrasekhar, 1960).

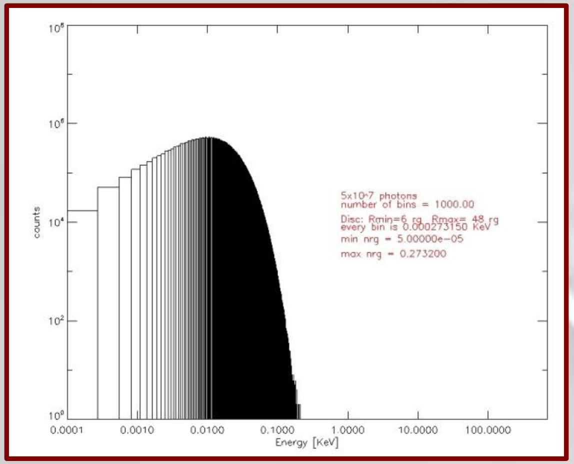
P_d K_d → Q_j U_j

Matt et al. 1996



OUTPUT: $h\nu$, Θ, Φ, Q_j, U_j, #sc

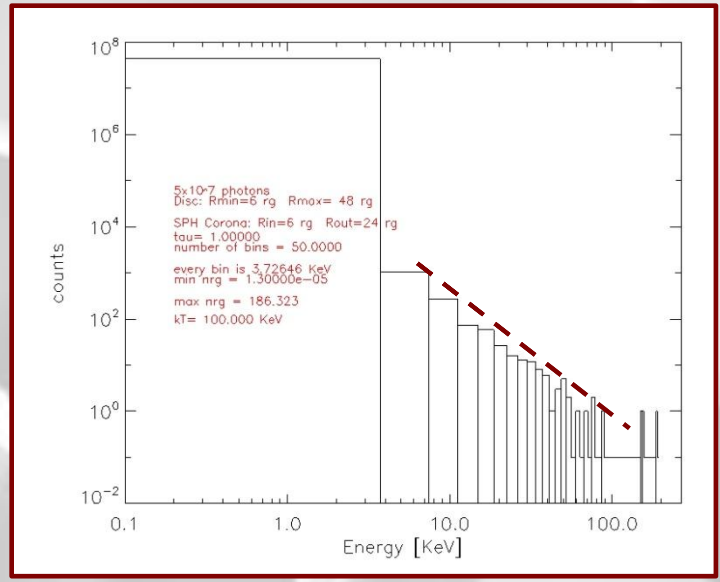
the spectra



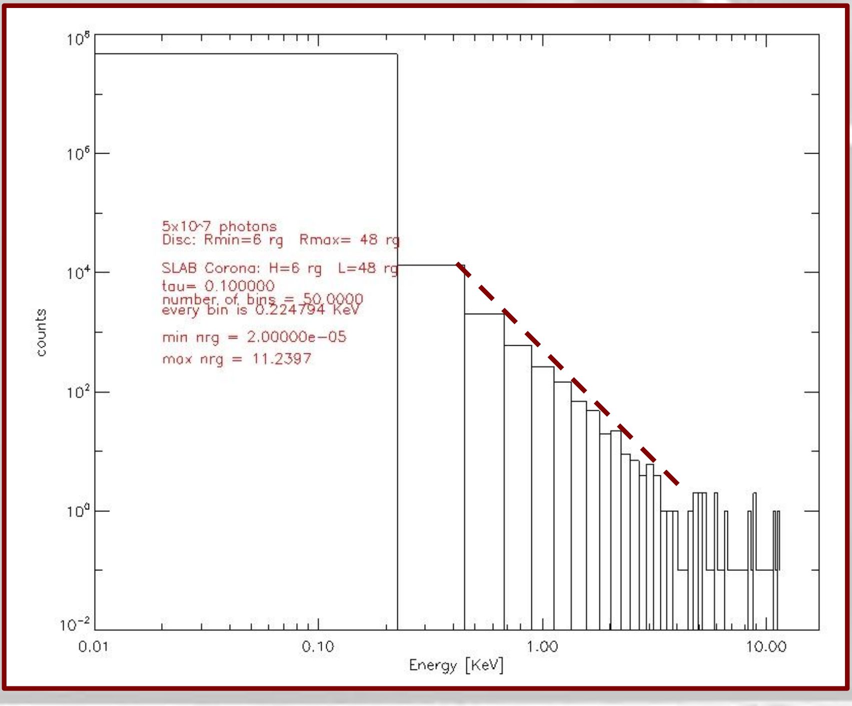
kT = 100 KeV

$5x10^7$ photons

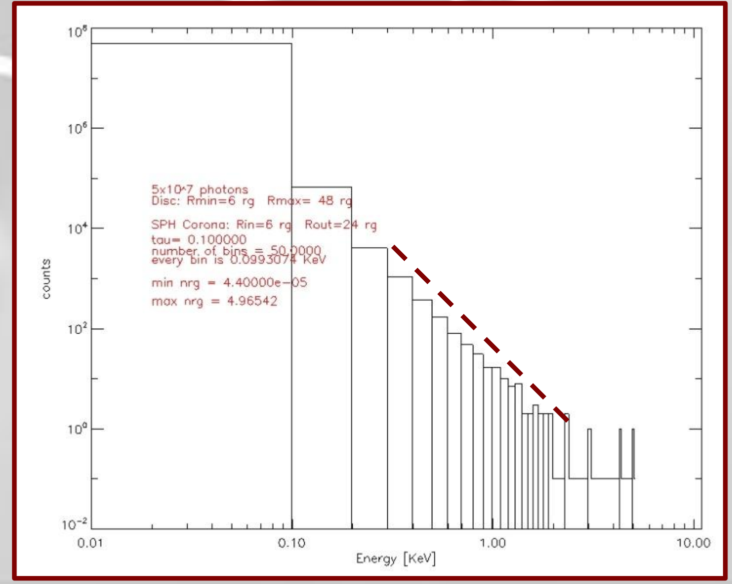
SPHERE, $\tau = 1$



SLAB, $\tau = 0.1$

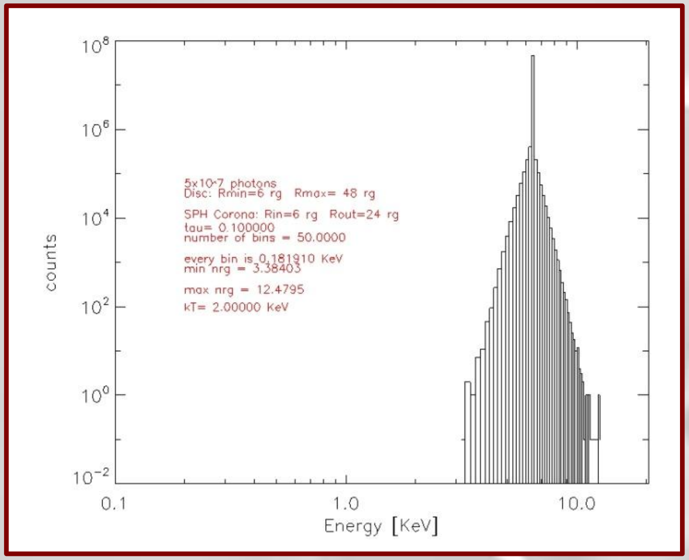


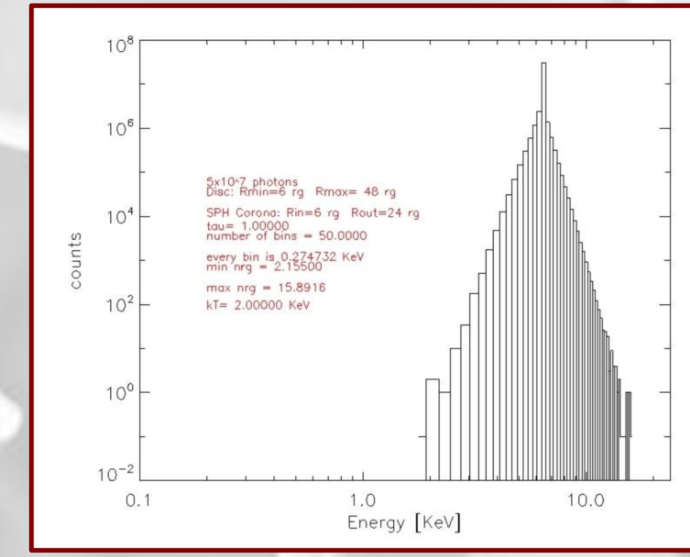
SPHERE, $\tau = 0.1$



the spectra

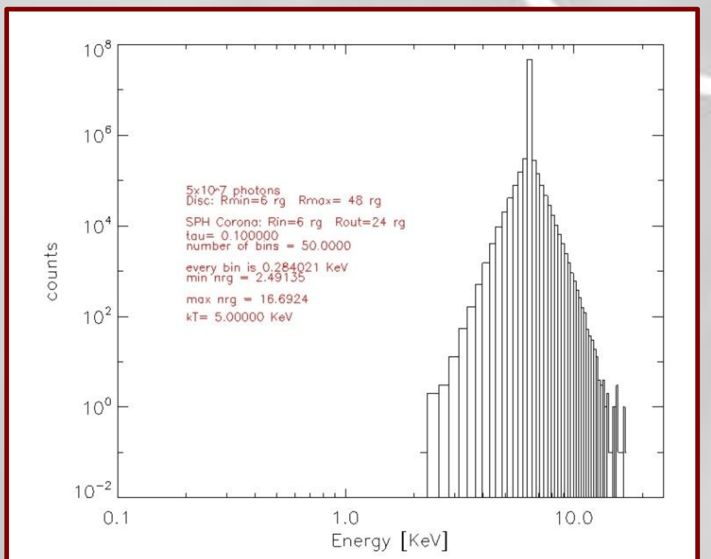
kT = 2 KeV
τ = 0.1





kT = 2 KeV
τ = 1

kT = 5 KeV
τ = 0.1

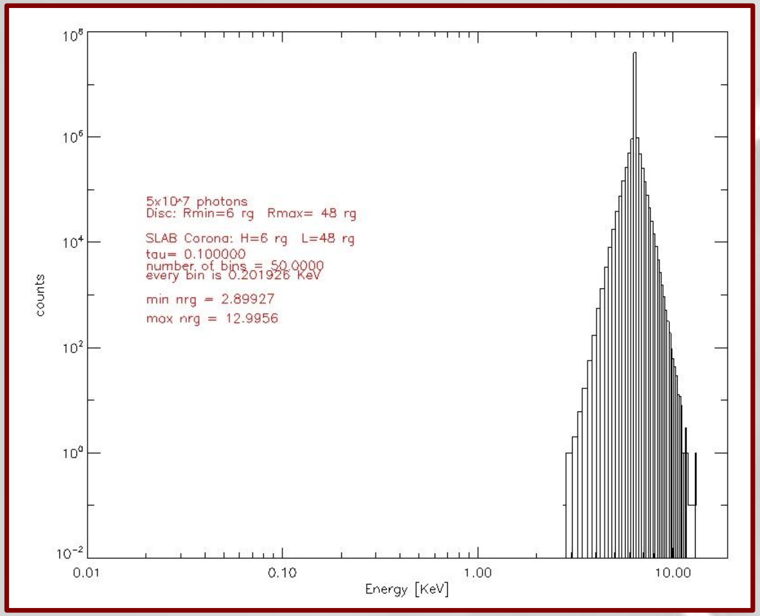


input energy = 6.4 KeV
(unpolarized)

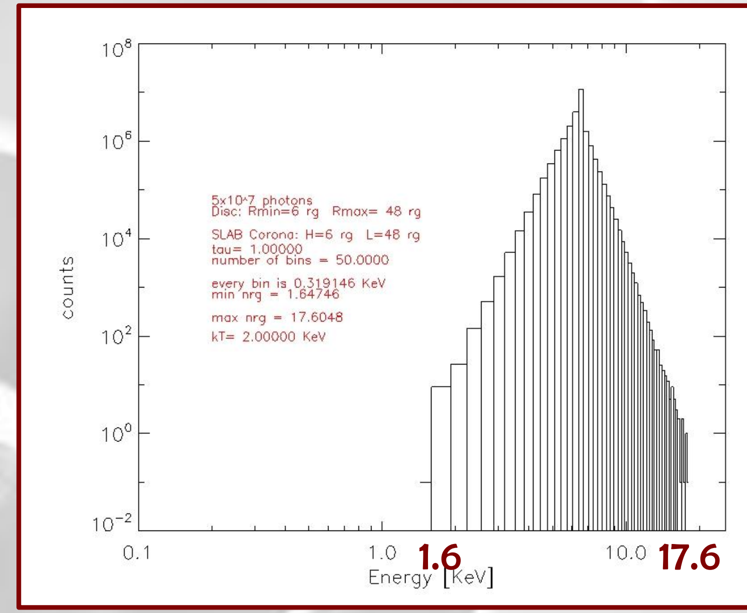
SPHERICAL corona

the spectra

kT = 2 KeV
$\tau = 0.1$



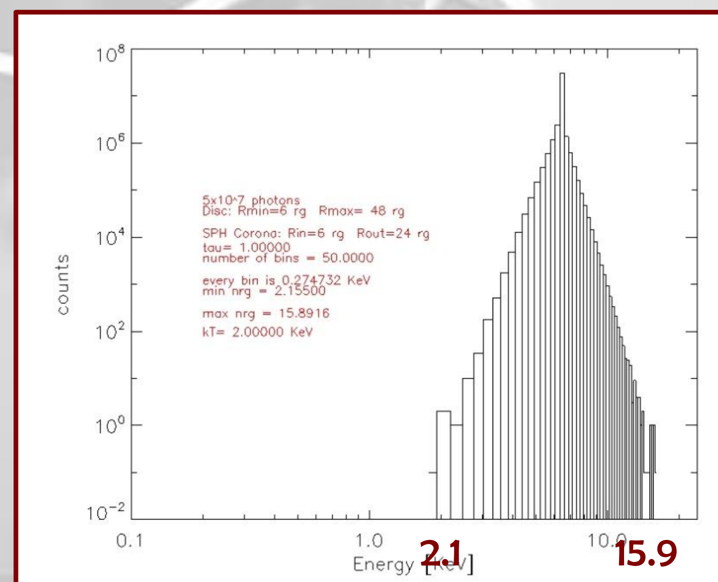
kT = 2 KeV
$\tau = 1$



input energy = 6.4 KeV
(unpolarized)

SLAB corona

SPHERE
kT = 2 KeV
$\tau = 1$



future developments & applications

- increase the statistics!!
- include GR (Michal Bursa ray tracing routine)
- include reflection
- apply the code to the iron line case to dicriminate between a scattering or a relativistic broadening in NS