2D electron spectroscopy of solar flares

A theorist needs to know F(**p**,**r**,t) –
a fingerprint of acceleration and propagation

In reality we recover an approximated values:
<nVF(E,t)> - spatially averaged distribution
<nVF(E,r,t)> - somewhat spatially resolved (imaging spectroscopy)

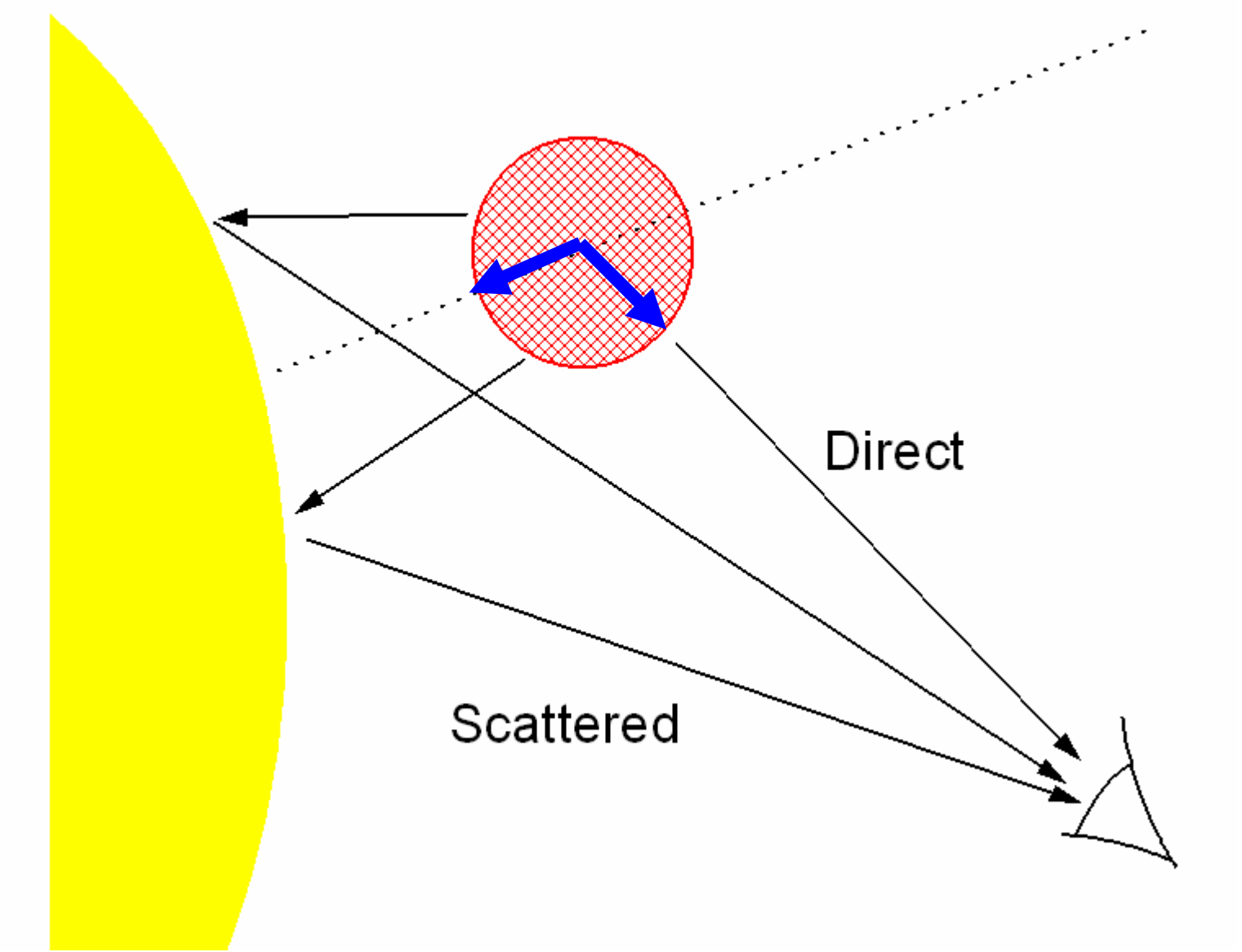
… but it assumes isotropic emission.

Beyond simple spectroscopy…

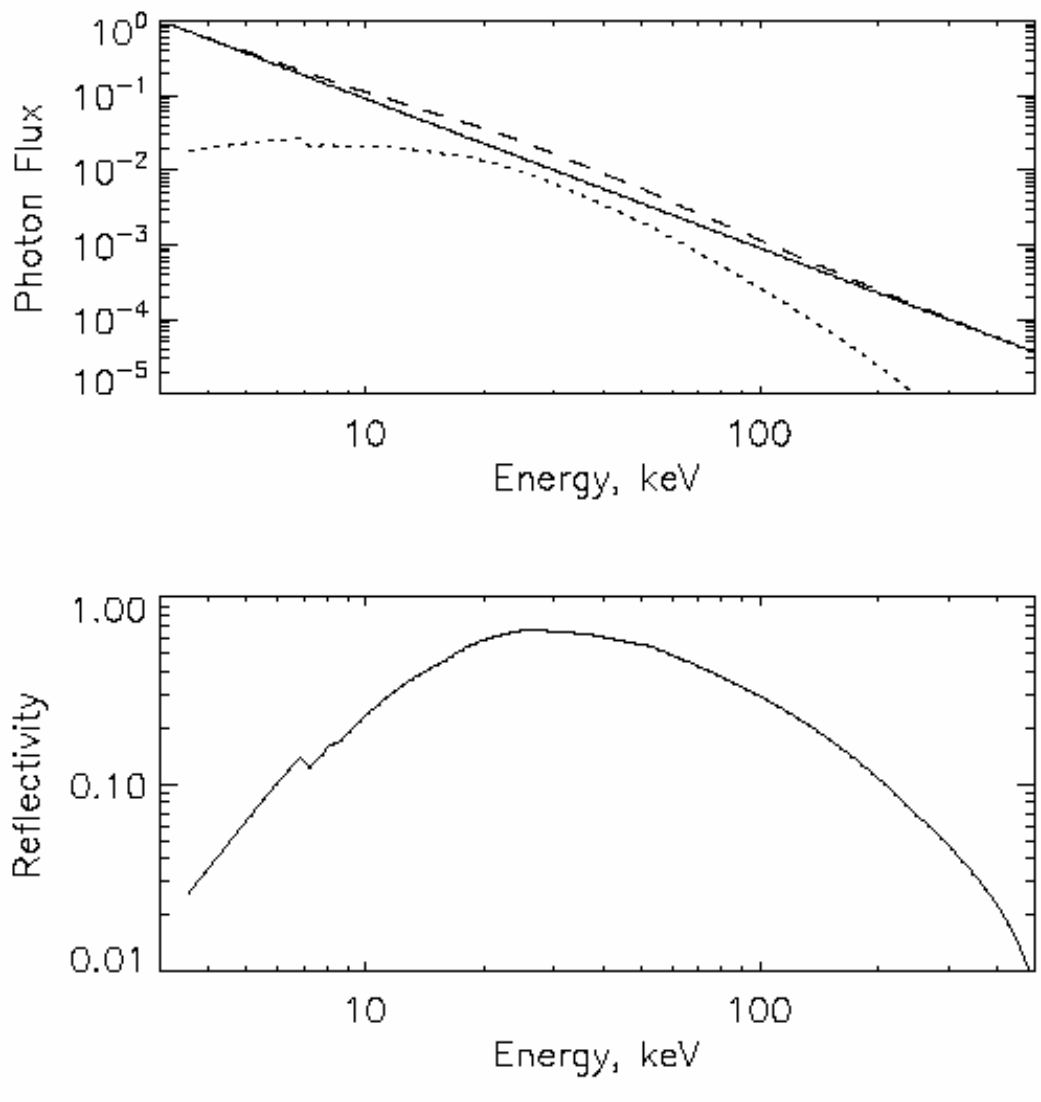
We can successfully recover electron distribution assuming isotropic emission: forward-fitting (Holman et al, 2003 etc) and model independent (Piana et al 2003, Kontar et al 2004 etc)

What about **angular distribution** of particles? Such information can be crucial in constraining an acceleration model.

Direct and scattered photons

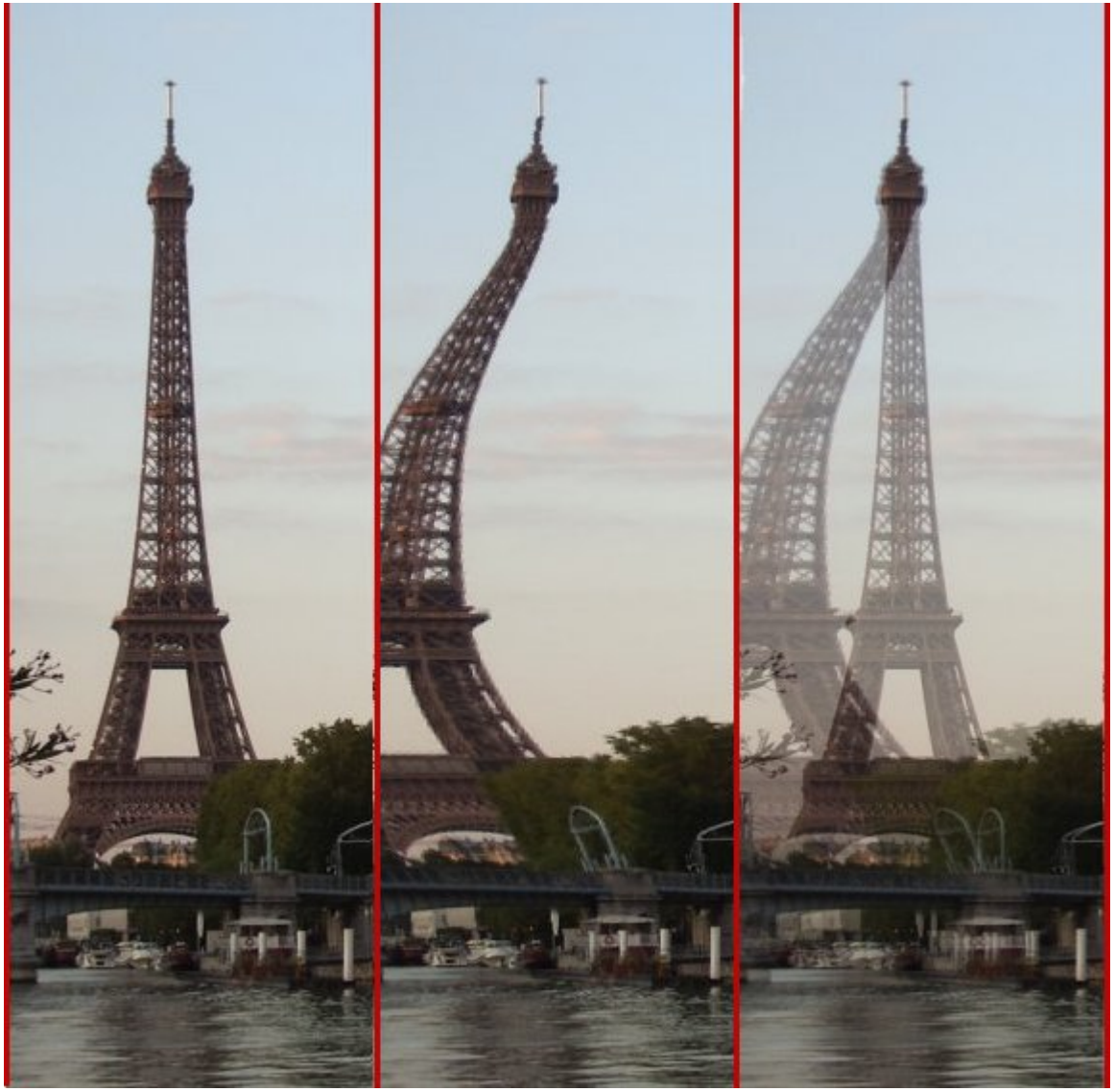


Direct and scattered photons



Primary and Scattered are functionally different

Direct and scattered photons



Primary + Scattered = Observed

Albedo: Green's functions and observed spectrum

Green's function is a probability density of a photon with energy $E_{0,}$ to scatter from the photosphere into observer's direction with energy E.

$$I_S(E) = \int_E^{E_{max}} I_P G(\mu, E, E_0) dE_0 \qquad \mu = \cos(\theta)$$

The total observed flux is a sum of a primary and scattered fluxes

$$I(E_i) = I_P(E_i) + G_{ij}(\mu) I_P(E_j) \qquad G_{ij} = \int_{1/E_{j-1}}^{E_j} G(\mu, E_0, E) dE_0$$

The primary photon spectrum formally can be written:

$$I_P(E_j) = (1 + G_{ij}(\mu))^{-1} I(E_i)$$

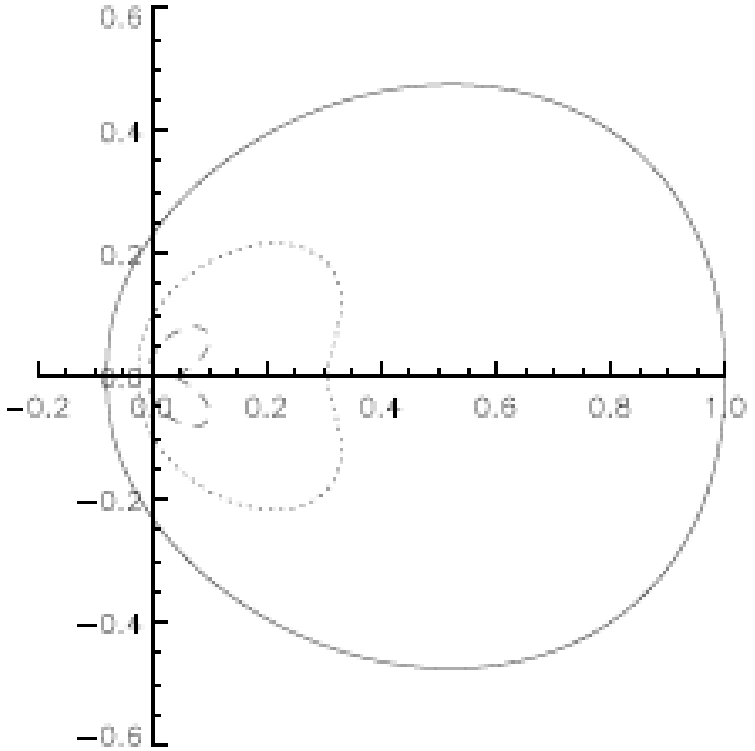
From counts to 2D electron distribution

The total photon flux is a sum of scattered and direct emissions

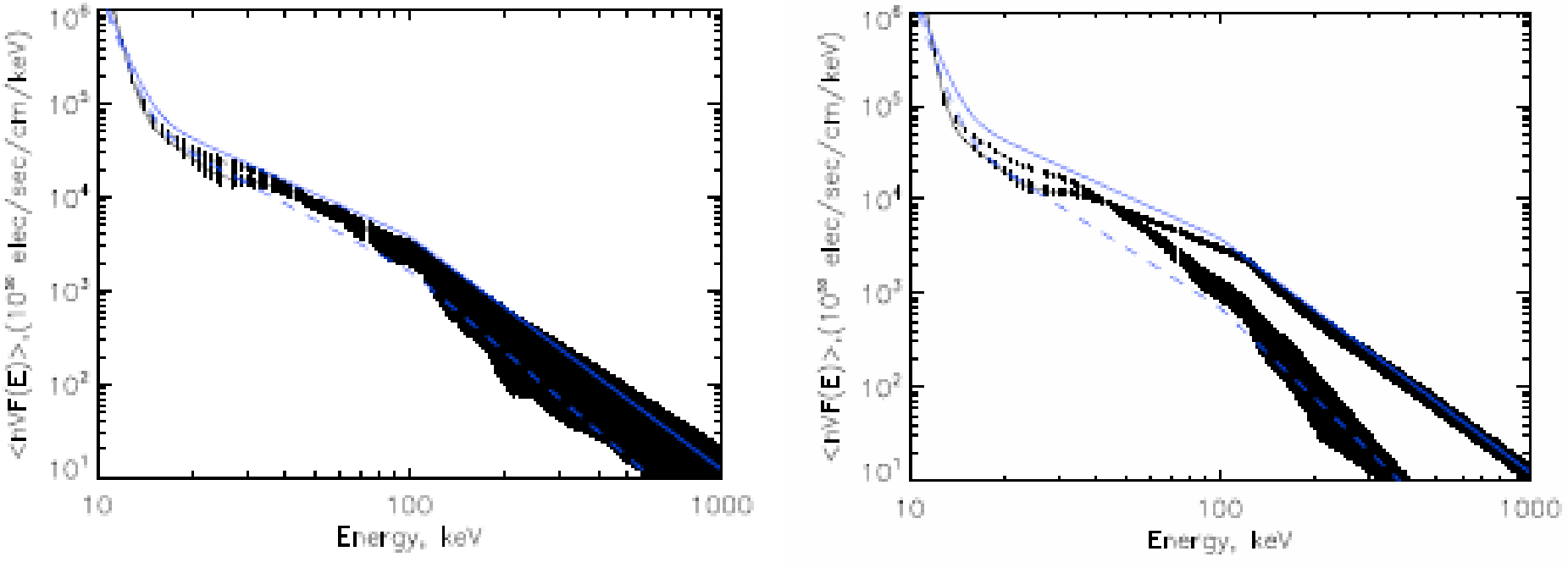
$$\mathbf{I} = \begin{pmatrix} \mathbf{Q^F} & \mathbf{Q^B} \\ \mathbf{GQ^B} & \mathbf{GQ^F} \end{pmatrix} \begin{pmatrix} \mathbf{F_u} \\ \mathbf{F_d} \end{pmatrix}$$

Where **Fu** – upward directed electrons and **Fd** – downward directed electrons.
We can rewrite the equation in a simple form:

$$\mathbf{I} = \mathbf{AF}$$

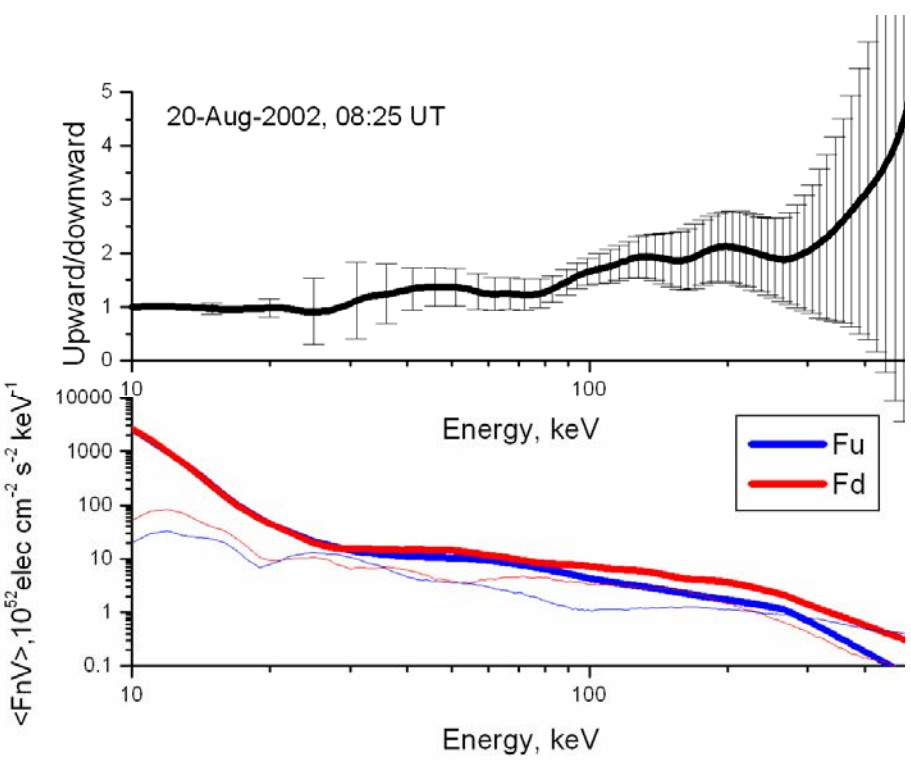


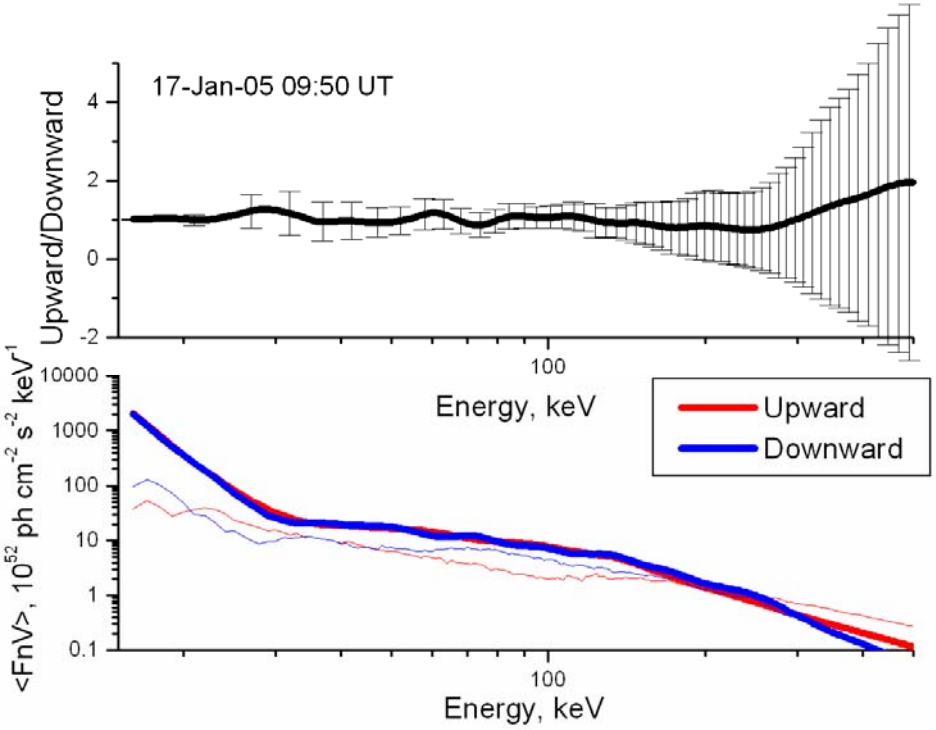
Test recoveries



Model (blue lines) and recovered (black lines) spectra

20-Aug-2002 and 17-Jan-2005





- Distribution is close to isotropic
- Data are not consistent with downward directed beam