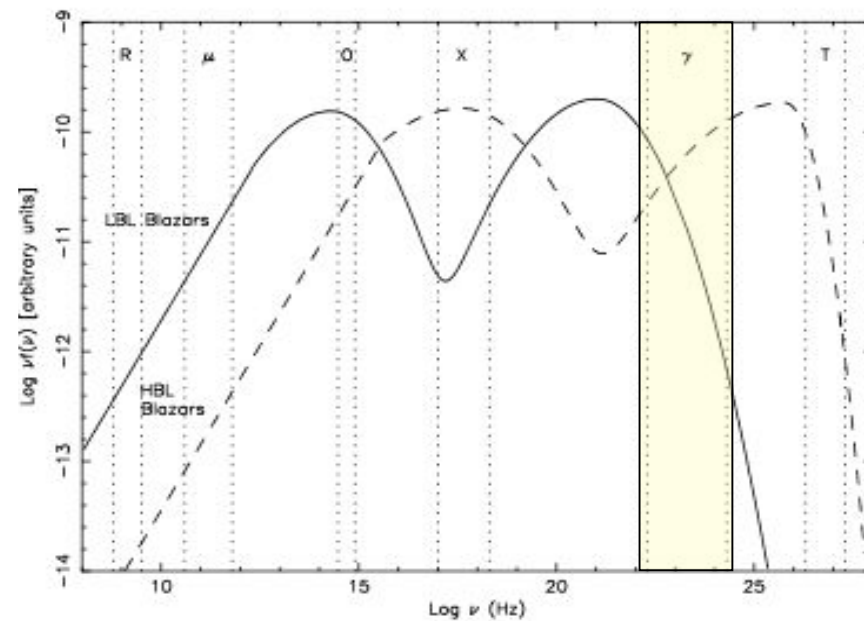# Simulated Blazar Surveys
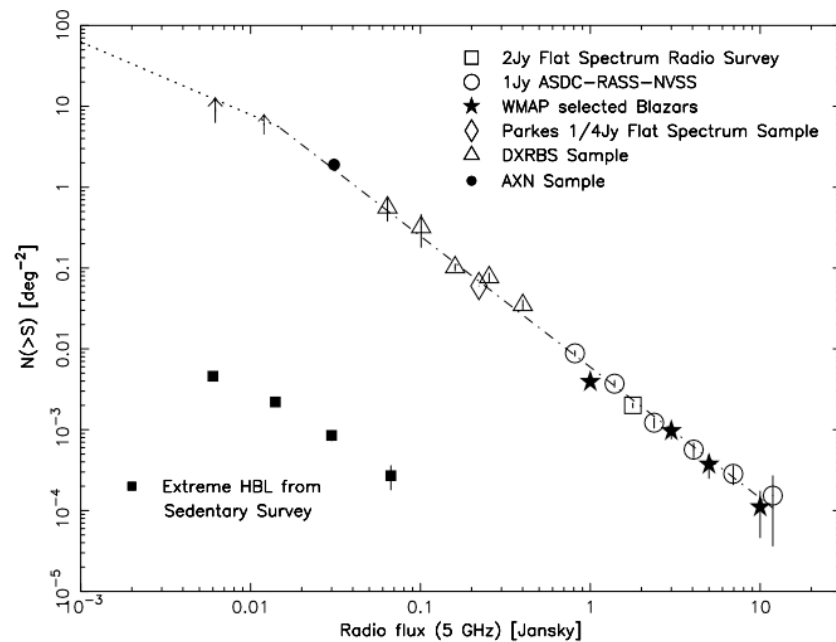
(PRELIMINARY RESULTS)

P. Giommi
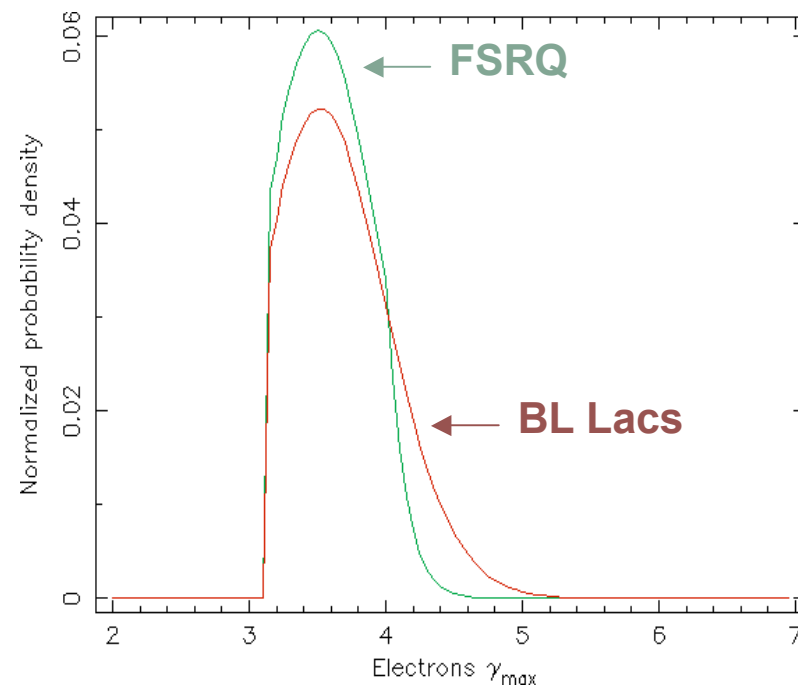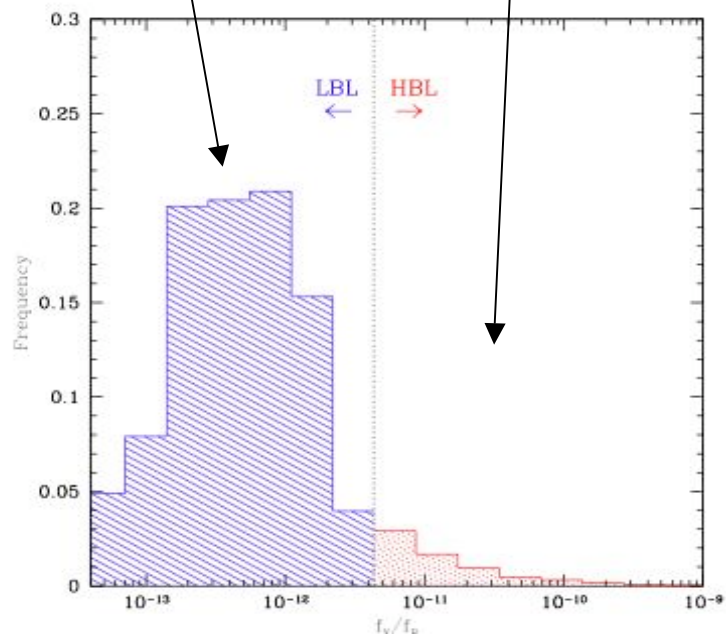
Software for blazar survey simulations
Main properties and parameters

• Starts from a radio Luminosity function + Cosmological evolution

  - Monte Carlo simulation of redshift and radio luminosity

• Radio luminosity of each source is extrapolated to other energy bands (micro-wave, optical, X-ray, gamma-ray) based on SSC model + and randomized based on observed distributions.

• Gamma-ray flux simulated taking into account of duty cycle and GRB constraints (see Giommi et al. 2005 A&A in press, astro-ph/0508034)

• Sources are accepted above a set of flux limits (radio, opt , X-ray etc.) that can be a function of the position in the sky

• Results are written to a DBMS or to a FITS file

FSRQ + BL Lacs   BL Lacs only

Legend (top-left panel):
- □ 2Jy Flat Spectrum Radio Survey
- ○ 1Jy ASDC–RASS–NVSS
- ★ WMAP selected Blazars
- ◇ Parkes 1/4Jy Flat Spectrum Sample
- △ DXRBS Sample
- ● AXN Sample

Extreme HBL from Sedentary Survey

Cosmological evolution

No evolution for BL Lacs

Pure luminosity evolution for FSRQs

$$L(z)=L(0)*e^{2.2*z/(1+z)}$$

New result from DXRBs survey :

Evolution depends on redshift

(Padovani, Giommi, Landt & Perlman 2005, in preparation)

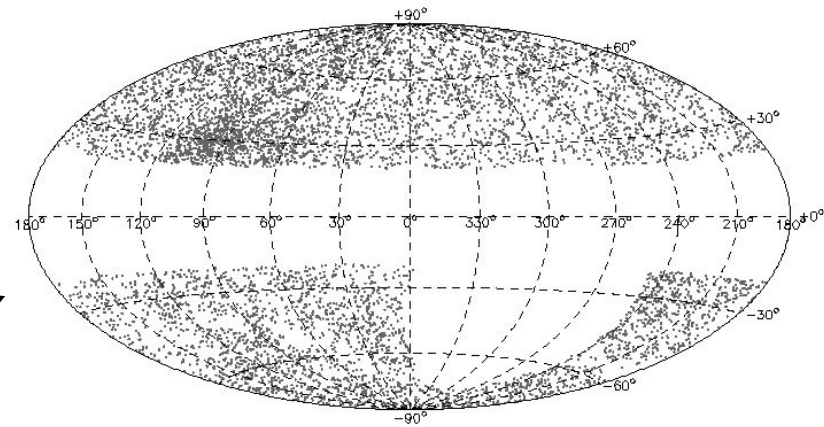# Checking the simulations against the RASS-NVSS-GSC2 Blazar candidates

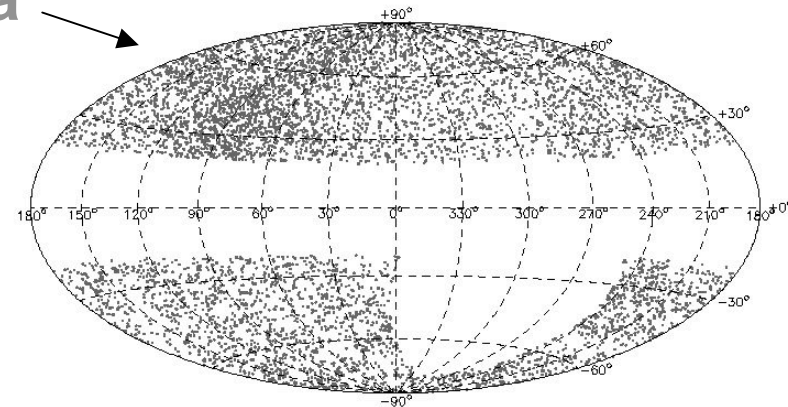**Cross-correlation between NVSS (radio) and RASS (X-ray) surveys.**

Optical magnitudes from GSC2
(assuming Jmag < 19.5 when no counterpart
is found in GSC2)

- $\Delta_{r-x} < 2.5\ s_{r-x}$
- **and < 0.8 '**
- α_{ox} and α_{ro}
  within
  Blazar area

Over 7400 Blazar candidates

Real data

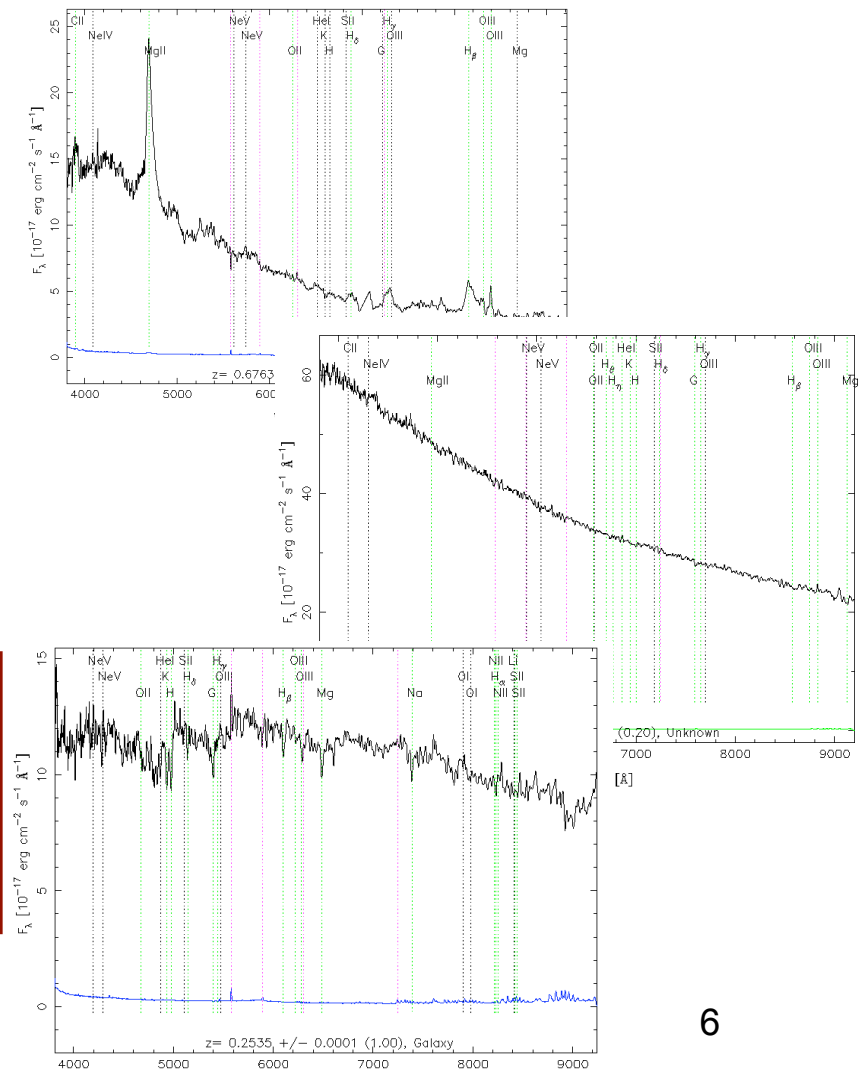**Simulated data**

11/29/05

RASS-NVSS Blazar Sample:
Identification through optical spectroscopy using SDSS-DR4 + 2dF spectra
Turriziani, Cavazzuti, Giommi et al, in preparation

669 SDSS spectra in Data Release 4

232 BL LACS [92 new objects]

223 FSRQs   [161]

  93 QSOs [xx](no radio spectral info)

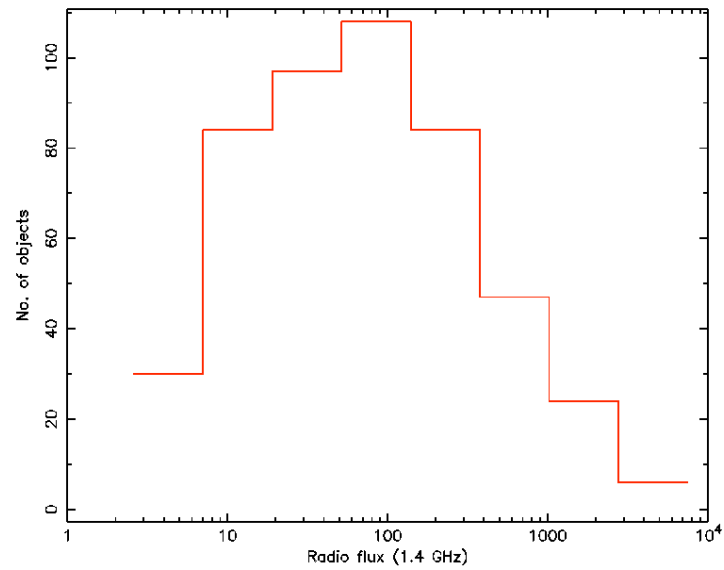103 SSRQs [79]

  34 Radio gal/BL Lac transition objects

~61% are genuine Blazars

~13%QSO with unknown radio spectrum

~13% are steep radio spectrum QSOs
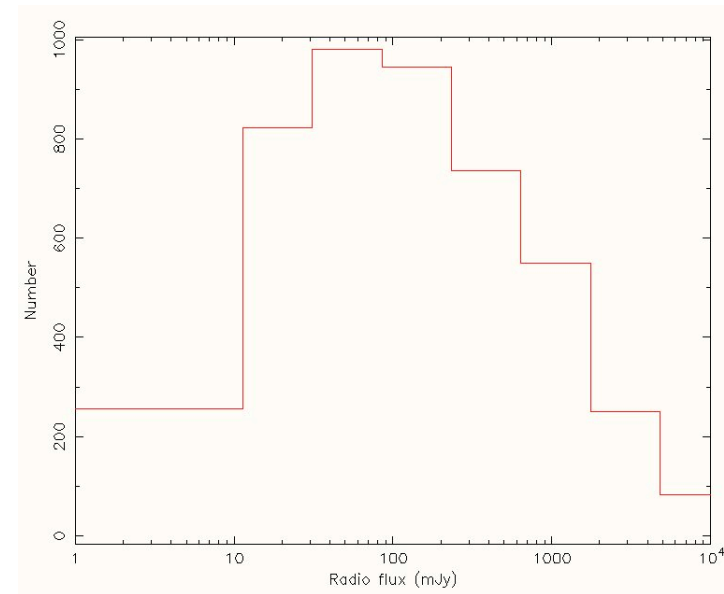
~13% are other AGN or galaxies

Radio flux distributions
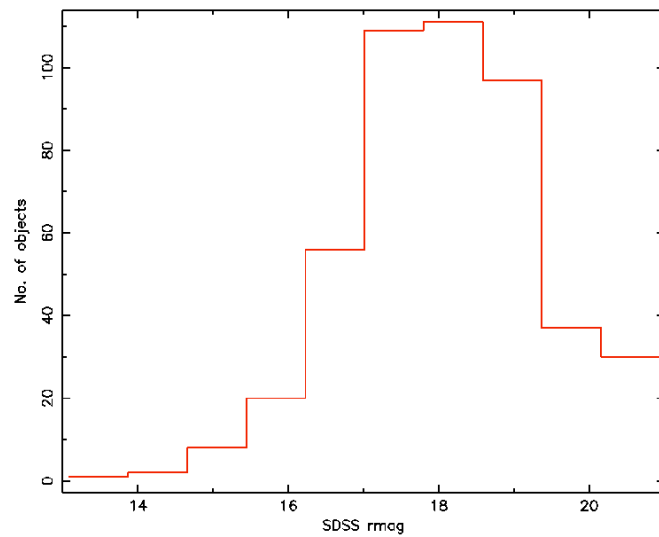
Data from RASS-NVSS-SLOAN
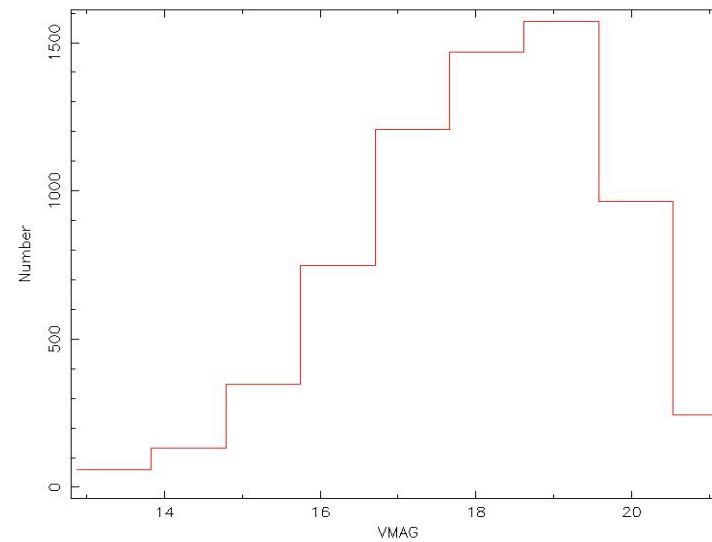Blazar Sample

Simulation

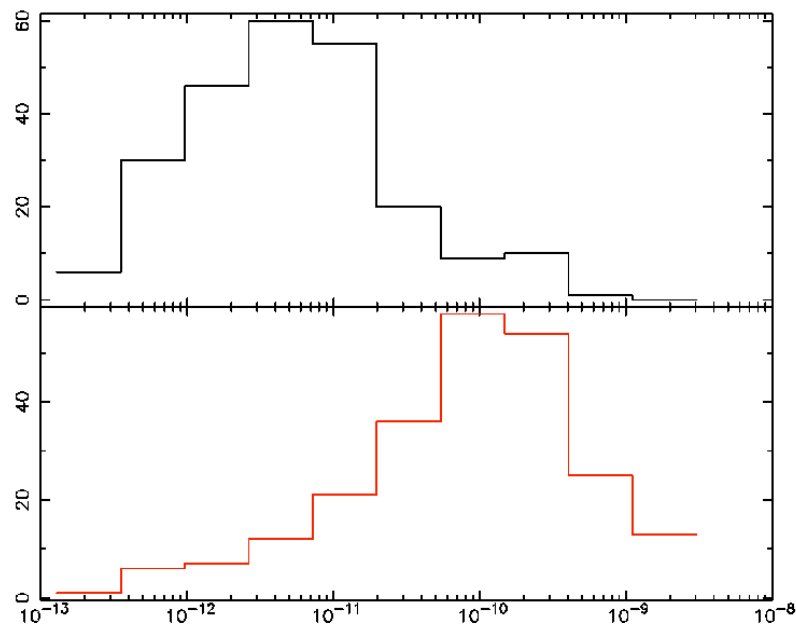# Magnitude distributions
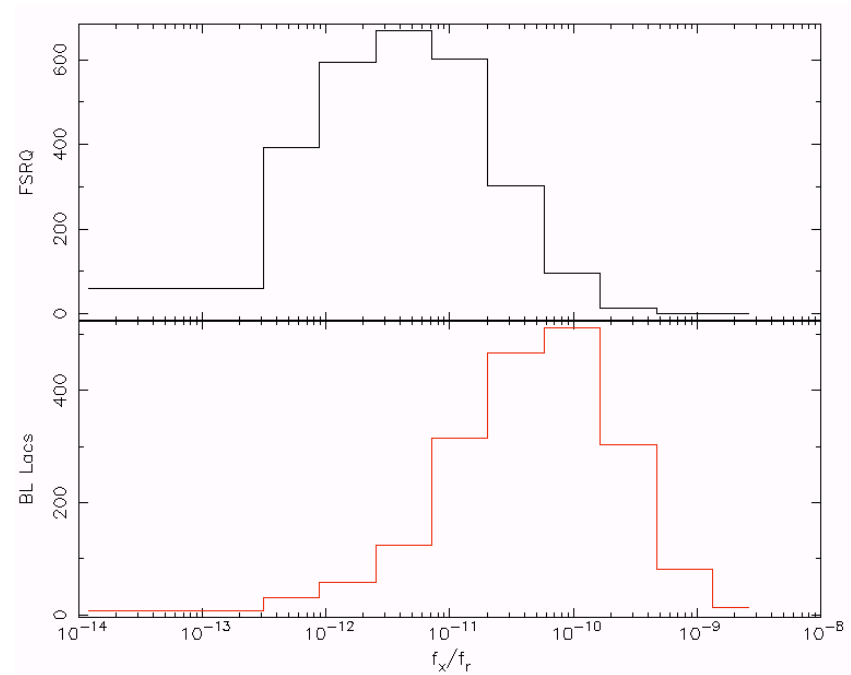
Data from RASS-NVSS-SLOAN
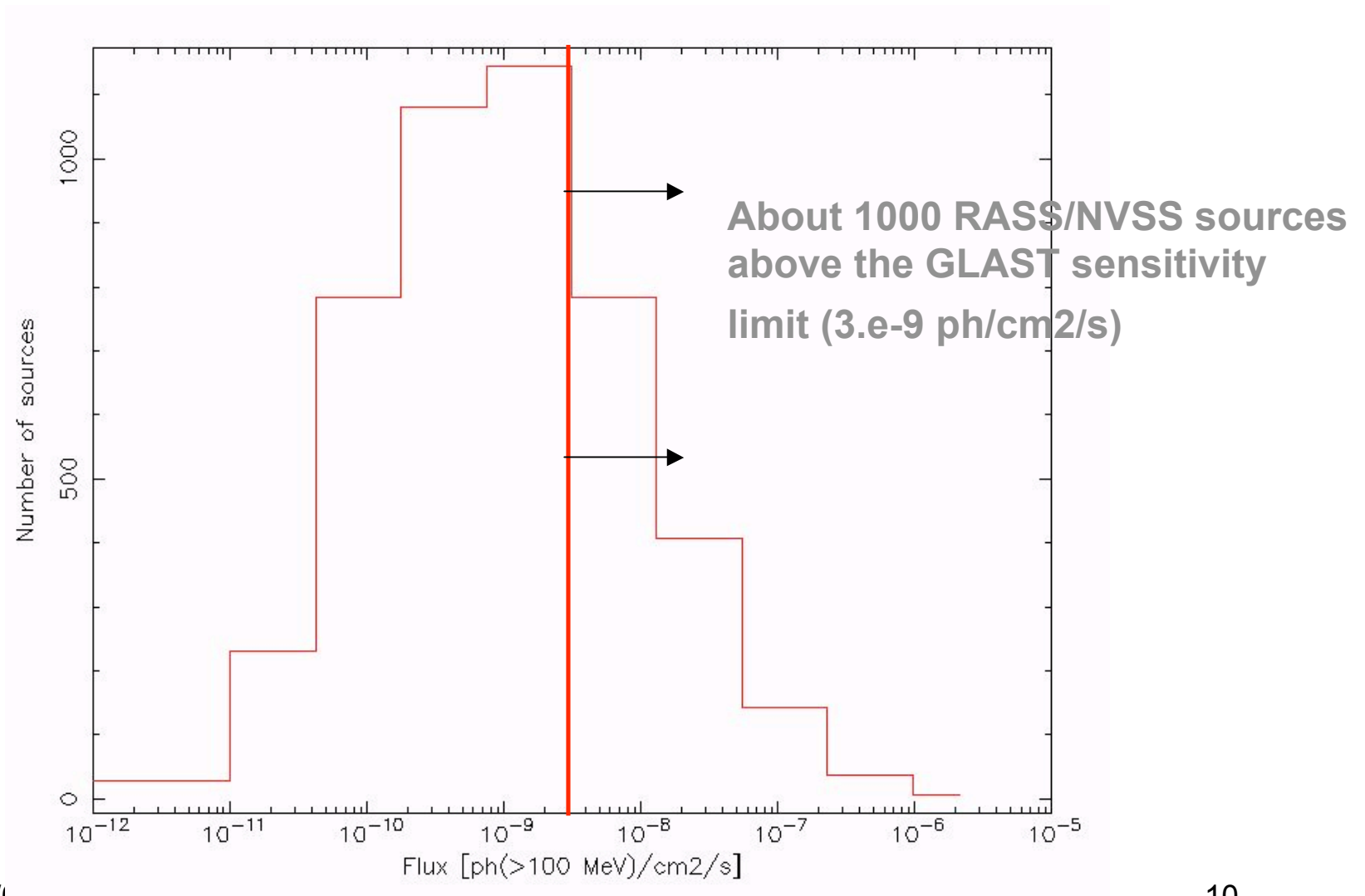Blazar Sample

Simulation

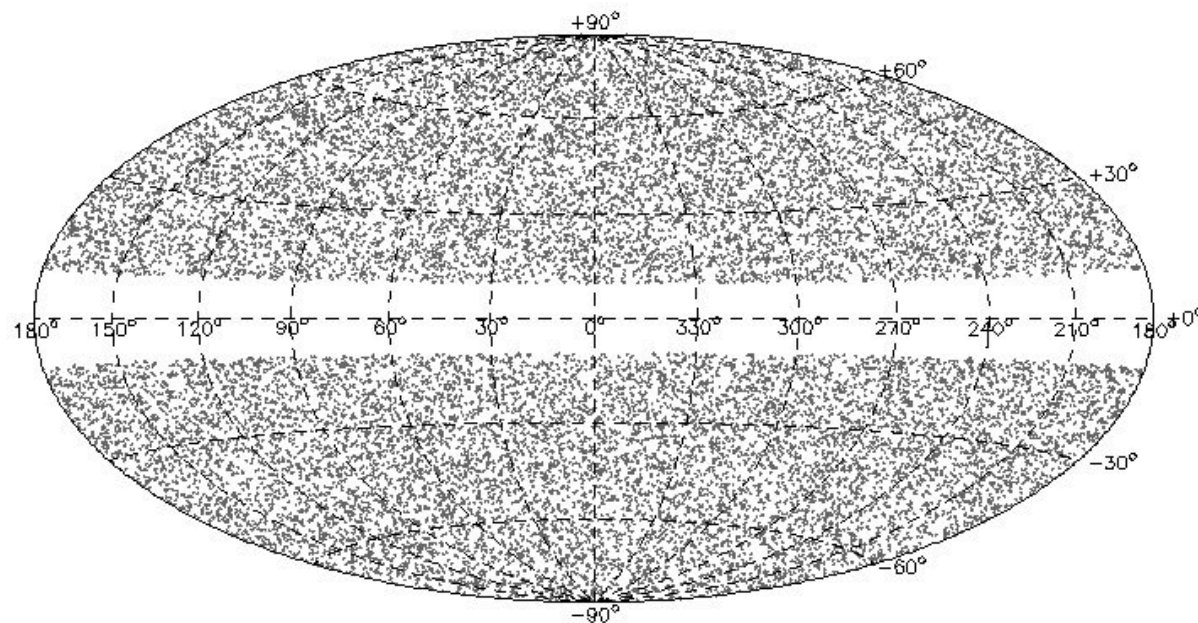# fx/fr distributions

Data from RASS-NVSS-SLOAN
Blazar Sample

Simulation

Predicted distribution of gamma-ray fluxes in
RASS-NVSS-SLOAN Blazar Sample

**About 1000 RASS/NVSS sources
above the GLAST sensitivity
limit (3.e-9 ph/cm2/s)**

A radio flux limited survey
(f_lim = 10 mJy)

Predicted distribution of gamma-ray fluxes in a 10 mJy radio survey

About 5,000 radio sources With f_radio > 10 mJy are above the GLAST sensitivity limit (3.e-9 ph/cm2/s)
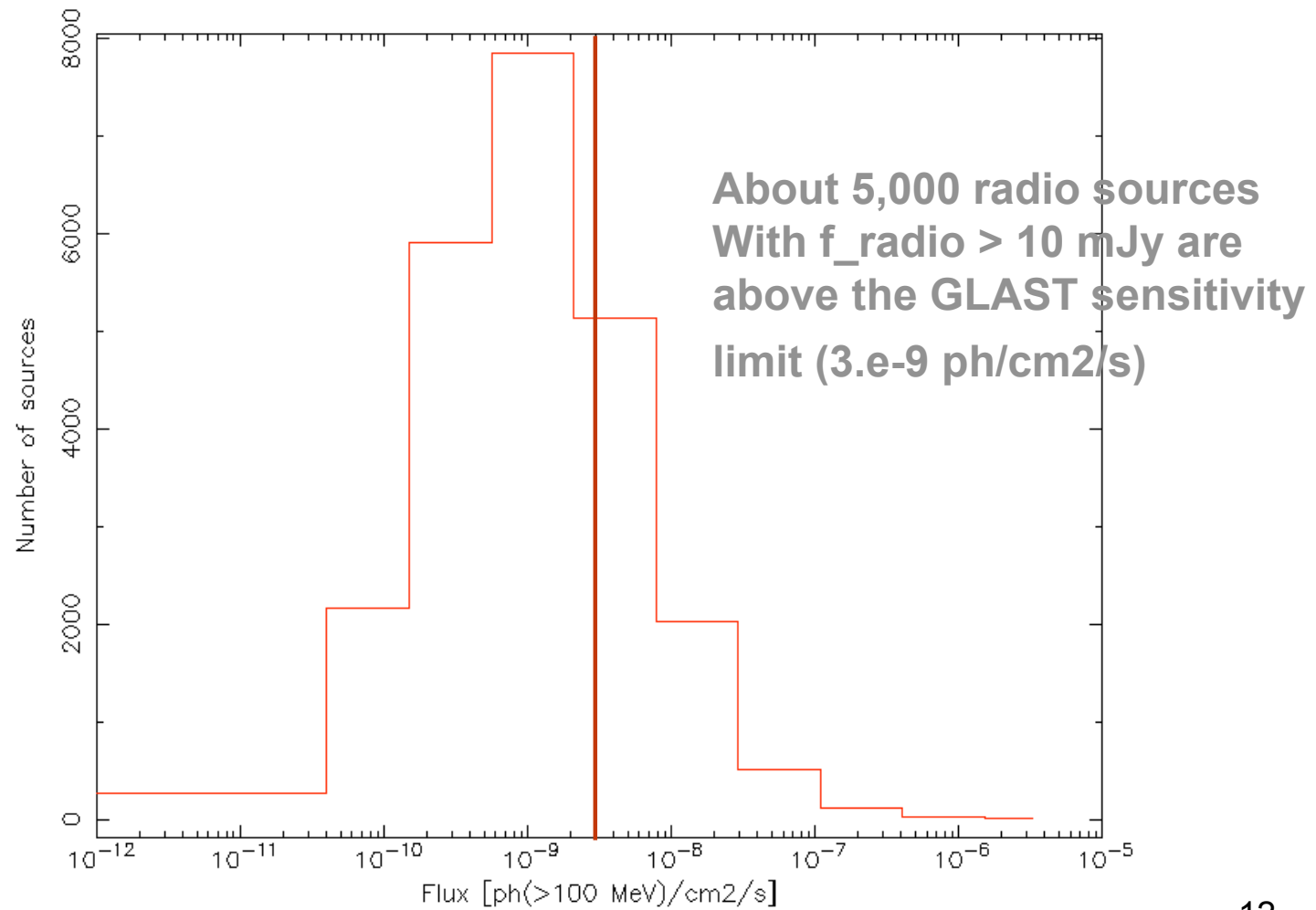
Predicted redhisft distributions

Not detected by GLAST
$f(>100\ \text{MeV}) < 3 \times 10^{-9}$ ph/cm2/s

Detected by GLAST
$f(>100\ \text{MeV}) > 3 \times 10^{-9}$ ph/cm2/s

Redshift
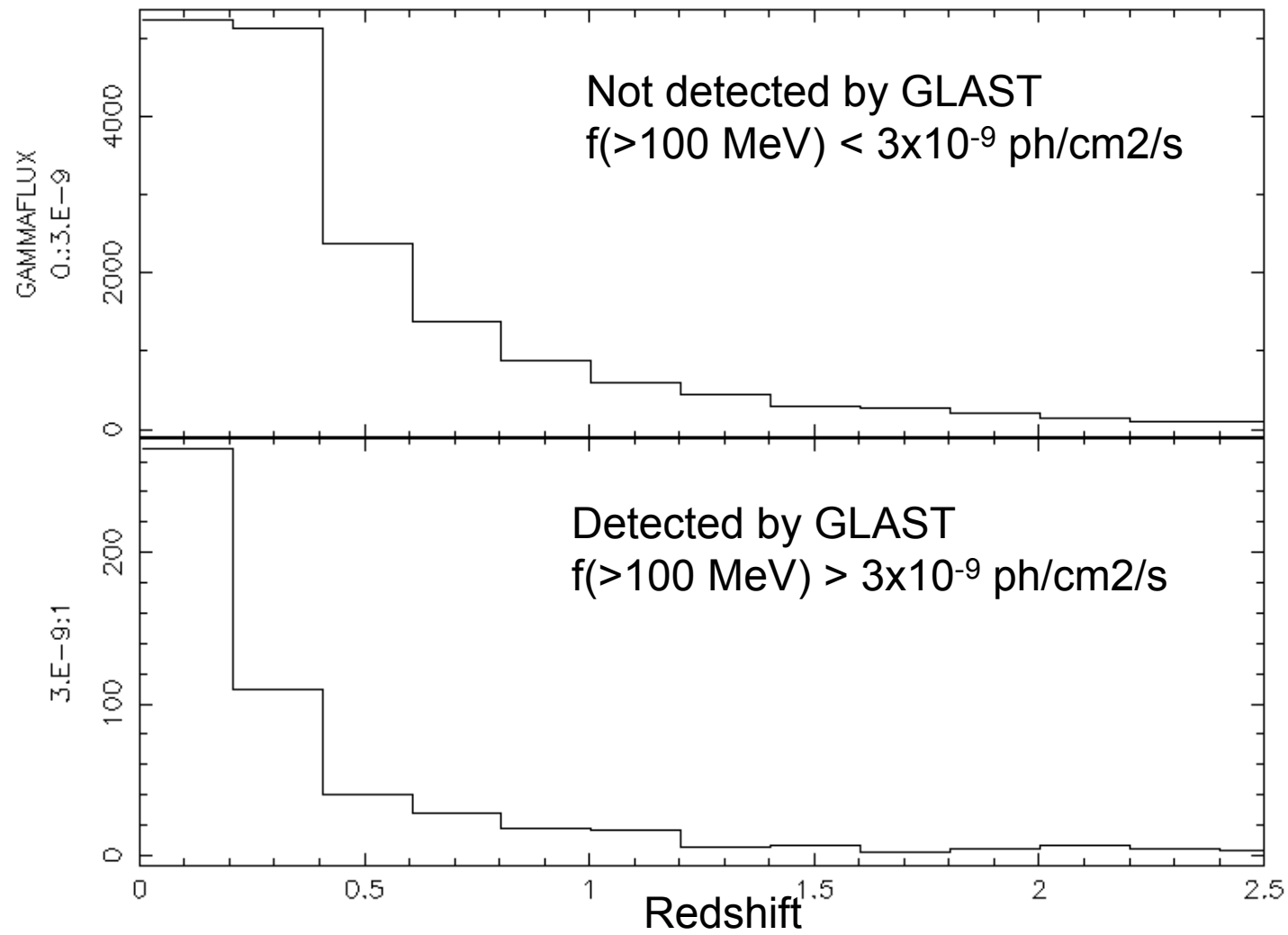
Vmag distribution of detected sources

$$8 \cdot 10^{-6} \, CMB$$

$$\alpha_{\mu\gamma} = -0.994$$

$$I_{Blazars} = \int_{0.1mJy}^{1Jy} S \, \frac{dN}{dS} \, dS$$

Max EGRET

Min EGRET

Log $\nu f(\nu)$ (nW m^{-2}sr^{-1})

Log frequency ν (Hz)
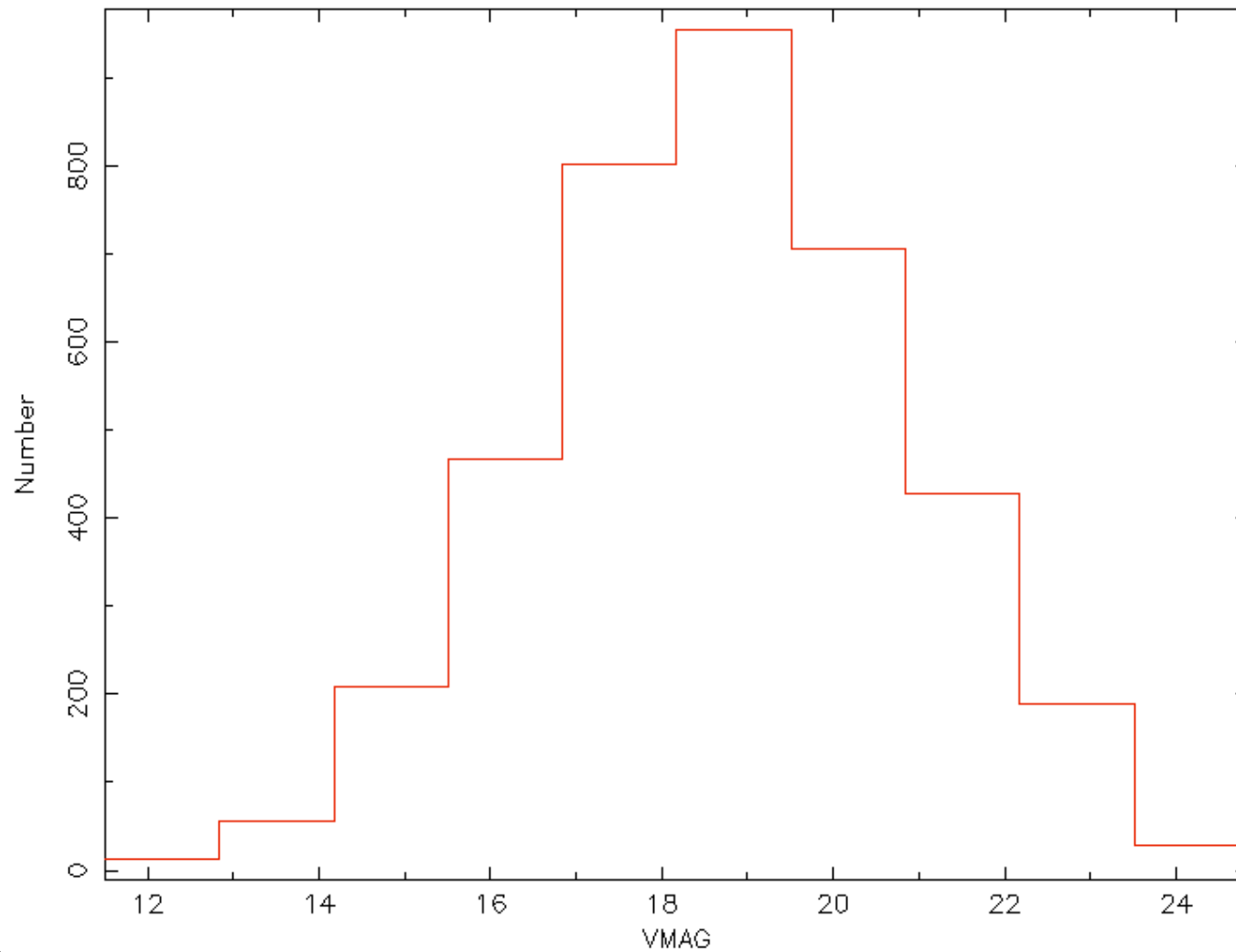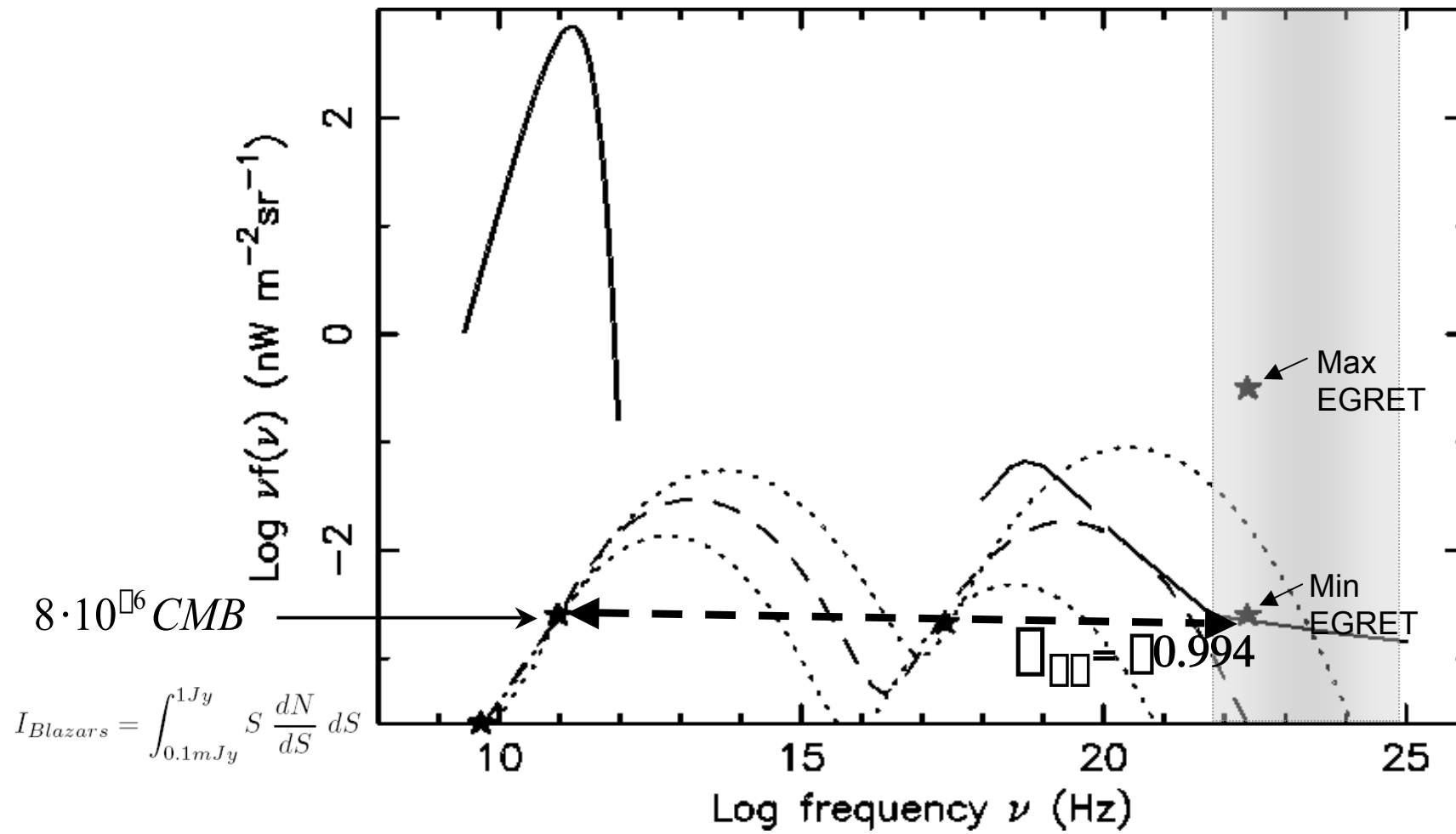
Expected distribution of microwave/gamma-ray spectral index $(\alpha_{\mu\gamma})$
in the subsample of EGRET detected ($f_\gamma > 1 \times 10^{-7}$ ph/cm2/s > 100 MeV)
in the 10 mJy simulated radio survey (50-100 blazars)
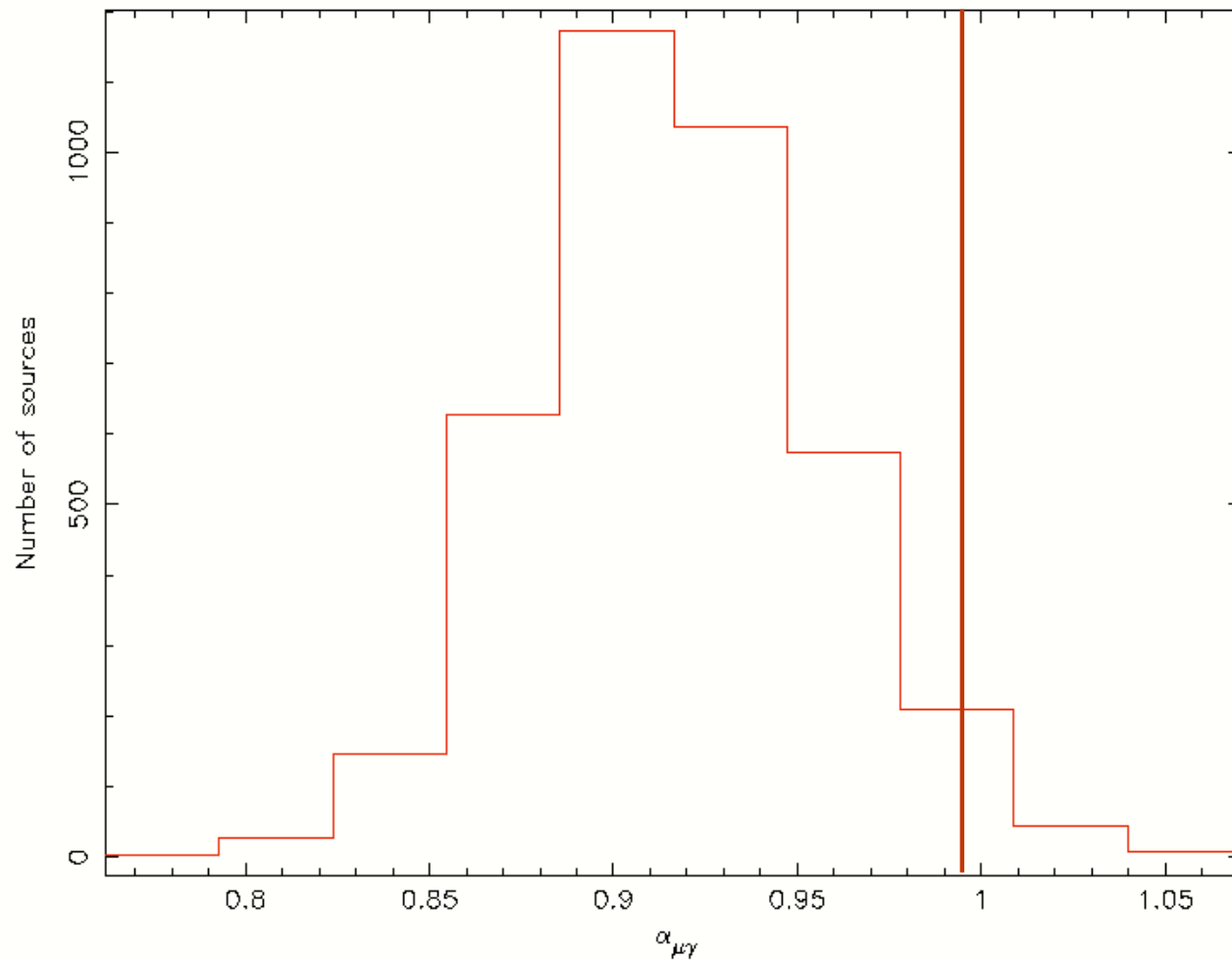

$\alpha_{\mu\gamma}$ observed range
0.816-1.00
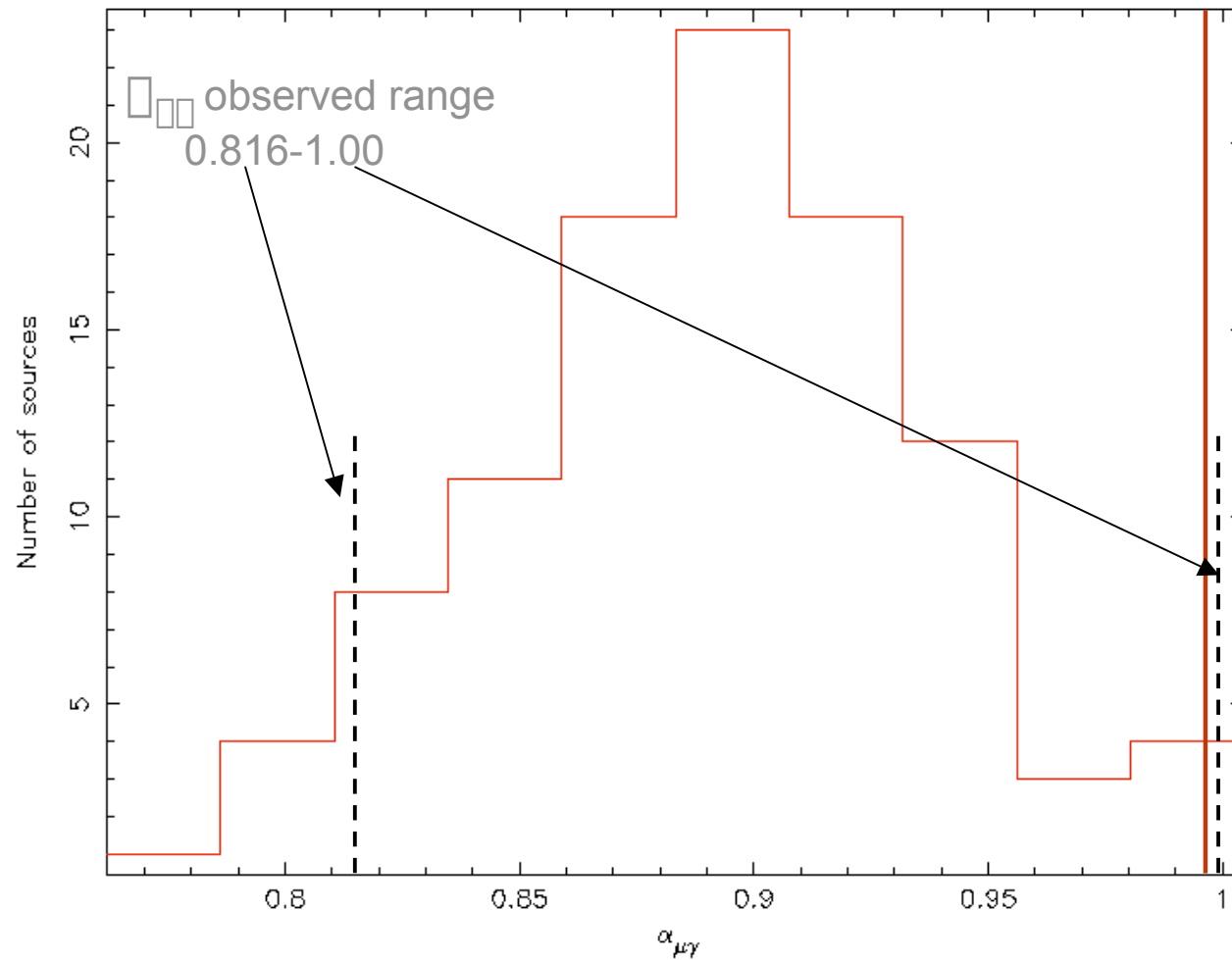
Expected distribution of microwave/gamma-ray spectral index $(\alpha_{\mu\gamma})$
in the subsample of GLAST detected ($f_\gamma > 3\times10^{-9}$ ph/cm2/s > 100 MeV)
in the 10 mJy simulated radio survey

Preliminary conclusions

- GLAST should detect over 4000 blazars
    - red-shift distribution peaked well below 1 and extending to z~2.
    - radio flux down to few tens of mJy
    - Vmag typically 18-20
    - about 1000 of these blazars are expected to be be included in the Rosat All Sky Survey
- Almost all detected objects are seen only during large flares/high intensity states

Improvements

- Add Ω_M - Ω_Λ cosmology

- Add red-shift dependant cosmological evolution for the case of FSRQs.

- Complete comparison with all statistically well-defined surveys to constrain simulation parameters.