Estimate of the Fermi LAT sensitivity for gamma-ray polarization

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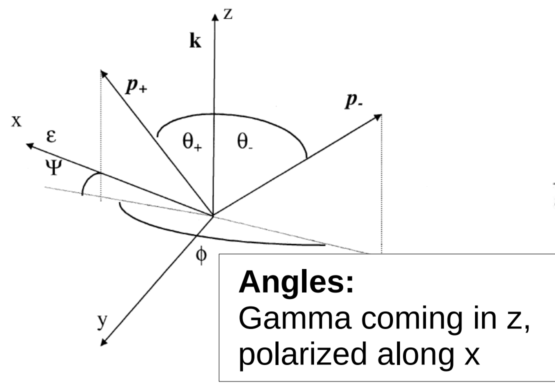
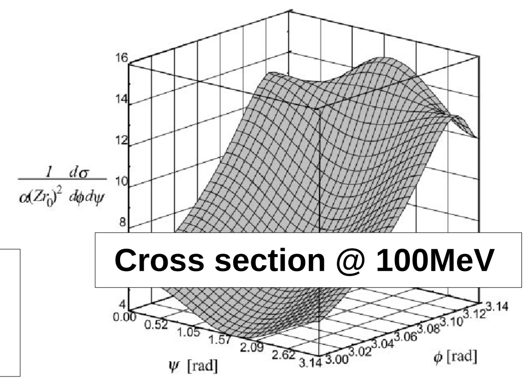
DESY

Polarization with the LAT

- **Polarization introduce azimuthal modulation in event distribution**

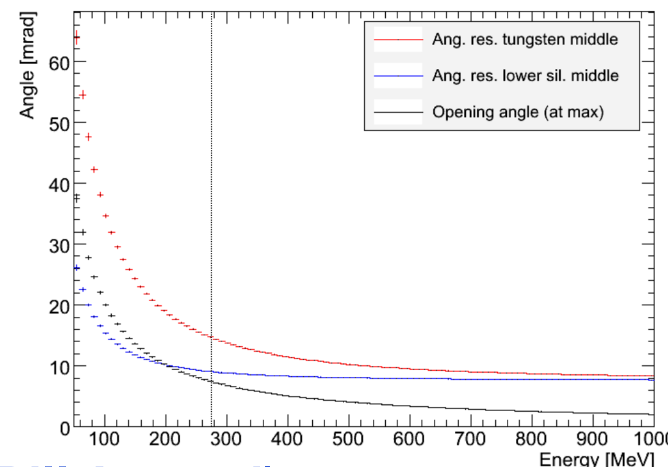




Azimuthal distribution:

$$\frac{dN}{d\psi} \propto (1 - A_{100}\,\Pi_0 \cos^2\psi)$$

- Π_0: degree of linear polarization
- **A_{100} ~ 15-20%**: modulation amplitude for 100% polarization



- **Multiple Scattering vs. Pair opening Angle:**

$$\theta_{MS} = \frac{13.6\,MeV}{E_\gamma/2}\sqrt{X}\,(1 + 0.038\ln(X))$$

$$\theta_{op} \approx \frac{4\,m_e}{E_\gamma} \sim 1\,deg\,@\,100\,MeV$$

  – **$\theta_{MS} < \theta_{op}$ → silicon conversion and E<200 MeV (Bill Atwood)**

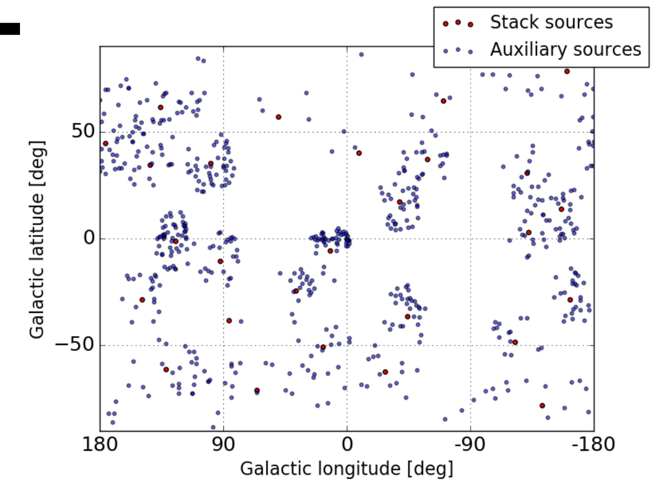
  – **<10% of the events are usable**

- **Measure feasible within statistic only for the brightest sources:**

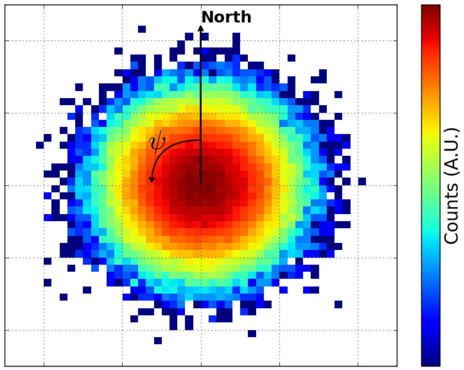
5sigma limit ←→ Π_0 > 35% (Bill Atwood, Rolf Bühler)

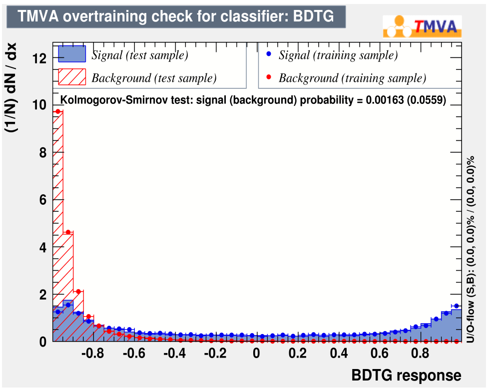
Measure systematics

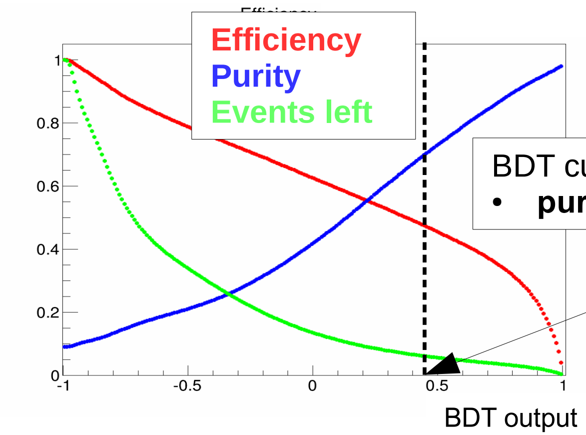
- **Choose AGN stack as unpolarized source**
  - **Bright (~Vela)**
  - **Unpolarized (assuming Π_0=60% for single AGN)**



- **Preliminary analysis and event selection:**
  - **1-track analysis:**
    - **e- direction ~ best track direction**
    - **Need to know where γ comes from**
    - **Azimuthal angle from sky maps**
  - **Selection of silicon-converted events using BDT:**







BDT cut for maximum significance:
- **pur=72%, eff=45%, 5.7% events left**

- **Simulation covers 5 years:**
  - **Stack AGN and neighbours (>600 sources)**
  - **Galactic and isotropic diffuse emission**

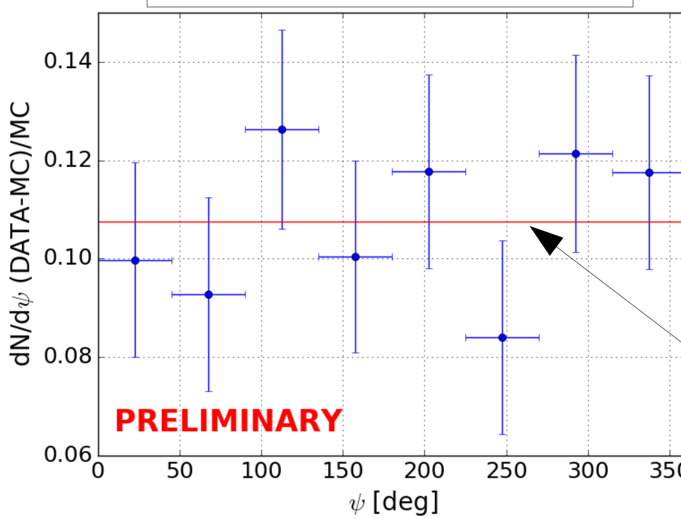
Systematics estimate

- **Residual azimuthal distribution:**
  - **Compatible with constant (no res. modulation) within statistic**

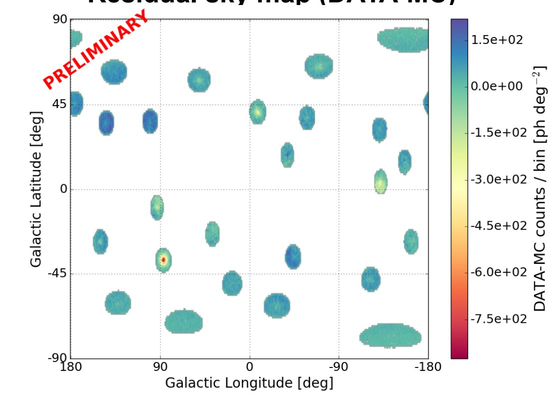
Find sensitivity limit:

- Fit the residual azimuthal distribution with increasingly larger signals.
- $A_{5\sigma}$: amplitude corresponding to p-value (from χ^2) <3e-7
- **$\Pi_{min} = A_{5\sigma} / 0.2$: smallest pol. degree that we can discriminate at 5σ CL**

(DATA-MC)/MC azimuthal dist



Residual sky map (DATA-MC)



~10% less MC than data, still not understood

- **5sigma sensitivity limit Π_{min} ~ 40 %**
  - **depends on analysis and event selection cuts.**
  - **Similar to purely statistical estimate: measure is limited by statistic**

- **Caveat:**
  - **The analysis is preliminary, need large MC simulation of polarized LAT event to develop event selection and 2-track reconstruction of azimuthal angle**