Crab nebula polarization from 0.2 to 0.8 MeV

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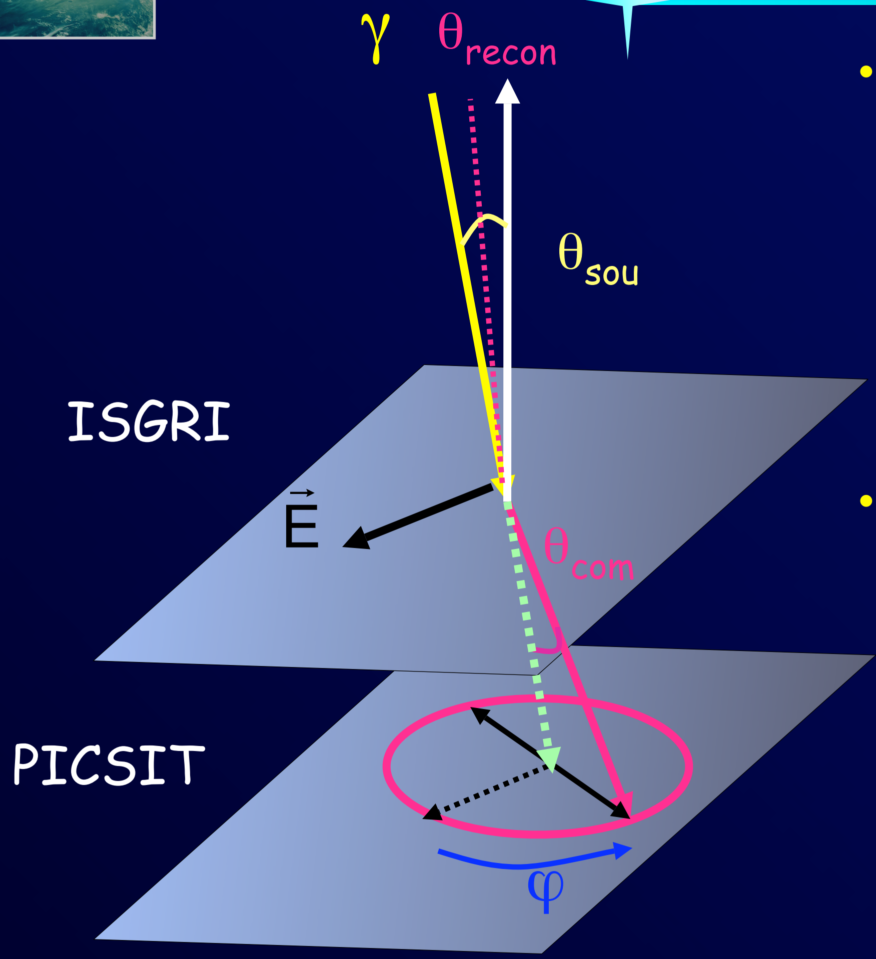
polarization with IBIS Compton mode



coincidence
window = 3.8μs

- Selections:
  - fully coded source images
  - forward scattered events
  - $| \theta_{recon}(E_{ISGRI}, E_{PICSIT}) - \theta_{source} | < 10°$
  - energy selection 200-800 keV
- Signal detection
  - analysis in 6 bins in φ azimuth

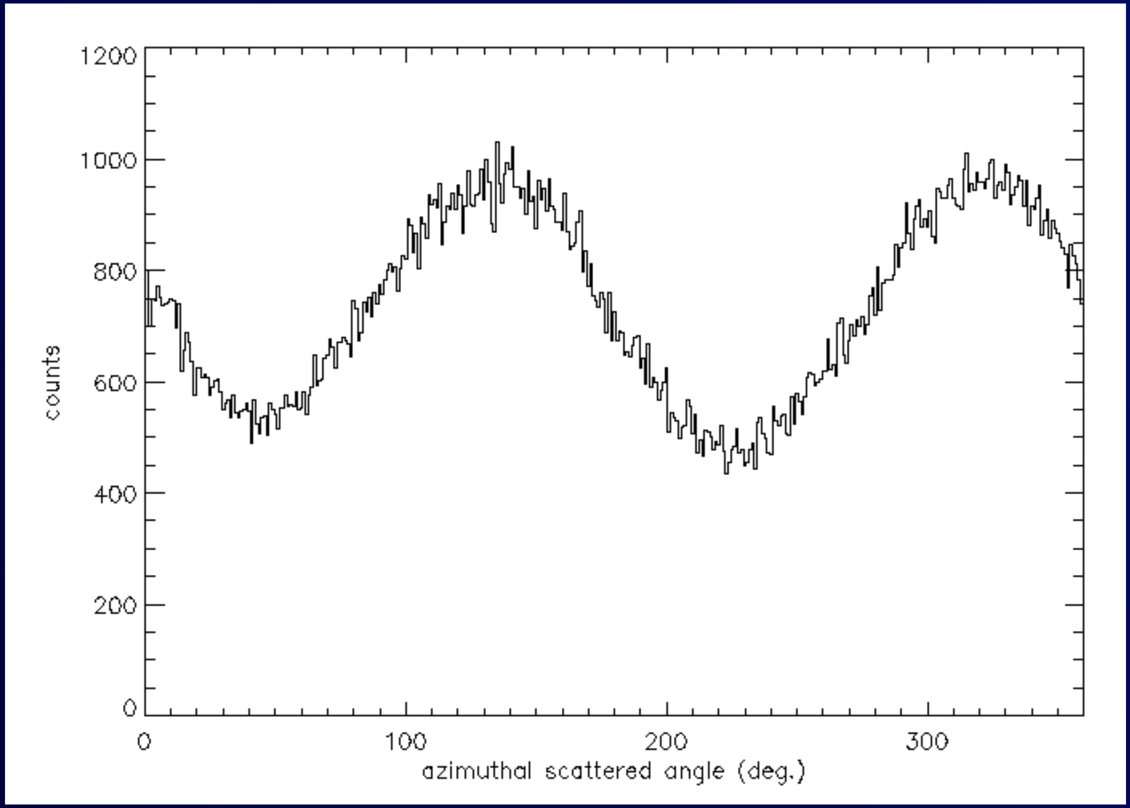
    $0° \leq \varphi \leq \pi$
  - spurious rate estimate and subtraction
  - uniformity correction across fov
  - shadowgram deconvolution

azimuth profile

- modulation
  - a = modulation factor
  - polar. fraction = PF = a/a_{100}
  - polar. angle = PA = $\varphi_0 + \pi/2$

$$S = \overline{S}\left[1 + a.\cos(2(\varphi - \varphi_0))\right]$$

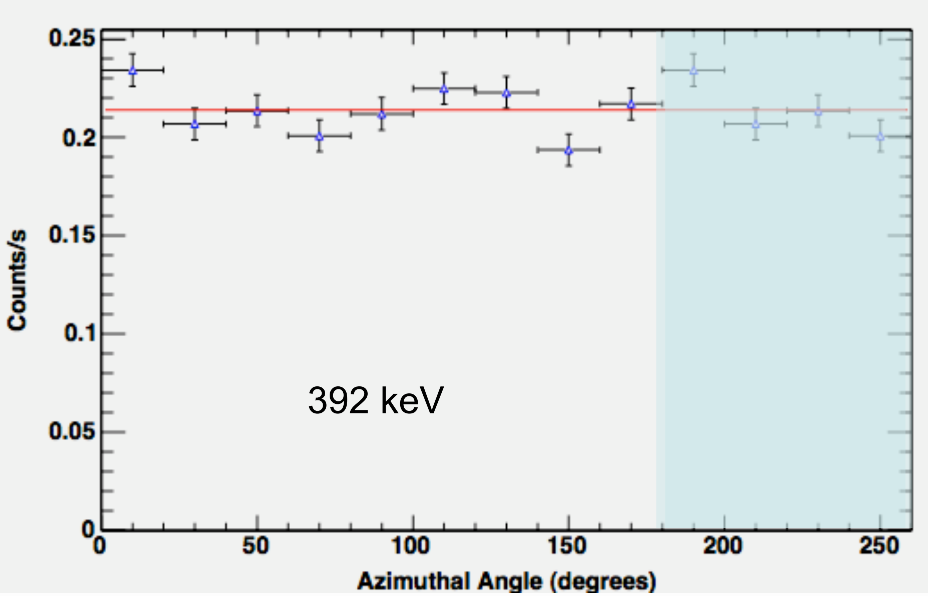
- calibration
  - GEANT 3 simulation
  - 100 % linearly polarized source
- $a_{100} = 0.304 \pm 0.003$

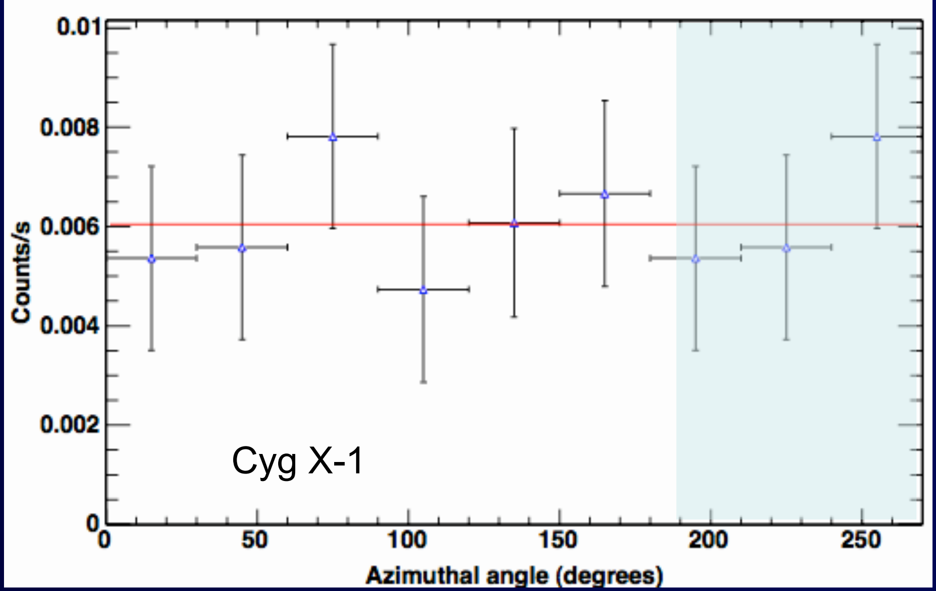


flatness checks

- maximum modulation for unpolarized data?
  - square detectors, grids, pixels, mask pattern…
- strong calibration source
  - at 392, 511, 662 keV
  - a < 1.3 - 2.6 %
- calibration source at 30° inclination
  - extreme projection effect
  - small 2π modulation

    erased by folding $0 \leq \varphi \leq \pi$
- spurious event files
  - a < 1 %
- empty fields
- Cygnus X-1
  - 200-800 keV, 500 ks



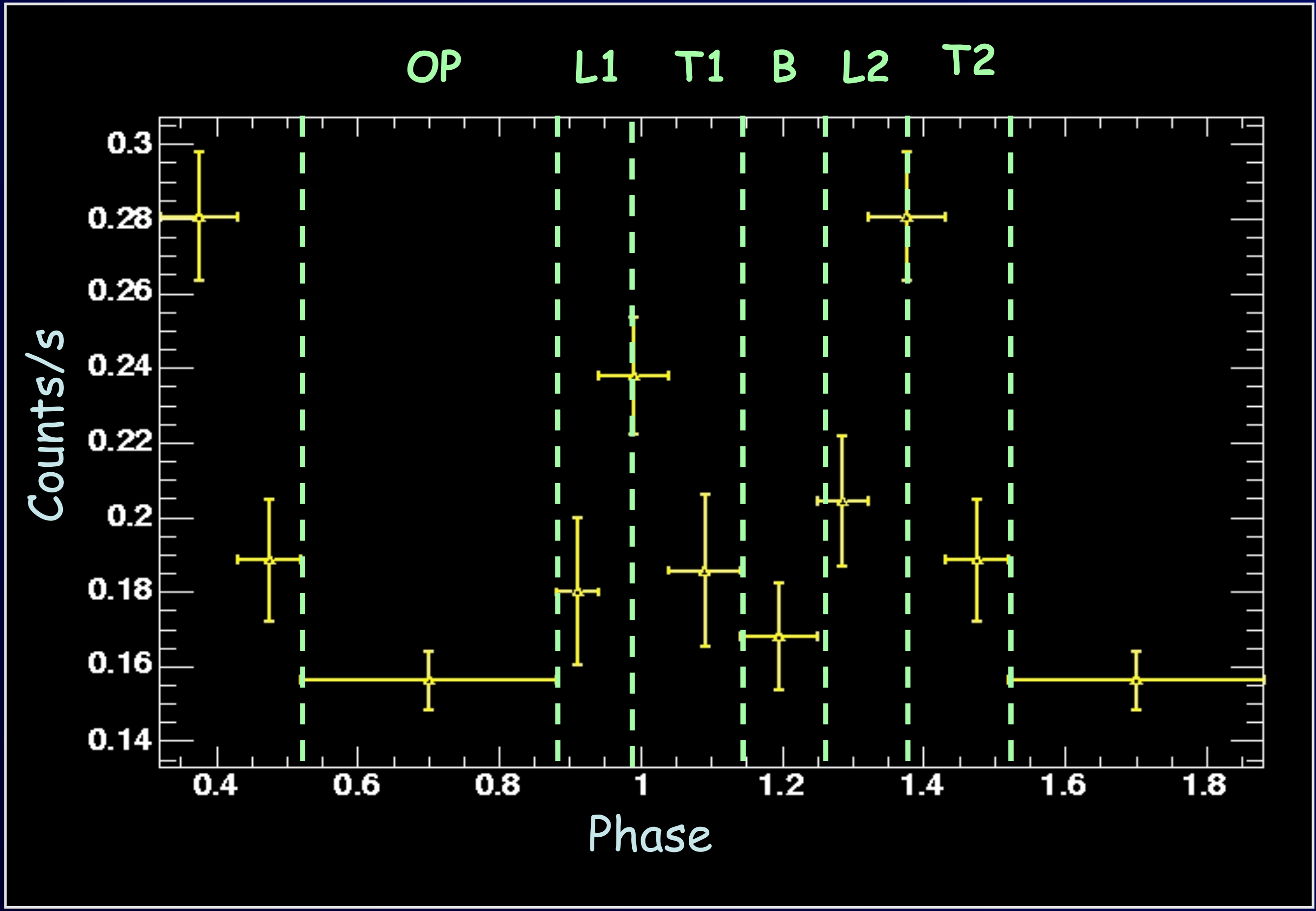


a < 3 %

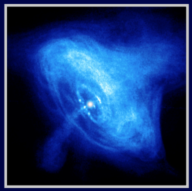
Crab pulsar lightcurve

T = 700 ks

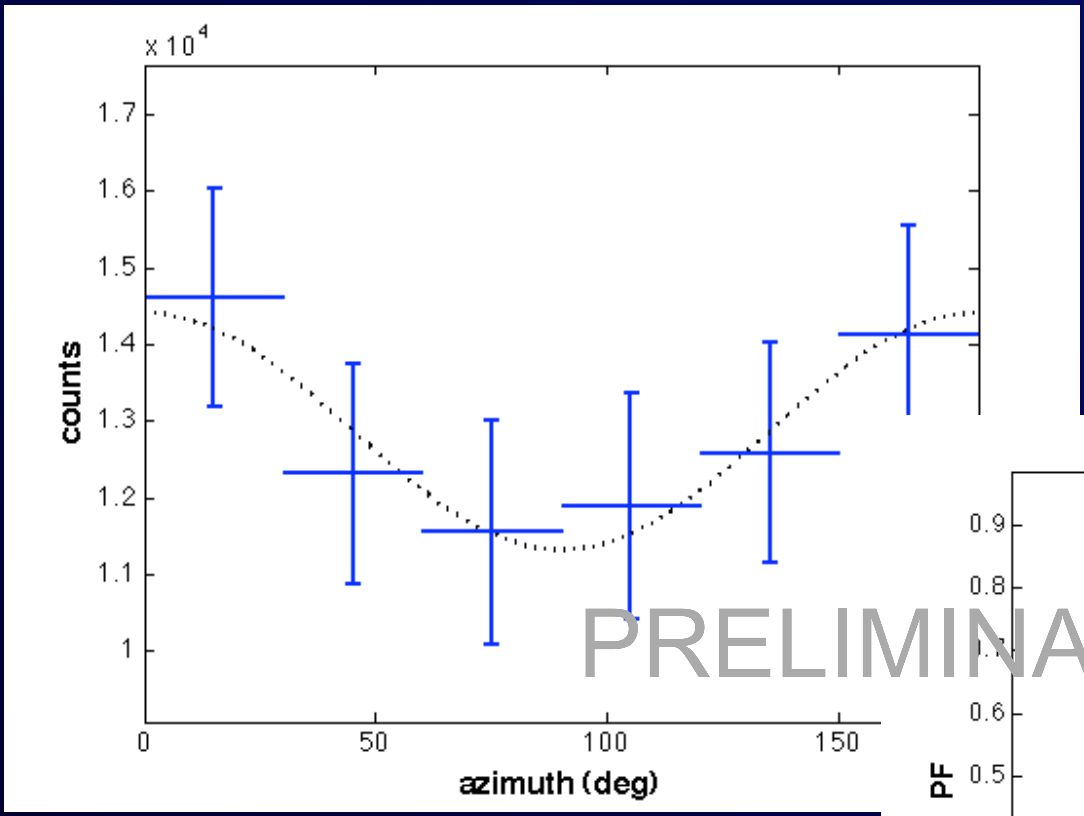
200 keV < E < 800 keV



Phases according to Kuiper et al. ‘01



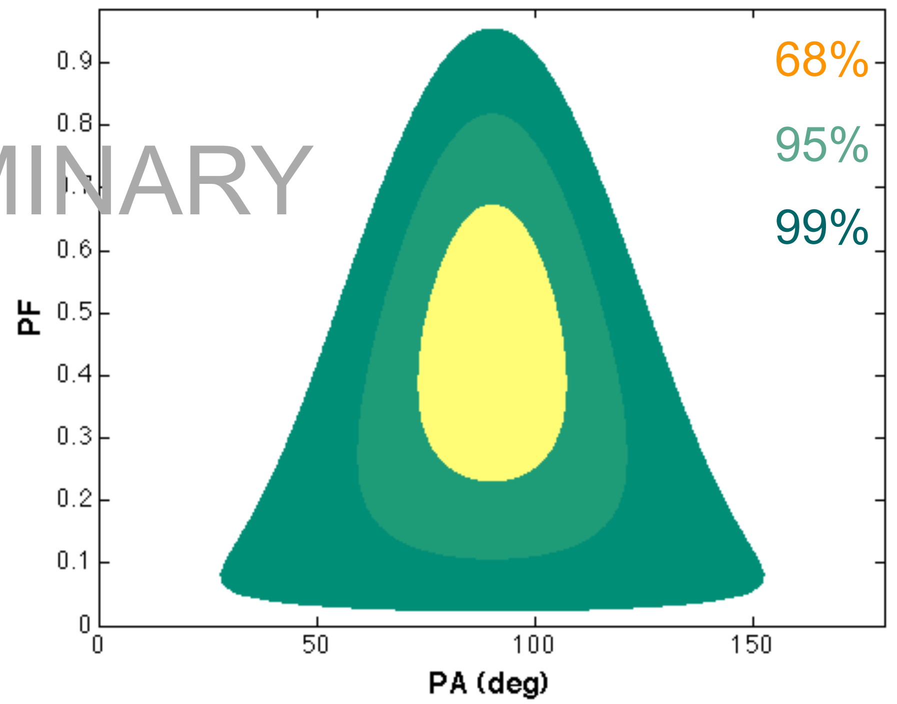
azimuth profile: all phases



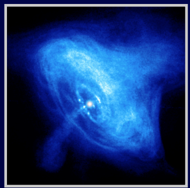
PA = 90° ± 11°

PF = $0.39 \pm^{0.19}_{0.11}$

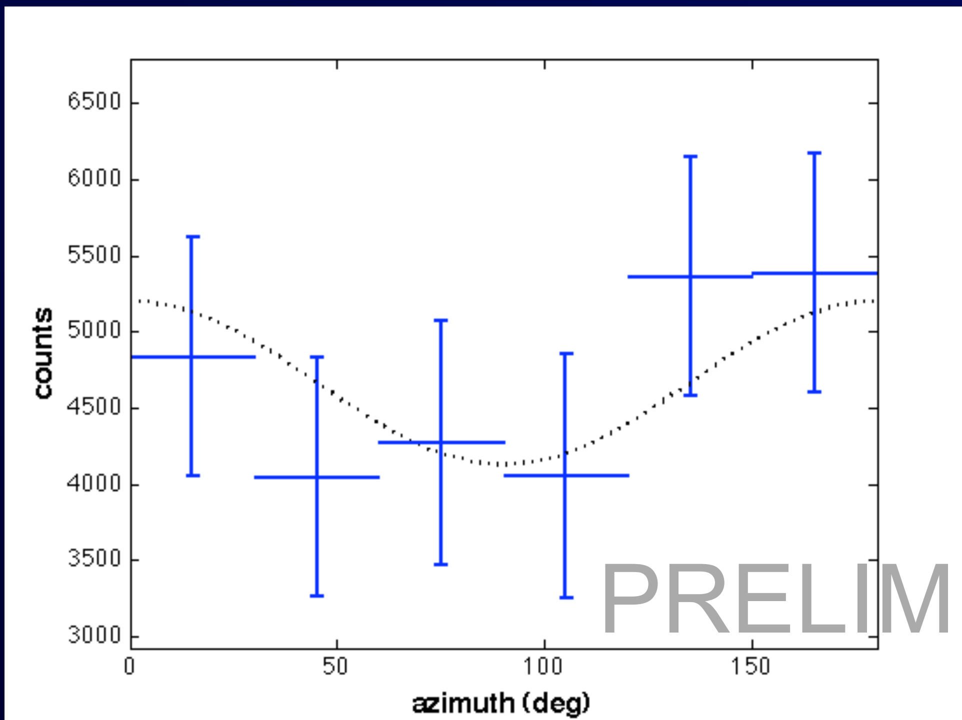
PRELIMINARY



proba(a > a_0, any φ) = 3.4%



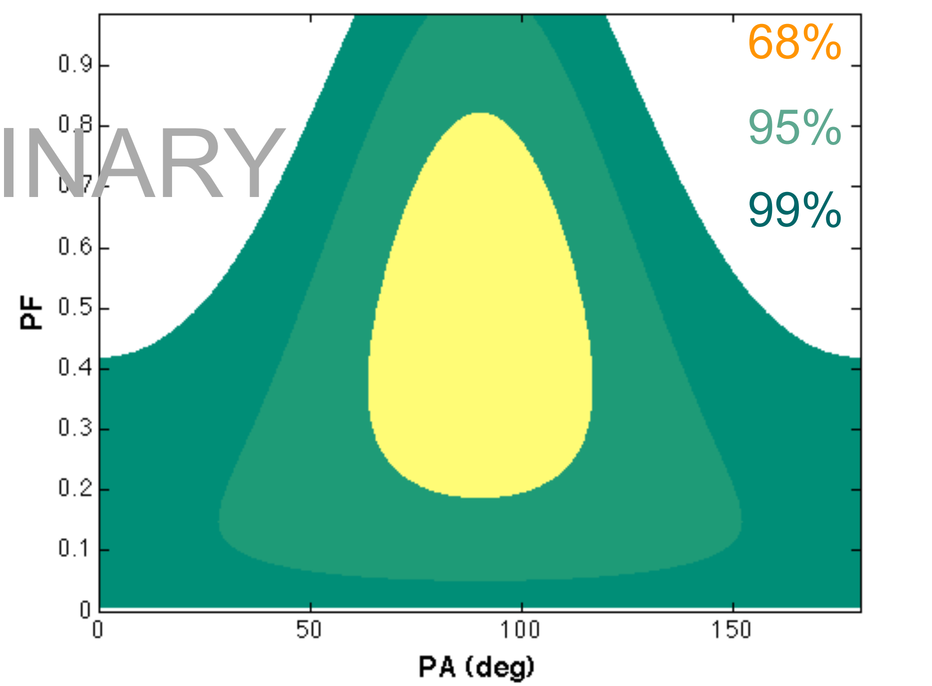
azimuth profile: P1+P2 peaks



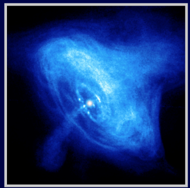
PA = 90.0° ± 16.4°

PF = $0.38 \pm^{0.28}_{0.17}$

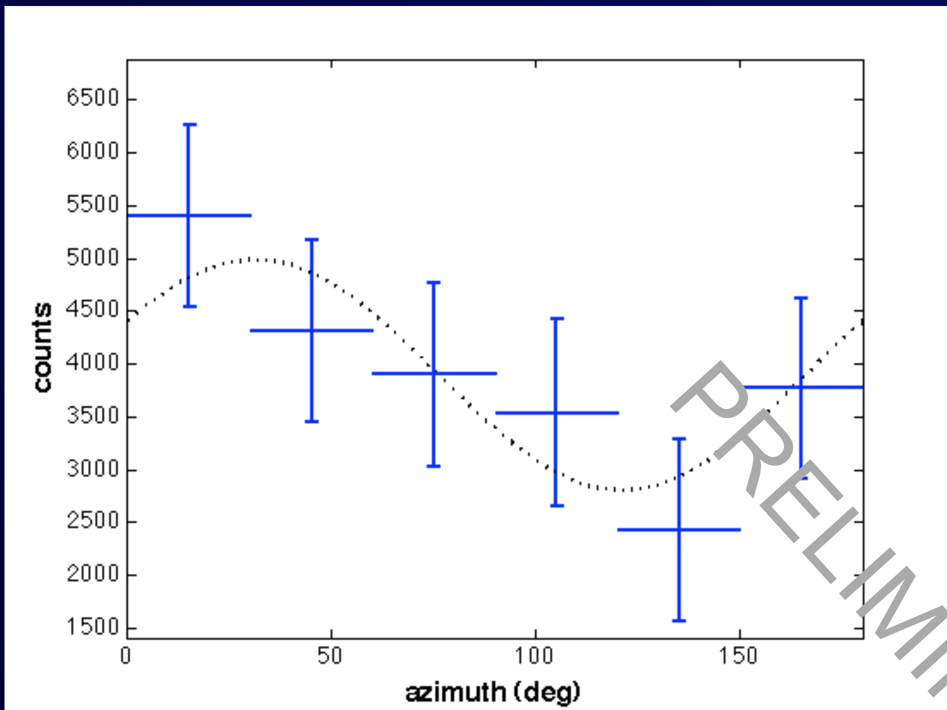
PRELIMINARY



proba(a > a_0, any φ) = 26.3 %

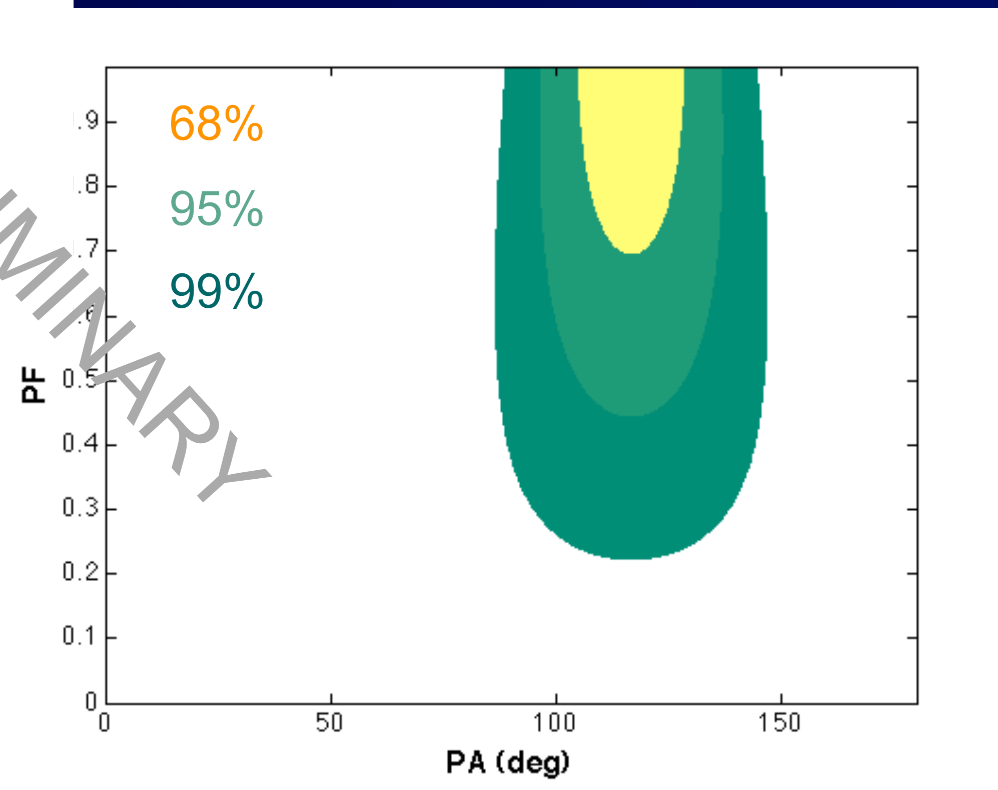


azimuth profile: off-pulse

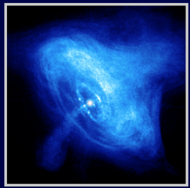


PA = 121.0° ± 10.0°

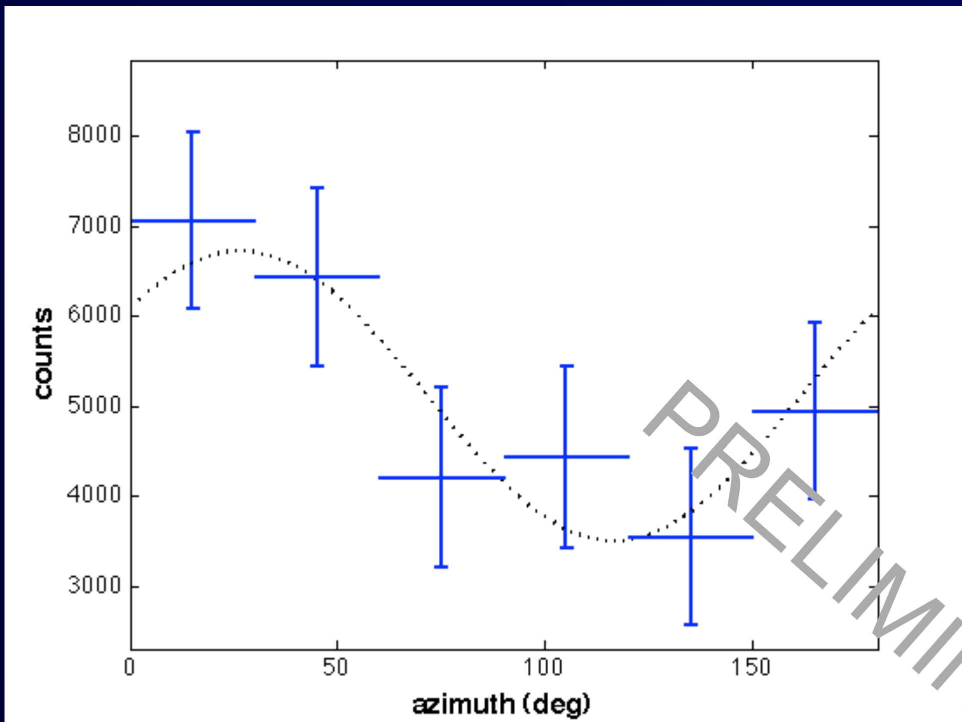
PF = $0.92 \pm^{0.36}_{0.26}$



proba(a > a_0, any φ) = 1.4 %



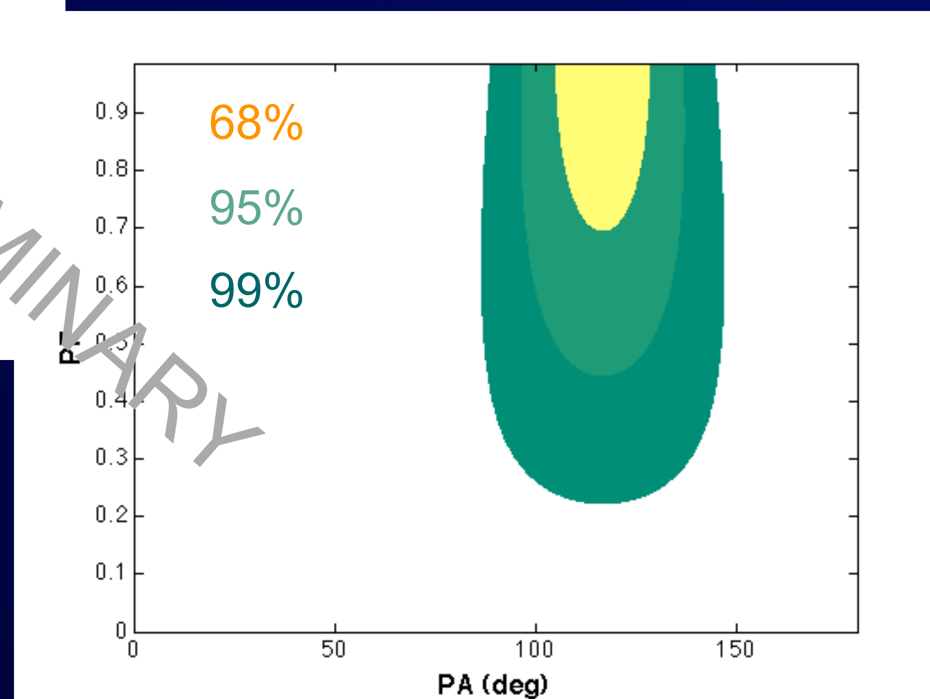
azimuth profile: off-pulse + bridge



PRELIMINARY

$PA = 116.6° \pm 7.9°$

$PF = 1.04 \pm {}^{0.30}_{0.25}$



proba($a > a_0$, any φ) = $8.7\ 10^{-4}$

DC polarization // rotation axis

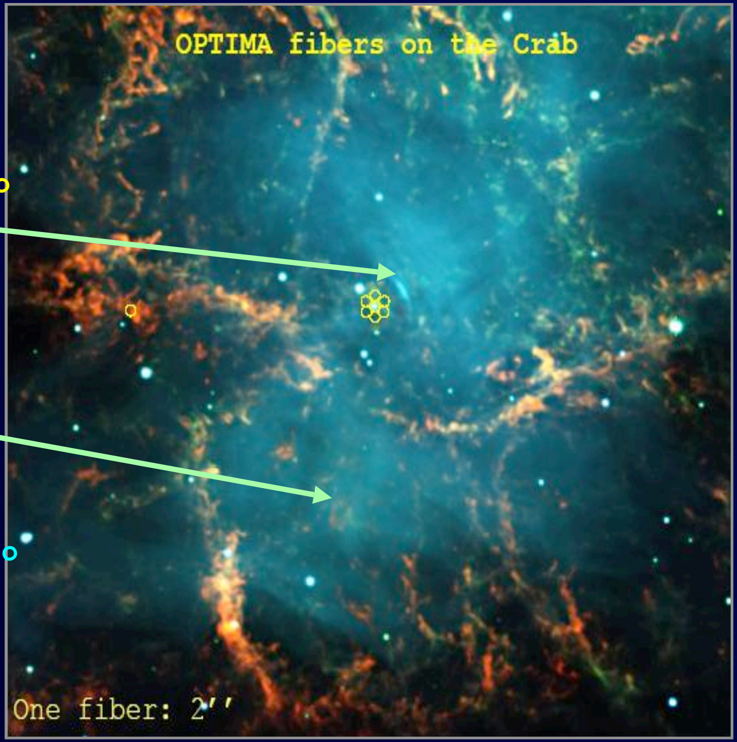
opt: 146°

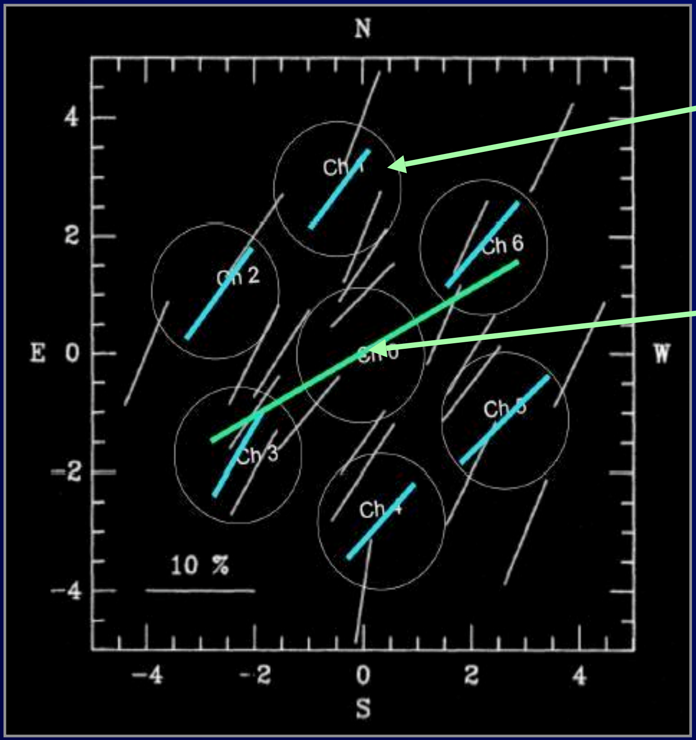
12%

X:

152°-156°

19%





152°

8%

119°

33%

Slowikowska et al. 06

Smith et al. '88

Weisskopf et al. '78

- polarization angles

  off-pulse: PA = 121.0° ± 10.0°

  optical r < 0.01 pc: PA = 119°

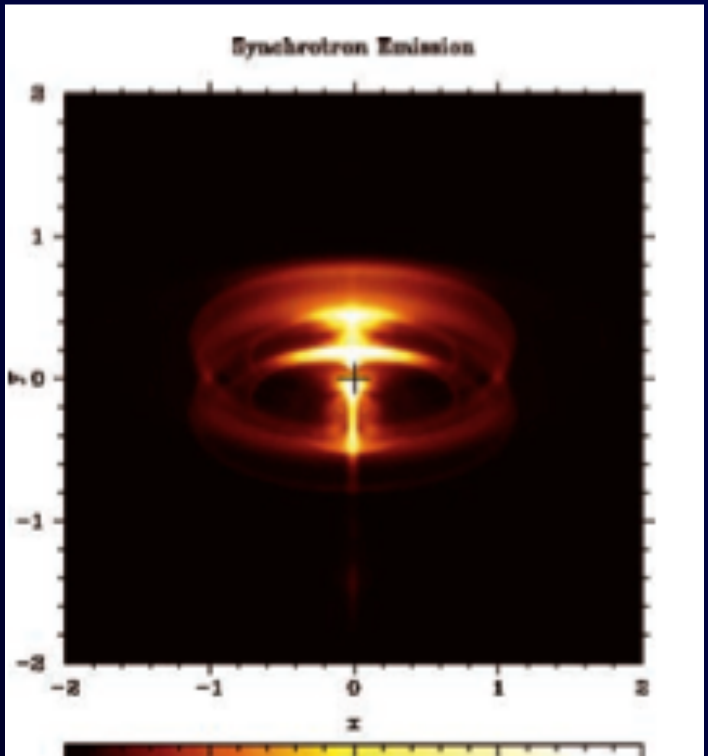
  projected rotation axis: 124.0° ± 0.1°

Ng & Romani '04

- any toroidal B field
  - jet
  - shocked wind torus
  - striped wind

hot spot / jet ?

- particle energies ~ 200-500 TeV in B_{nebula} = 16.2 ± 1.8 nT
- opt/IBIS similar angles suggests that polarized emission come from
  - inner jet / equatorial flow (hot spot) / striped wind
- inner magnestosphere DC emission more unlikely
  - slot gap: PA ~ 20°- 40°
  - outer gap: PA ~ ζ_{obs} ~ 20°- 40°



Komissarov et al. 2004