The Search for Muon Neutrinos from Gamma-Ray Bursts with AMANDA B-10 and AMANDA-II

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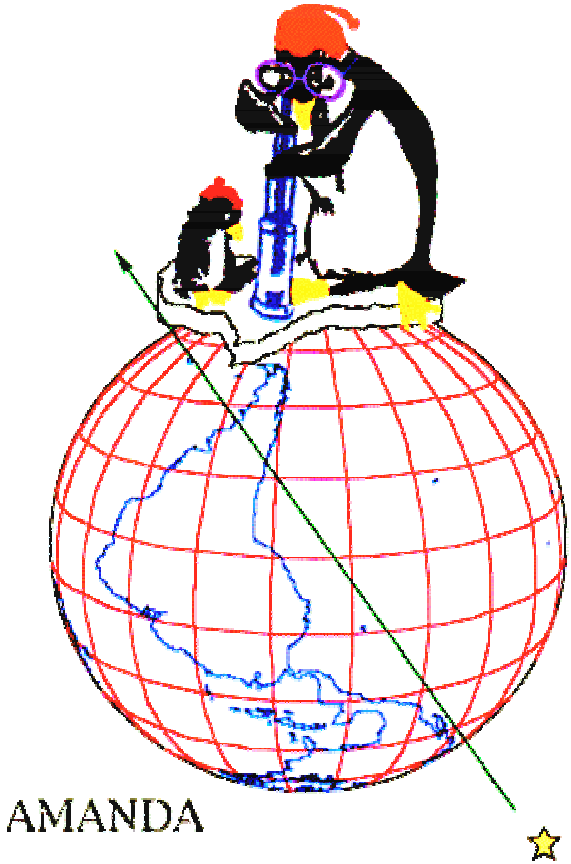
for the AMANDA Collaboration



TAUP 2003

University of Washington

Science Motivation

- **Cannot see the inner engine of GRBs**
- **If protons are accelerated in the GRB environment, neutrinos will be produced:**

$$p + \gamma \rightarrow \pi^{\pm} \rightarrow \mu^{\pm} + \nu_{\mu} \rightarrow e^{\pm} + \nu_{e} + \nu_{\mu}$$

- **Probe inner engine and physics of the explosion**
- **Predicted neutrino flux varies depending upon specific model parameters**

Fireball Model of GRB Emission

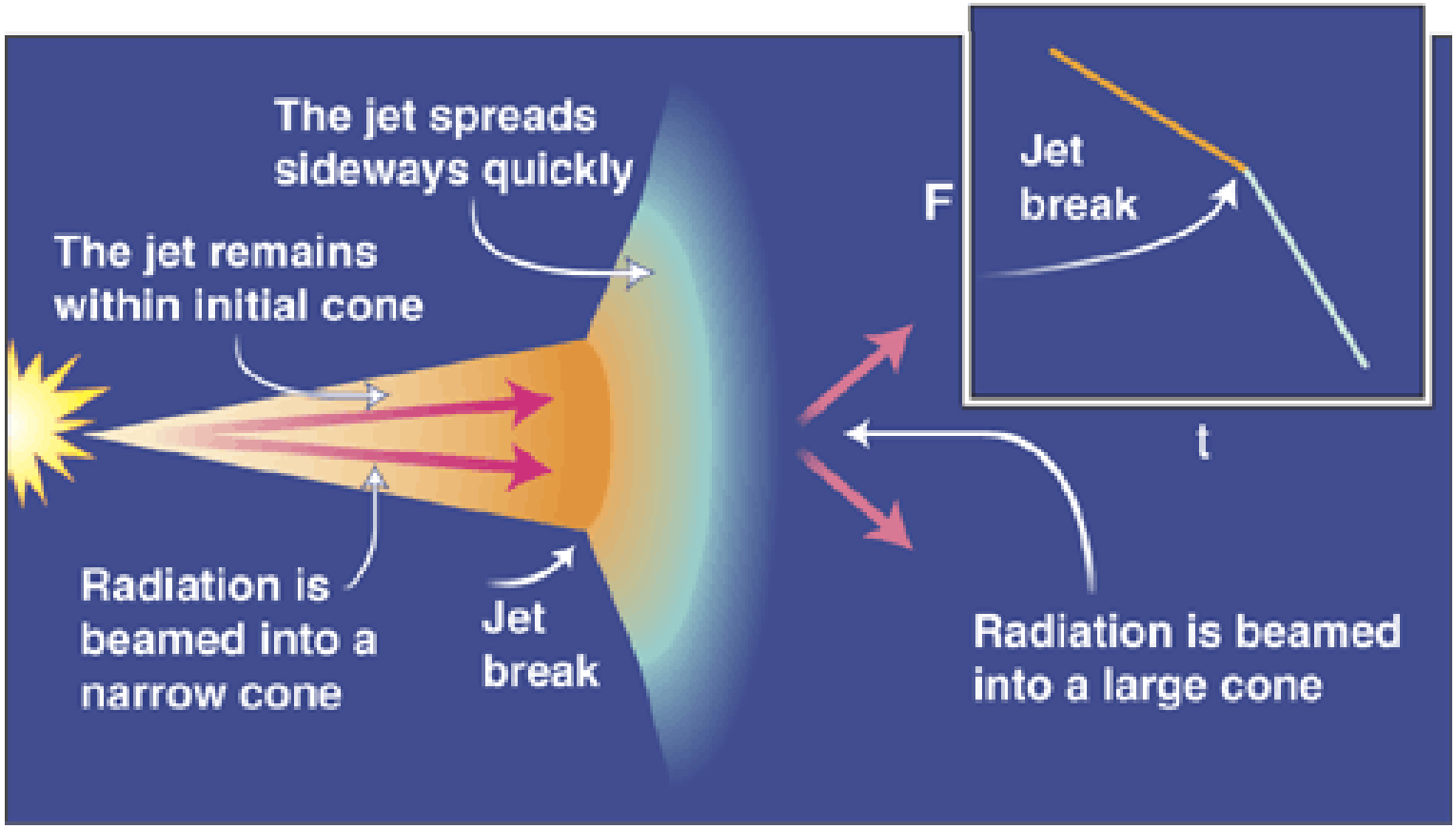


Image courtesy of T. Piran (*Science v.295, p.986*)

Observation Procedure

Burst location and timing determined by:

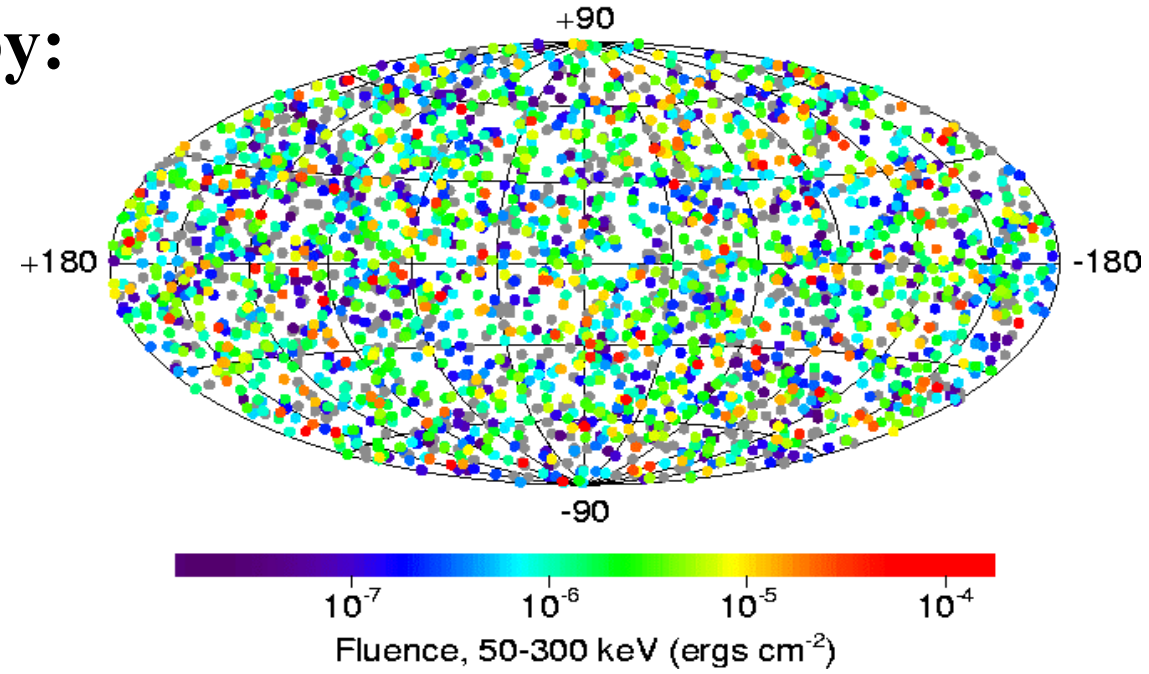
BATSE

- **Burst Catalogs**
- **Stern, Kommers**
- **GUSBAD**

IPN3

- **IPN Circulars**
- **Archival search**

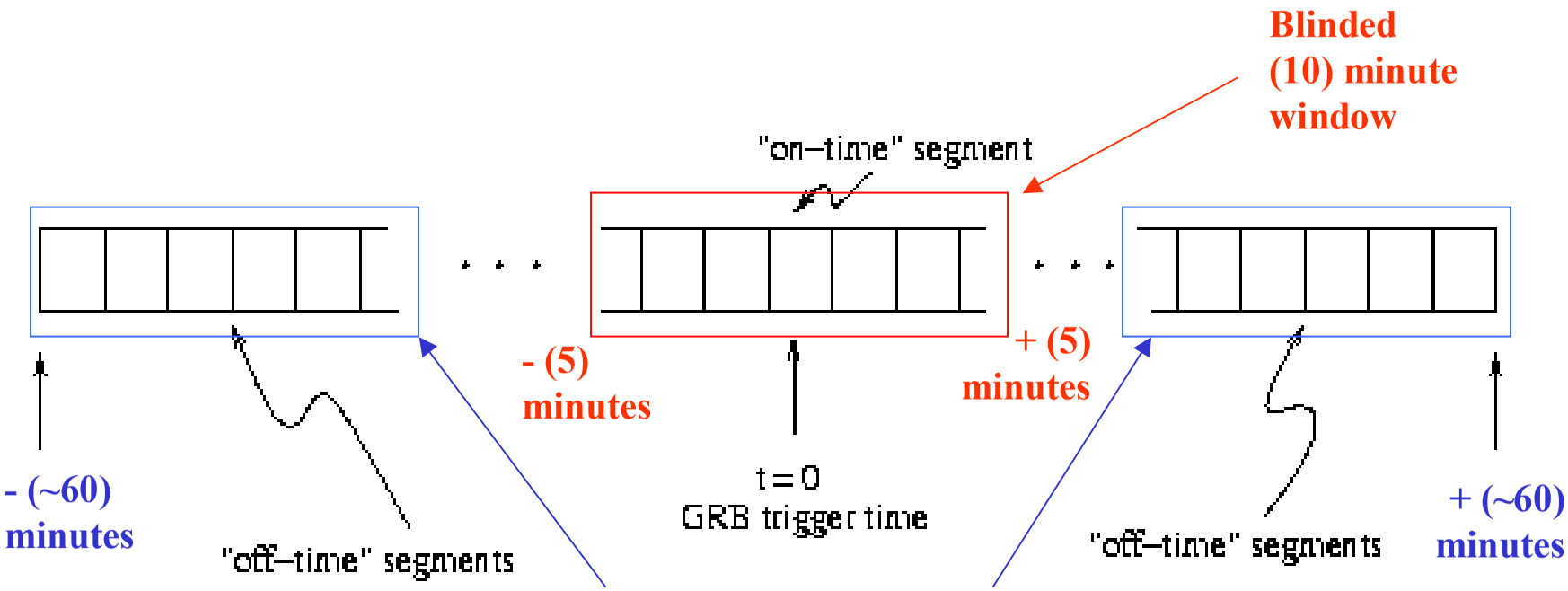
(K. Hurley et al.)



2704 Gamma-Ray Bursts

(*http://cossc.gsfc.nasa.gov/batse/index.html)*

Observation Procedure (continued)

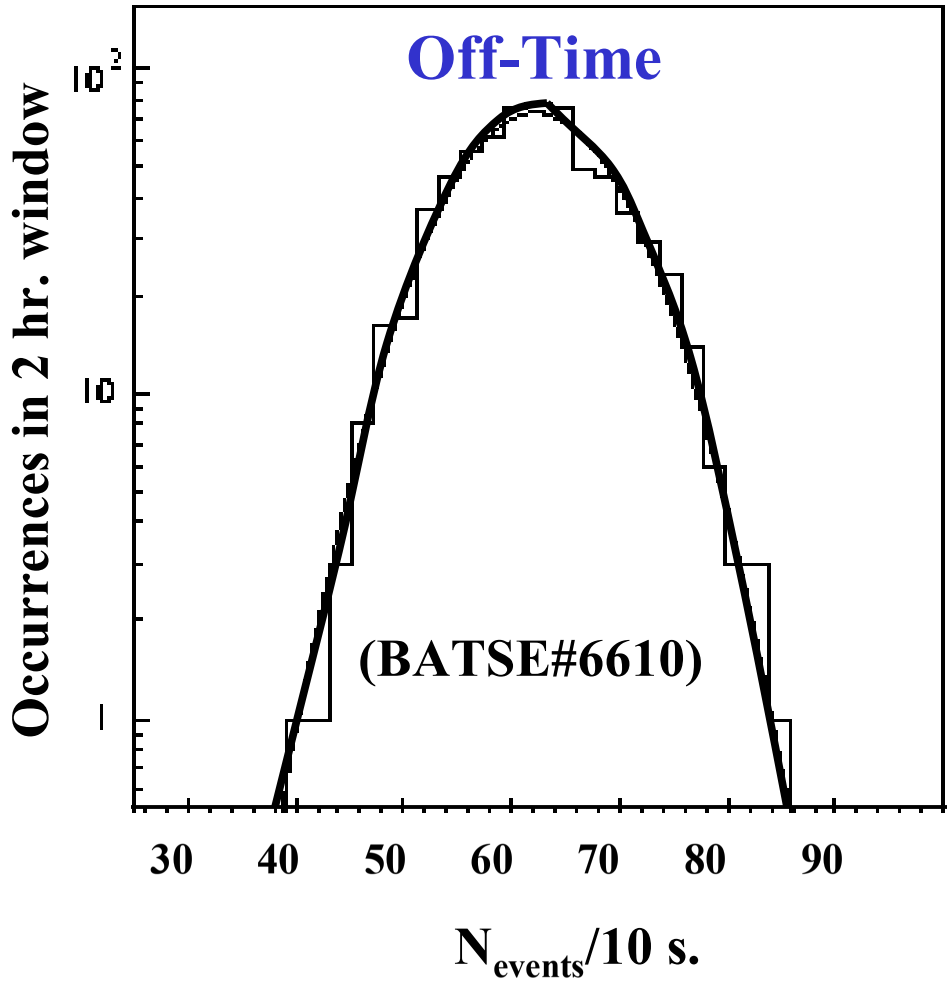


~110 (120-10) minute background used to set cuts and check for data quality & stability

- Background region is approximately ±60 minutes surrounding each GRB
- Omit ±5 minutes surrounding GRB trigger time

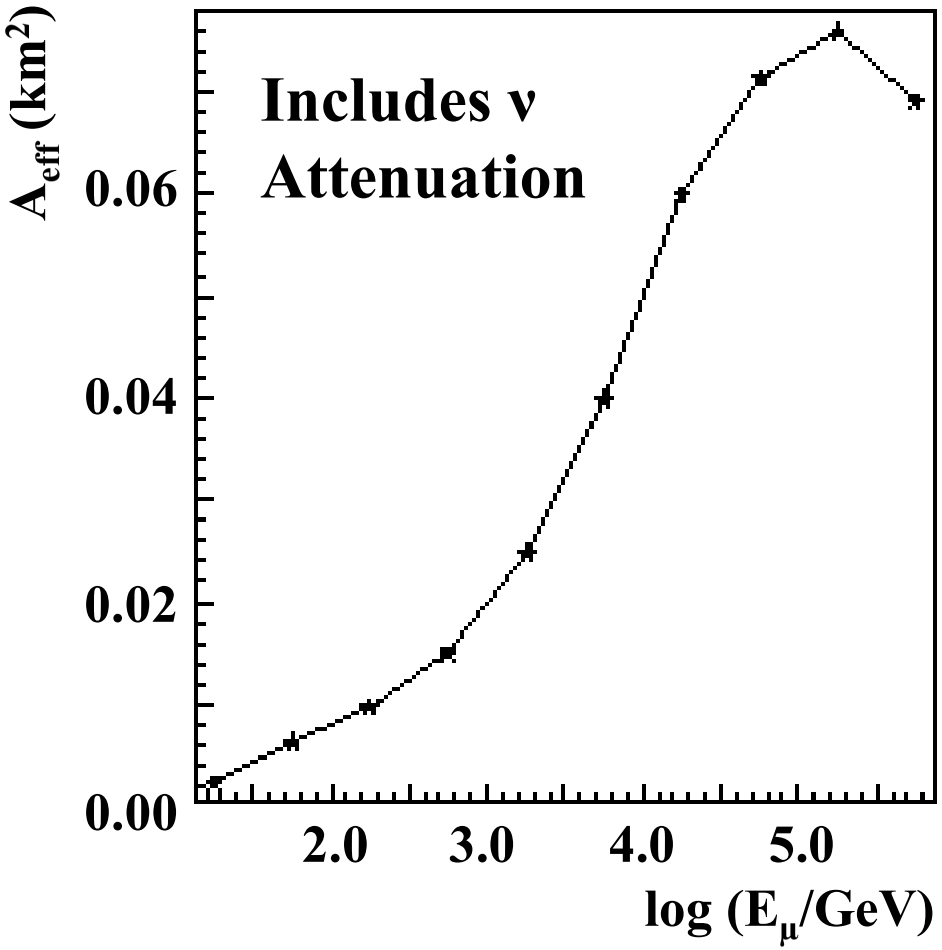
Observation Procedure (continued)

- Detector stability evaluated for all bursts
- 564 GRBs in 4 years (1997-2000)



AMANDA-II Effective Area

- **Quality Cuts**
  - **Location/Duration (T_{90})**
  - **Track reconstruction likelihood, smoothness**
  - **Number of direct hits**
  - **Number of hit channels**
- **A_{eff}(100TeV) > 70,000 m²**



GRBs in the 1997-2000 Dataset

- 312 BATSE Triggered Bursts
- 206 BATSE Non-Triggered Bursts
- 44 IPN Bursts in 2000 (Excluding BATSE)
  - 19 Bursts from IPN Circulars
  - 14 Additional Well-Localized Bursts
  - 11 Additional Bursts with Annular Localization
- 2 GUSBAD Bursts in 2000

Summary of Observations

Year	Detector	N_{Bursts}	$N_{BG,\ Pred}$	N_{Obs}	Event U.L.
1997	B-10	78 (BT)	0.06	0	2.41
1998	B-10	94 (BT)	0.20	0	2.24
1999	B-10	96 (BT)	0.20	0	2.24
2000	A-II (2 analyses)	44 (BT)	0.83/0.40	0/0	1.72/2.05
2000	A-II	24 (BNT)	0.24	0	2.19
2000	A-II	46 (New)	0.60	0	1.88
97-00	B-10/A-II	312 (BT)	1.29	0	1.45

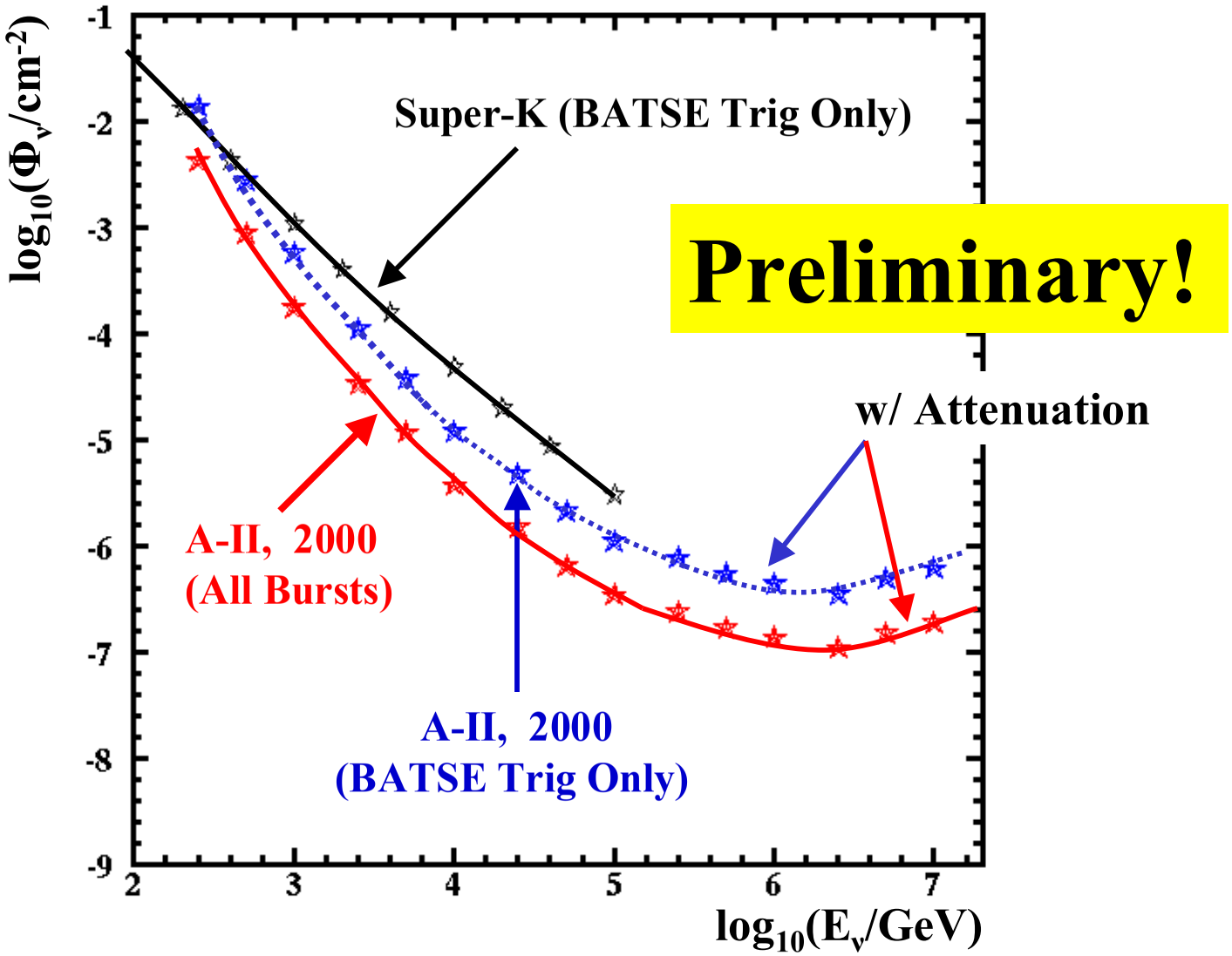
BT = BATSE Triggered BNT = BATSE Non-Triggered New = IPN & GUSBAD

Flux (at Earth): $E^2\Phi_\nu < 4\times10^{-8}$ GeV cm^{-2} s^{-1} sr^{-1}

for 312 bursts with Waxman-Bahcall-type spectrum

Green's Function Fluence Limit

following Super-Kamiokande method (*2002ApJ, 578:317F*)



What's Next?

- **Expanding analysis into 2001 and 2002**
  - **Approximately 40 bursts in IPN Circulars**
  - **Total with archival search: ~80-100**
- **Determining burst distance/luminosity → ν flux predictions for each burst**
- **Set limits for specific theoretical models**
- ***Swift* will dramatically increase burst detection rate, starting in 2004**

Acknowledgements

- **S. Desai and D. Turcan for helpful clarifications of the Super-Kamiokande limit-setting method**
- **K. Hurley and the IPN3 collaboration for burst localizations which allowed AMANDA-II follow-up observations**