High Energy Astroparticles

Ephemeral Universe

Perth 12 Nov 2013

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CSIRO/Curtin, Australia

SgrA* magnetar

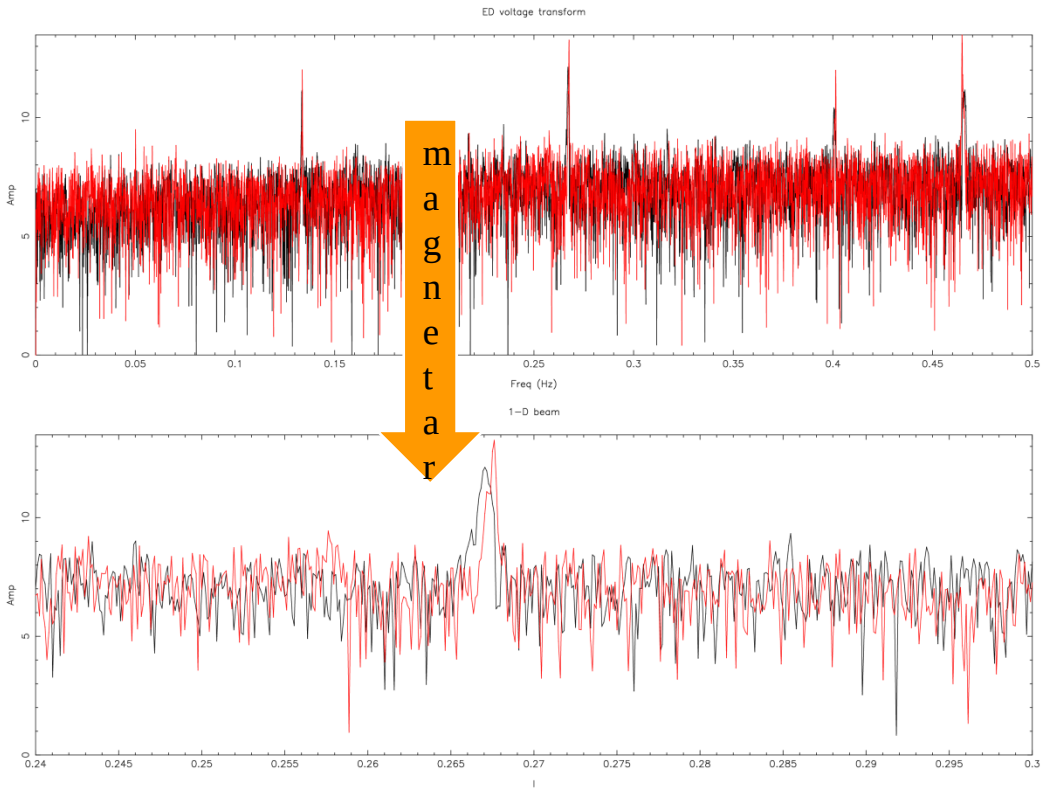
- Galactic Centre magnetar J1745-2900
  - discovered by the *Swift* satellite[1]
- Pulsing source of both X-rays[2] and radio waves[3,4,5,6]
- Period of 3.76 seconds
- Regular pulsar
  - very high dispersion and Faraday rotation[4,5,7]
  - 3" (0.1 parec) from the centre of the Galaxy.
- Mysterious zero DM signal

Zero DM magnetar

- Parkes and Greenbank reported periodic radio emission with almost the same period as the magnetar but with **near-zero** dispersion[8]
  - *Burgay et al Atel #5035 (2013)*
- Has to be local so generate radio in our atmosphere
  - Only pulsed gamma rays from Magnetar can do it
  - Need to amplify the radio (maser emission)
  - Search for nsec time scale pulses
- Can use the Parkes UHE neutrino detection backend

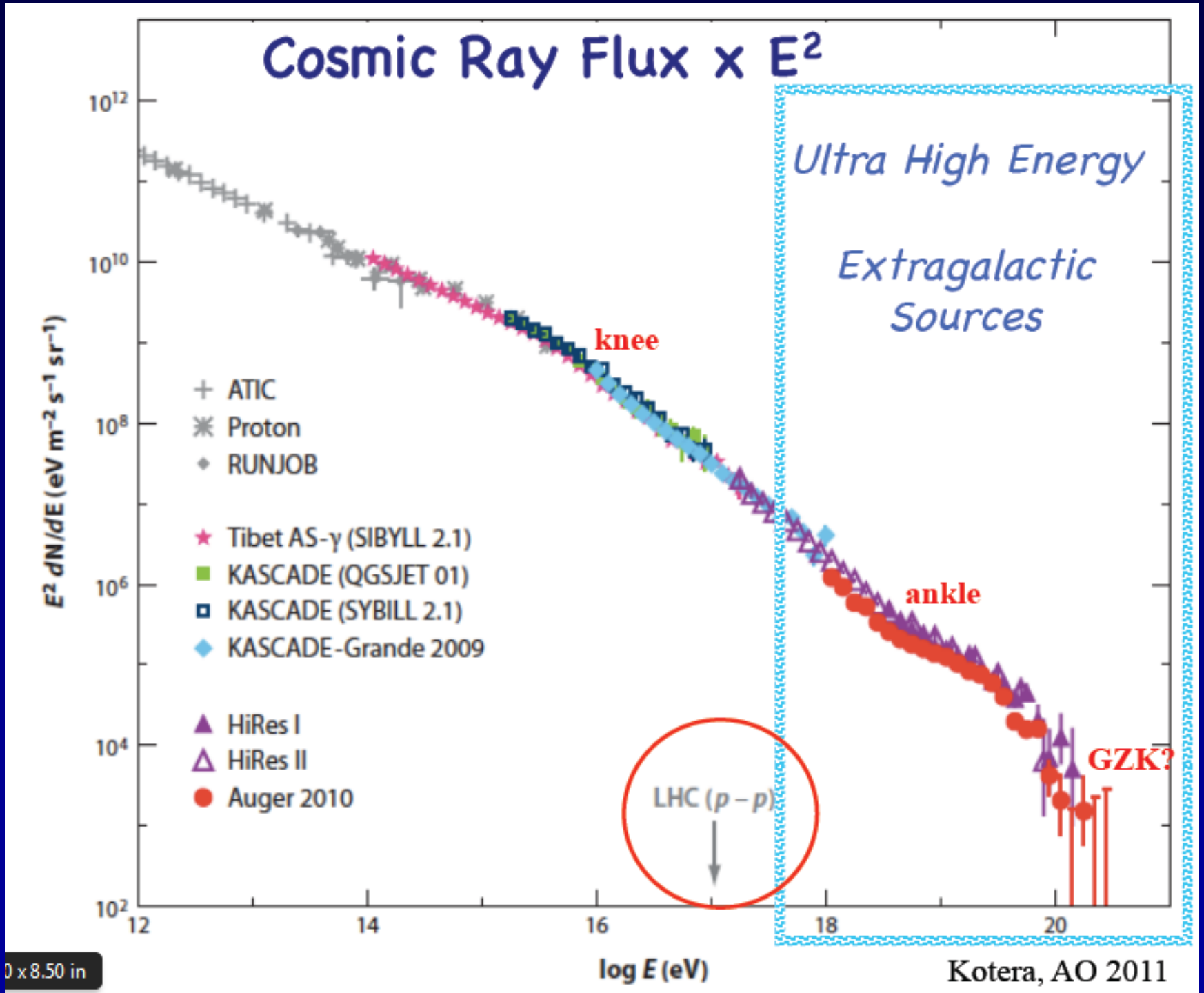
Goodbye zero dm magnetar

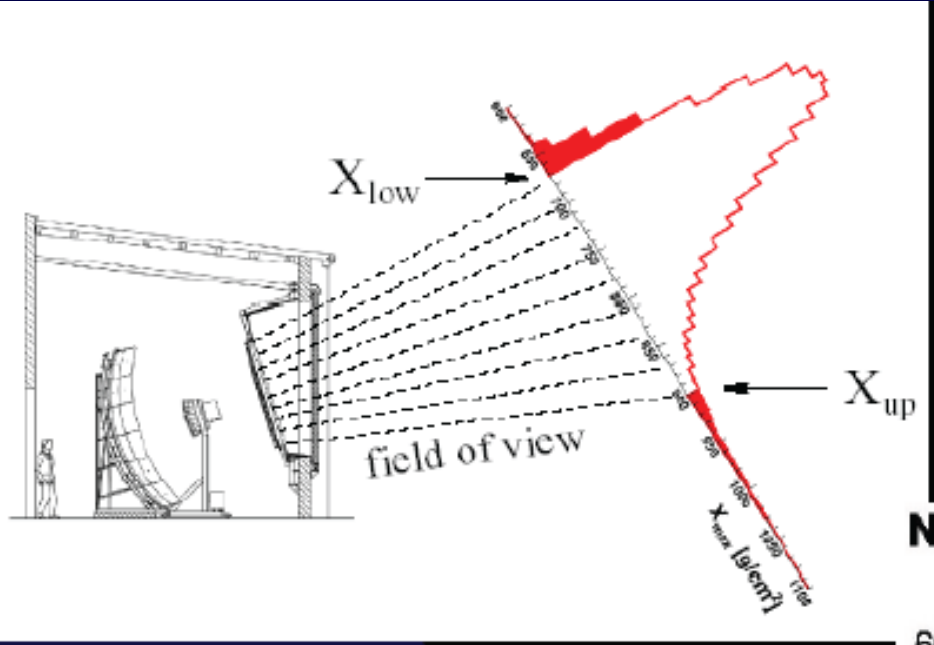
- Ryan Shannon observes
  - Strong periodic signa power
- John Reynolds: FT of M voltages
- 7.48 sec peak
  - periodic shift in HA
- second harmonic 3.74 sec
- Magnetar 3.76 sec !



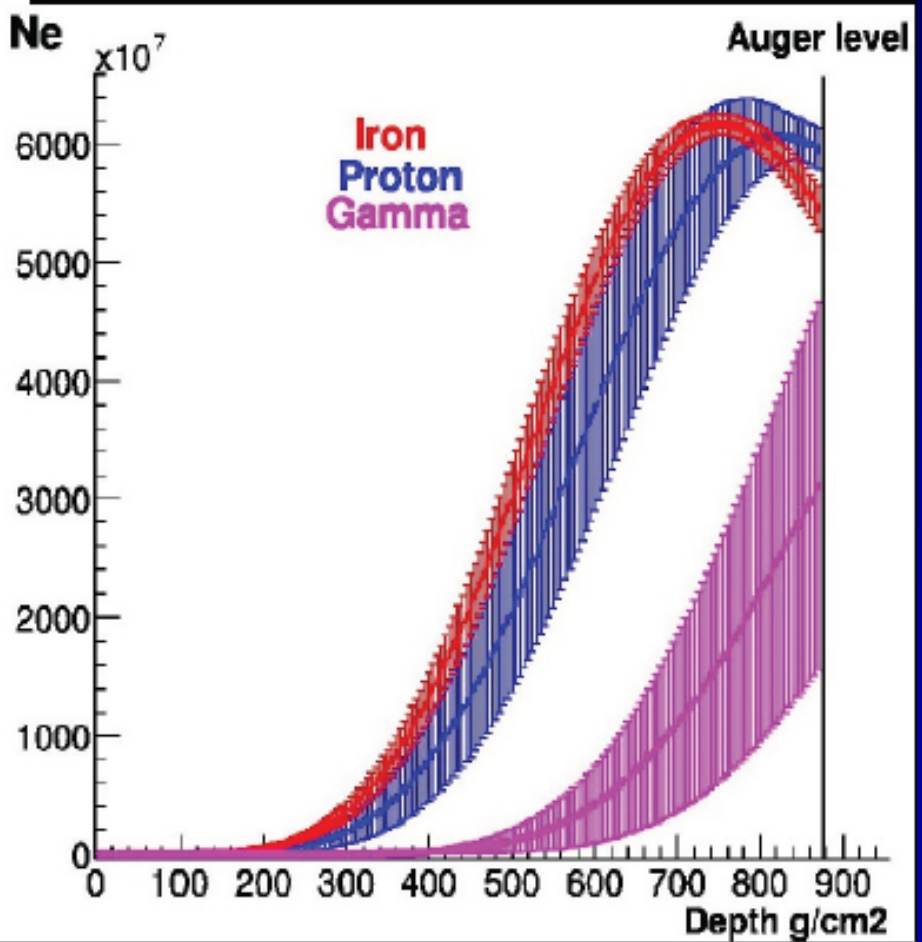
But still triggered interesting follow-up

- Plasma amplification in air shower
  - Don Melrose talk
- Properties of radio pulses from air showers
  - Why this is very interesting

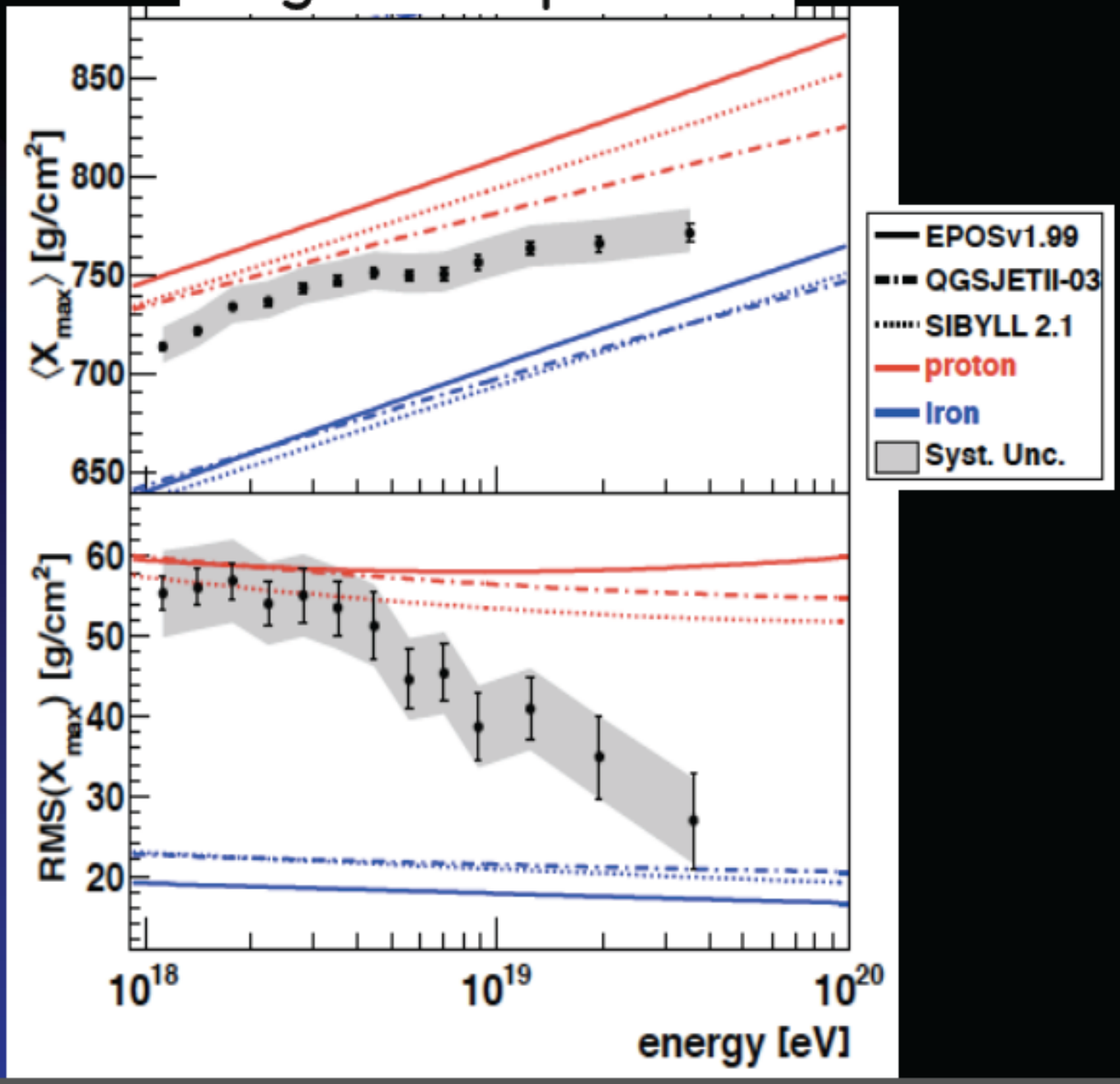

Cosmic Ray Flux x E²
Ultra High Energy
Extragalactic Sources
knee
ankle
GZK?
ATIC
Proton
RUNJOB
Tibet AS-γ (SIBYLL 2.1)
KASCADE (QGSJET 01)
KASCADE (SYBILL 2.1)
KASCADE-Grande 2009
HiRes I
HiRes II
Auger 2010
LHC (p – p)
E² dN/dE (eV m⁻² s⁻¹ sr⁻¹)
log E (eV)
10¹²
10¹⁰
10⁸
10⁶
10⁴
10²
12
14
16
18
20
Kotera, AO 2011



Composition observable: shower maximum



Auger Composition



Crome
Karlsruhe Institute of Technology

- Searching for molecular bremsstrahlung.
  - Recombination time 10-100 nsec
- Array of 3m fixed dishes
  - 3x3 multi-beam receivers
  - 3-4 GHz

- CROME have found the distribution over the ground is a ring so they are seeing some kind of anisotropic emission and not molecular bremsstrahlung.

Why Radio

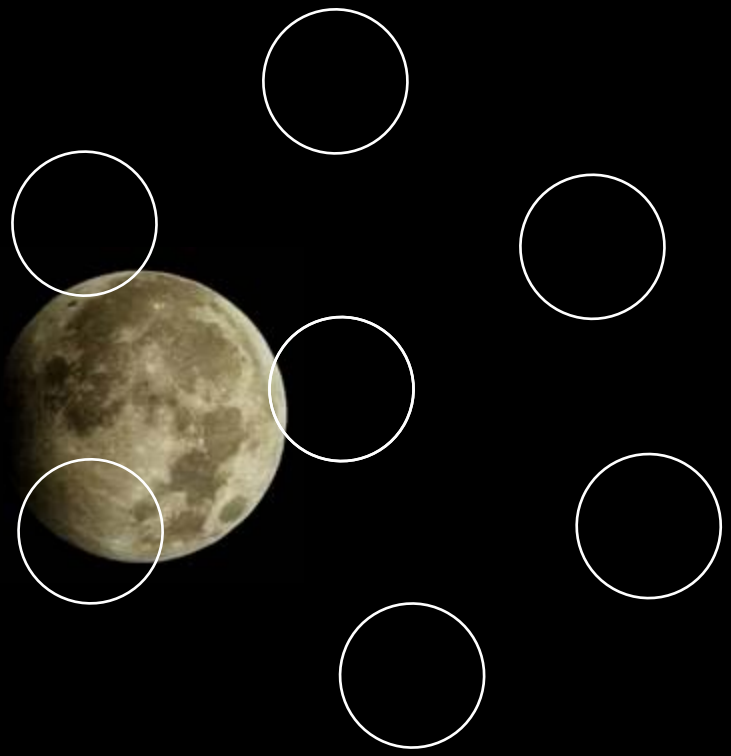
- Fluorescence detectors have too low a duty cycle to see rare events (10%)
- Radio detectors have 100% duty cycle
- Need radio detection to measure composition etc above the GZK threshold at 10^{19} eV
- Need to calibrate the radio detection method
  - Existing arrays are too small to reach 10^{19} eV but modeling can be validated at lower energy
- Extraction of information from air shower emission will require radio pulse imaging

High Energy Neutrino's

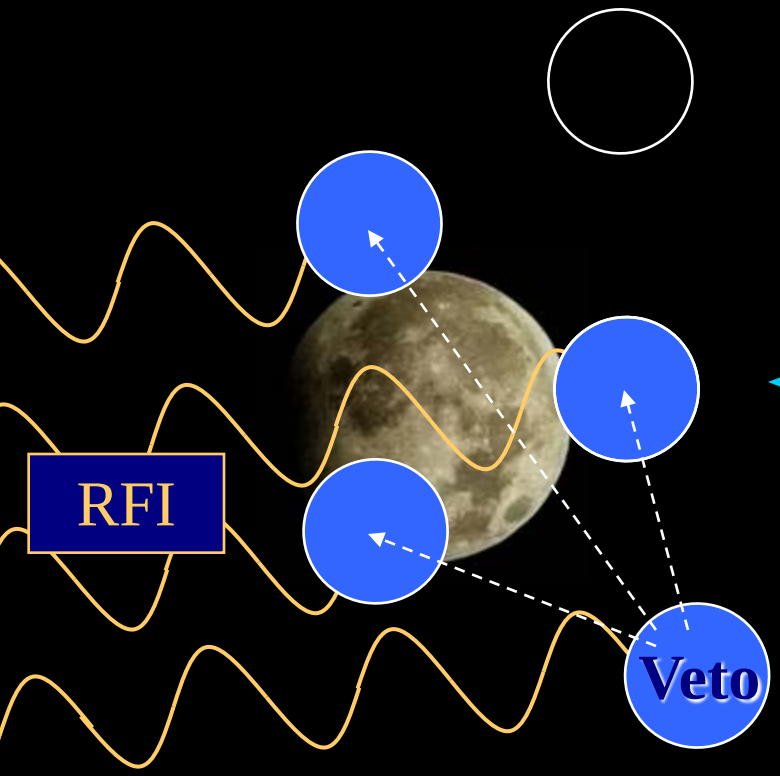
- Topological Defects
  - 10^{20}- 10^{22} eV
  - Extremely uncertain
- UHE protons + CMB photons
  - 10^{19} – 10^{20} eV
  - Guaranteed – both components seen!
  - What volume?
- AGN's
  - Up to 10^{20} eV
  - Wide range of models
- GRB's
  - 10^{16} eV

Eg Protheroe
Neutrino98, Takayama

Parkes 21cm Multibeam Experiment

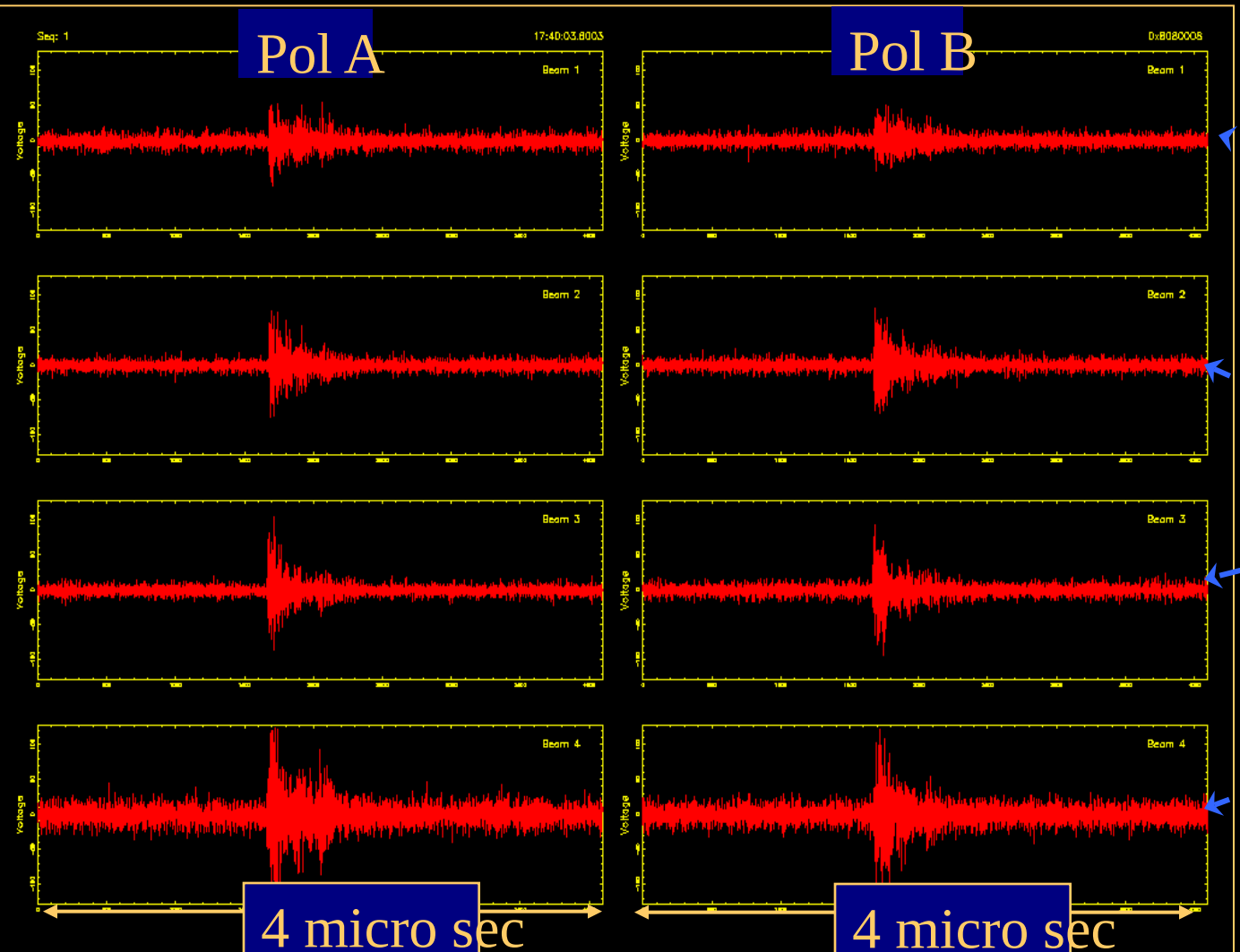


Parkes 21cm Multibeam Experiment

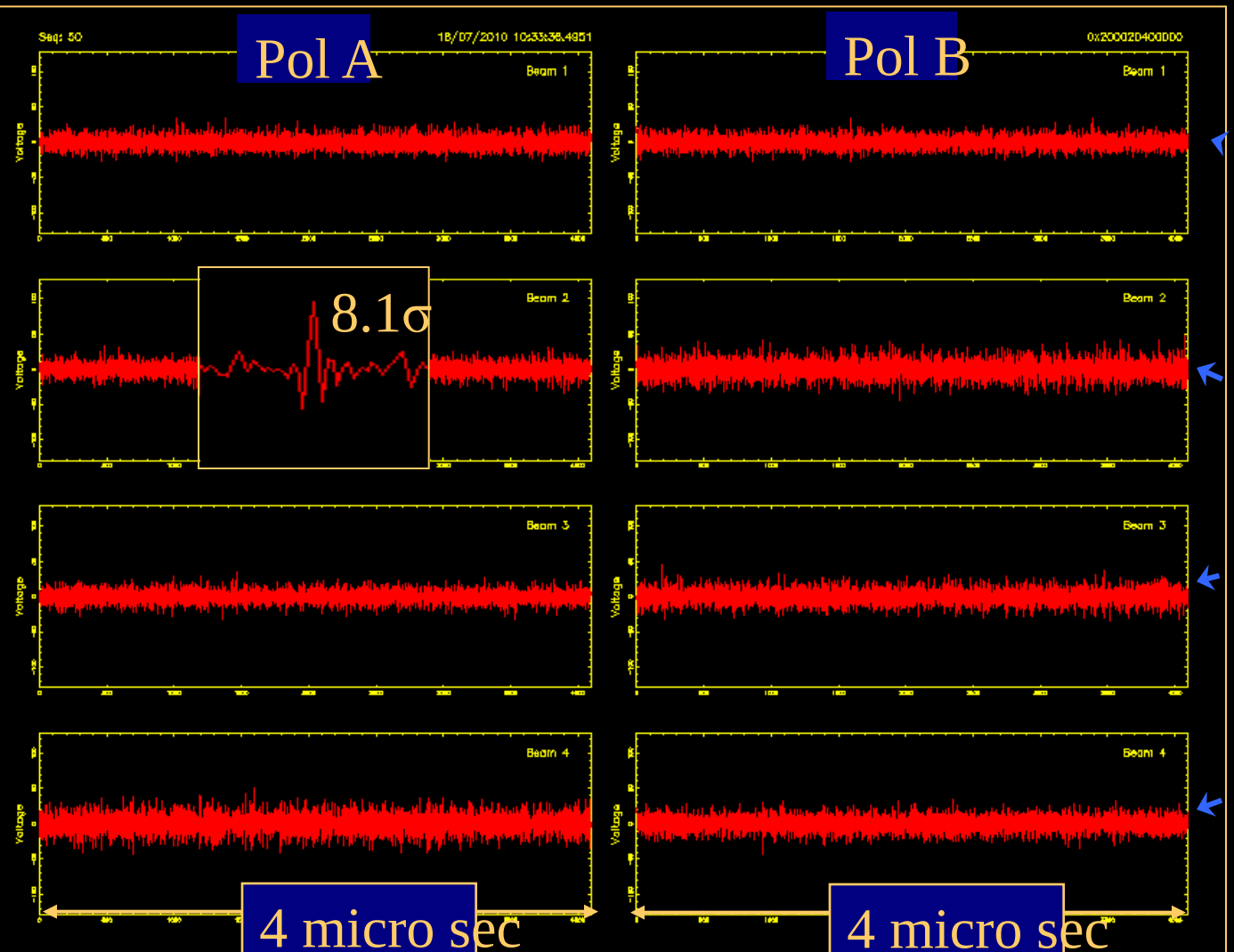


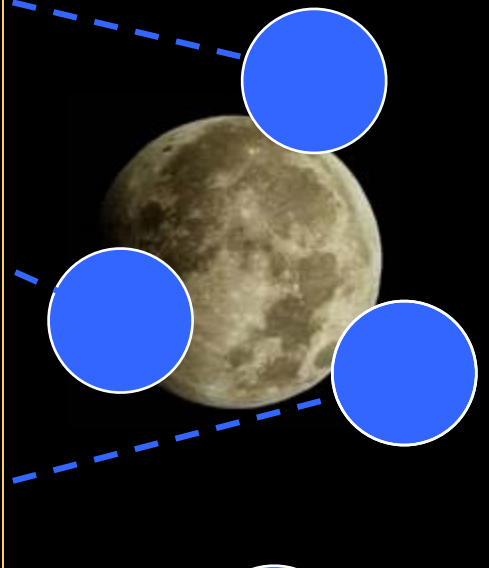
Centaurus A neutrinos

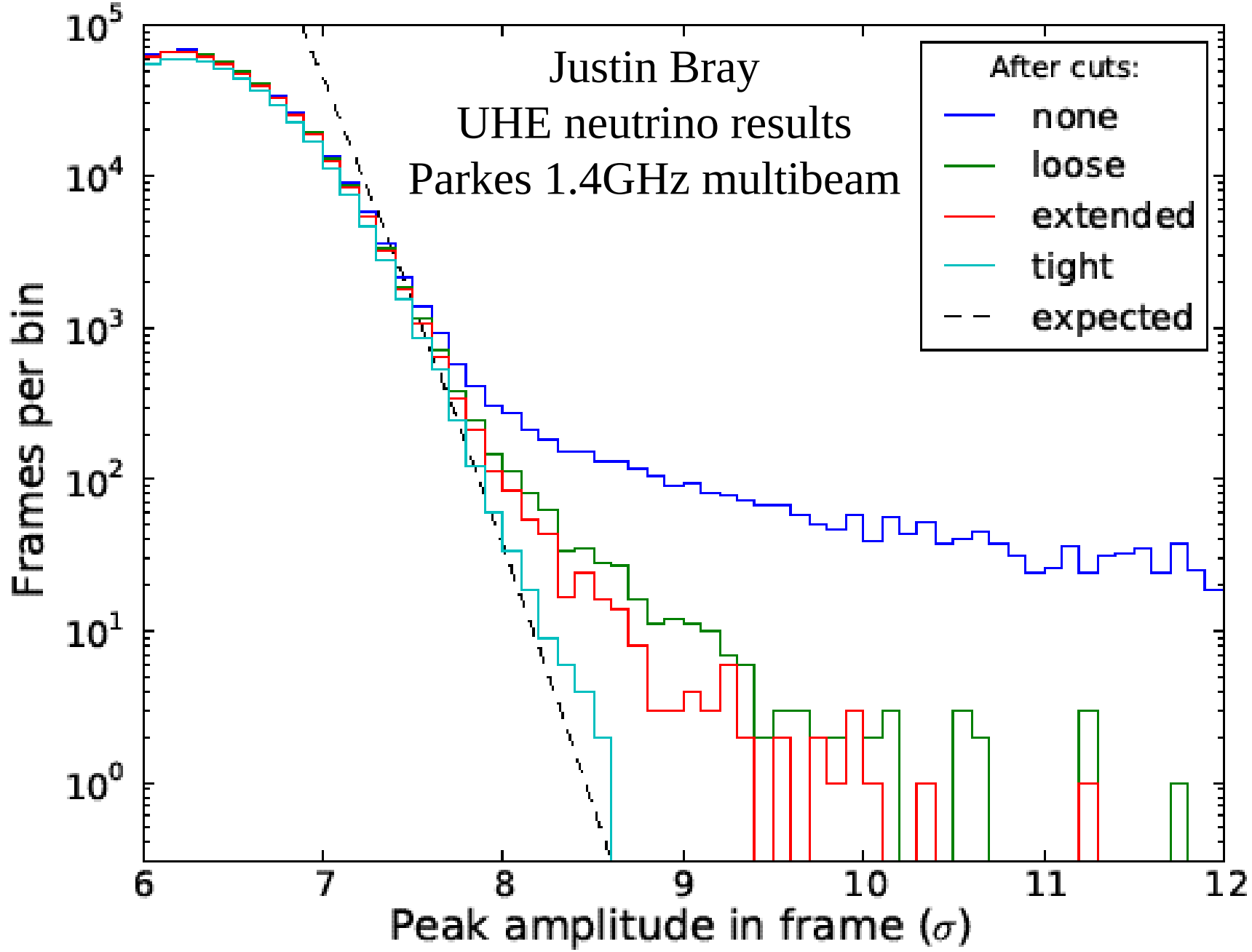
Parkes: RFI pulse



Parkes: Possible Event






Justin Bray
UHE neutrino results
Parkes 1.4GHz multibeam
After cuts:
none
loose
extended
tight
expected
Frames per bin
Peak amplitude in frame (σ)
10^5
10^4
10^3
10^2
10^1
10^0
6
7
8
9
10
11
12

Parkes search for Cosmic Ray pulses

- Parkes
  - very high sensitivity but very narrow beam
  - Use multi-beam to expand FoV
  - η sec pulse detection on all 13 beams at 1.4 GHz
  - Measure higher order statistics of undetected volages
- Gamma Rays direct from source
  - compensates for small FoV
- Sources
  - SgrA magnetar
  - Crab
  - Vela
  - RX J1713- 39 (PWN)
  - Zenith (blind CR search)