CTA Science

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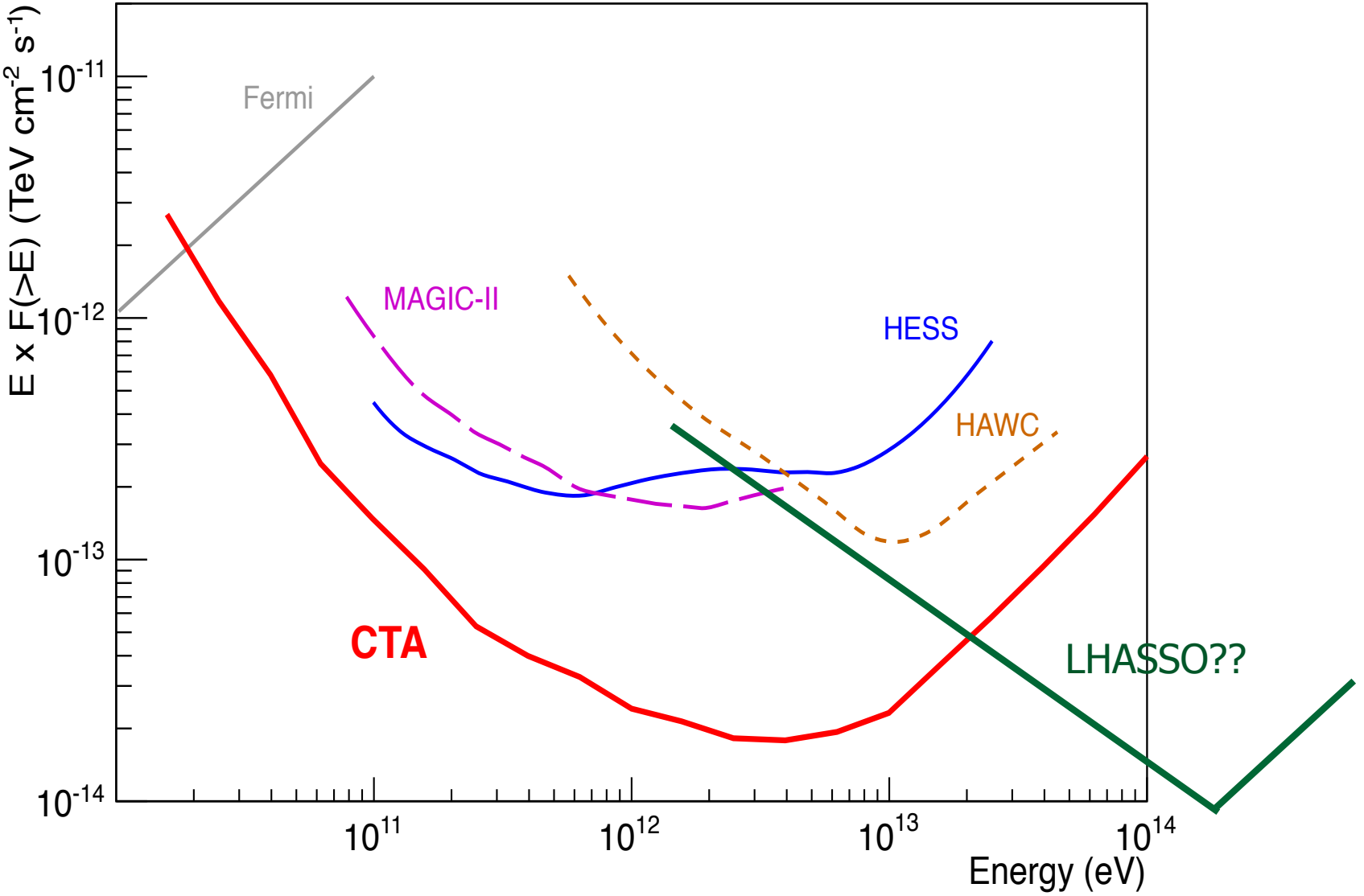
2 This Talk

- Introduction to science sessions
- Highlight
  - Unique CTA capabilities
  - CTA (non-SST) working groups where we should (ideally) be more visible
- Summarise current CTA Science activities
  - that I know about!
- Mention some current hot topics

3 CTA Capabilities

- Sensitivity
  - ~10^{-14} erg/cm^2/s above a few TeV (<1 mCrab)
  - Distance range ~15 kpc for luminosity 10^{34} erg/s objects (10^{50} erg of protons in n=1 cm^{-3} = 2.10^{34} erg/s)
  - Extended objects – distance reach goes linearly with sensitivity – background reduction
- Collection area
  - several km^2 at 10 TeV – factor >10 improvement - in signal limit ➔ linear sensitivity improvement
    - *short time scales and or high energies*
- Angular resolution and Energy Resolution
  - Towards 1 arcminute (from 5)
  - ~5% - from 10-15%

4 Sensitivity



5 CTA Working Groups

- MC
  - Prod-2 – new burst of activity
  - (New coordinator)
- PHYS
  - Science studies with MC response matrices
  - Little UK involvement in “official” PHYS activities
  - (+ LINK – workshops for ….)
- Data Management
  - RECO task – important time MC->DM
  - End-user requirements being defined
  - Trying to get part of this transferred to be an activity managed by the Project Scientist

6 Current UK Activities

Axions	Jo+Jon+Tim+	Results here
Pulsars	Cameron+	Results here
PWN Population	Jim+Stefan+(Aris?)…	Idea
Pevatrons Diffuse	Rich+Jim+Stefan	Idea
Starbursts	Stefan+Jim	Part done
Pair Halos	Richard+Jim+Lisa+Kate	Results shown
Prompt GRBs	Rhanna Starling+Jim	Part done
Real-time analysis/Triggers	Phil Evans + Jim	Results shown
Radio galaxy Inverse Compton	Martin Hardcastle	Results shown
SNR/Diffusive Shock Acceleration	Tony Bell, BR, KS	Results shown
Cluster-scale AGN outbursts / BCGs	Jim, Alistair Edge?, Kate D.	Idea

+? (Please let me know your plans)
To be discussed today

7 e.g. Pevatrons

- What does the galaxy look like at 100 TeV?
  - Diffuse emission+sources!
  - Sources?
    - *small number of very young SNR ?*
      - *500 y / 50 y/SN ➔ 10 objects – typical distances 3-15 kpc*
  - Diffuse?
    - *Depends on extrapolation of diffusion coefficient, residence time of PeV particles ~10^4 years? (Larmor radius ~1 pc)*
    - *May see only "halos" around O(100) sources, not much of a smooth component – detectable for CTA??*
- Plan
  - Mass Distribution ➔ Population ➔ Propagation ➔ Gamma Spectrum/Map
    - *both sources and target material for pp sampled from model*

8 New Ideas

- Line emission (Weniger, Finkbeiner+Su+++ 2012)
  - ~130 GeV line (or pair of lines) in Fermi data
  - 1.5° offset from GC
  - Starting to show up elsewhere (arXiv:1207.7060)

27	2012JCAP...08..007W	1.000	08/2012	A	E	X		R	C		U
	Weniger, Christoph	A tentative gamma-ray line from Dark Matter annihilation at the Fermi Large Area Telescope									
25	2012arXiv1206.1616S	1.000	06/2012	A		X		R	C		U
	Su, Meng; Finkbeiner, Douglas P.	Strong Evidence for Gamma-ray Line Emission from the Inner Galaxy									
22	2012arXiv1205.4723R	1.000	05/2012	A		X		R	C		
	Rajaraman, Arvind; Tait, Tim M. P.; Whiteson, Daniel	Two Lines or Not Two Lines? That is the Question of Gamma Ray Spectra									
17	2010JCAP...04..004J	1.000	04/2010								
	Jackson, C. B.; Servant, Géraldine; Shaughnessy, Gabe; Tait, Tim M. P.; Taoso, Marco	Higgs in space!									

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- TeV heating (Pfrommer, Chang ++ 2012)
  - e^+ e^- pairs generated in gamma-gamma absorption on EBL by TeV blazar beams lose energy dominantly by plasma excitations (rather than IC scattering)
    - *no pair halos*
    - *significant heating of voids -> suppression of late time structure formation – explains e.g. deficit of dwarf galaxies*
      - *10x more effective than photo-heating at redshift 3*
    - *avoids problem of different evol. of TeV blazars (EGGB)*

10 Discussion

- Mini-array science
  - ~6 SSTs, most sensitive device >10 TeV
  - think about mini-array targets/questions
    - *good case could help get cash from STFC for mini-array phase*
- DM + Heating
  - Unique angles – highlight
- Optical Follow-up
  - measuring redshifts, polarisation, rapid response, non-thermal spectra (wide wavelength coverage)
  - Driven by LSST+SKA+(CTA)
- X-ray alerts
  - from where