“Sensitivity” or “GNN” paper: rationale, outline & discussion

Clancy W. James,
MANTS, Mainz 2016

ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS

FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG

Basic idea

More general paper on sensitivities and how detectors in South and North complement each other

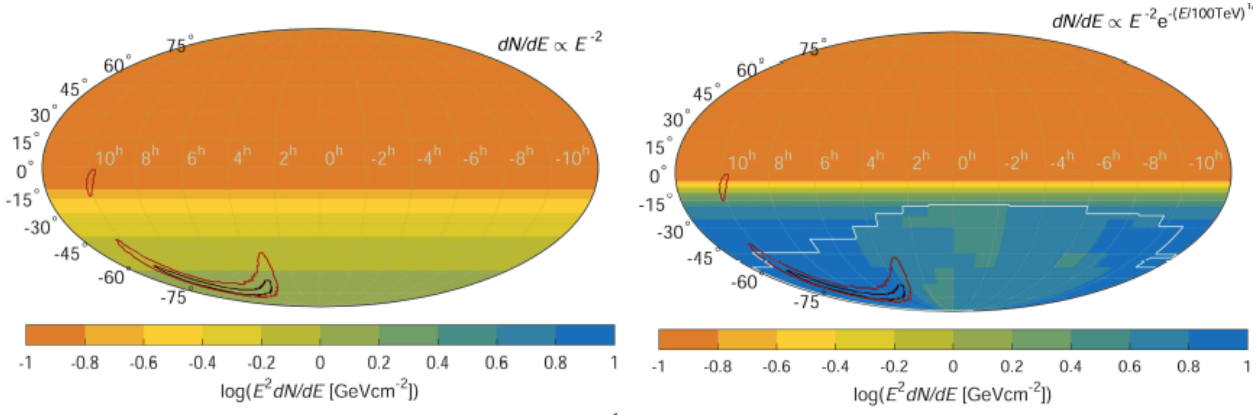
- Figure of merit discussion:
  - Produce comparable figures between experiments (clarity)
  - Highlight complementarity (funding!)
  - Previous MANTS meetings – use differential sensitivity plots

- To do this properly, we need close cooperation between experts
- Why not write a joint (GNN) paper on this?

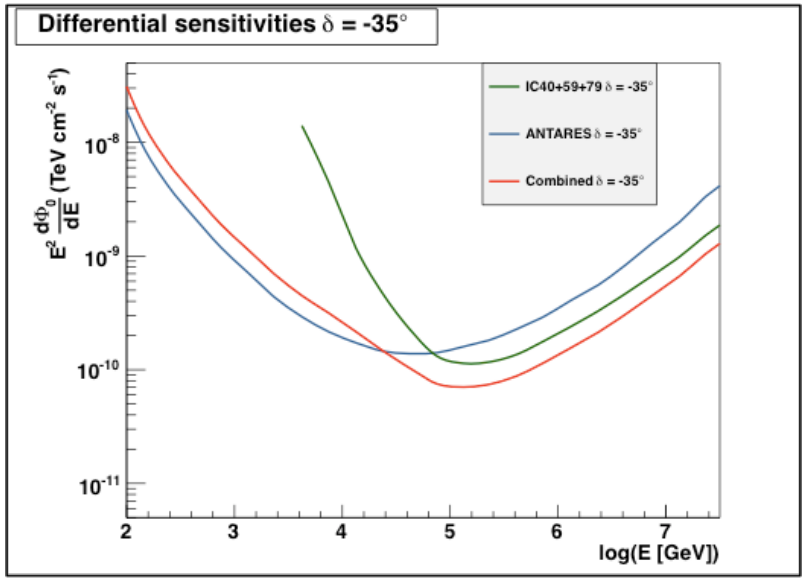
- Other motivation:
  - Simplifies talks (just show plots, save thousands of words)
  - Simplifies papers (recent GW paper for two spectral models)
  - Makes MANTS feel like a worthwhile meeting

Current ways of comparing experiments

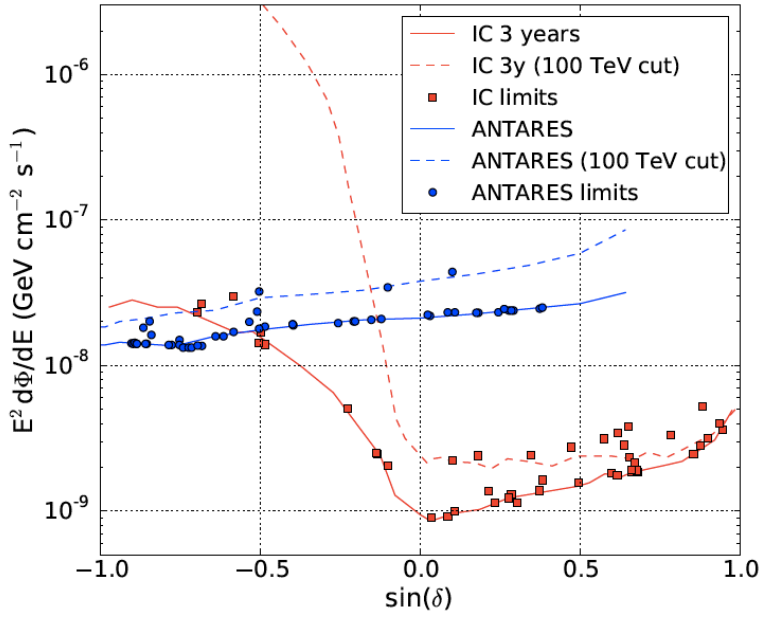
GW150914



ANTARES IceCube < 80 joint analysis
NOT official - stolen from wiki
Ignore the red line!



ANTARES IceCube < 80
joint analysis
Official plot



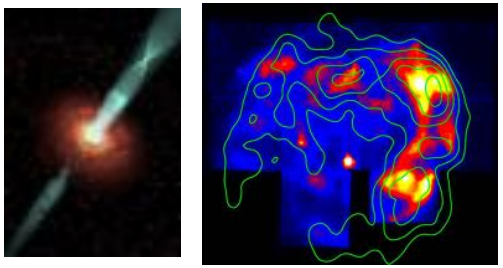
Differential sensitivity vs models

- Different spectra:
  - Pros: most strongly relates to the sensitivity estimates (~KM3NeT LoI)
  - Cons: infinite number of them, probably all wrong, requires on line per model, will cause arguments over which models, hides energy dependence
- Differential sensitivity
  - Pros: universal way – readily apply to all models
  - Cons: can not be perfectly applied to any model, numbers tend to be larger (due to smaller applicable energy range)

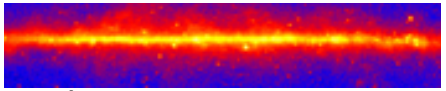
- Previously discussed – decided on differential sensitivity
- Still, better to voice objections now – but this is last time!

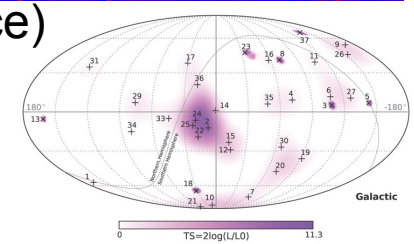
What classes of sources/searches?

- Current work: point sources

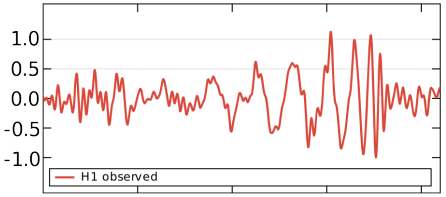


- Suggested minimal additions:
  - Extended sources / diffuse analysis (energy resolution vs angular resolution)
  - Transient sources (removes background, just acceptance)





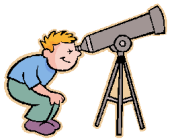
- My personal thoughts:
  - Keep it simple – smallest number is best, future experiments have not yet fleshed out their sensitivity estimates
  - Natural limit of diffuse source: sensitivity to 4 pi flux
  - Natural limit of transient sources: ~GRB, GW



Do we put technical details in the paper?

- Real question: who are we writing the paper for?

  - Us / similar experiments: “This stuff matters when you do a neutrino search” - technical details very interesting and relevant



  - Astro community: “This is how sensitive these instruments are to your favourite astrophysical phenomena” – details just get in the way

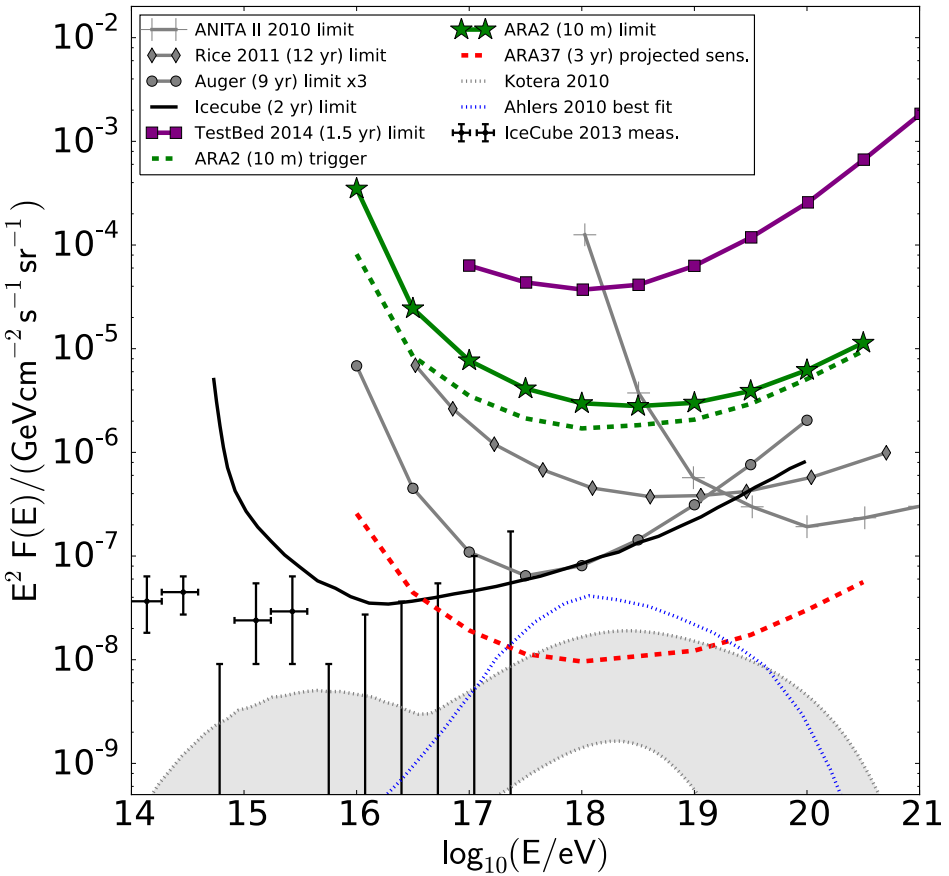
  - Funding agencies / grant proposal reviewers: “I am doing this project with that experiment because it is more sensitive in this parameter space” – details get in the way IF they read the paper at all

- My proposal: target astro community and people with money
  - Sort out technical details first
  - Use common methods in paper
  - Do NOT include any detailed discussion of them

Technical details – differential sensitivity

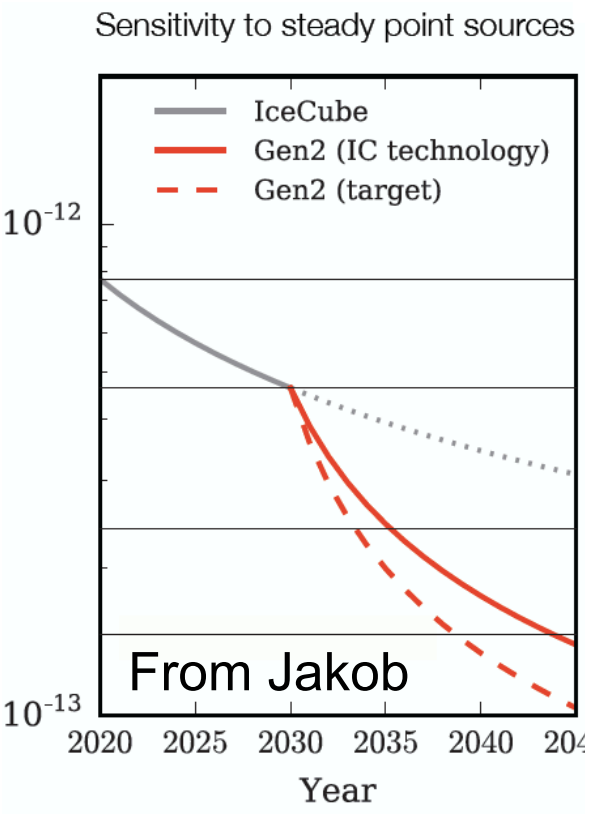
- UHE particle searches
  - ~Backgroundless
  - 90% Upper Limit = $2.3/A_{eff}(E)/t$
  - Equivalent to differential sensitivity with bin width e
- Great!
  - Clear precedent in literature
  - Do it ourselves
  - Small-bin limit: diff. sens. ~ bin width, just rescale by actual bin width / e.

Copied from ARA paper I found on my computer…



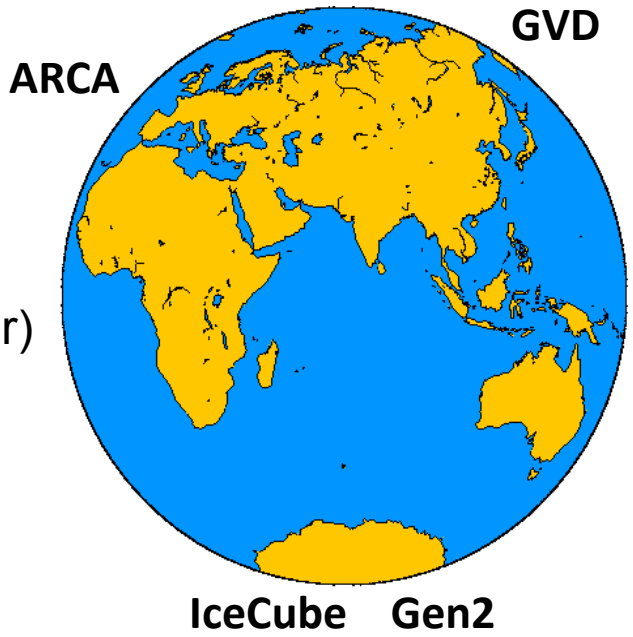
Time

- Why does time matter?
  - Some experiments operating longer than others / built before others (ANTARES->IceCube->KM3NeT->Gen2, ORCA->PINGU) + GVD???
  - Searches with different time-scaling (t vs $t^{0.5}$)
  - Experiments with different efficiencies (livetime vs real years)



- Possible solutions (brainstorming, no real idea)
  - Plots with real years on x-axis (2015, 2016 etc)
  - Plots for common time interval, write down scaling with t
  - Plots with different assumed analysis times?
  - ...

Which experiments?



- The more the better!
  - Currently: ANTARES, IceCube (Chad & Javier)
  - KM3NeT: Recent work (Rosa/Agata)
  - Gen2: seen estimates by Markus Ackermann
  - GVD: find out this meeting?
- Expect we need a lead author from each collaboration. Others:
  - Science working groups
  - PCs
- When to get these other groups formally involved?

Which data (real or simulated)?

- ANTARES & KM3NeT:
  - clear separation between cascade-like and track events
- IceCube:
  - Several different data samples used
- GVD? Gen2?

Searches Combined in the Maximum-likelihood Analysis

ID	Topology	Containment	Energy Range[a] (TeV)	Zenith Range (deg)	Data-taking Period	Observables	Reference
T1	Tracks	No	>100	90–180	2009–2010	Energy, zenith	(1)
T2	Tracks	No	>100	85–180	2010–2012	Energy, zenith	(2)
S1	Showers	Yes	>100	0–180	2008–2009	Energy	(3)[b]
S2	Showers	Yes	>30	0–180	2009–2010	Energy	(4)[c]
H1	Showers, tracks	Yes	>50	0–180	2010–2013	Energy, zenith	(5), (6)
H2	Showers, tracks	Yes	>20	0–180	2010–2012	Energy, zenith, topology	(7)

The Astrophysical Journal, 809:98 (15pp), 2015 August 10

- Suggestion: let each experiment do whatever they like

(presumably similar to what is done now, so “as per \cite{…}”)

Summary of issues

- Will NOT be resolved at MANTS!
- But we may look at the way forward:
  - Which experiments (solve now?)
  - Technical details (officially appoint experts: Chad, Javier, + …)
  - Target sources (at least raise suggestions; dark matter?)
  - Time axis (???)
- Any other major discussion points?
- *Q1: do we even want to do this?*