THE OHIO STATE UNIVERSITY

In-situ arrays: Looking forward

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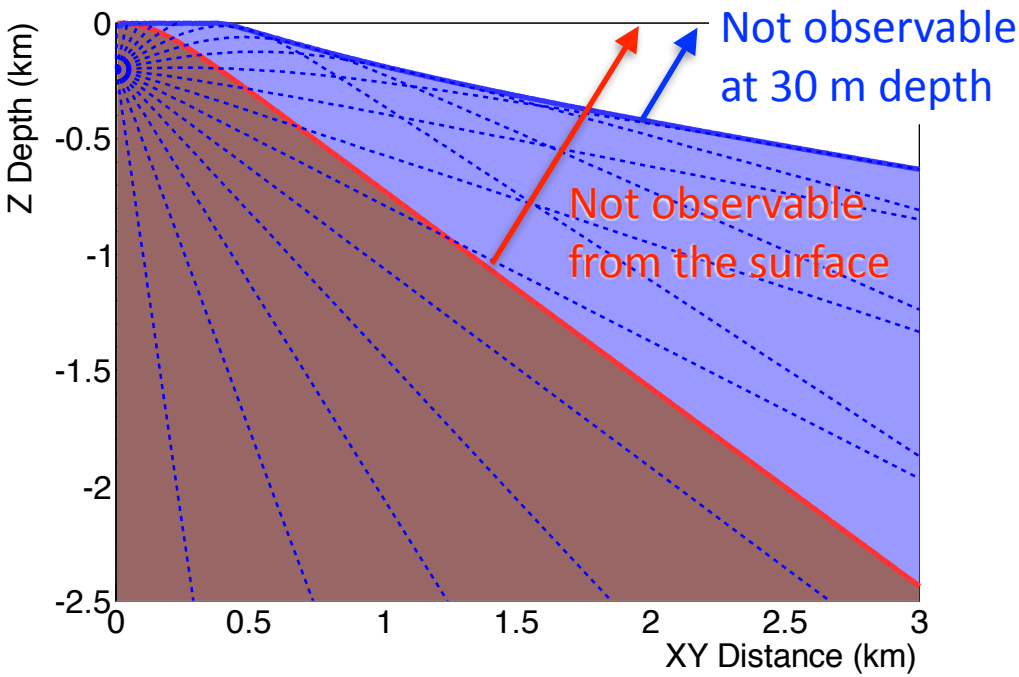
Outline

- My take-aways from Weizmann discussions (Jan. 2017)
- Actions since then
- Thoughts on the future

ARA/ARIANNA discussions at Weizmann Institute Jan. 2017

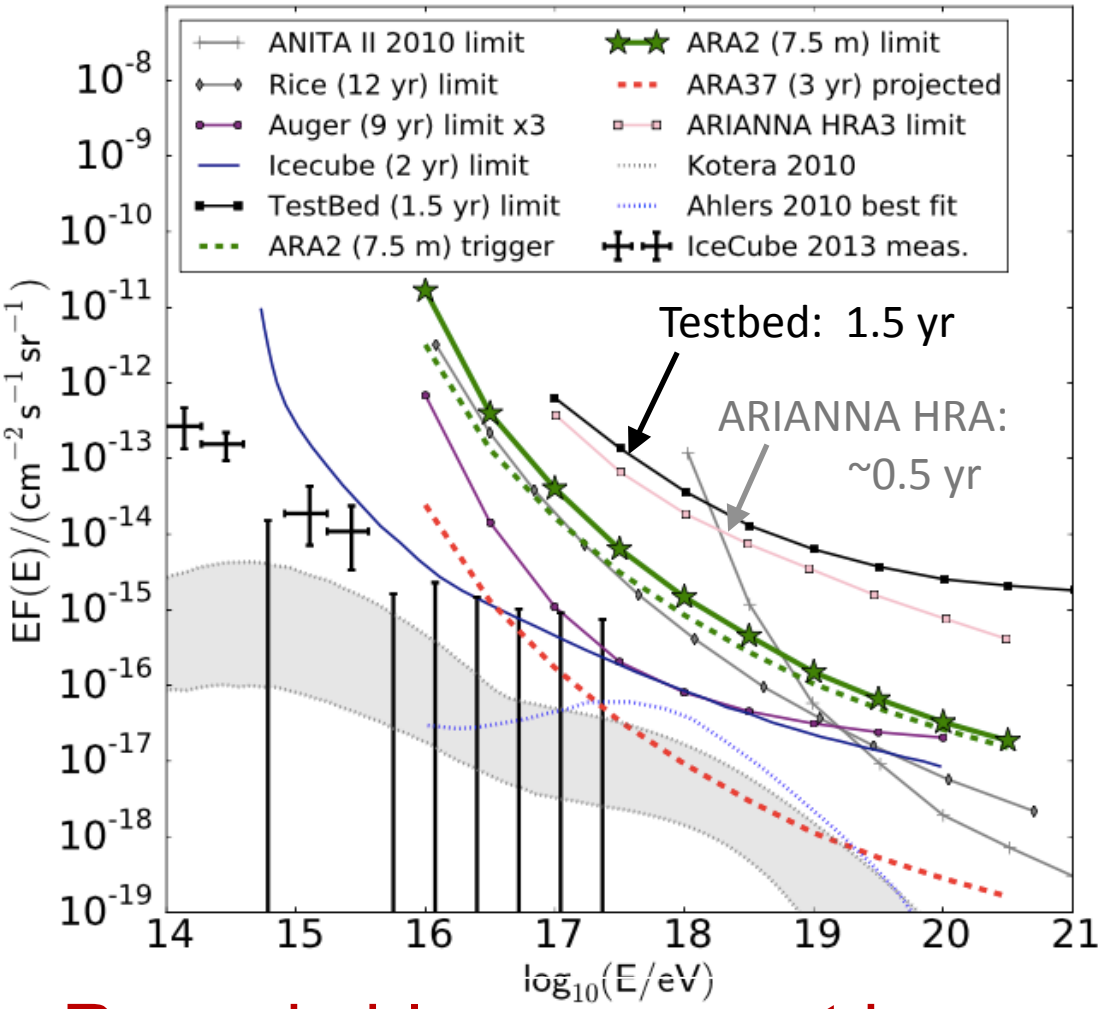
Effect of depth-dependent ice properties

- This is the model ARA has been using so far:
- Depth-dependent index of refraction
- Changing density loose snow → packed ice
- Near surface, portion of ice unobservable



Published limits as benchmarks

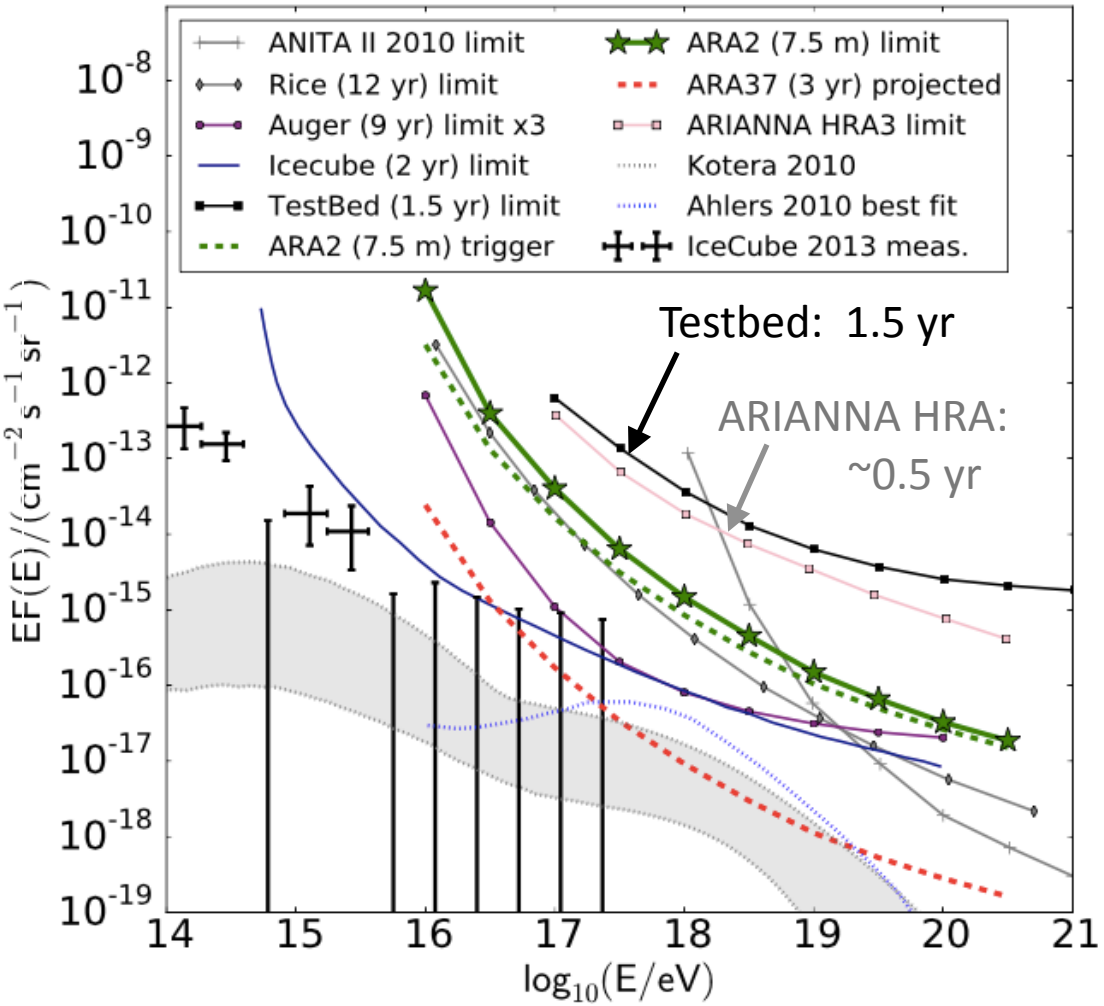
- ARA Testbed: 1.5 yr*10% eff. (aggressive cuts, first analysis)
- ARIANNA HRA: 1yr*50%*90% eff.
- Expect (0.5*0.9)/(1.5*0.1)=3 better HRA3 limit



- Remarkable agreement in overall level and shape!

Published limits as benchmarks

- ARA Testbed:
  1.5 yr
  *10% eff.
- ARA2:
  2 (going to depth)
  *2 stations
  *0.8 yr livetime
  *~50% eff.

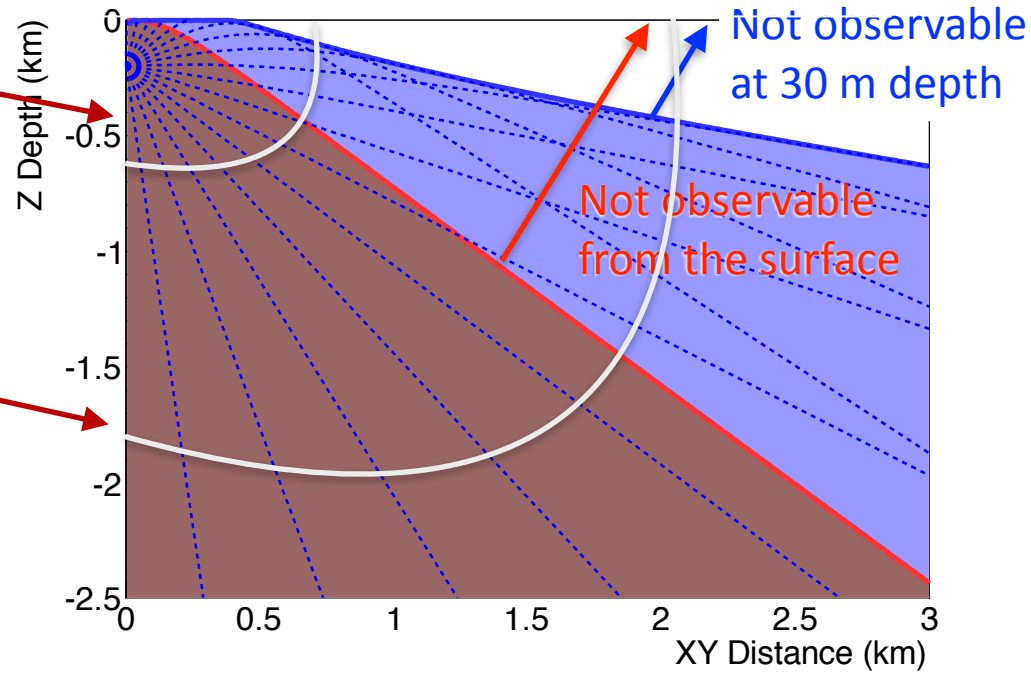


- As expected, (2*2*0.8*0.5)/(1.5*.1)=factor of 10 improvement ARA Testbed→ ARA2

Effect of depth-dependent ice properties

- This is the model ARA has been using so far:

- Less of an impact at lower energies
- More of an impact at higher energies

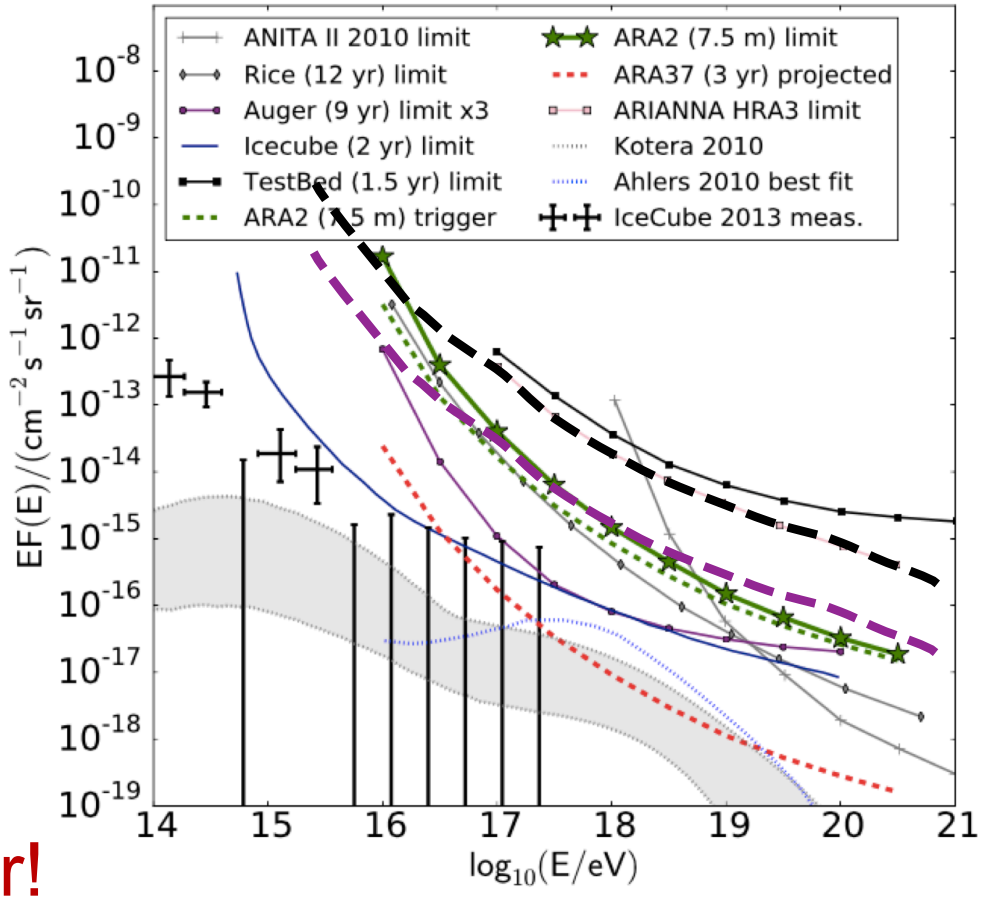


How much better is deep vs. surface station

- Traditional firn model, not efficient in summer:
  - 2(depth)*2(efficiency)=4
  - Lower energies: depth less important → just 2
- Traditional firn model, fully efficient in summer:
  - 2(depth)=2
  - Lower energies: depth less important → not much difference

Reenactment of a Weizmann chalkboard discussion:

- South Pole:
- For every deep station, deploy several surface stations (they are cheaper)
- End up with array with strong sensitivity over a broader energy range
- Together we are stronger!



Since Weizmann meeting

"InIce" Simulation Meetings have ramped up in intensity

- UC Irvine
- OSU
- Cal Poly
- Kansas
- Delaware
- Chicago
- Uppsala Univ., Sweden

ARIANNA: ShelfMC
ARA: AraSim

The OSU InIce Simulation Team

Currently meet Fridays 1 pm Eastern.
Email Jordan Hanson (918particle@gmail.com) to join.

New Results

- ShelfMC, AraSim effective volumes AGREE (within 10% stat. errrors) for:
  - $E_\nu = 10^{18}$ eV
- Detectors made to be similar:
  - Flat geometry, 4 ARA-like antennas
  - At the surface
  - South Pole n(z)

This is the first time the two simulations have attempted to reproduce the same result and they agree within statistical uncertainties! Woohoo!

Carl Pfendner, OSU

Chris Persichilli, UC Irvine

Exploring parameter space

- Developed scripts to loop over parameter space:
  - Energy
  - Distance between antennas
  - Depth
  - Firn depth

- Plan is to test where in this parameter space the simulations agree

Hannah Hanson, OSU rising Sophomore

Jude Rajasekera, rising sophomore

Developing common interfaces

- AraSim:
  - Developing a standard interface for incorporating antenna parameters (measurements, models)

Anna Nelles
UC, Irvine

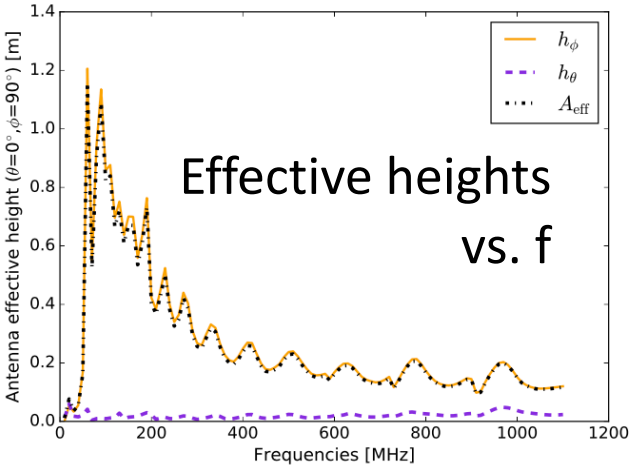
Stephanie Wissel,
Cal Poly

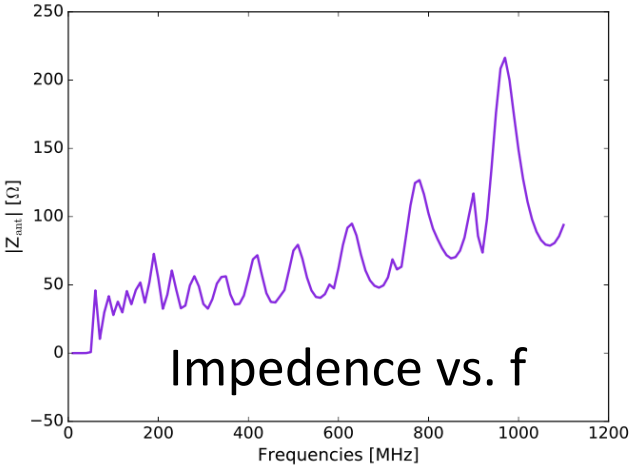
Jorge Torres
Espinosa

- Next: Develop ability for ShelfMC to use the same interface (w/ Carl)

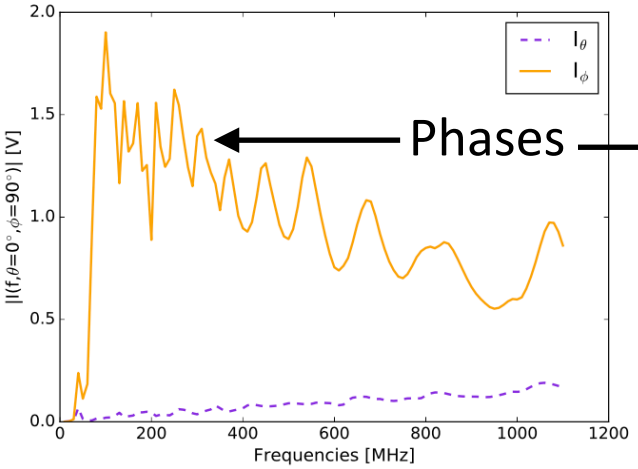
Developing common interfaces

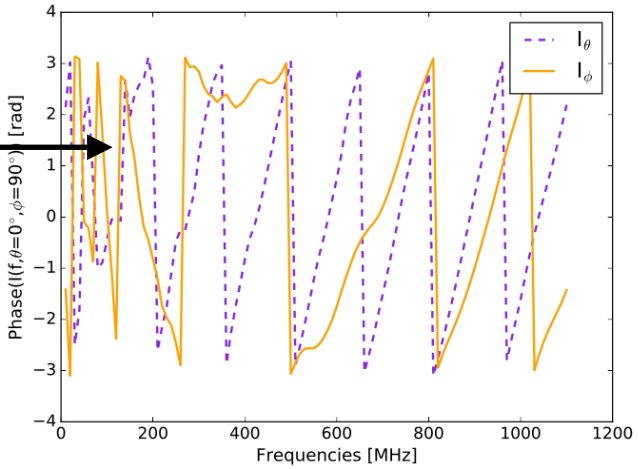
ARIANNA antenna model in AraSim!





Phases

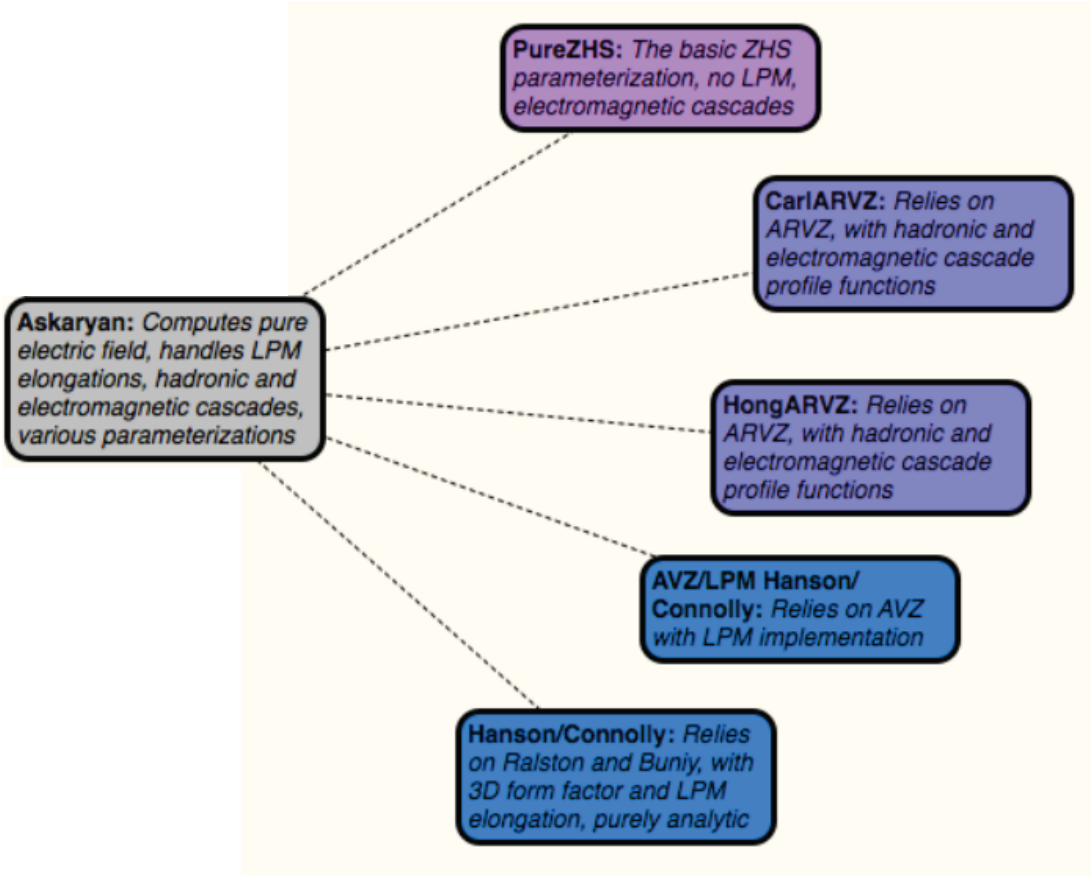




Stephanie Wissel, Cal Poly

Jorge Torres Espinosa

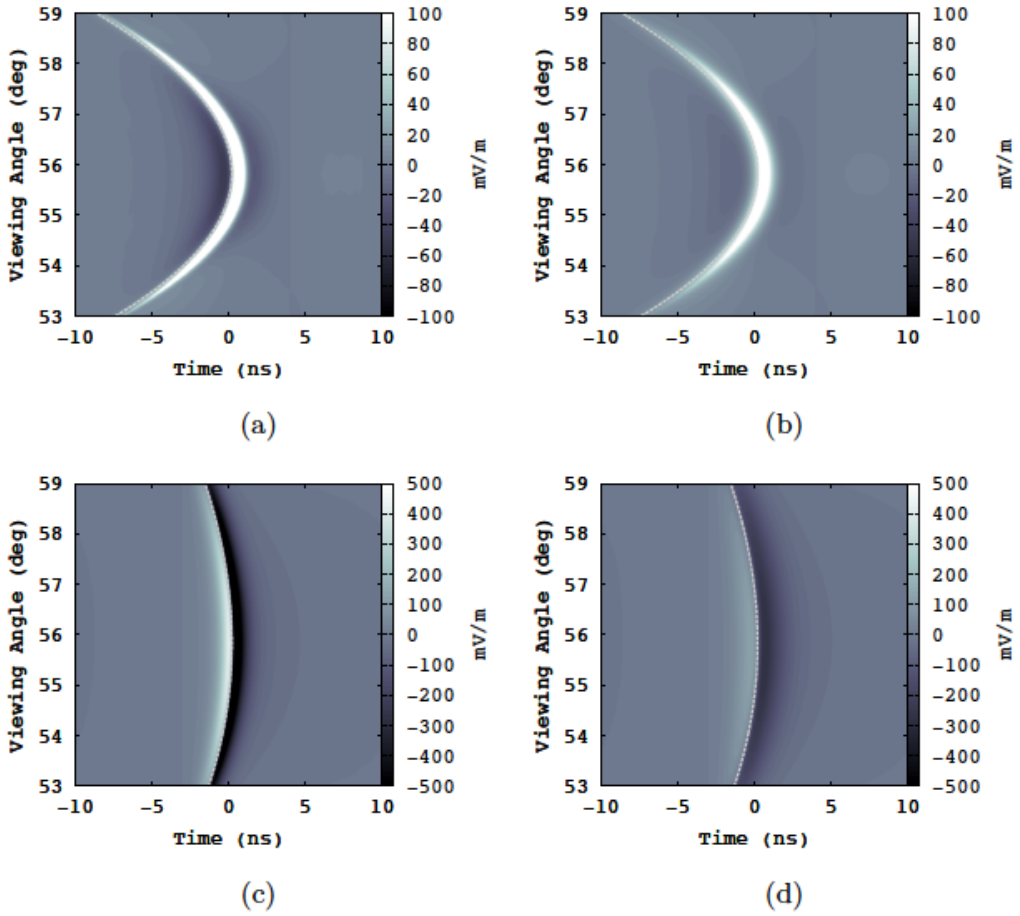
Developing common interfaces



Jordan Hanson (OSU, soon to join Whittier College as faculty)

New Analytical Model

J.C. Hanson and A. Connolly, Astroparticle Physics, 91 (2017) 75-89.



Jordan Hanson (OSU, soon to join Whittier College as faculty)

Figure 3: Contours of $\hat{e}_\theta \cdot \mathbf{E}(t)$, for a cascade energy of 1000 PeV. (a) R=1000 m, lateral ICD width of 5 cm. (b) R=1000 m, lateral ICD width of 10 cm. (c) R=200 m, lateral ICD width of 5 cm. (d) R=200 m, lateral ICD width of 10 cm. The LPM effect has been taken into account. See text for details.

Ray Propagation

- Revisiting how we do ray propagation
  - We have a model in AraSim developed by Chris Weaver of UW
  - Seckel has one he developed in Mathematica
- Effects of different n(z) models

Spoorthi Nagasamudram, OSU rising senior

You will hear more today

- There may be evidence that emission is propagating over further distances than expected
  - Could be due to a layered rather than continuous n(z)
- This would impact statements I made earlier about deep vs. shallow station
  - Going deep would not have an great an effect on number of expected events
- *My initial thoughts: Let's remember to think ahead about the impact on event reconstruction, flavor ID as well!*

There is more being done…

- I'm sure I'm leaving out something important!
- Lots of great stuff

Looking ahead to Gen2

- Is it a wonderful development that ARA and ARIANNA folks are
  - Working together
  - Finding agreement between simulations that haven't shared code in over ~10 years
  - Developing common code for use across the radio field
- With these tools in place we will be in a great position to optimize a detector that could be part of Gen2 if that is the plan
- Design for improved chance of coincidences?

Thank you for the invitation!