Interim Presentation

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February 20, 2023

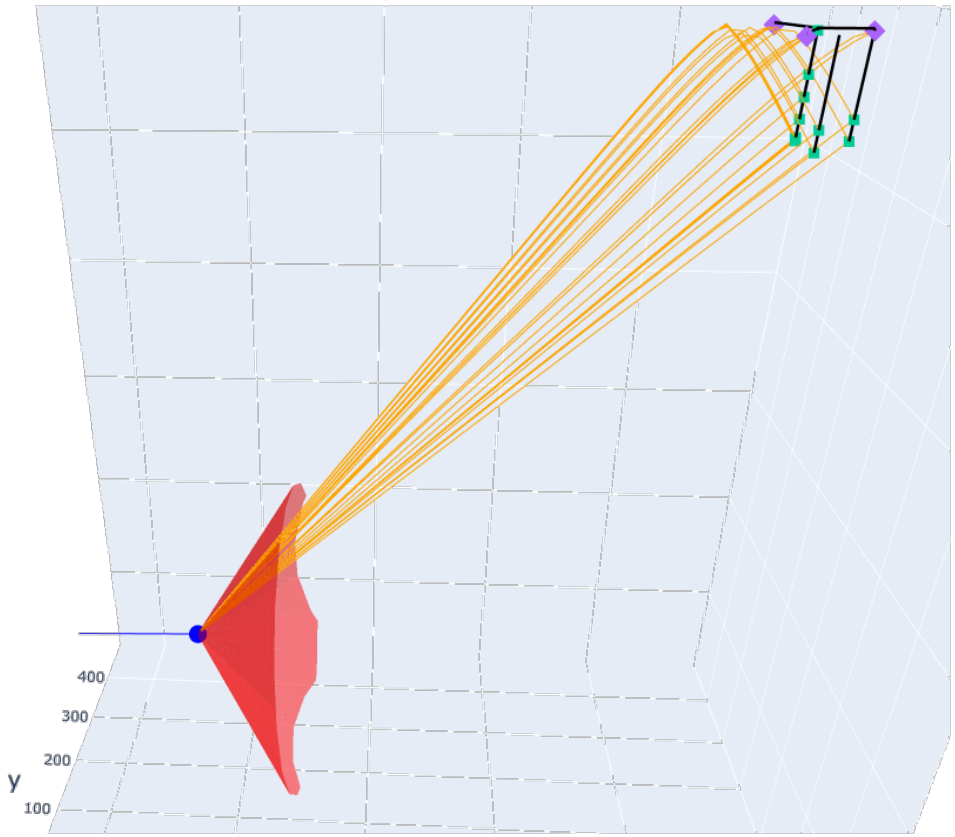
Setup

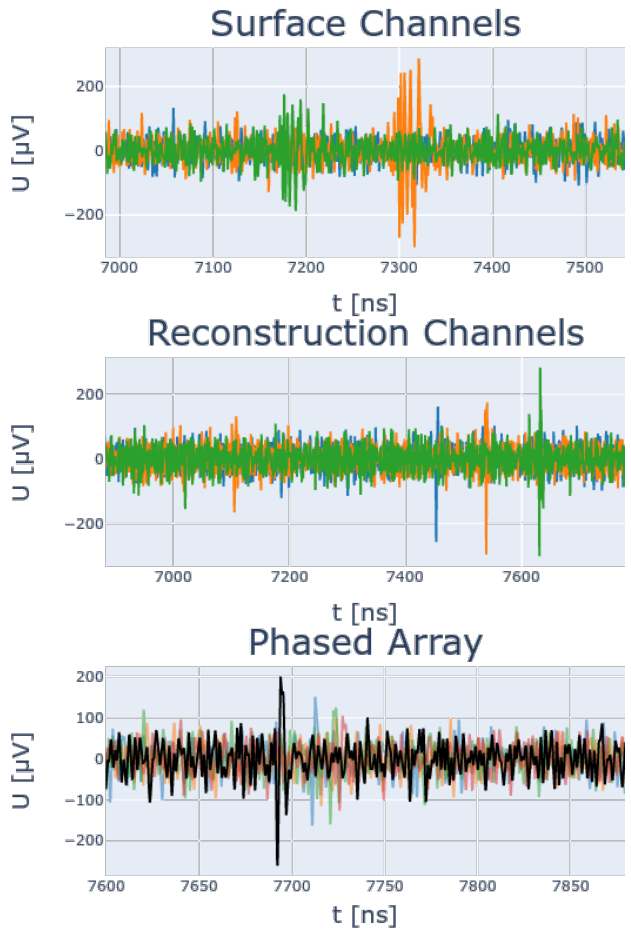
- principle
- The need for RNO-G
- RNO-G
- Ice Models
- Iterative Ray Tracer
- Hybrid Ray Tracer

Principle

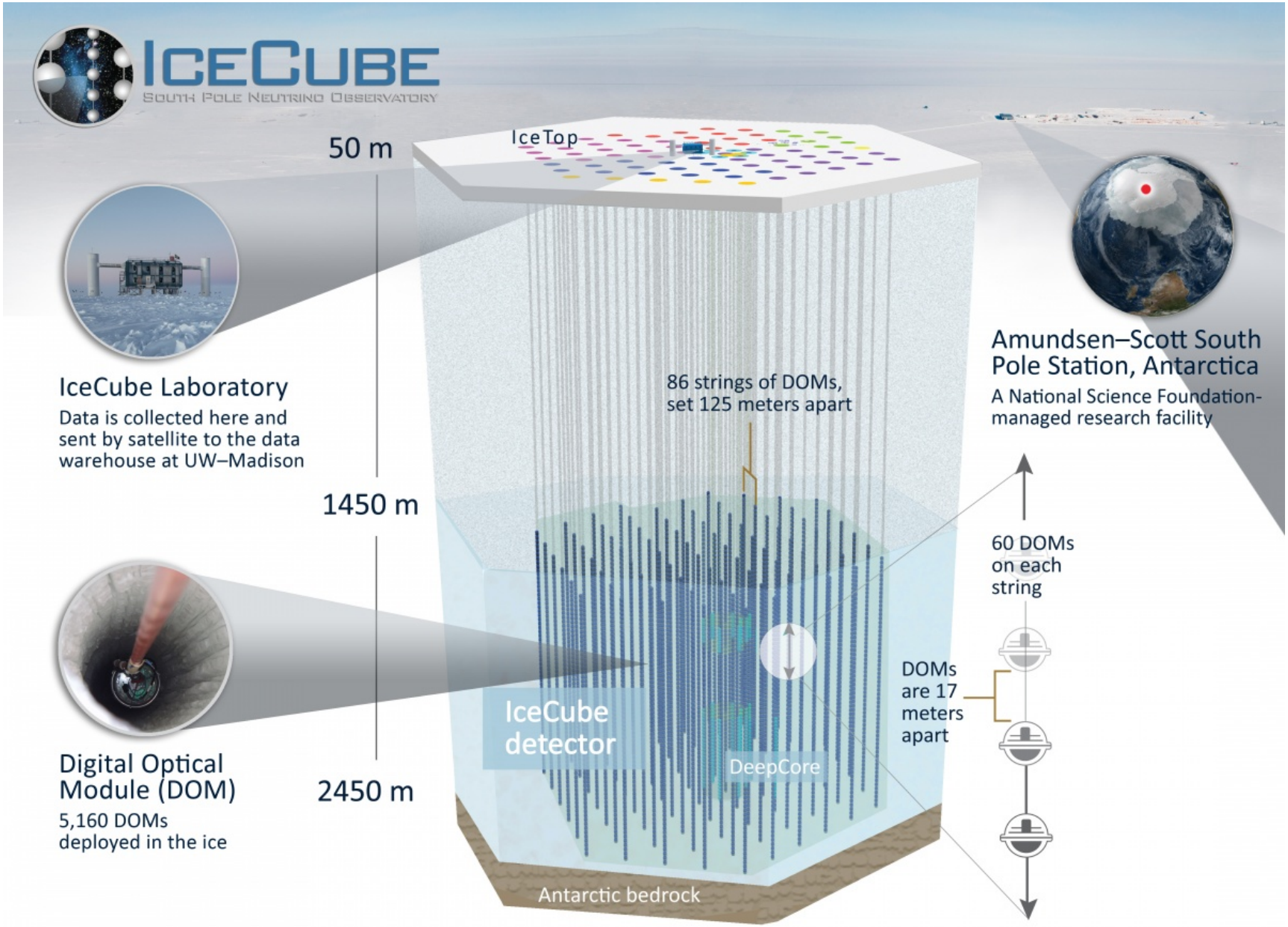
vertex
ray path
dipoles
LPDAs

E=2e+18eV
θ=93.3°
φ=178.8°

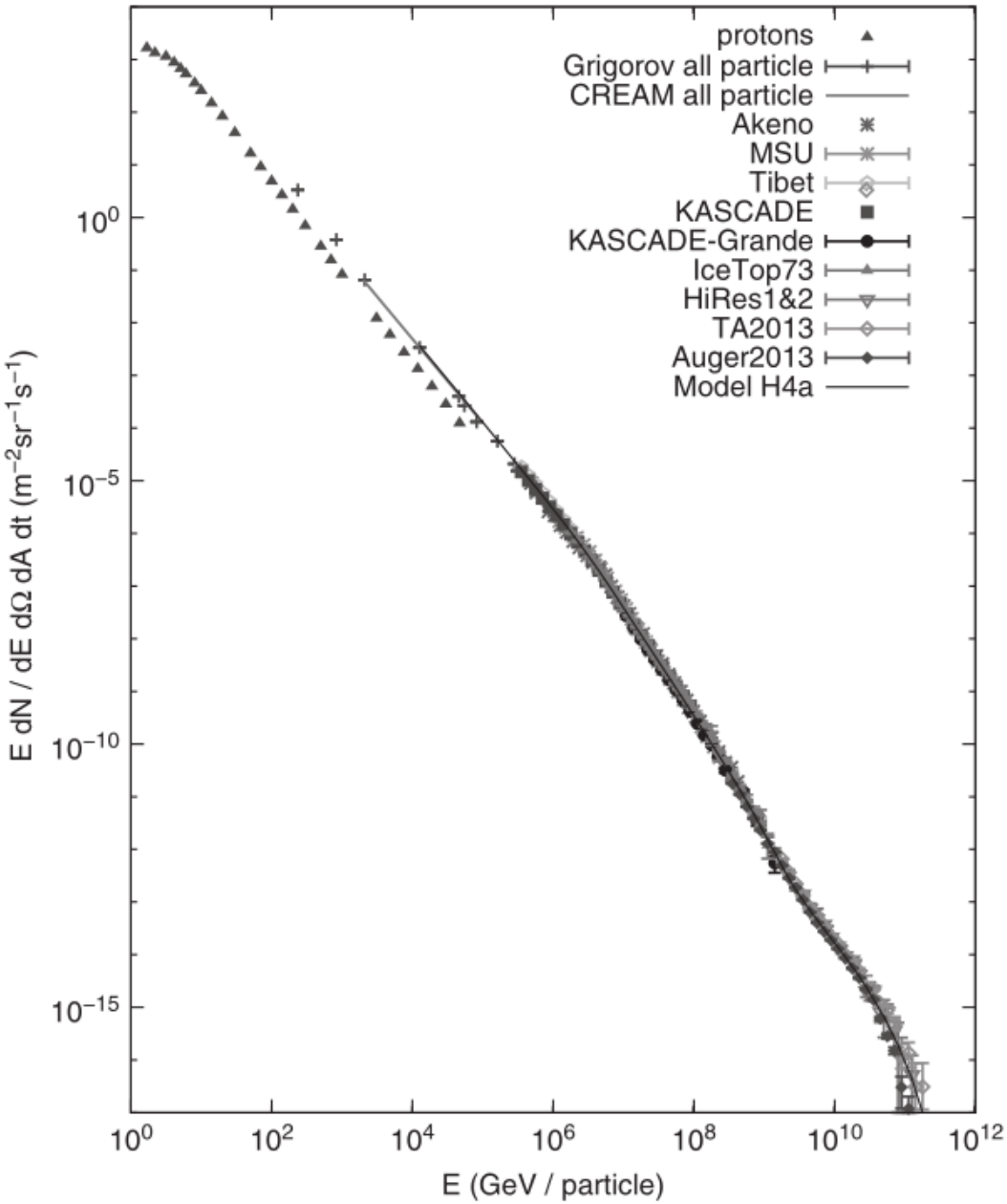




The need for RNO-G



The need for RNO-G



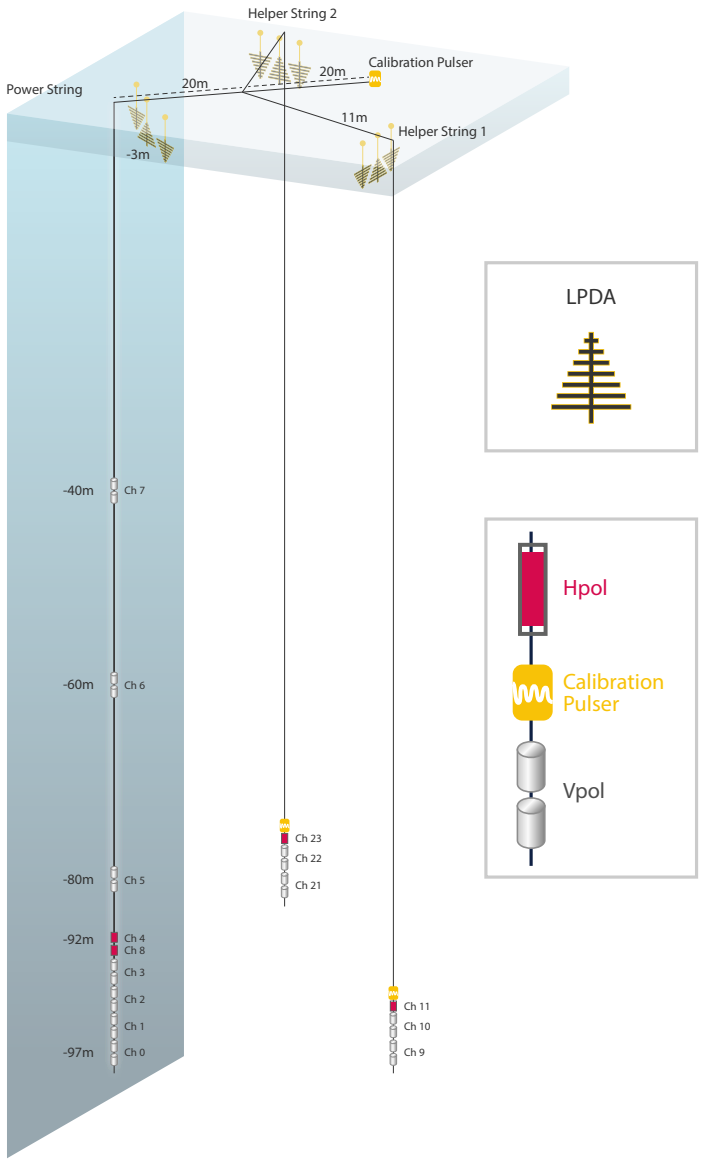
The need for RNO-G

- IceCube finds no events for energies $> 3PeV$ (*IceCube study of down-going neutrinos for the spectral cutoff determination by Palczewski and Tomasz)*

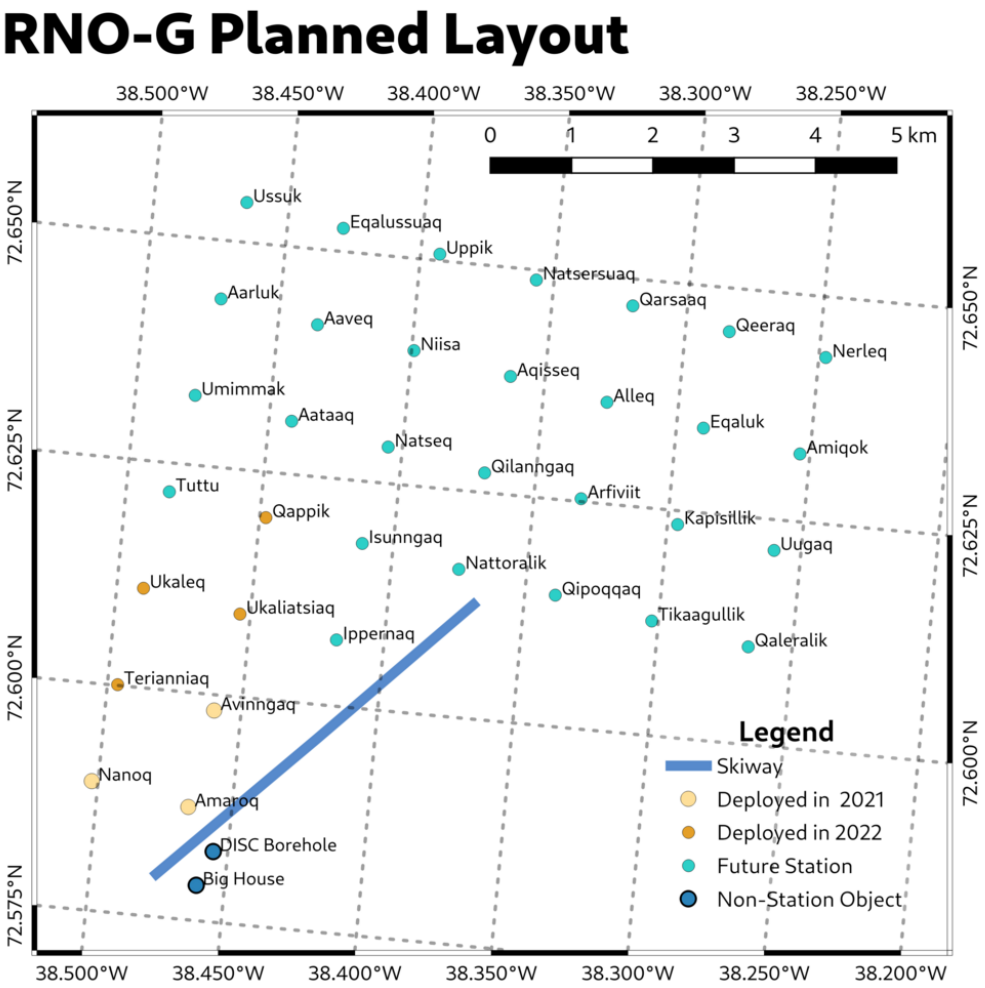
RNO-G

Problem: visible light doesn't travel far in ice
$\rightarrow$ Solution: radio waves

RNO-G

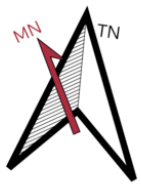

Helper String 2
Power String
20m
20m
Calibration Pulser
11m
Helper String 1
-3m
-40m
Ch 7
-60m
Ch 6
-80m
Ch 5
-92m
Ch 4
Ch 8
Ch 3
Ch 2
Ch 1
-97m
Ch 0
Ch 23
Ch 22
Ch 21
Ch 11
Ch 10
Ch 9
LPDA
Hpol
Calibration Pulser
Vpol

RNO-G

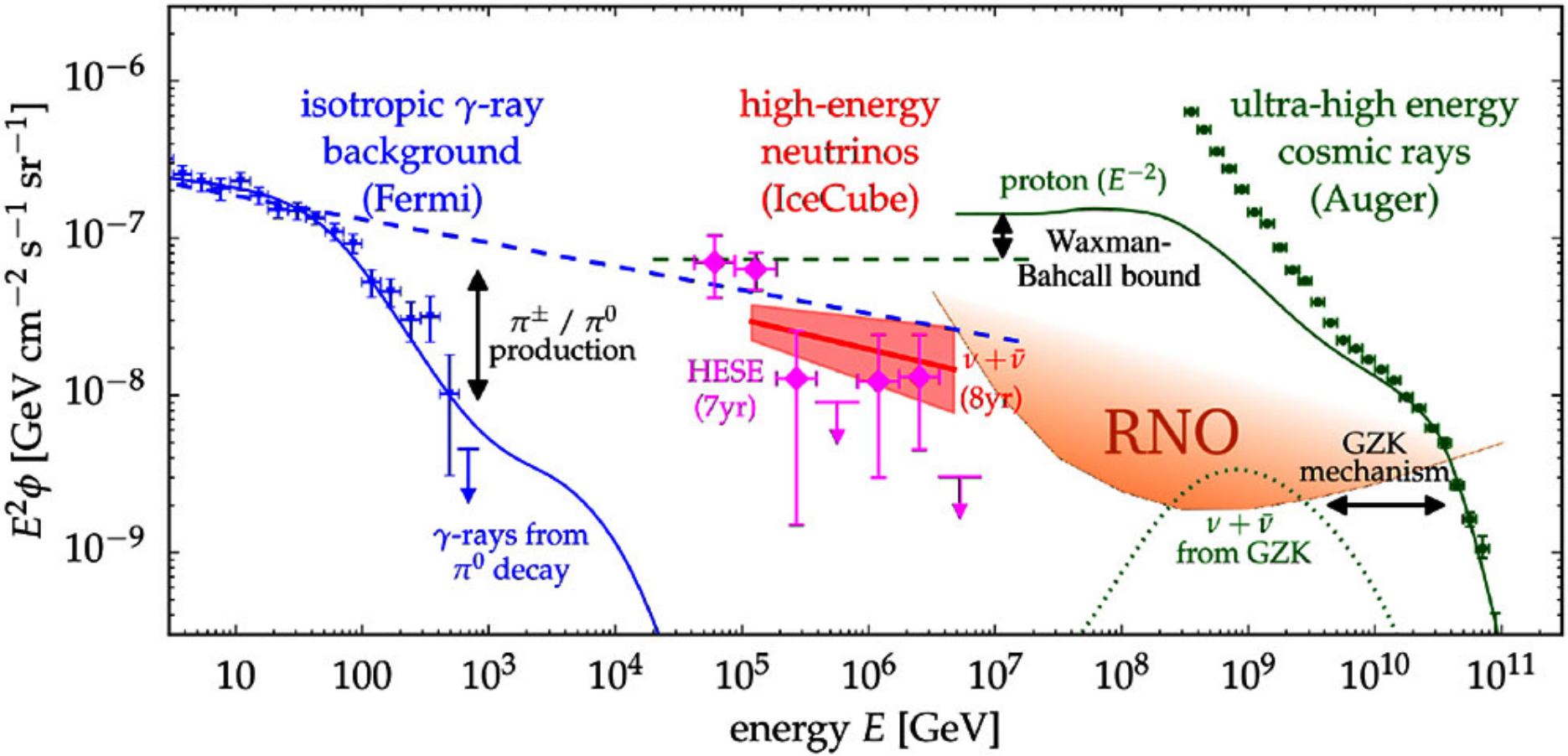


Notes:

- Station numbering follows a grid, where the first numeral is in increasing W-E and the second numeral is in increasing S-N, skipping non-existent stations (the Seckel method).
- Station spacing is 1.25 km in map coordinates (but really 1.23 km due to projection, which creates a 2% scale difference.)
- Projection is Greenland Polar Stereographic (EPSG:5938). True north indicated by Rose, offset from grid north by 5.37°.
- Magnetic Declination, for August 1 2022, is -25.2° according to the WMM.
- In list below, all future stations labeled as 2023



v 0.5.1


isotropic γ-ray background (Fermi)
high-energy neutrinos (IceCube)
ultra-high energy cosmic rays (Auger)
proton (E^{-2})
Waxman-Bahcall bound
$\pi^{\pm}$ / π^0 production
HESE (7yr)
$\nu + \bar{\nu}$ (8yr)
RNO
GZK mechanism
$\nu + \bar{\nu}$ from GZK
γ-rays from π^0 decay
$E^2\phi$ [GeV cm^{-2} s^{-1} sr^{-1}]
energy E [GeV]
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10
100
10^3
10^4
10^5
10^6
10^7
10^8
10^9
10^{10}
10^{11}

RNO-G

"A Pathfinder for IceCube-Gen2 Radio"

Ice Models

vertex
ray path
dipoles
LPDAs

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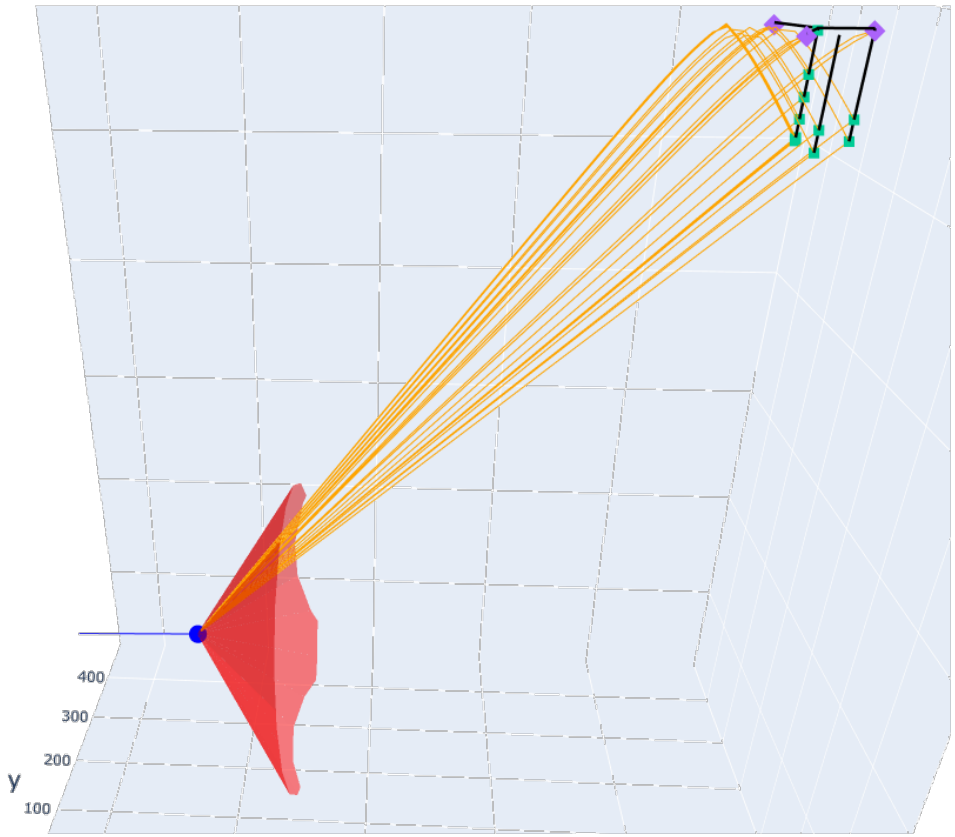
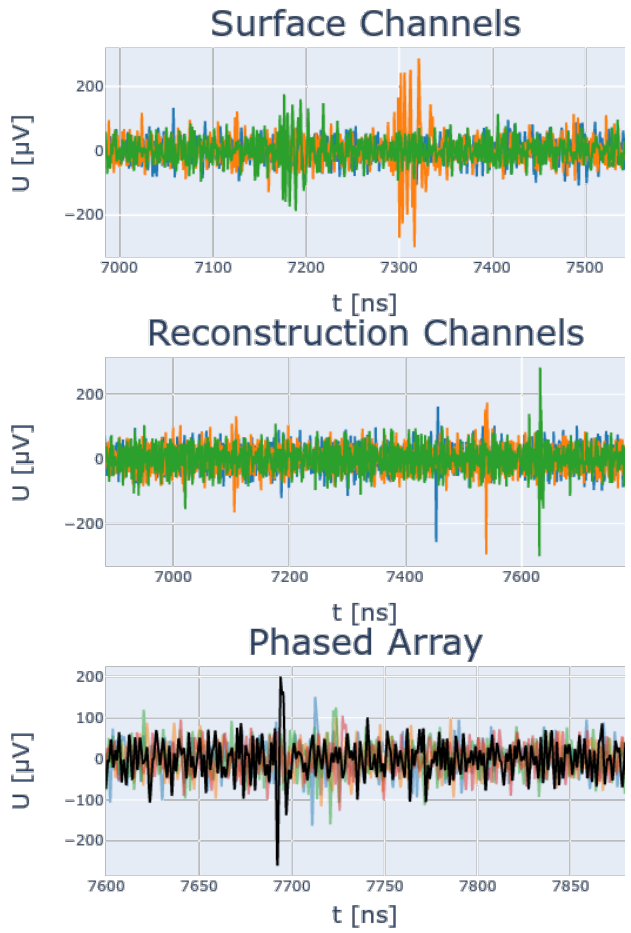
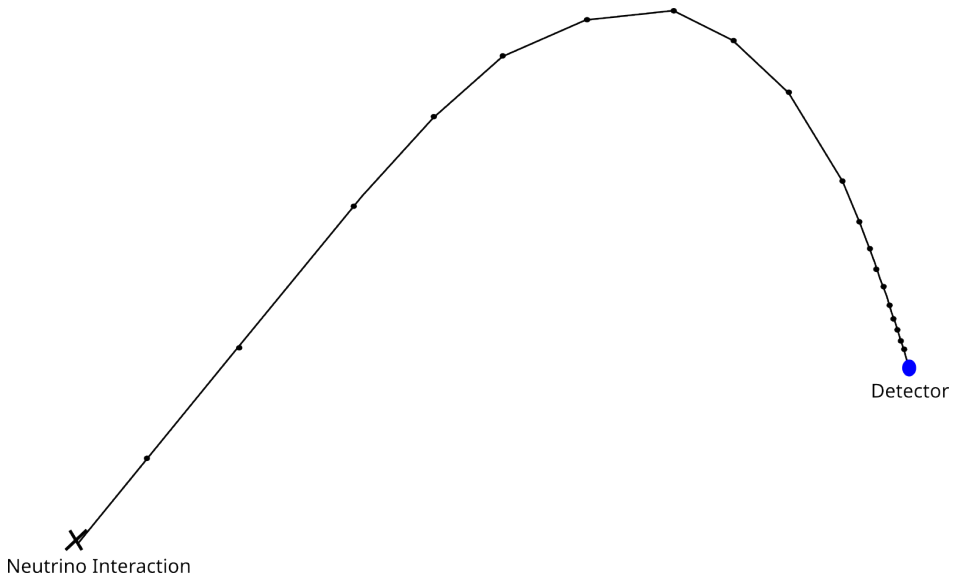




Ice Models

Eikonal:

$$\nabla n \approx n(\mathbf{r}) \frac{d^2\mathbf{r}}{ds^2} \tag{1}$$



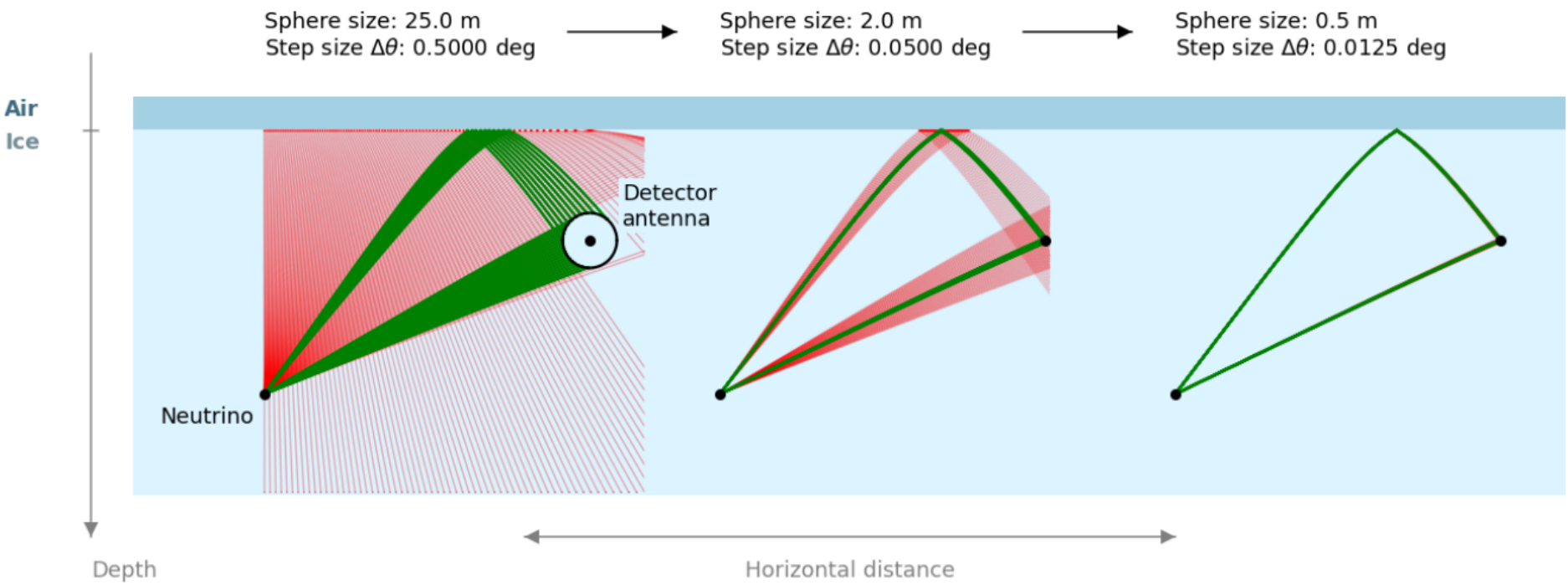
Exponential model:

$$n(z) = n_0 - \Delta n \; e^{-z/z_0} \tag{2}$$

Ice Models


Greenland simple trajectory with GL1 attenuation
solved with analytic ray tracer
vertical distance (m)
0
−50
−100
−150
−200
−250
−300
−350
−400
100
80
60
40
20
0

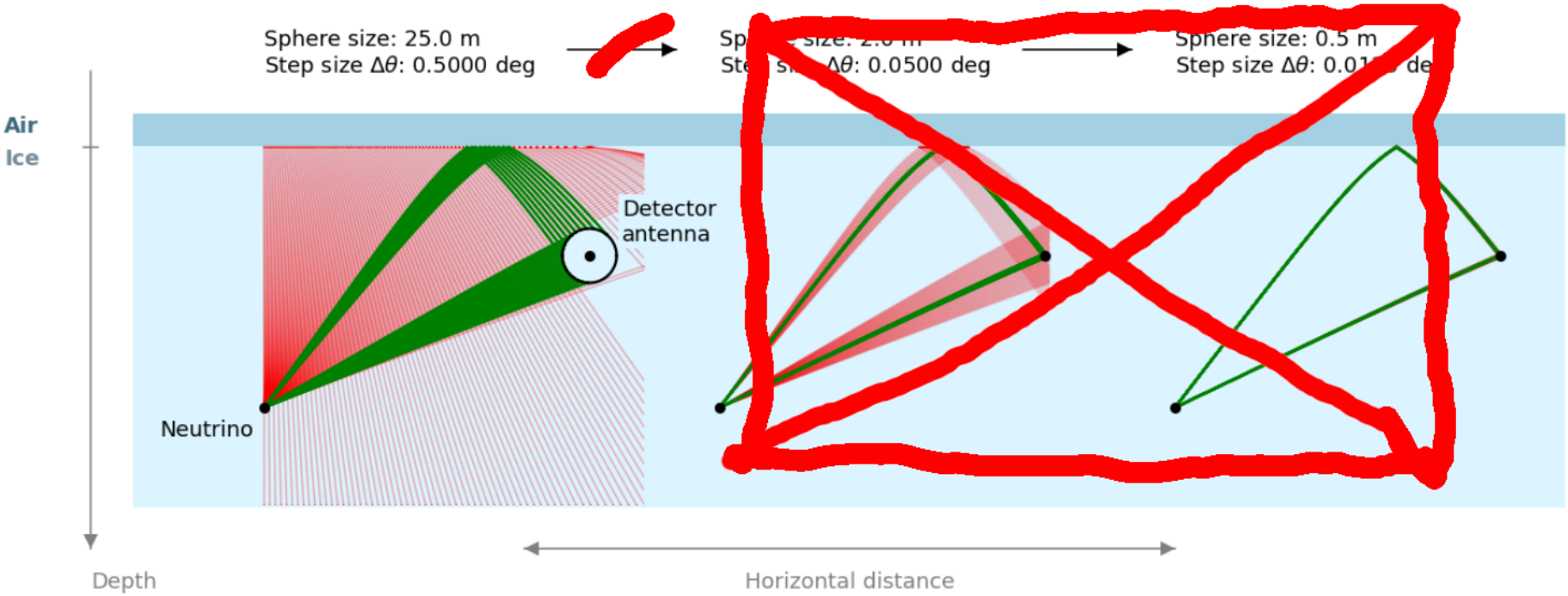
Iterative Ray tracer

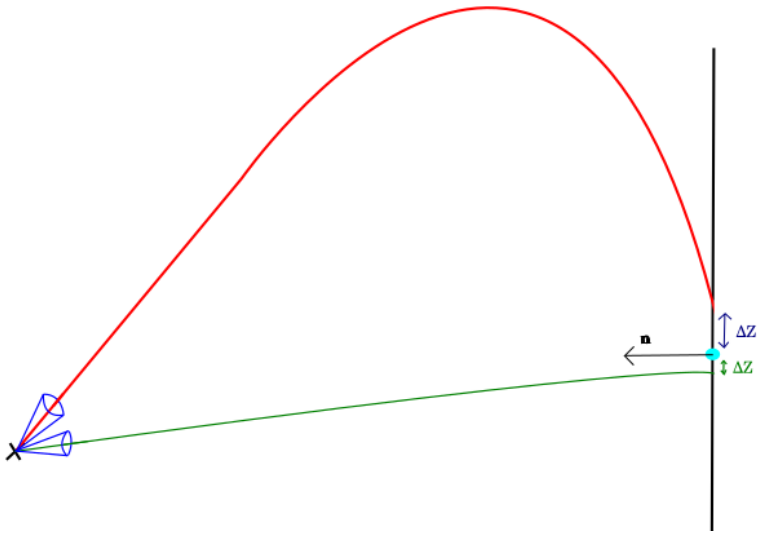


Hybrid Ray tracer

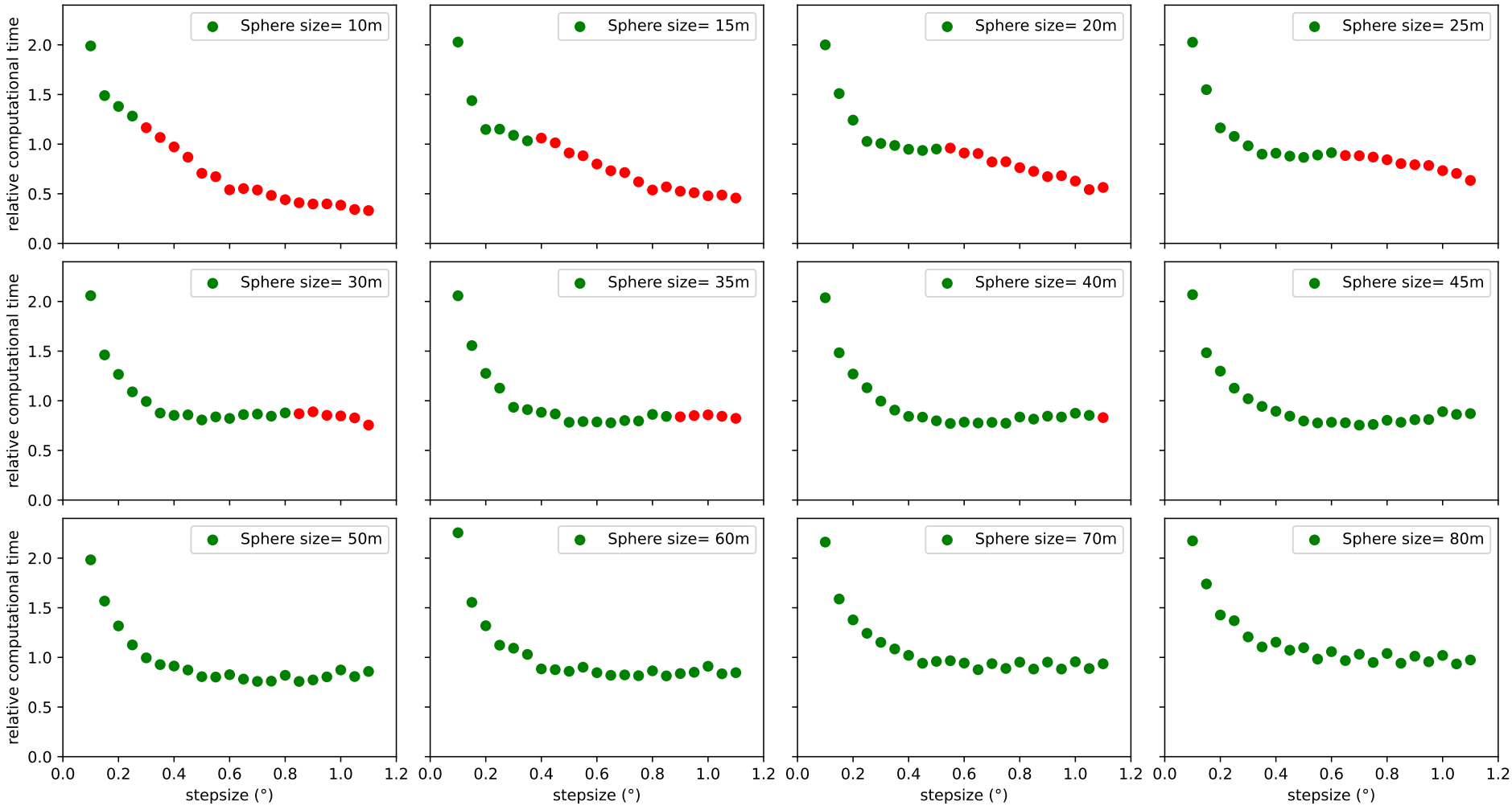
What we want?: Scipy

Hybrid Ray tracer





Hybrid Ray tracer: Optimization



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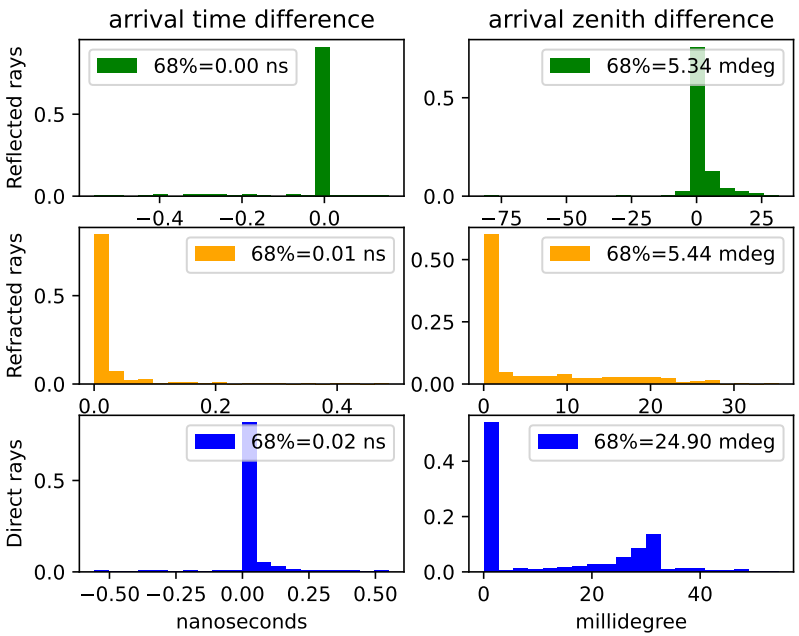

Figure: Hybrid

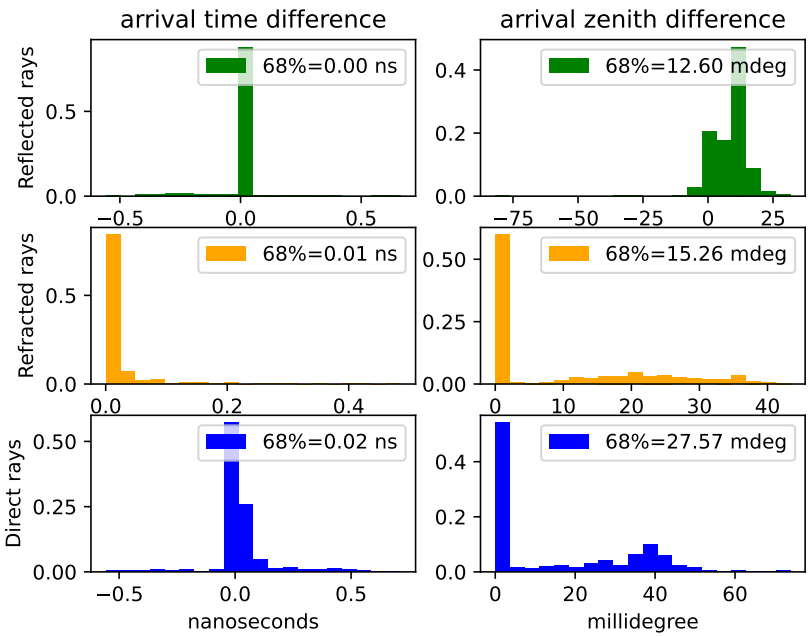

Figure: Iterative

i.e more accurate whilst being $\approx$ 30% faster (30% more computations per second) than the iterative ray tracer