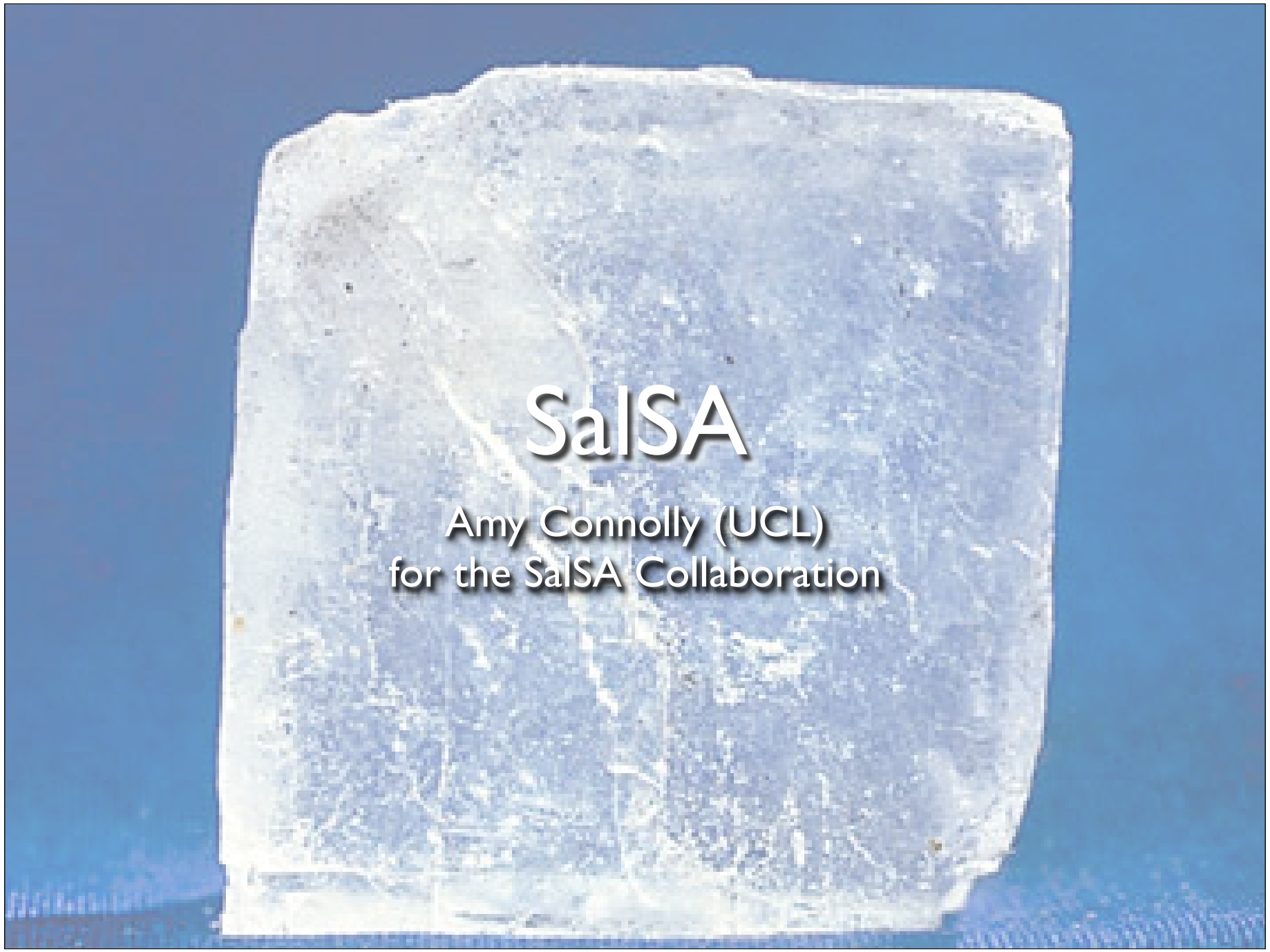
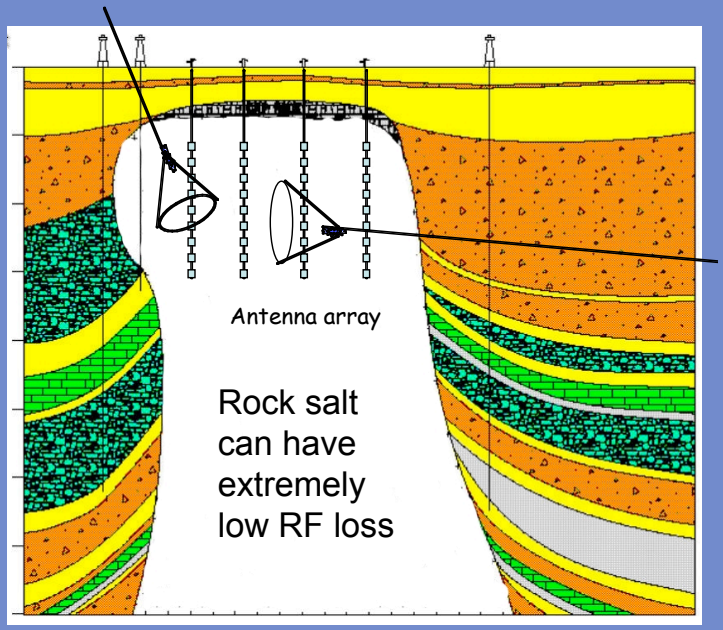

SalSA
Amy Connolly (UCL)
for the SalSA Collaboration

Concept

- Salt formations that extend several km's wide x 10 km deep exist throughout the world
- Domes are formed from 100-200 M year old dried sea salt - diapirism

- Salt domes can be very pure
- Askaryan array in salt could be drilled from surface (expensive) or laid along floors of a salt mine



SALSA Collaboration

University of Delaware

University of Hawaii

University of Minnesota

U.C.L.A.

S.L.A.C. and Stanford University

Louisiana State University

Washington University

University of Kansas

UC Berkeley and LBNL

University of Utah

Endeavour Corporation

Deutsches Elektronen Synchrotron (Germany)

UT Austin

Kernfysisch Versneller Instituut (Netherlands)

Ohio State Univesity

UC Irvine

UCL

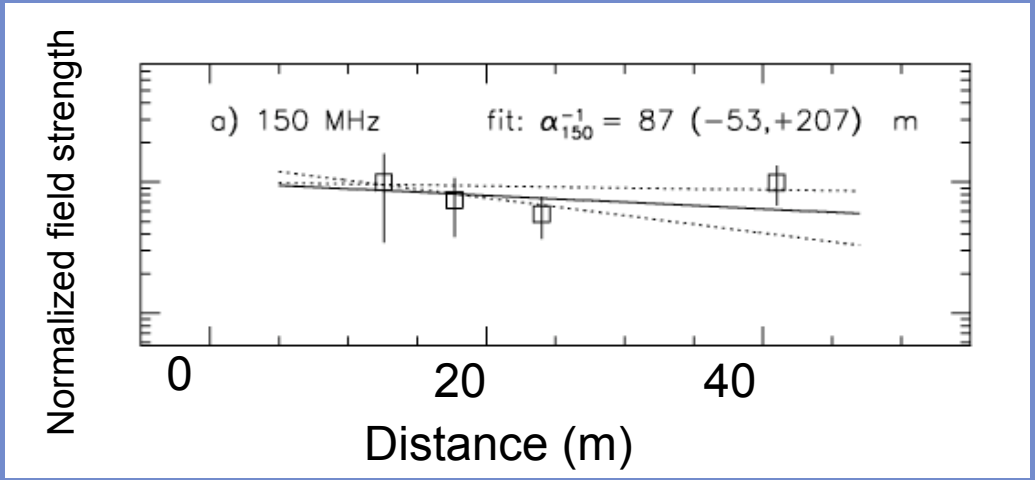
Salt Clarity

- Before a SalSA experiment can proceed, long attenuation lengths for radio in salt need to be confirmed
  - Ideally >250 m at 200 MHz
- Ground penetrating radar (GPR) measurements point to low loss
- 1970's Stewart and Unterburger (440 MHz radar at Cote Blache Salt Mine)
  - Quote 2-3 dB/100 ft. typical for dry salt in general
    → 90-140 m field attn. lengths typical
  - One multi-reflected signal with total path length 1244 m
    → 138 m field attn. lengths *minimum*

Previous Attenuation Length Measurements in Salt

P. Gorham, D. Saltzberg, A. Odian, D. Williams, D. Besson, G. Frichter, S. Tantawi

- Hockley mine near Houston, Texas:
  - Minimum 40 m, up to ~250 m
  - Large uncertainties due to lower power system used



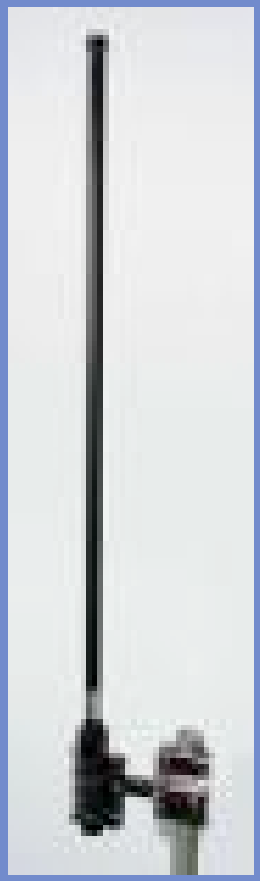
Cote Blanche Salt Mine, Louisiana, USA

A. Connolly (UCL) ,A. Goodhue (UCLA), C. Miki (Hawaii), R. Nichol (UCL), D. Saltzberg (UCLA), M. Cherry (LSU), J. Marsh (LSU)

- Visited Cote Blanche salt mine to measure radio attn. lengths in salt
- Same mine where GPR experts saw lowest loss in any mine visited

Antennas

MF
~200-
400 MHz

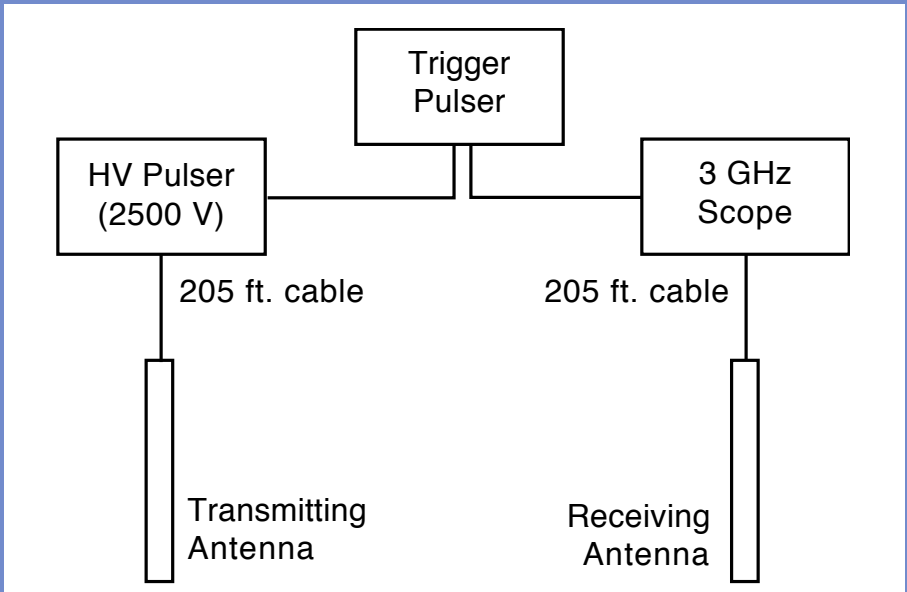


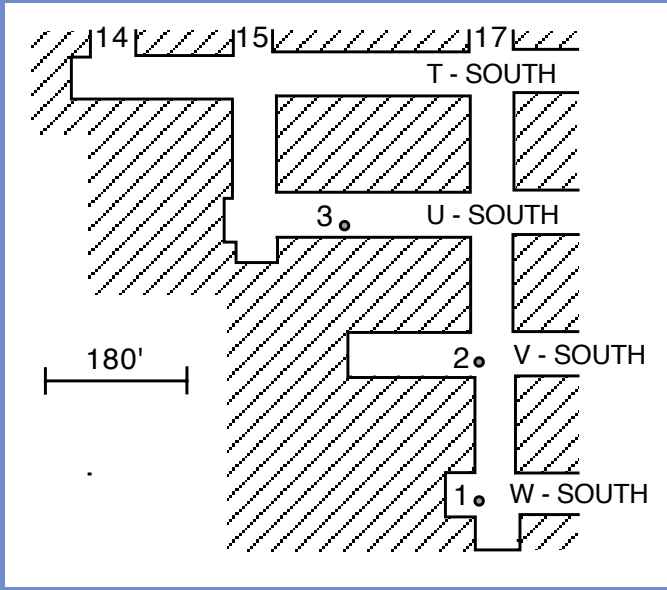
LF
144-176 MHz

HF
800 MHz,
25 MHz
BW

Measurement

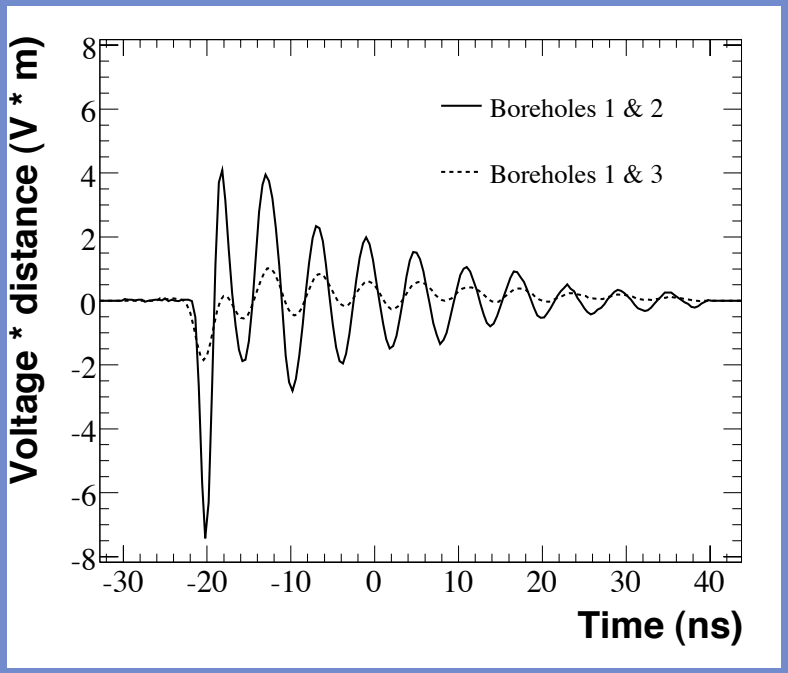
- Measurements made at 1500 ft. level of the mine
- Rx and Tx separated by 163 ft. and 663 ft. (168 m) distance in custom boreholes 100-200 ft. (30-60 m) deep

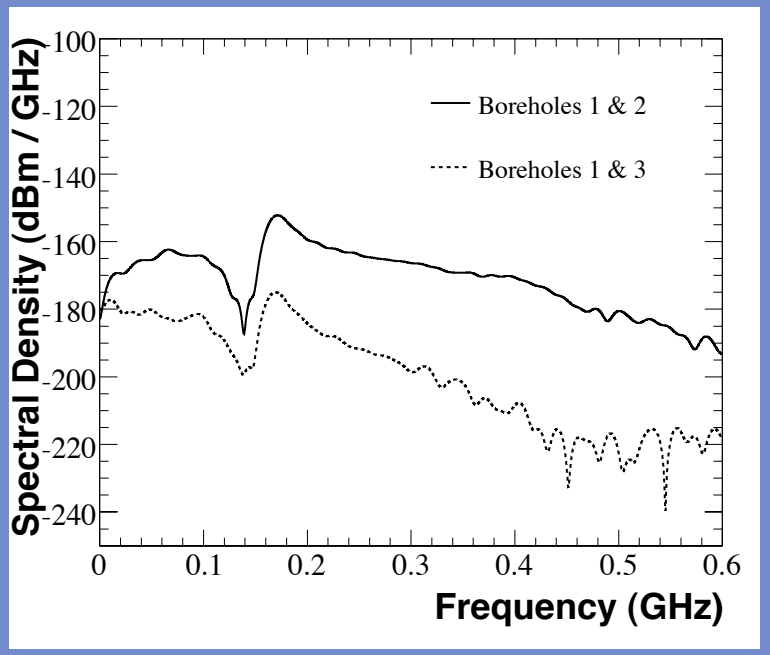




Sample Waveforms

90 ft. depth
MF antennas





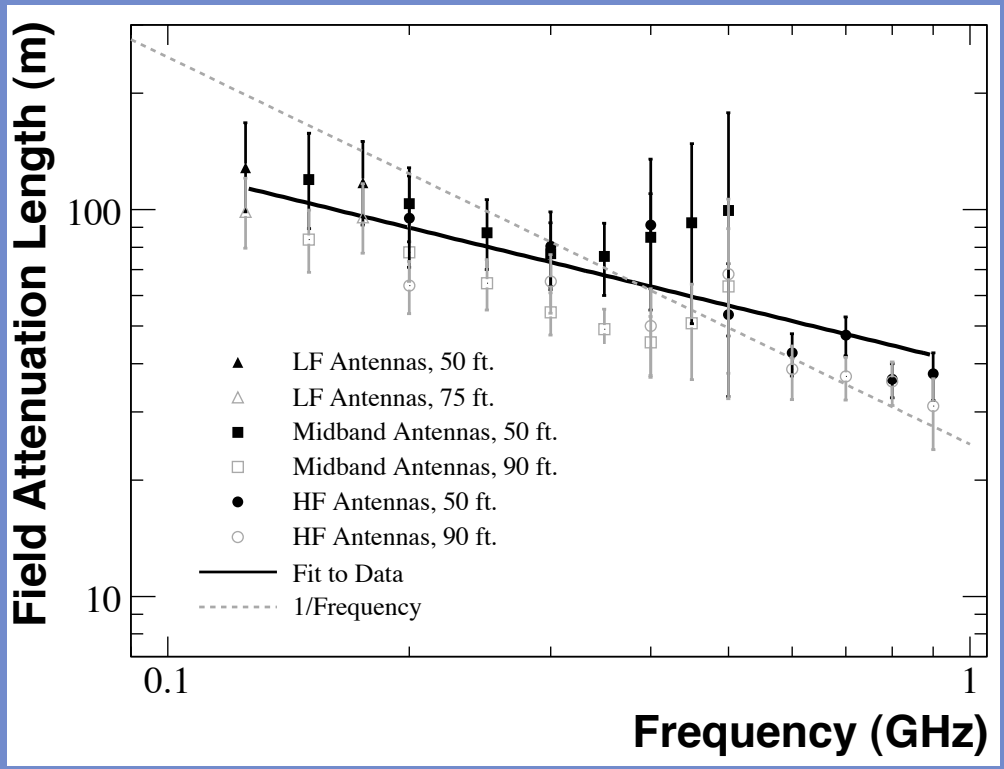
Attenuation Lengths

Fit to $$L_\alpha(\nu) = a \cdot \left(\frac{\nu}{1\ \mathrm{GHz}}\right)^b$$

b = -0.57 ± 0.06

χ^2 / dof = 25.6 / 36

- 150 MHz: 93 ± 7 m
- 300 MHz: 63 ± 3 m
- 800 MHz: 36 ± 2 m



Recall: We estimate from Cote Blanche GPR result
L_α >139 m @ 440 MHz have been observed

Simulations

- Simulate the impact of these attn. lengths on a SalSA sensitivity
- For comparison with previous estimates:
  - 10 x 10 x 10 dipole antennas
  - 150 MHz center frequency, 50% BW
  - 4 antennas hit, SNR=4σ

Previous: 300 m at 300 MHz, ν^{-1} dependence
~10 GZK events / year

Compare: 63 m at 300 MHz, $\nu^{-0.57}$ dependence
~1 GZK event / year

Future / Conclusions

- Before a SalSA can proceed, affordability aside, we need to definitively measure long attenuation lengths in salt (> ≈250 m)
- Borehole method works well, but only allows to sample limited region of salt per mine visit
- Would like to construct a GPR system to sample salt more efficiently
- Currently it looks difficult for salt to compete in sensitivity with any future detector in ice, but
  - It is important to explore new media
  - Salt could complement ice (Northern sky, accessibility)