SALSA: STATUS

AMY CONNOLLY

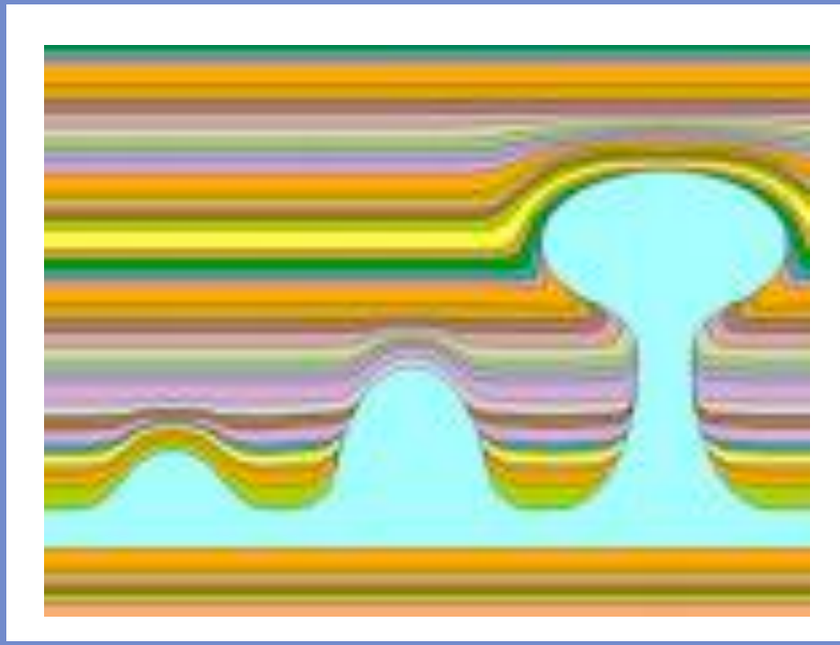
FOR THE SALSA COLLABORATION

ARENA 2010

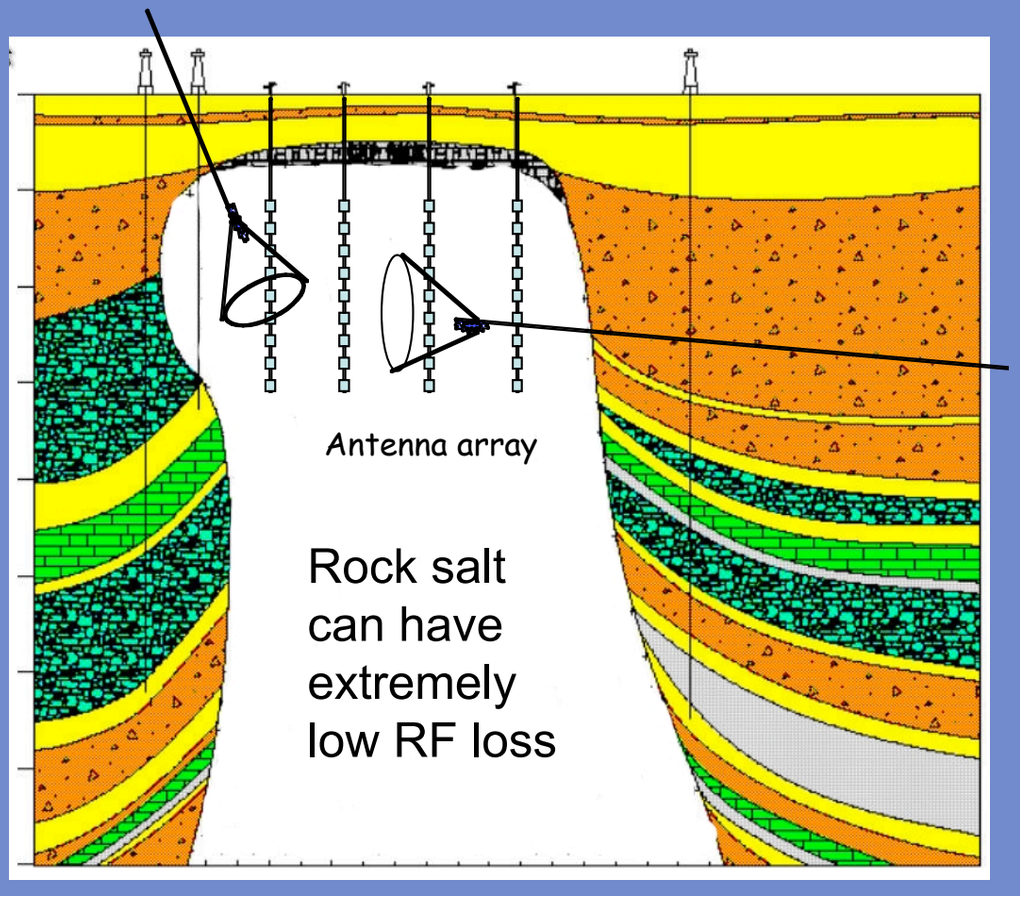
NANTES, FRANCE

2 JULY 2010

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 FROM WITHIN A 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

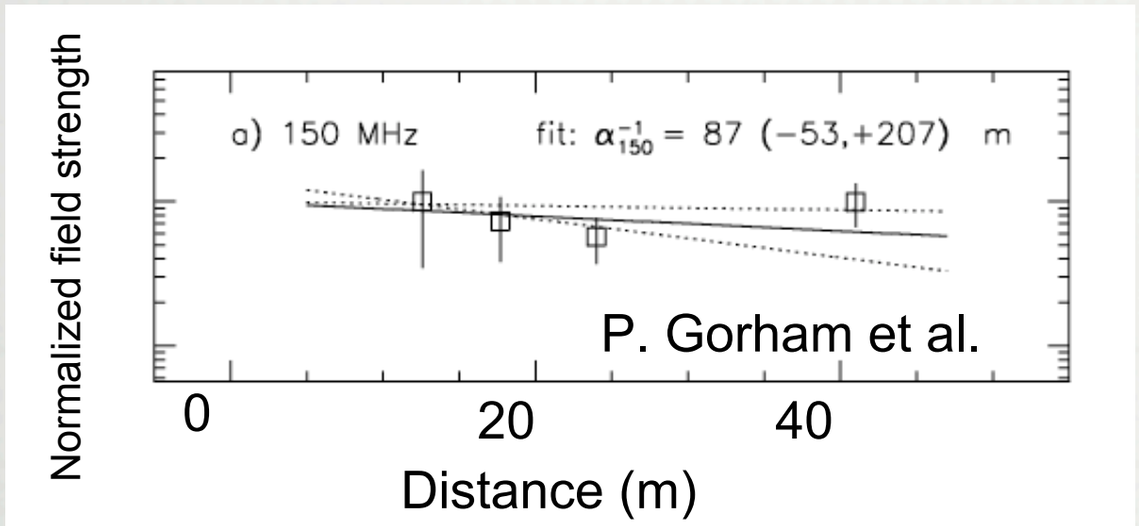
UCL

SALT CLARITY

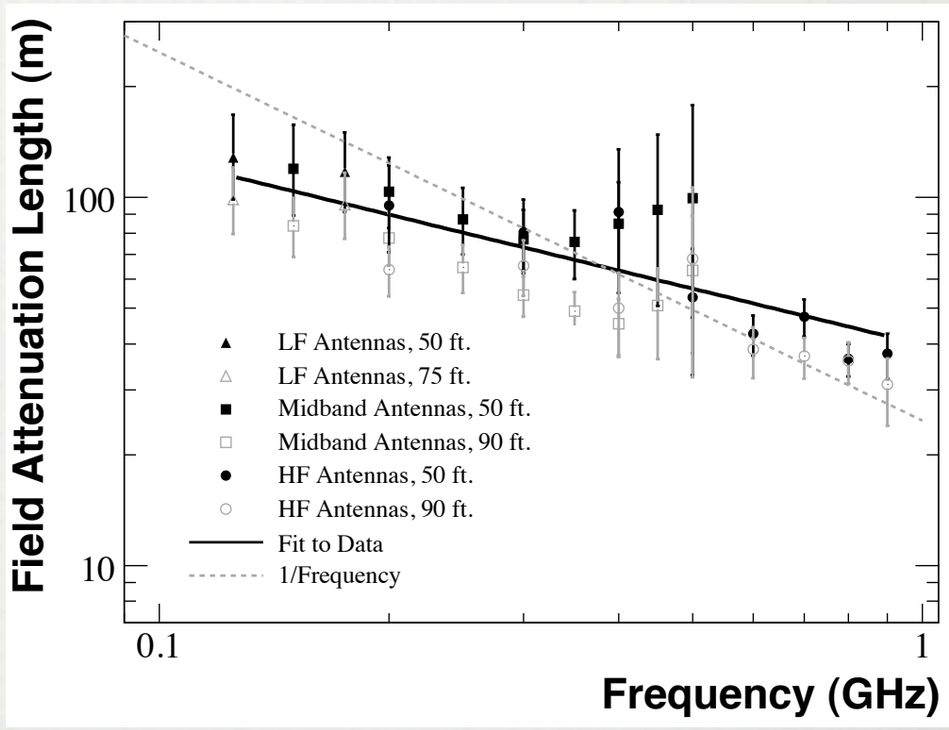
- BEFORE A SALSA EXPERIMENT CAN PROCEED, LONG ATTENUATION LENGTHS FOR RADIO IN SALT NEED TO BE CONFIRMED
  - IDEALLY >250 M AT 200 MHZ
- GROUND PENETRATING RADAR (GPR) MEASUREMENTS POINT TO LOW LOSS
  - AS MUCH AS 140 M @ 440 MHZ
  - EXPECT L $\propto$ 1/FREQ

ATTENUATION LENGTH MEASUREMENTS

HOCKLEY:



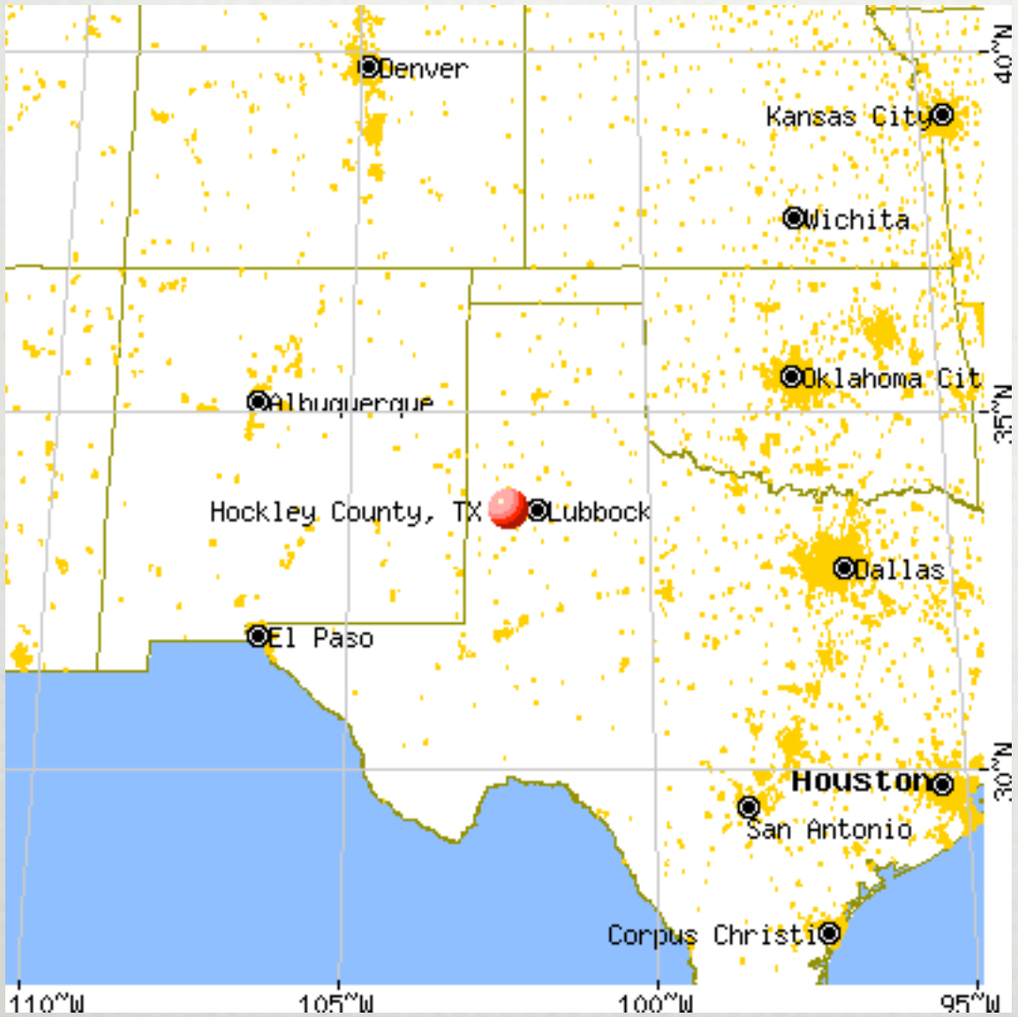
COTE BLANCHE:



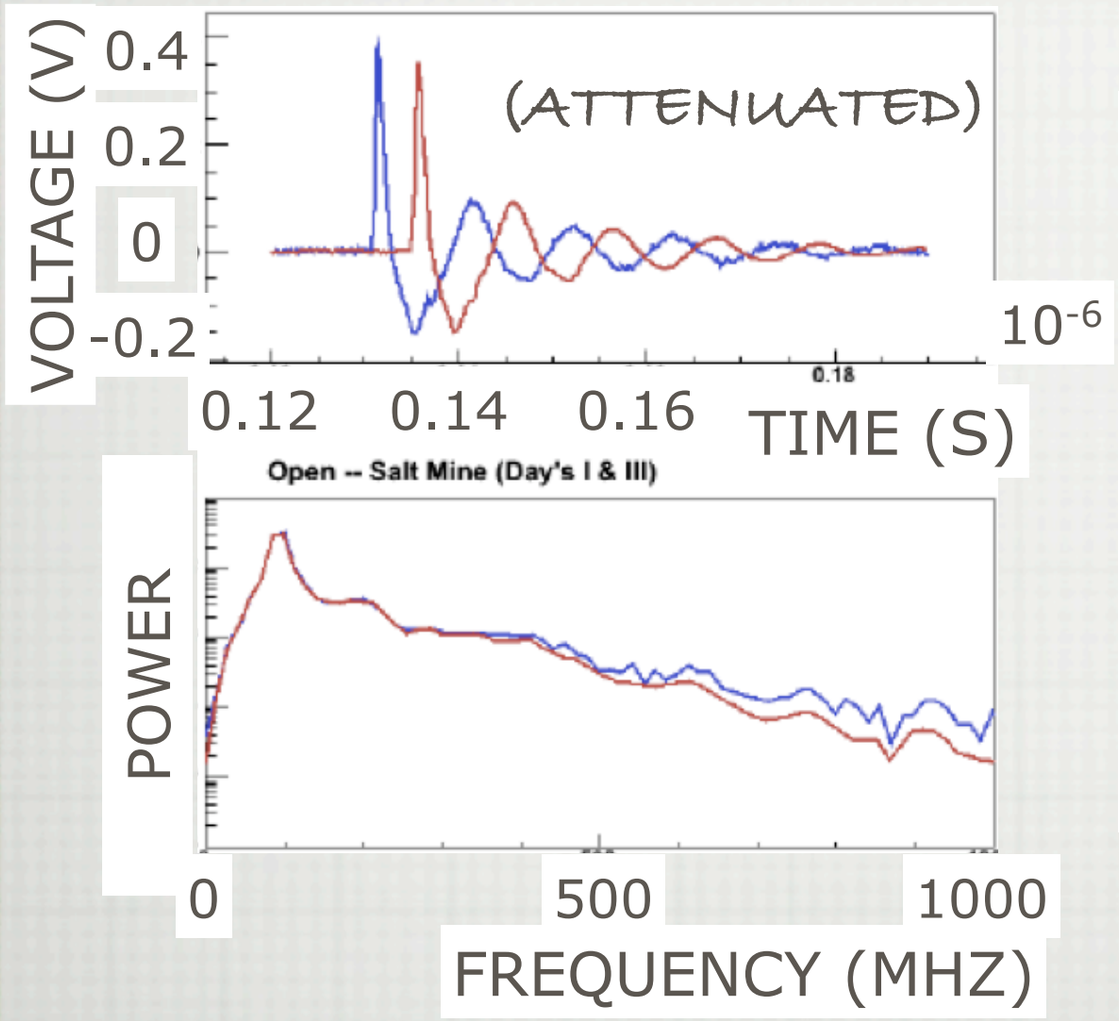
- WIPP, HOCKLEY: Gorham et al., Nucl.Instrum.Meth.A490:476-491,2002
- HOCKLEY: 2009 (next slide)
- COTE BLANCHE: Connolly et al., Nucl.Instrum.Meth.A599:184-191,2009
  - most precise measurement
  - STILL ONLY ~150 M AT 100 MHZ

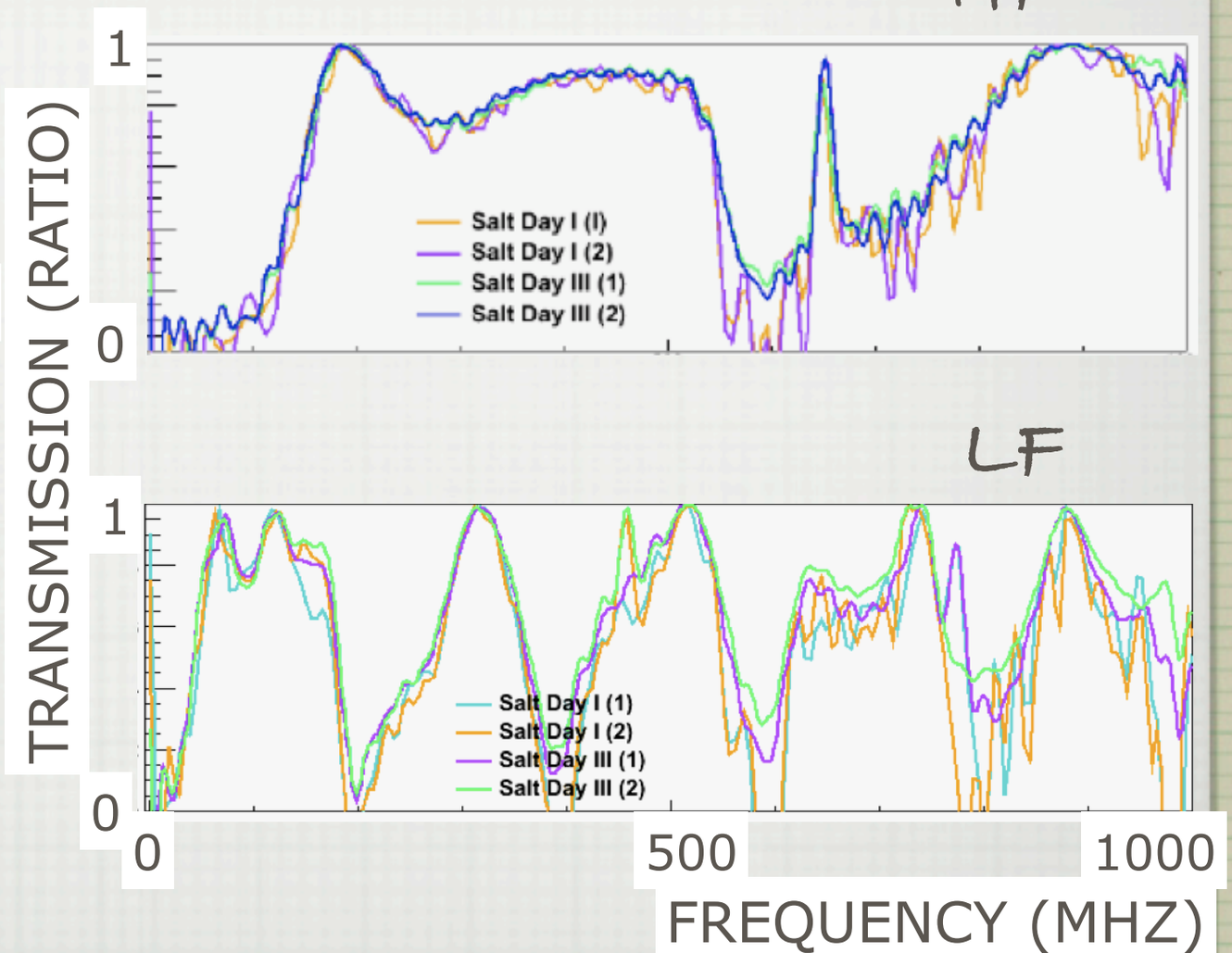
2009 HOCKLEY MEASUREMENTS

- Ryan Nichol, Abby Goodhue, Matthew Mottram, Simon Bevan revisited Hockley for a more conclusive result with a higher voltage pulser (~5 kV)
- Set of narrow antennas constructed by Gorham, Miki in Hawaii
- David Saltzberg also collaborated

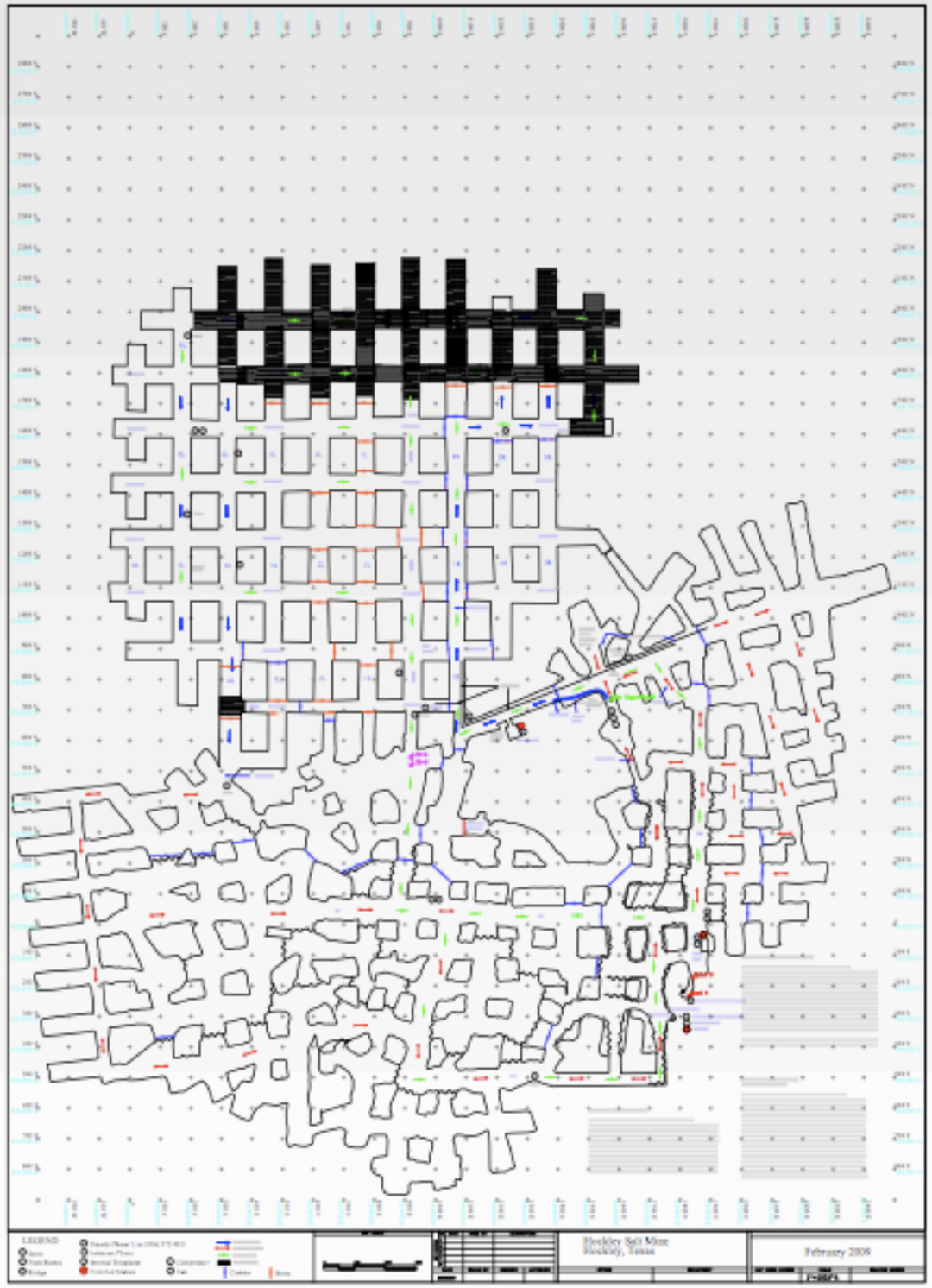


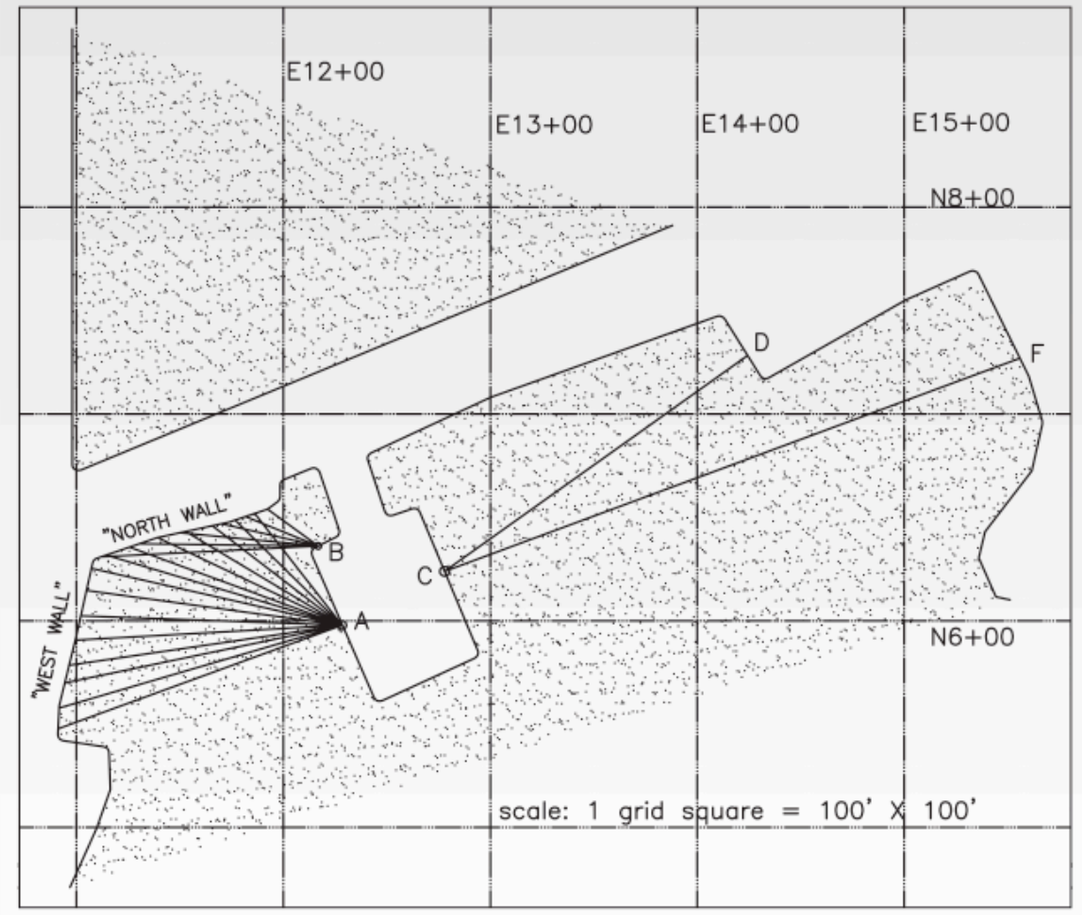
HOCKLEY: PULSERS AND ANTENNAS



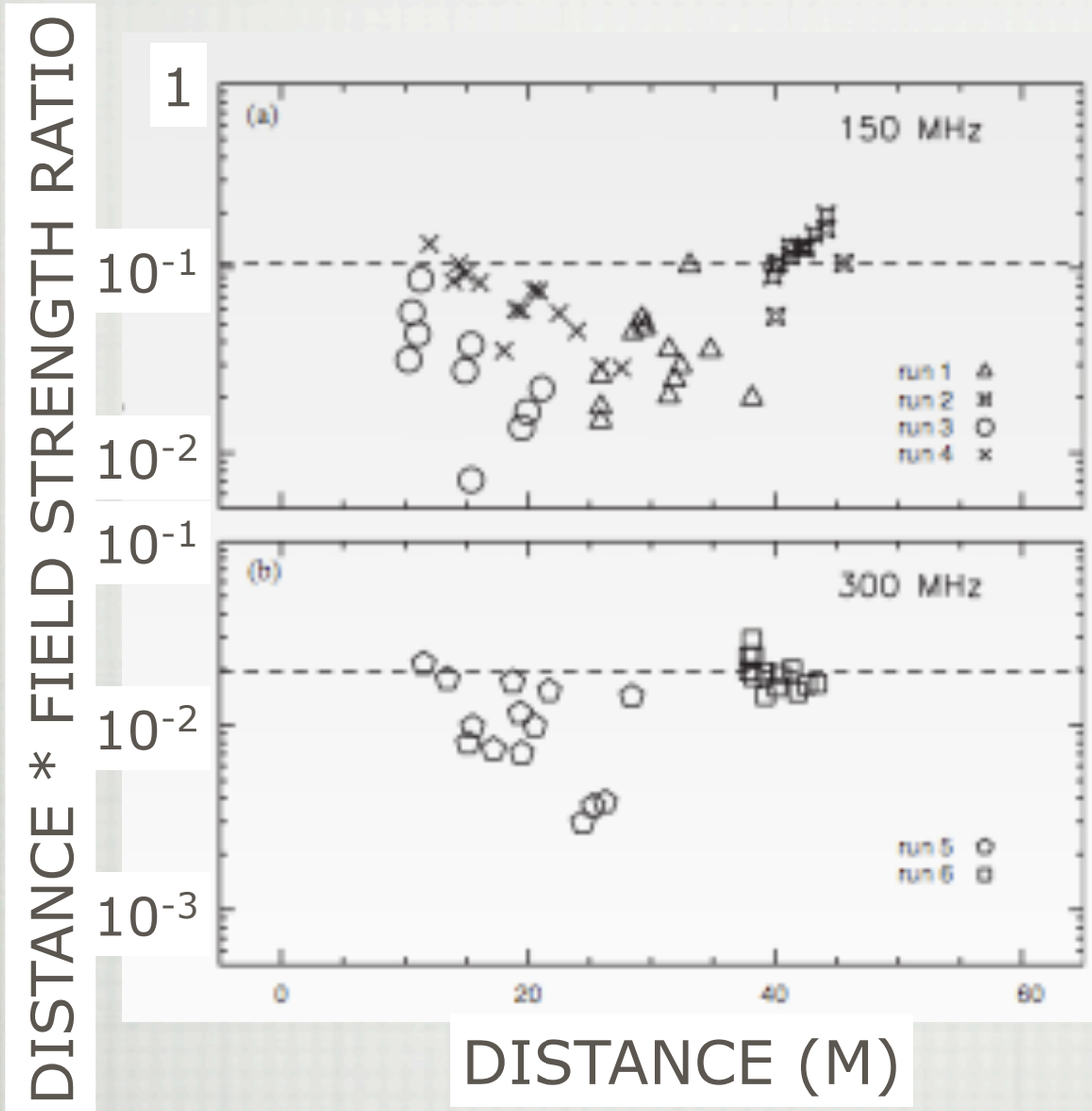


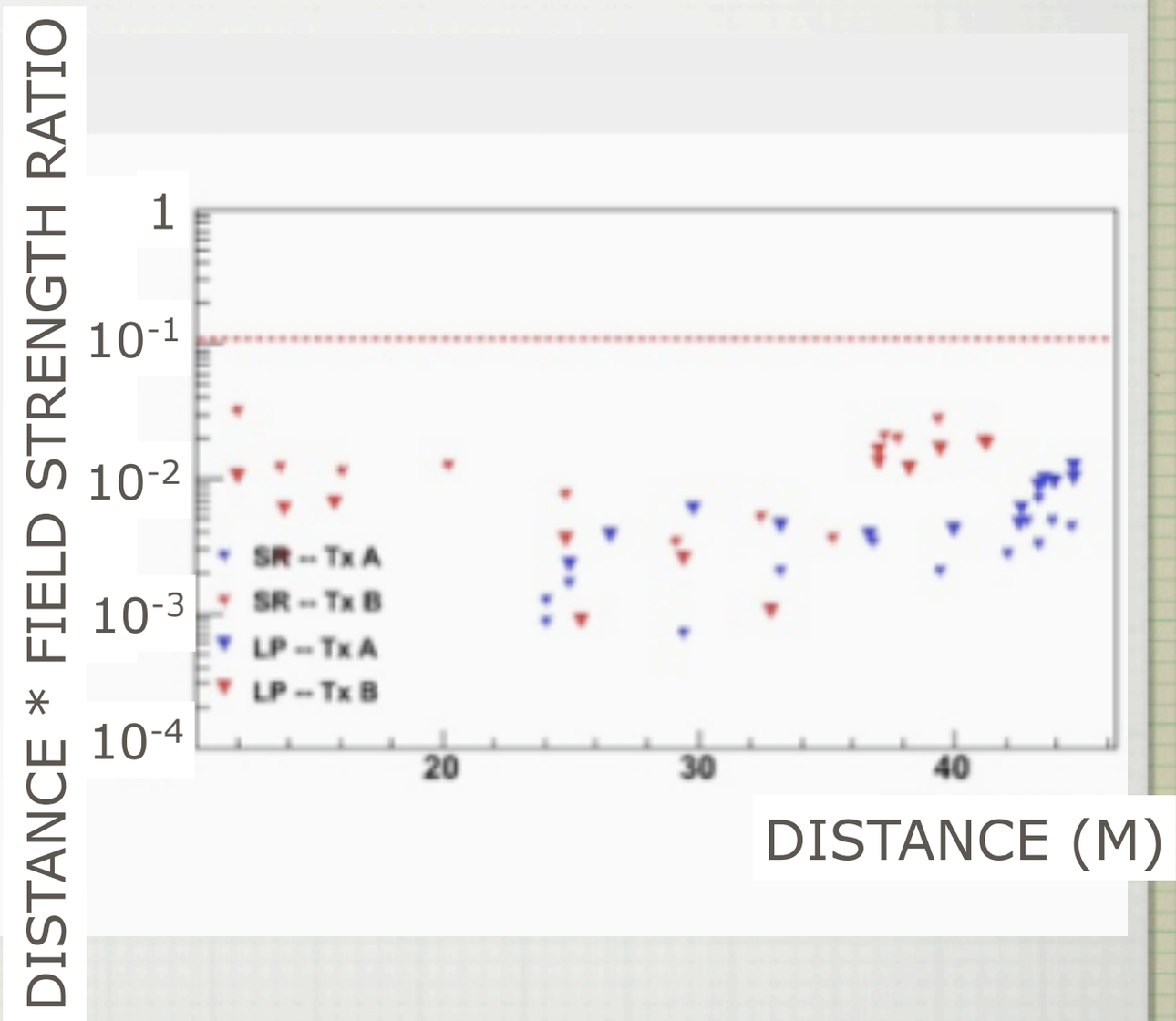
WATERMELON PIT MEASUREMENT





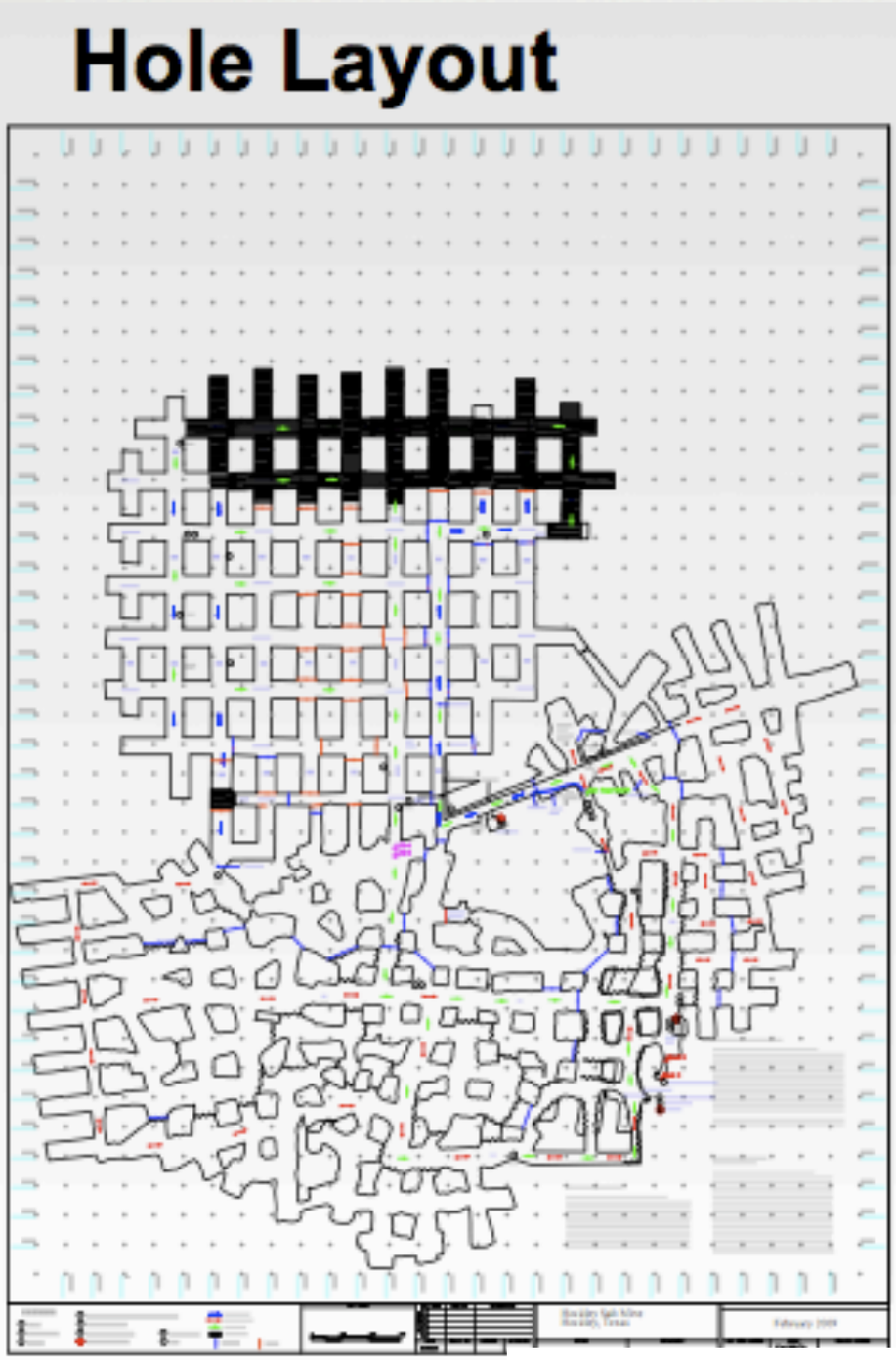
COMPARING WITH 2002 RESULT

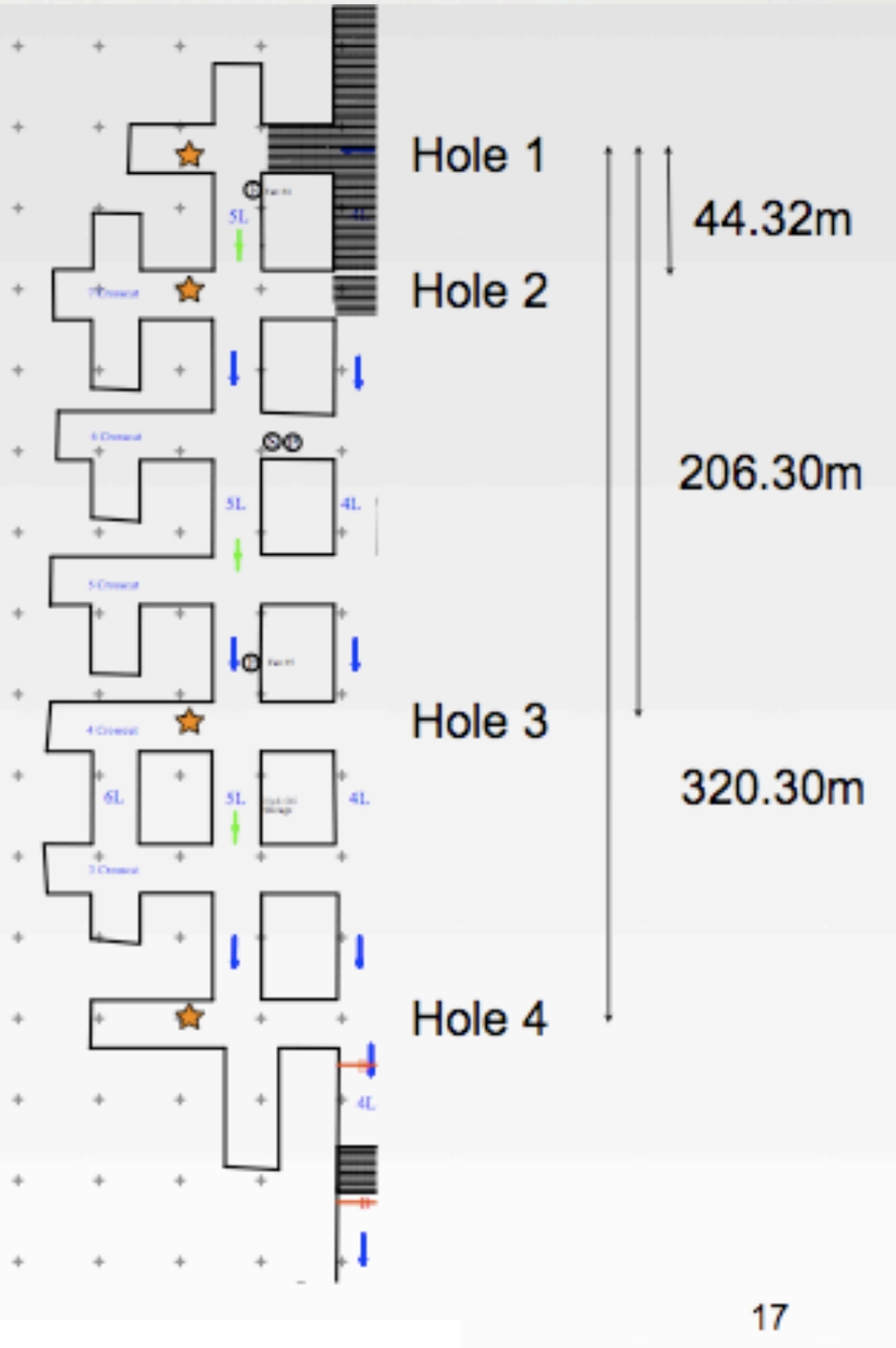




GORHAM ET AL. 2002

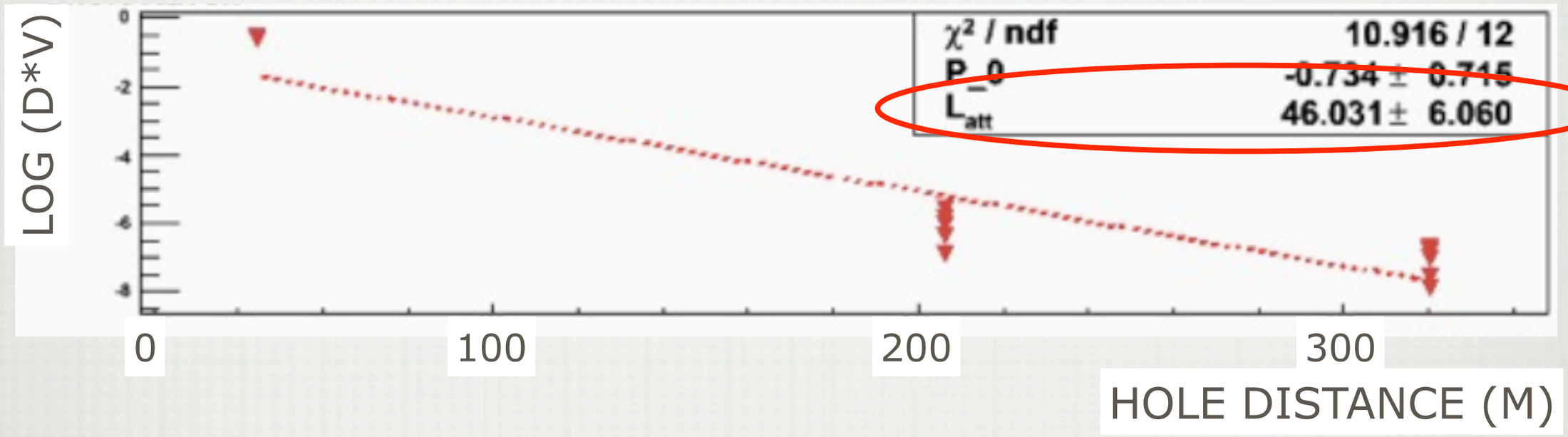
HOCKLEY BOREHOLE MEASUREMENT





HOLES ONLY ~10 M DEEP

RESULT FOR ~400 MHZ ANTENNA PAIR



- ATTENUATION LENGTHS IN THE RANGE 30-50 M

SIMULATIONS

- SIMULATE THE IMPACT OF COTE BLANCHE 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, f^{-1} DEPENDENCE
~10 GZK EVENTS / YEAR

COMPARE: 63 M AT 300 MHZ, $f^{-0.57}$ DEPENDENCE
~1 GZK EVENT / YEAR

☐ CLEARLY NOT COMPETITIVE WITH ICE - (ARA)

WHERE TO GO FROM HERE

- MORE ATTENUATION MEASUREMENTS?
  - DOESN'T SEEM TO BE STRONG MOTIVATION - THEY ARE A LOT OF WORK AND COTE BLANCHE SALT MAY BE AS GOOD AS IT GETS
  - IF WE DID CONTINUE, GPR MAY BE THE WAY TO GO (SAMPLE MORE VOLUME, BUT WITH AN UNCERTAINTY AT THE REFLECTION) BUT MAY NEED HELP FROM GPR EXPERTS

WHERE TO GO FROM HERE

- I THINK FOR SALSA TO GO FORWARD WE SHOULD TRY TO DO SOMETHING INNOVATIVE WITH THE DECENT SALT WE KNOW (AT COTE BLANCHE FOR EXAMPLE)

CAN WE DO ANY PHYSICS AT COTE BLANCHE

(IF THEY WILL HAVE US)

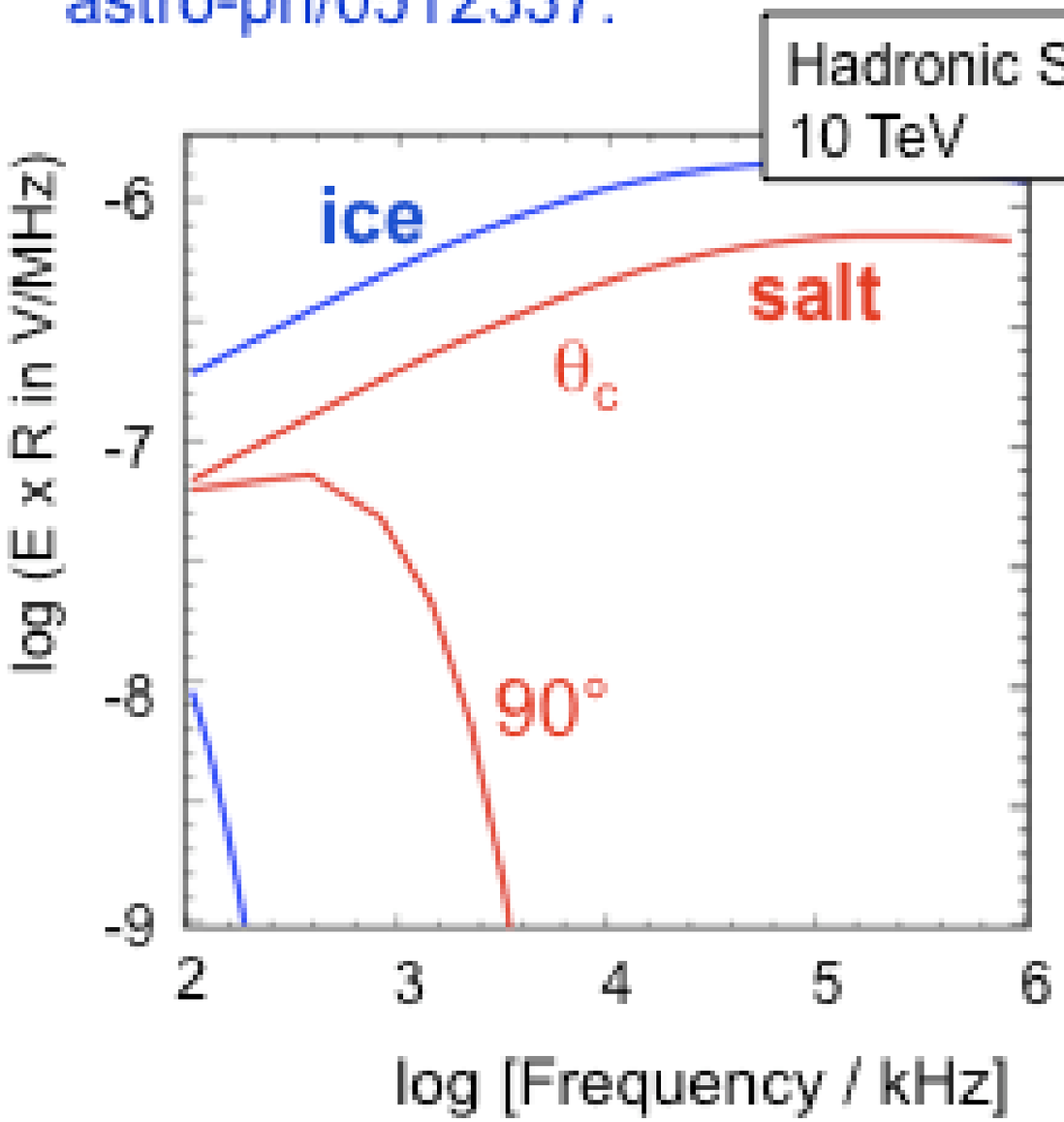
- THE MINE MANAGEMENT (GORDON BULL & HIS TEAM) AT COTE BLANCHE ARE VERY FRIENDLY TO SCIENCE

- THE ATTENUATION LENGTHS WE MEASURED ARE NOT WHAT WE HOPED FOR BUT IT'S NOT LOSSY SALT EITHER

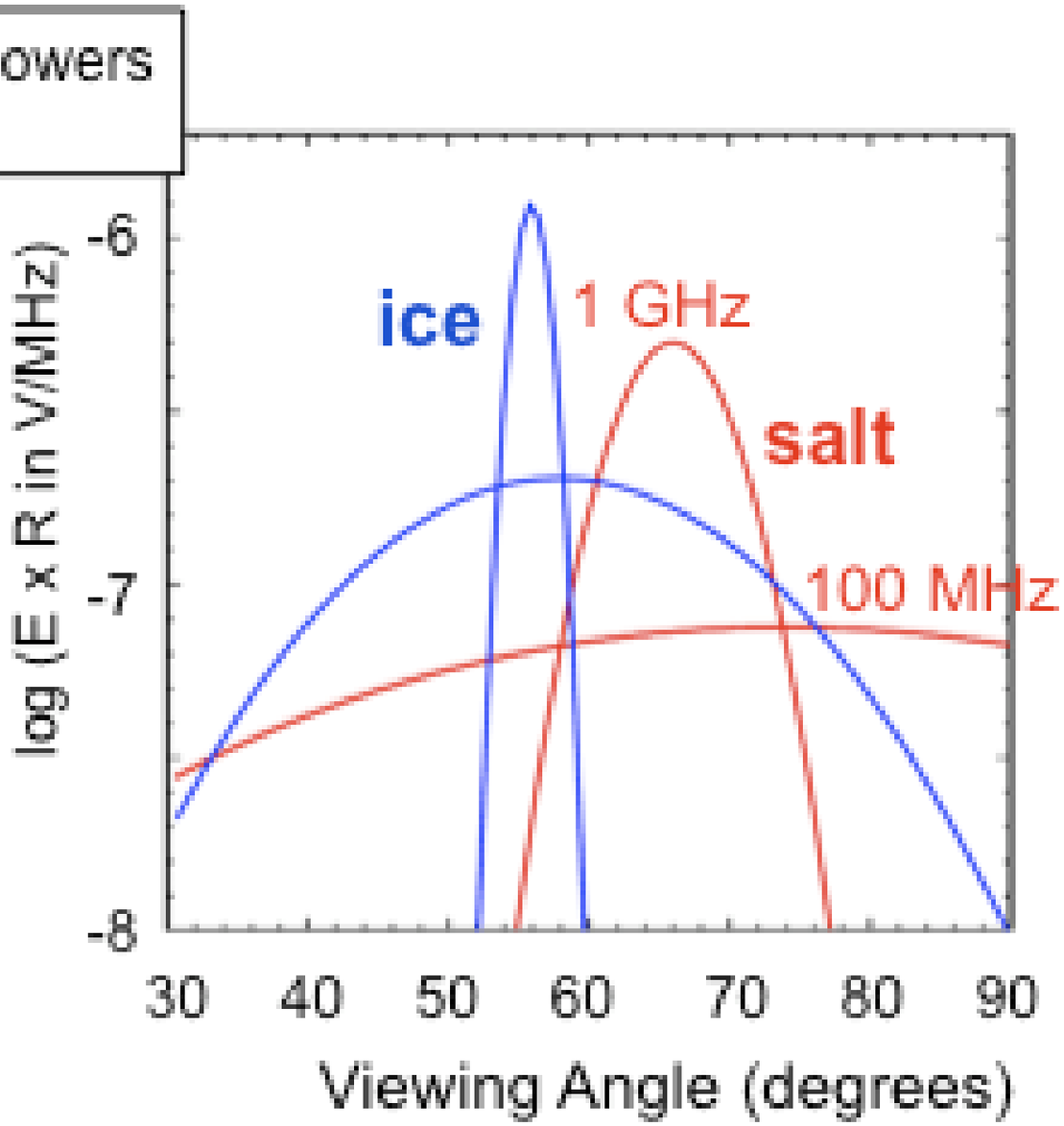
- THE WHOLE DOME IS LARGE VOLUME (FEW KM X FEW KM X SEVERAL KM) BUT ONLY A SMALL AREA IS MAINTAINED (AND SAFE)

Askaryan Signal in Salt

Parameterization in the simulation from J. Alvarez-Muniz astro-ph/0512337:



Electric field α shower energy



Electromagnetic showers narrow beyond ~ 10 PeV due to LPM effect

LOWER FREQUENCIES?

- PERHAPS LOW FREQUENCY ANTENNAS ARE THE BEST USE OF THE RELATIVELY LOW VOLUME OF SALT ACCESSIBLE AT COTE BLANCHE
  - WIDER CONES
  - LONGER ATTENUATION LENGTHS: EXTRAPOLATE COTE BLANCHE RESULT: 175M @ 50 MHZ
  - DUE TO ROCK OVERBURDEN ABOVE THE SALT, IMMUNE FROM SOME LOW FREQUENCY GALACTIC BACKGROUND THAT SOUTH POLE EXPERIMENTS WOULD HAVE
- SIMULATION WORK NEEDS TO BE DONE!

CONCLUSIONS

- WE HAVE MAKE ATTN LENGTH MEASUREMENTS IN SITU
- BEST FROM COTE BLANCHE ~150 M @ 440 MHZ
  - WORLD'S MOST PRECISE
  - NOT GREAT BUT NOT AWFUL EITHER
- I THINK WAY FORWARD IS TO DO SOMETHING INNOVATIVE WITH SALT WE KNOW AND/OR EXPLORE SAND
- CAN WE DO ANY PHYSICS WITH COTE BLANCHE SALT?
  - PERHAPS GO TO LOW FREQUENCIES