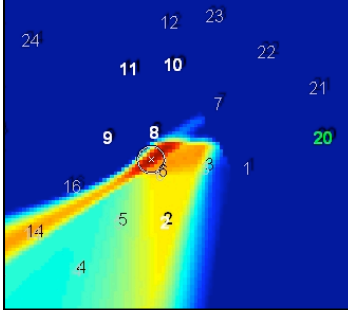
Time of arrival localization algorithms

Increasing acoustic location accuracy by reducing time of arrival estimation errors

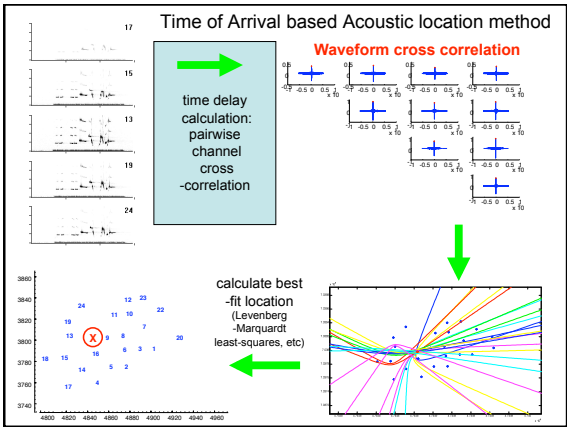


John Burt
University of Washington

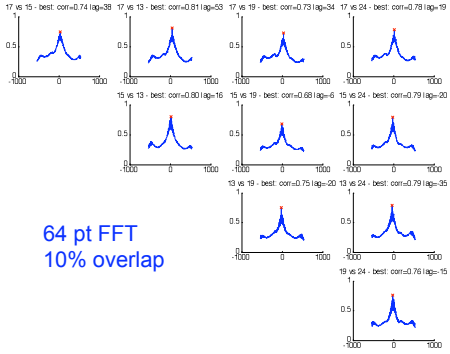
Array Playback Recording:
Gail Patricelli
Alan Krakauer

Least Squares best-fit acoustic location code
Dave Mellinger

Time of Arrival based Acoustic location method



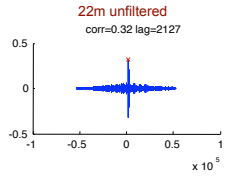
SPCC based time delay estimation

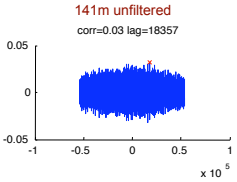


64 pt FFT
10% overlap

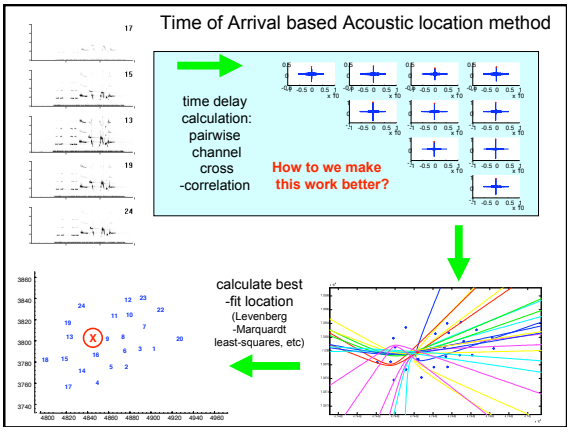
Sources of time delay error

- Low signal to noise ratio:
  - signal too quiet at channel
  - high background noise
- Other sounds overlapping with target sound
- Acoustic degradation due to distance

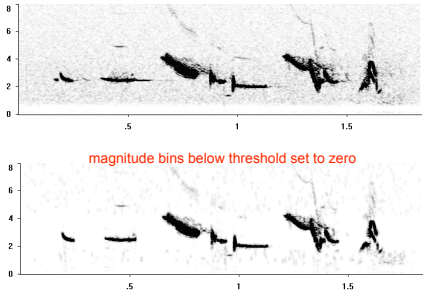


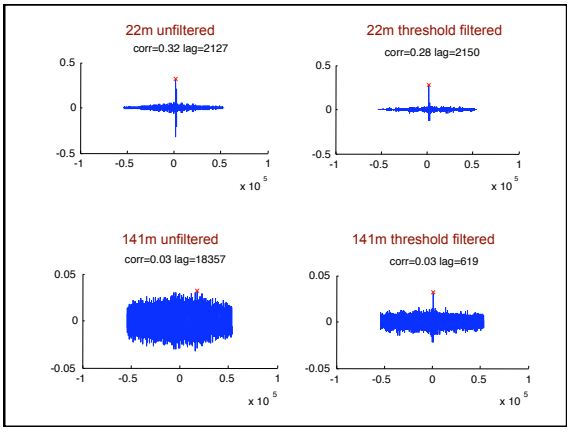


Time of Arrival based Acoustic location method

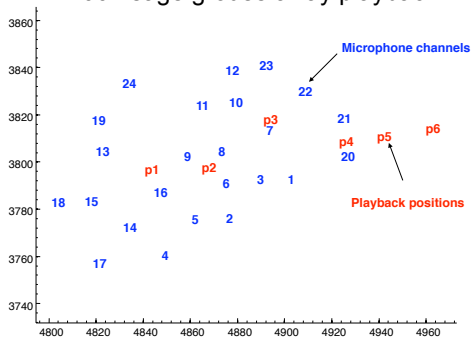


Whitening threshold filter

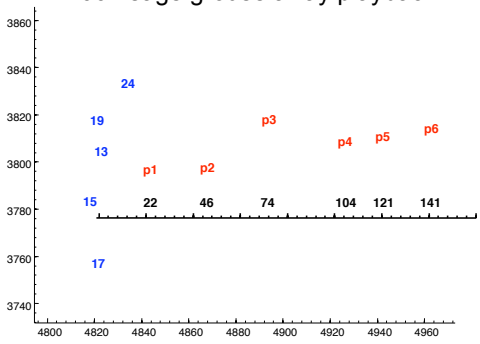




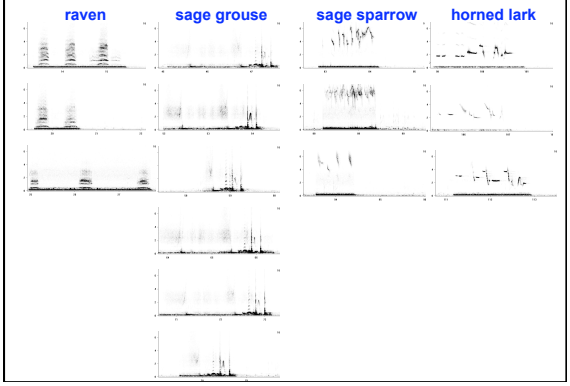
2007 sage grouse array playback



2007 sage grouse array playback



Playback stimuli

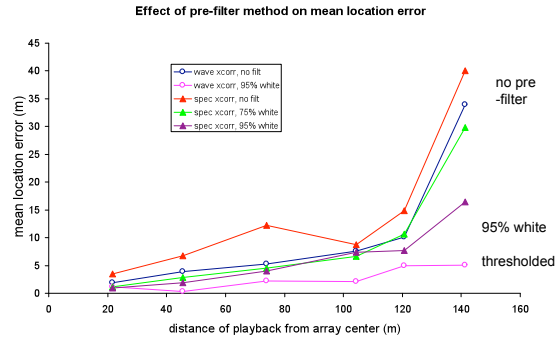


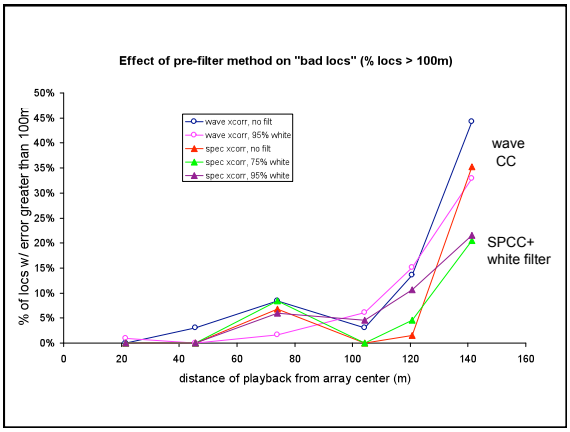
playback regime

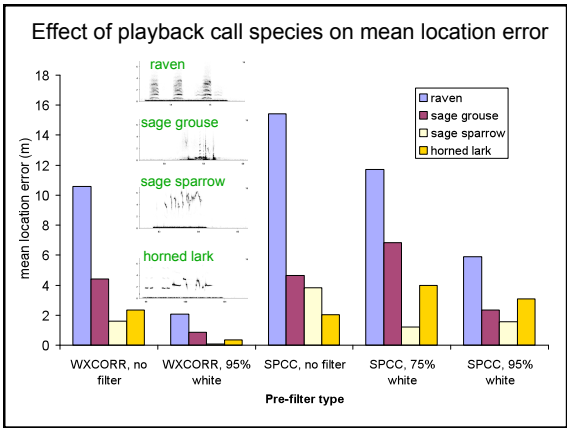
Stim species	#Stim examps	# reps p1	# reps p2	# reps p3	# reps p4	# reps p5	# reps p6
raven	8	40	24	40	24	24	32
sage grouse	8	40	24	40	24	24	32
sage sparrow	3	15	9	15	9	9	12
horned lark	3	15	9	15	9	9	12
Total:	22	110	66	110	66	66	88

results analysis

- Locate all playback sounds using different pre-filter conditions:
  - waveform xcorr, no filter
  - waveform xcorr, 95% whitening filter
  - spectrograph xcorr, no filter
  - spectrograph xcorr, 75% whitening filter
  - spectrograph xcorr, 95% whitening filter
- Separate “good locs” from “bad locs” (error distance > 100m)
- Analyse effect of pre-filter on :
  - good loc error
  - number of bad locs
  - differences across species

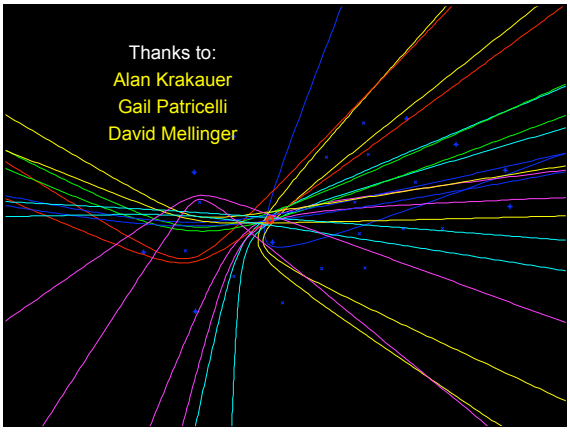


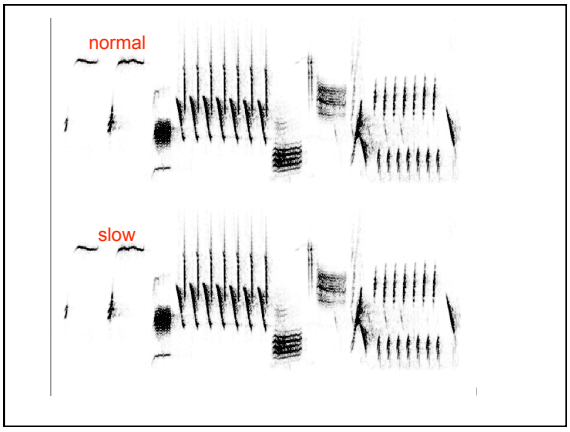


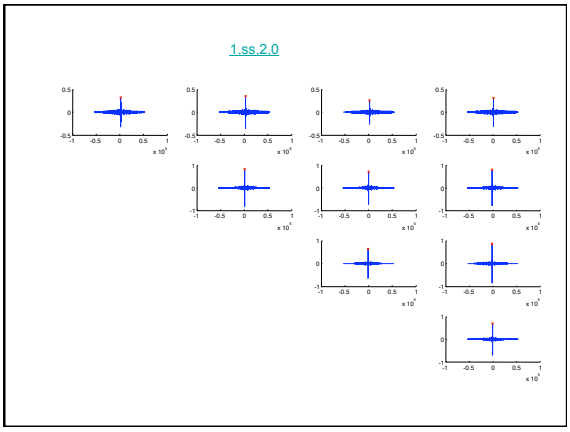


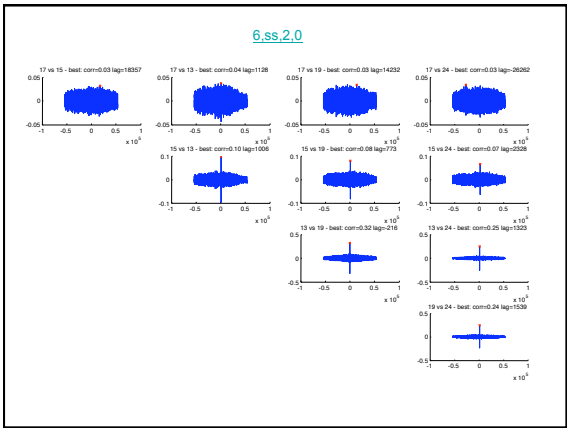
Summary

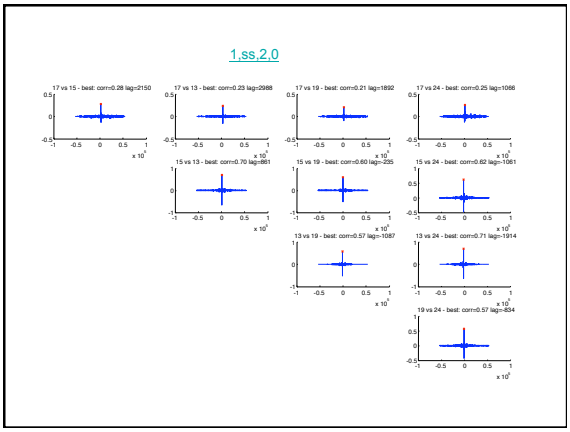
- Whitening filters reduce time delay estimation error
- Best combination for accurate “good” locs: waveform cross correlation + 95% whitening filter
- Best combination for reducing “bad” locs: spectrograph cross correlation + whitening filter
- Many other pre-filtering possibilities
- All source code will be made available to workshop participants

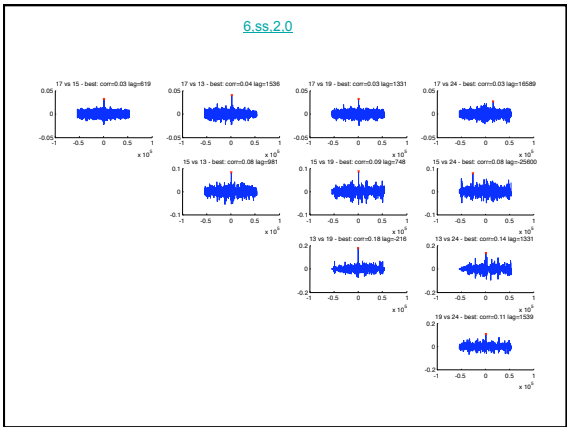


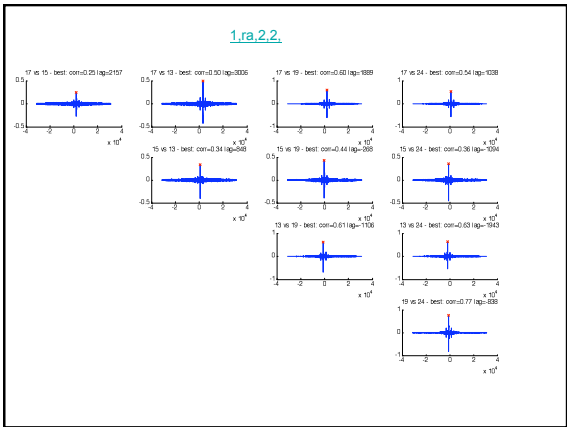

normal
slow

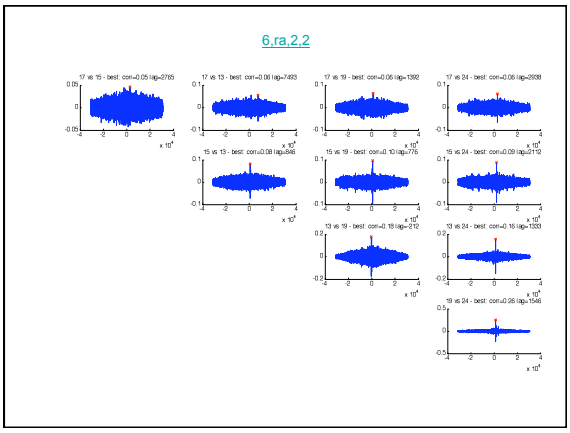

1,ss,2,0

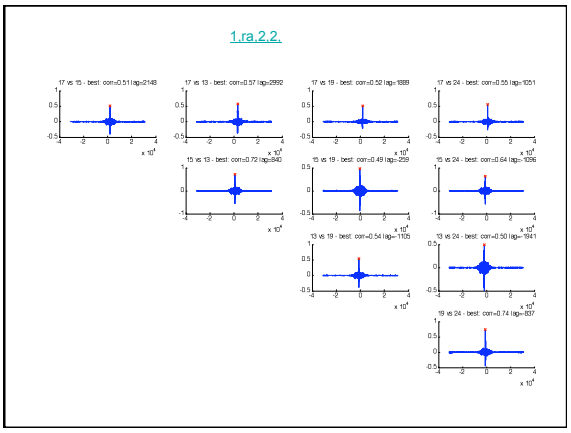

6,ss,2,0

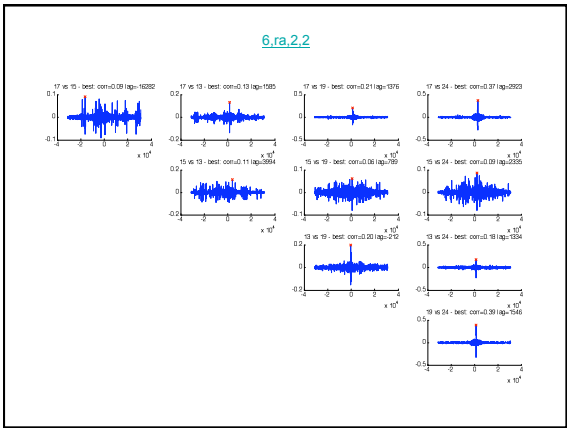

1,ss,2,0

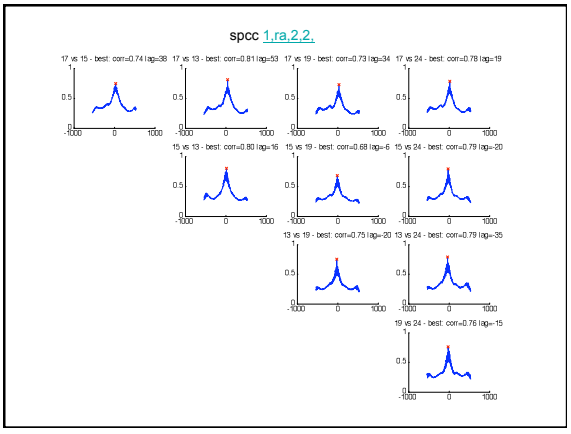

6,ss,2,0

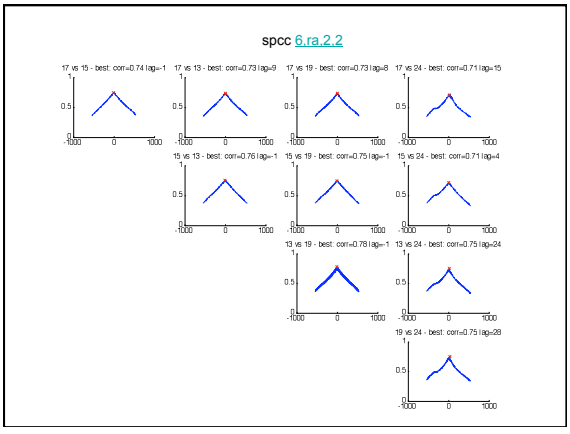

1,ra,2,2,

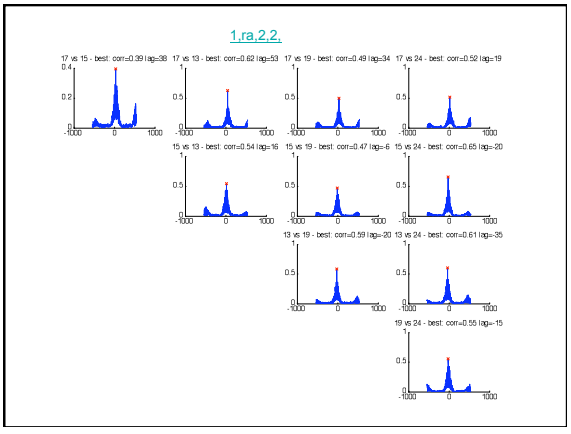

6,ra,2,2

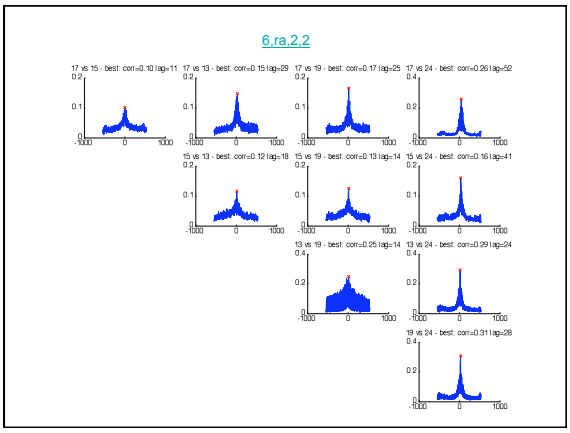

1,ra,2,2,


6,ra,2,2


spcc 1,ra,2,2,


spcc 6,ra,2,2


1,ra,2,2,


6,ra,2,2
17 vs 15 - best: corr=0.10 lag=11
17 vs 13 - best: corr=0.15 lag=29
17 vs 19 - best: corr=0.17 lag=25
17 vs 24 - best: corr=0.26 lag=52
15 vs 13 - best: corr=0.12 lag=18
15 vs 19 - best: corr=0.13 lag=14
15 vs 24 - best: corr=0.16 lag=41
13 vs 19 - best: corr=0.25 lag=14
13 vs 24 - best: corr=0.29 lag=24
19 vs 24 - best: corr=0.31 lag=28