Angular coverage and efficiency of acoustic sensors of the South Pole Acoustic Test Setup

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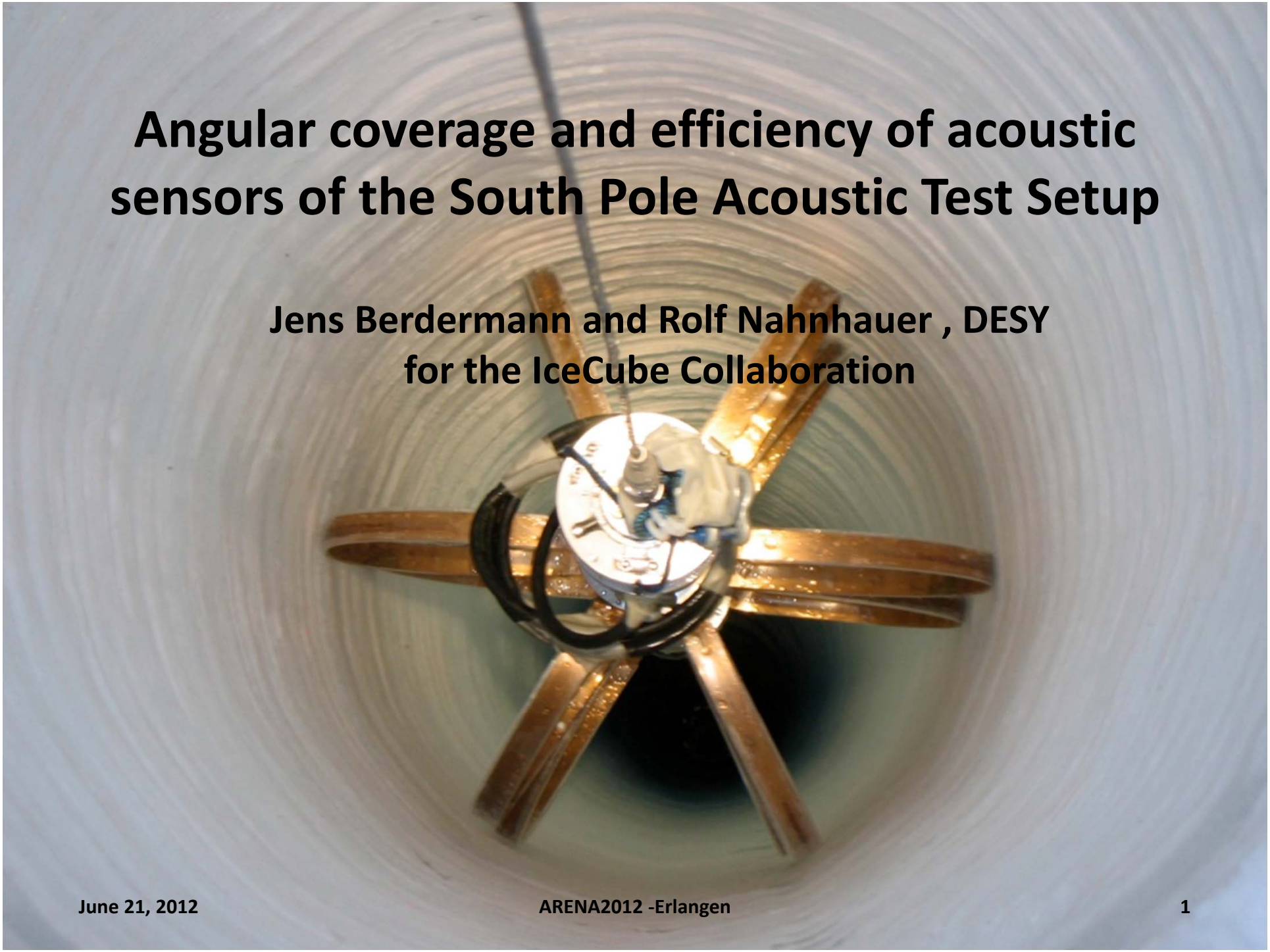
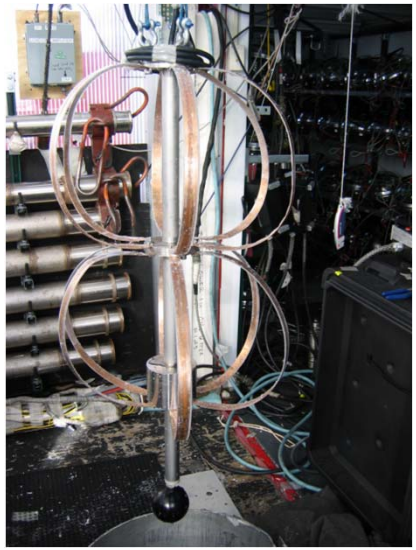
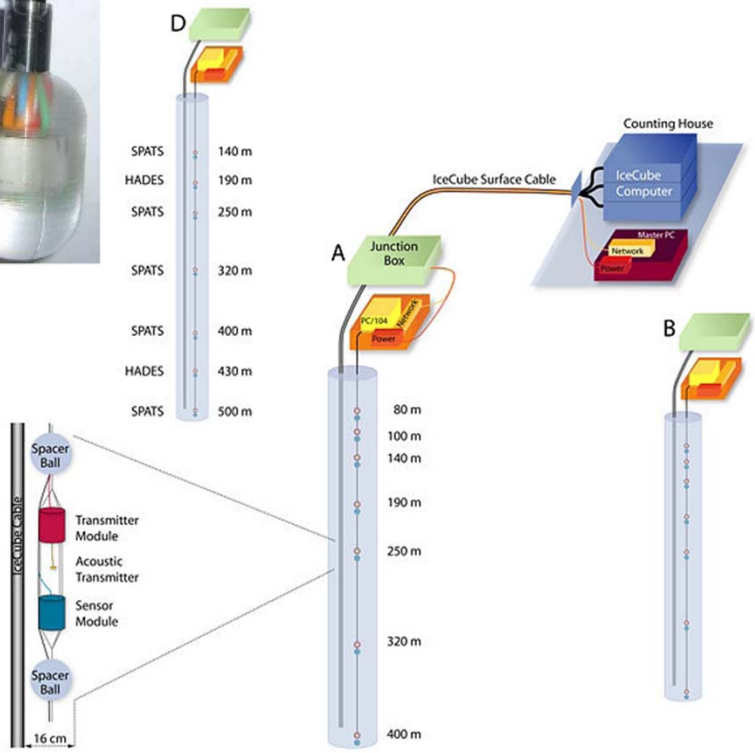
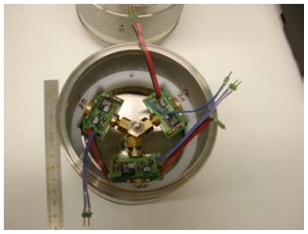


South Pole Acoustic Test Setup

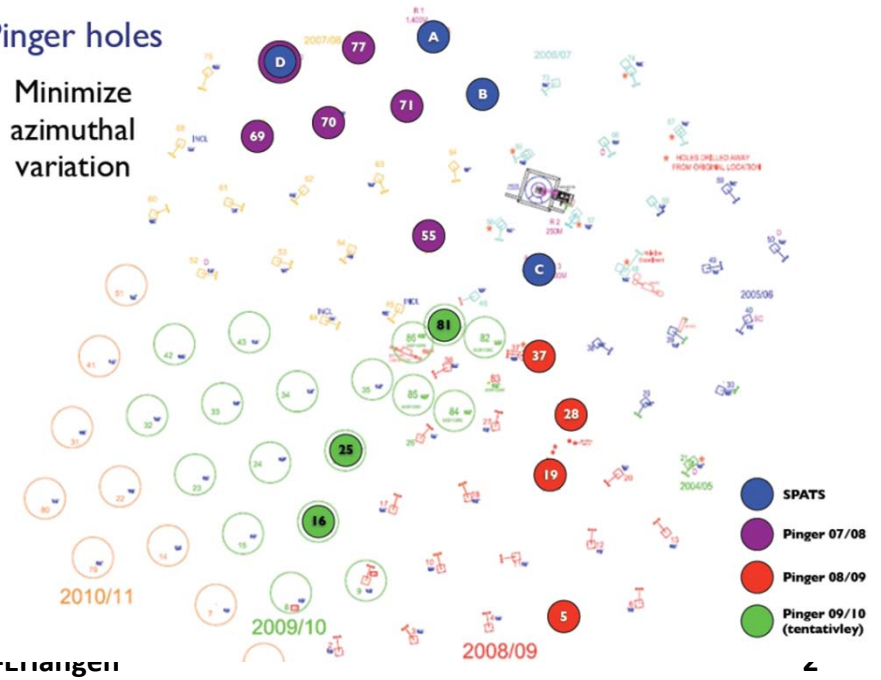






Pinger holes

Minimize azimuthal variation



in-situ calibration of sensors in ice very difficult, problems:

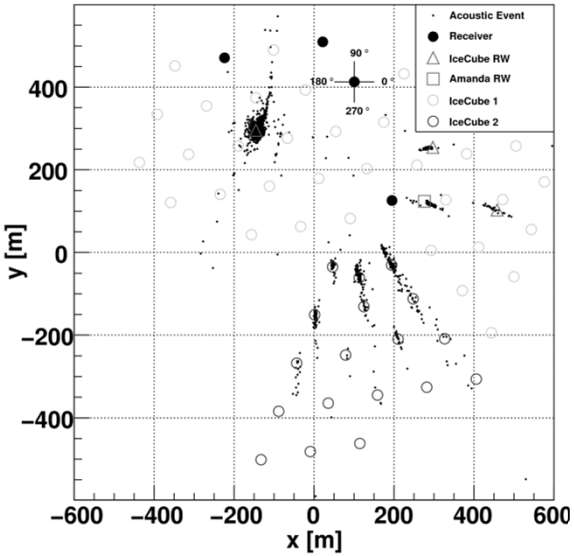
- → deep temperature
- → high pressure
- → sensitivity change (ice/water/air)
- → solid medium (access limitations)

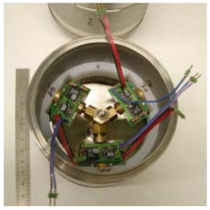
assume until now factorization of effects

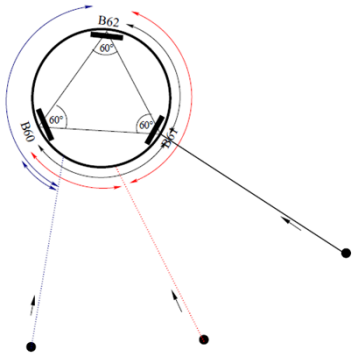
- → measure sensor sensitivity in water
- → measure temperature dependence in air
- → measure pressure dependence in water/oil
- → compare sensitivities in water/ice at
  ~ -20 degree, normal pressure

New ideas:

Use transients to study angular dependence of sensitivity

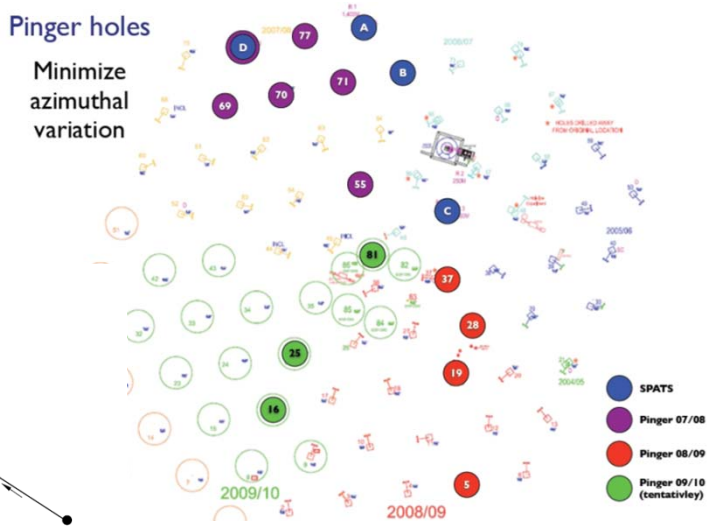






reconstructed 4 string event vertices

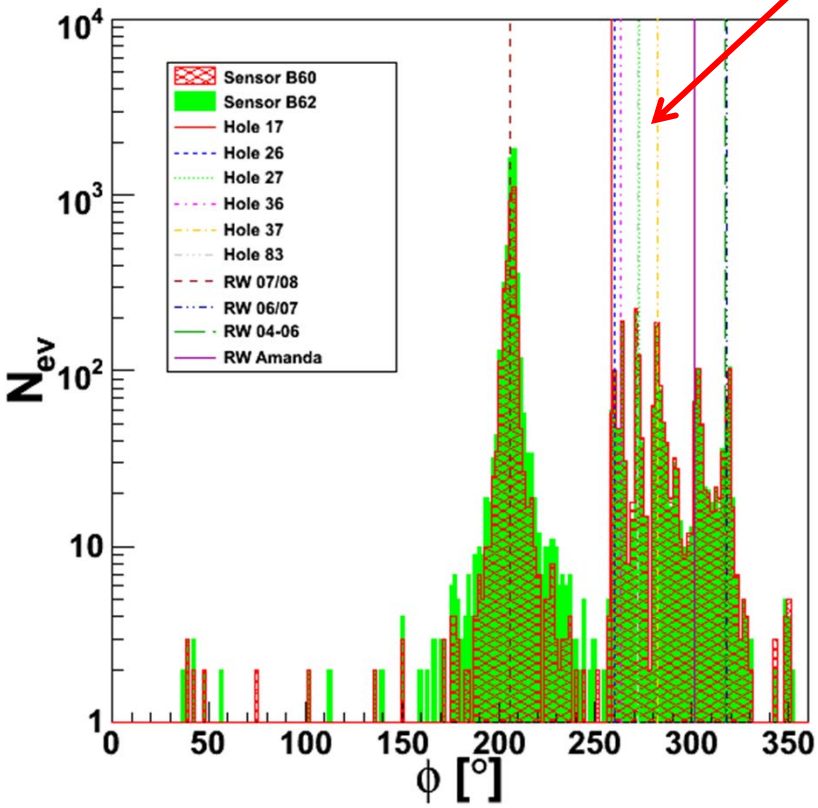
Use pinger data to do relative sensor calibration



pinger signals at each sensor z-level, only hole distances important (assuming homogeneous bulk ice)

Sensor sensitivity study using transient data (28.08.2008 – 20.02.2009)

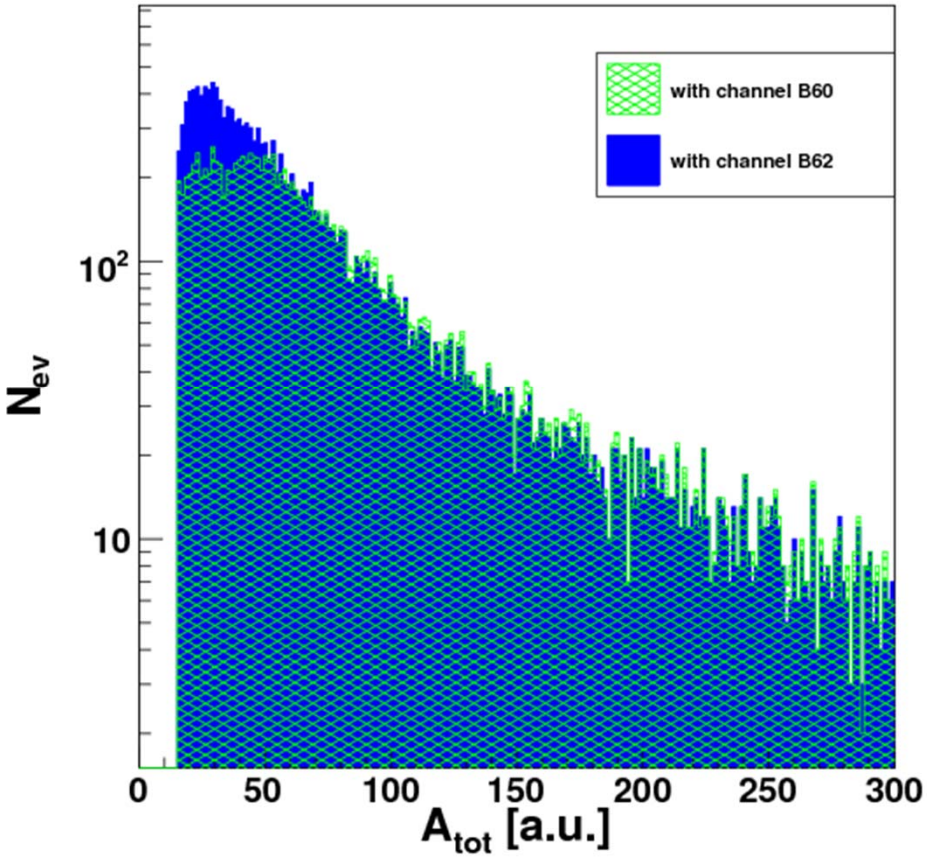
Full position information of localized transient events allow to calculate their angle in respect to the position of channel B60 and B62 in same sensor



excellent x-y resolution
$\sigma(x) = 2.6$m
$\sigma(y) = 5.0$ m

- **Both sensors on String B behave as expected over a wide azimuthal range (all holes and rodwells except RW07/08)**
- **Both channels get the same rate of hits for RW07/08 above a certain signal strength**

Reason for inefficiency of sensor B60 at ~ 200 degree :



Sensitivity ratio measure in water:

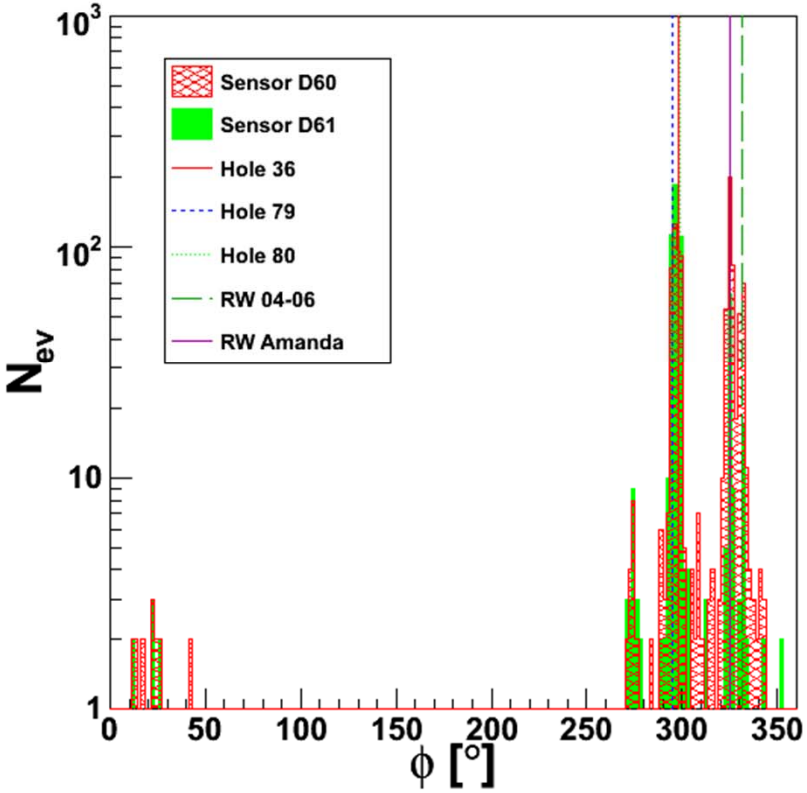
SB60 / SB62 = 1.2 +/- 0.1

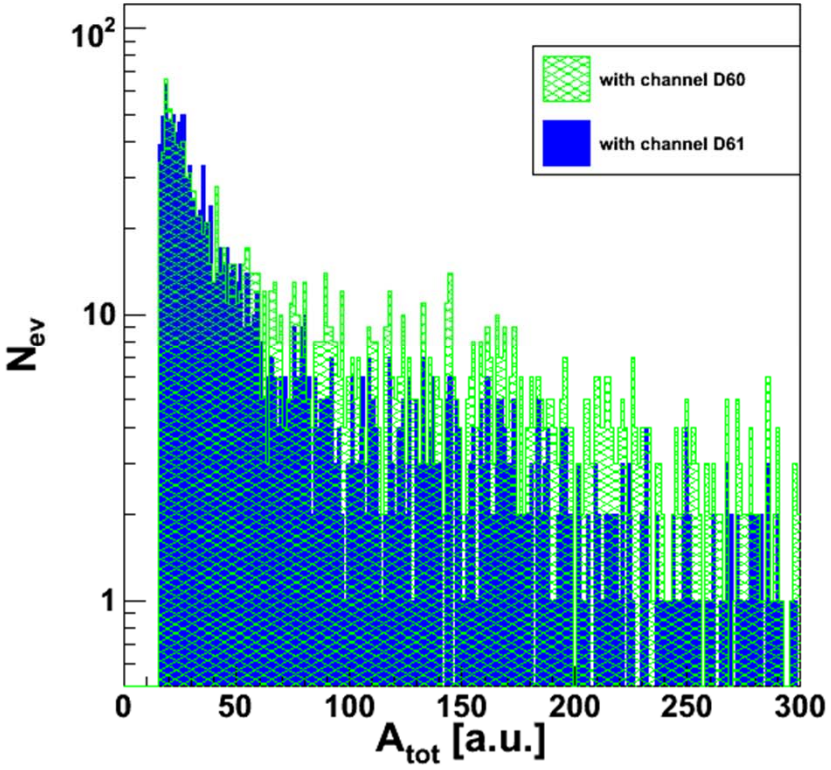
does not explain effect

- Reduction of signals at sensor B60 in the ϕ range compared to B62 around RW07/08 might come from a shadowing effect

→ the IceCube cable ?

Results for string D (27.11.2010 – 20.4.2012)





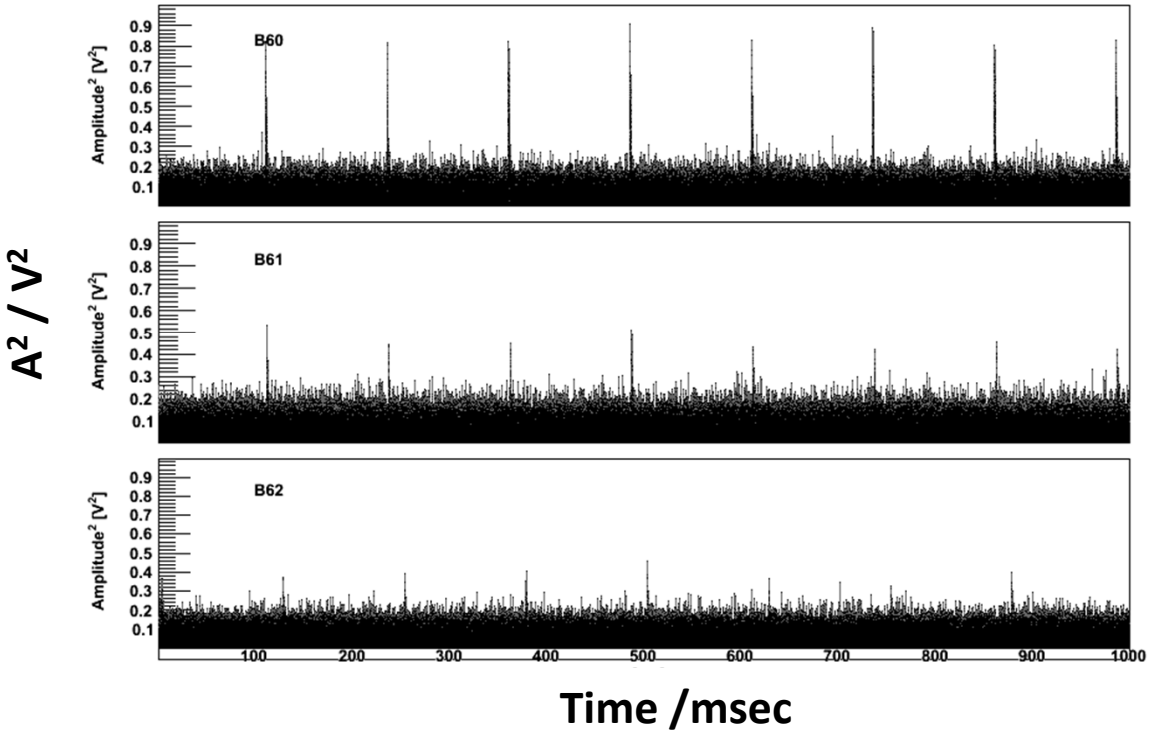
statistics low
no clear shadowing effect seen
differences most likely due to different sensitivities

Relative sensor sensitivity from pinger data

Preliminary

Check first for sensors at level B6 and pinger in hole 37 level 6:

→ found nearly 100% efficiency for transients (slide5)

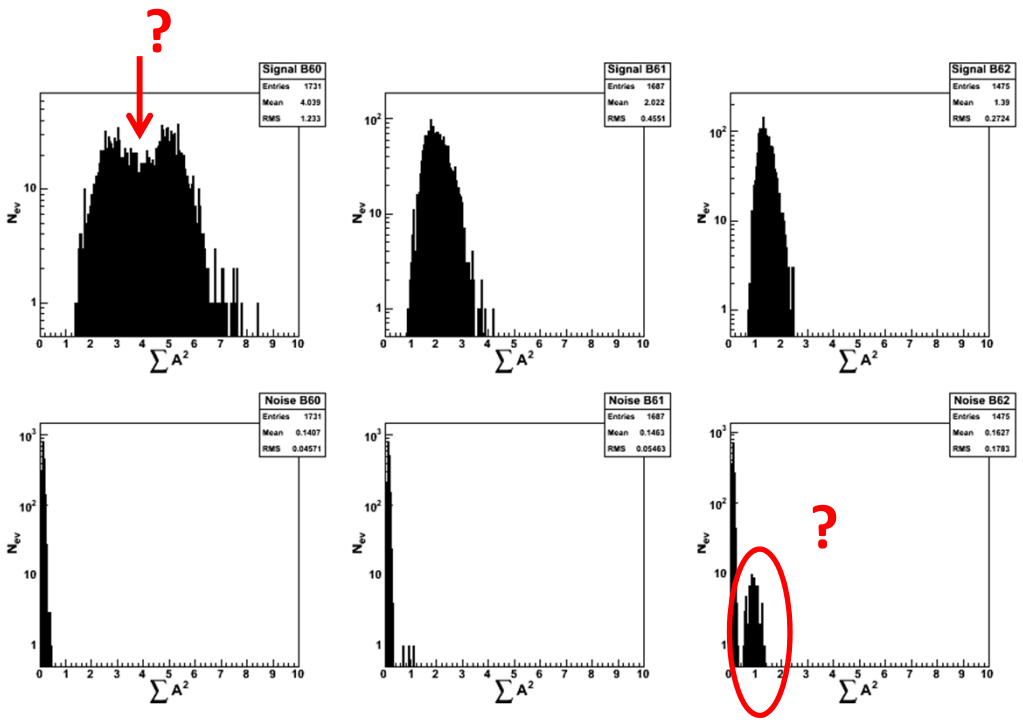


Identify pinger signal
by eye
in almost all cases
for all three channels

“power” distributions:

signal

noisel



Preliminary

Relative sensitivity ratios:

	In lab.	in situ
B60	1.00	1.00
B61	0.89	0.71
B62	0.85	0.58

find same trend as in lab.data, error still ~10%

Selection criteria for signals like for “real” data
No timing information used
But some peculiarities have still to be understood

		amplitude^2 / arbitr. units			
depth/m	channel	str. A	str. B	str. C	str. D
190	0		4.6	5.5	
	1		3.1	7.2	
	2	2.2	1.0	5.5	4.6
250	0		2.0	5.8	1.2
	1	1.9	1.9	4.9	2.9
	2		3.0	4.5	2.4
320	0	1.4	4.0	2.4	1.2
	1	1.2	2.0	7.1	0.8
	2	1.0	1.4	8.1	1.2
400	0	1.5	0.8	2.5	0.8
	1	1.0	1.1	5.6	1.0
	2	0.8	1.0	4.6	1.7
500	0				1.0
	1				1.2
	2				1.0

very preliminary

pinger in hole 37

correct for:

$A^2 \rightarrow A$

different distances

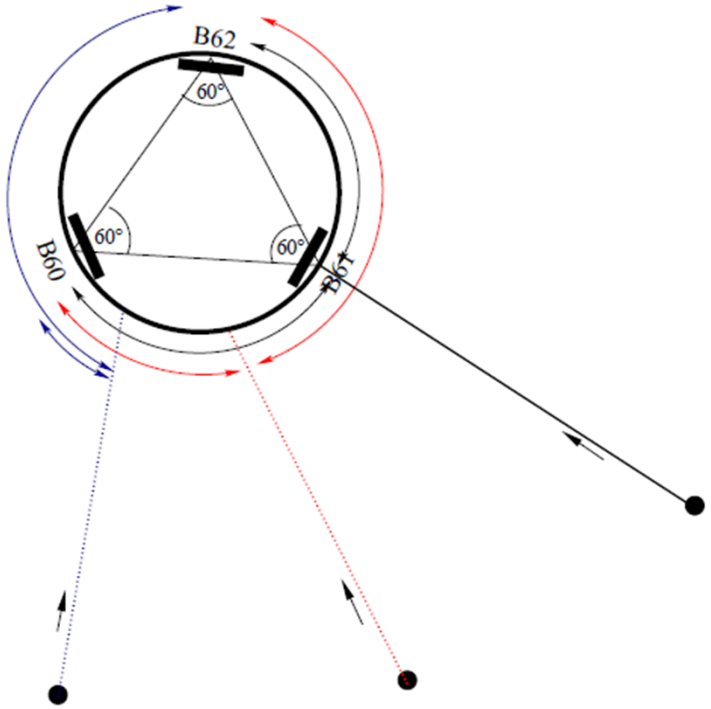
calculate errors

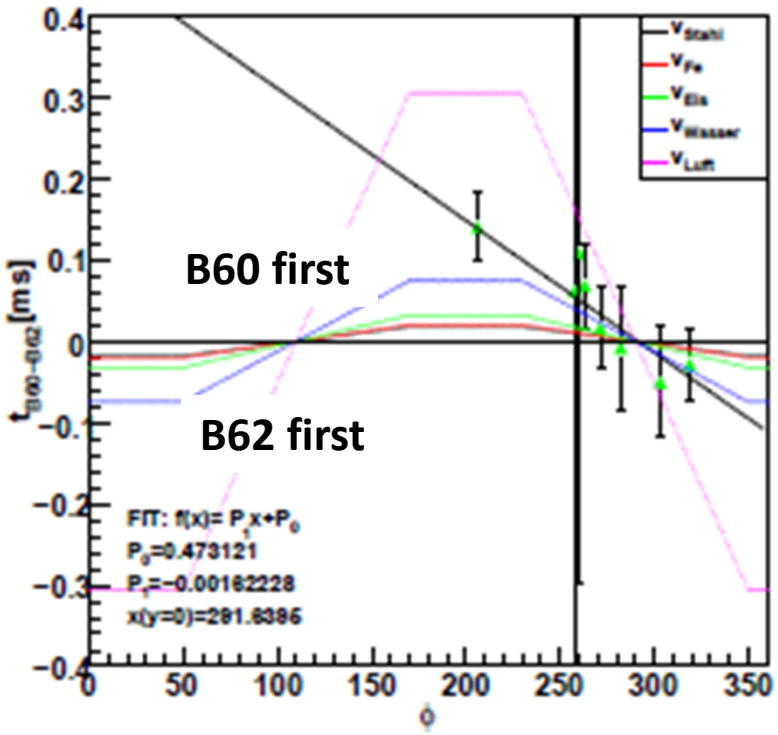
try for other hole

Future possibility:
get sensor orientation in ice hole:

Use arrival time of signals from different directions

Find angle where sensors have same Δt





Example from transients
Pinger data under study

Summary

Available SPATS data for transients and from pinger measurements allow to get valuable information on:

- **→ angular sensitivity and shadowing effects**
- **→ relative in-situ sensitivity of all deployed channels**
- **→ eventually orientation of sensors in the ice**

Some assumptions needed:

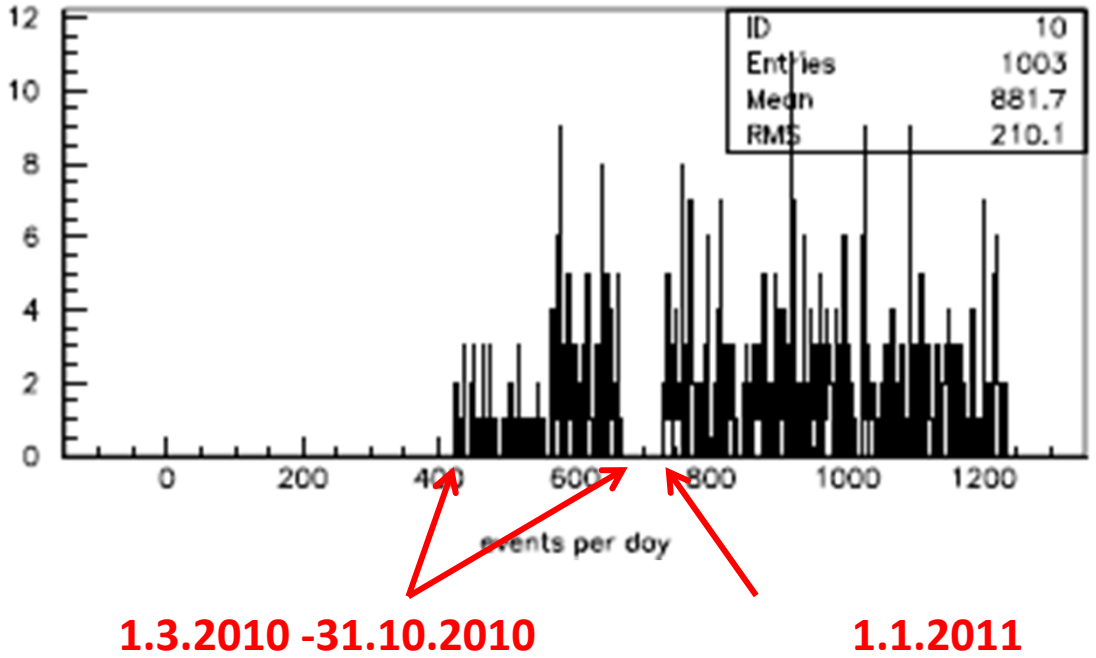
- **→ homogeneous bulk ice**
- **→ small influence of hole ice**

Can partly be tested by using different holes
More work necessary

Present whisper from the South Pole

Do we hear still signals from the South Pole after IceCube construction has finished for more than a year?

Yes! A few 4-string events per day



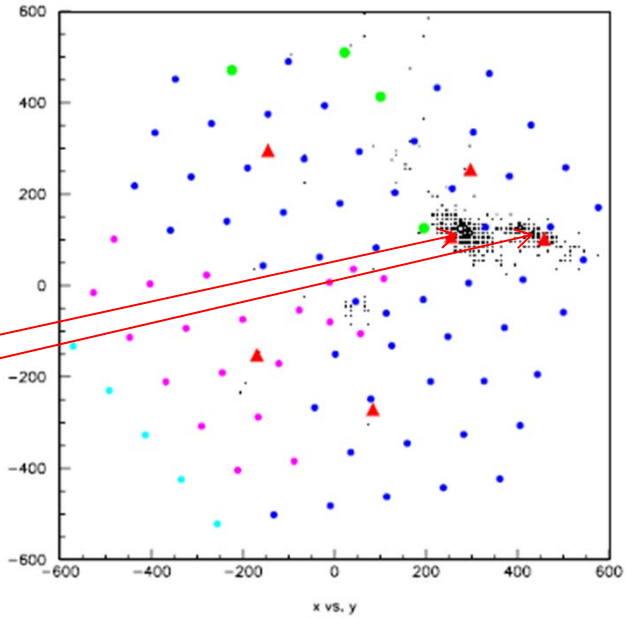
1.3.2010 -31.10.2010

1.1.2011

Where these signals are coming from:

Positions of two Rod-Wells used twice during AMANDA IceCube drilling

AMANDA 1999/2000
IceCube 2004/2005



Rod-Wells used for drilling water circulation:
huge caverns,
> 20 m diameter
second one
>100 m depth

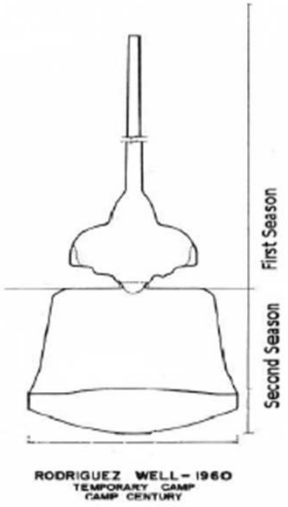
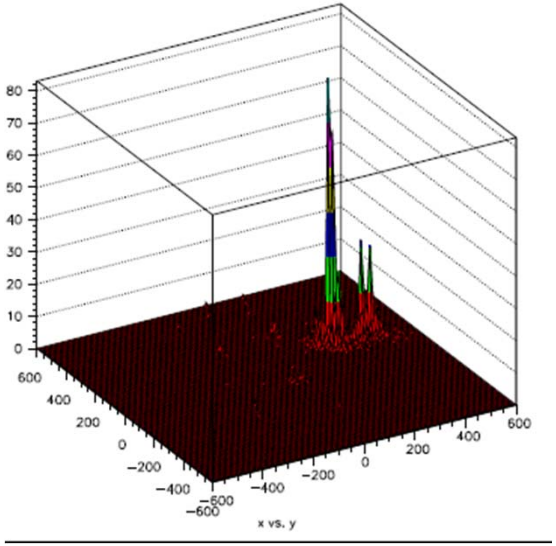
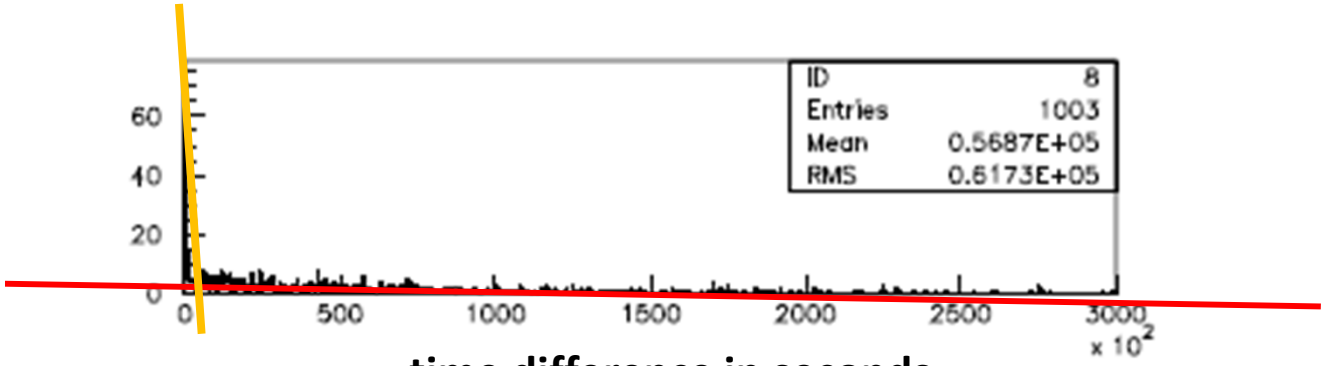


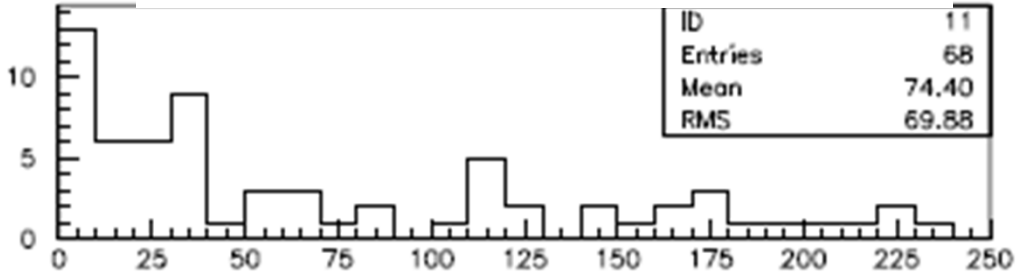
Figure 10: Section of the Camp Century well after a first and second season of operation (Schmidt and Rodriguez 1962) from [10].



Time between two signals:



time difference in seconds

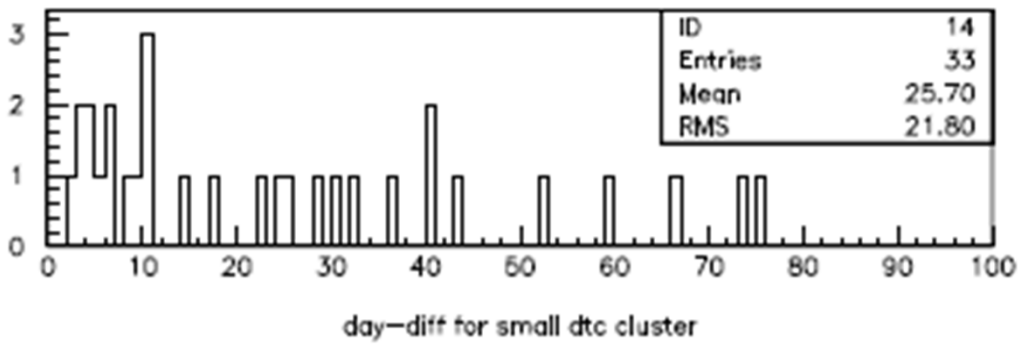


time difference in seconds

Find two components

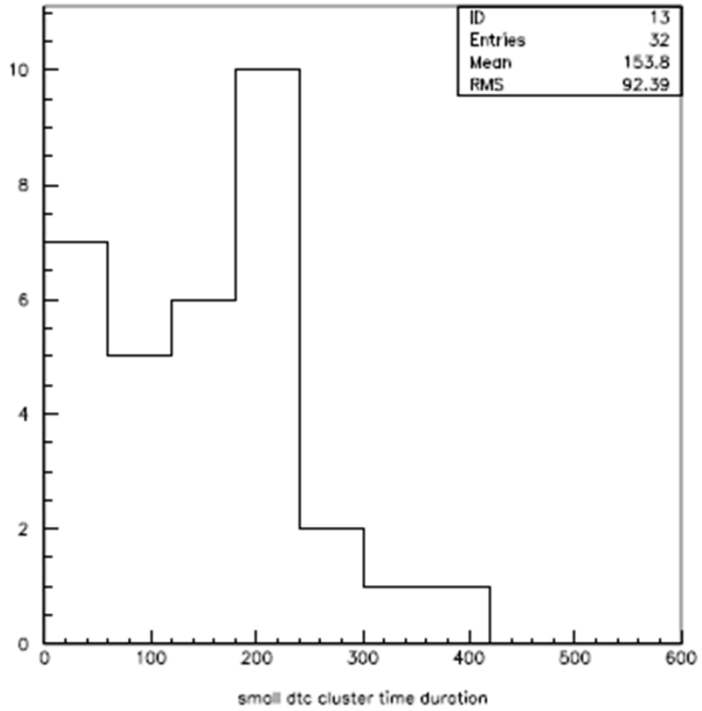
→ separated single events

→ signal clusters



Average time difference between signal clusters is 26 days

Time duration of signal clusters is a few minutes (peak at 4 min)



Open questions:

Can we correlate signal clusters with measured seismic activities?

Can we correlate signal clusters with ice flow?