Acoustic tomography applied to the Baikal Neutrino Telescope

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Objectives:

- evaluation of possibilities for acoustic 3D localization/positioning elements of the Baikal telescope from the ice surface.

- distant localization of the Baikal Neutrino Telescope string positions
- estimation of telescope spatial orientation;

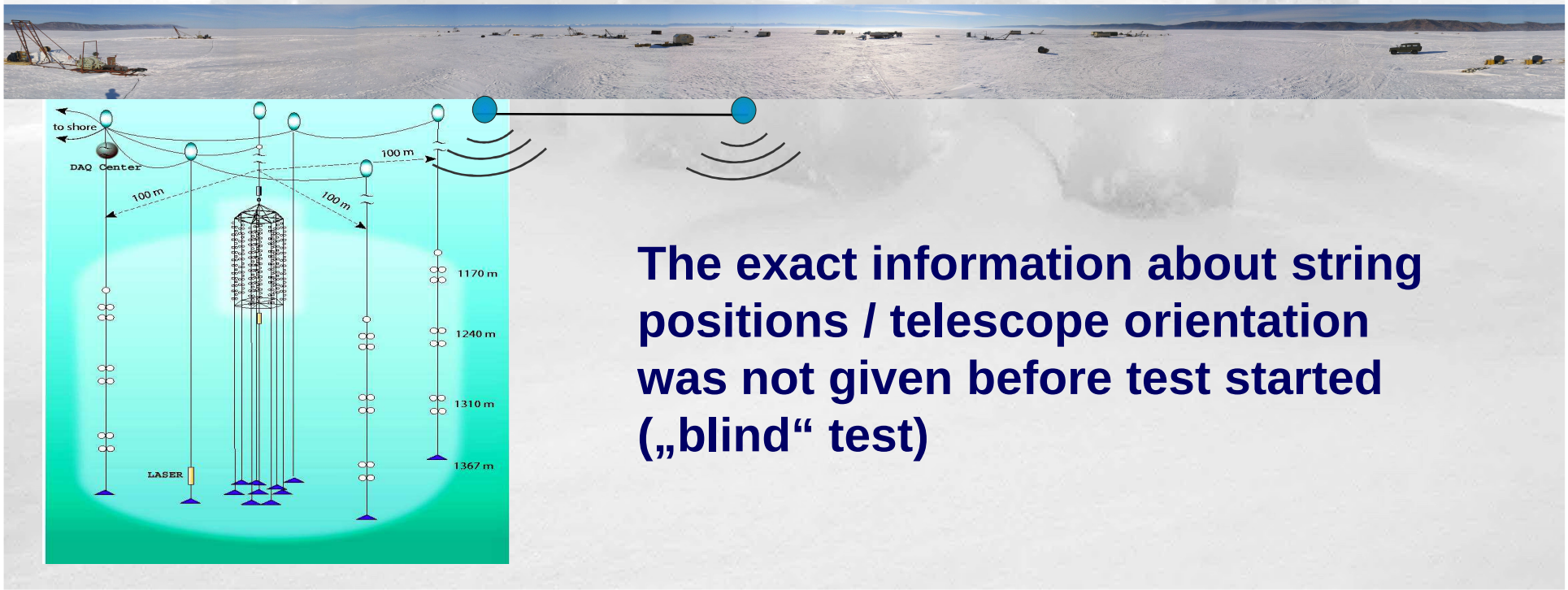
- gain first experience

  estimation of signal parameters necessary for future improved acoustic tomography

Conditions:

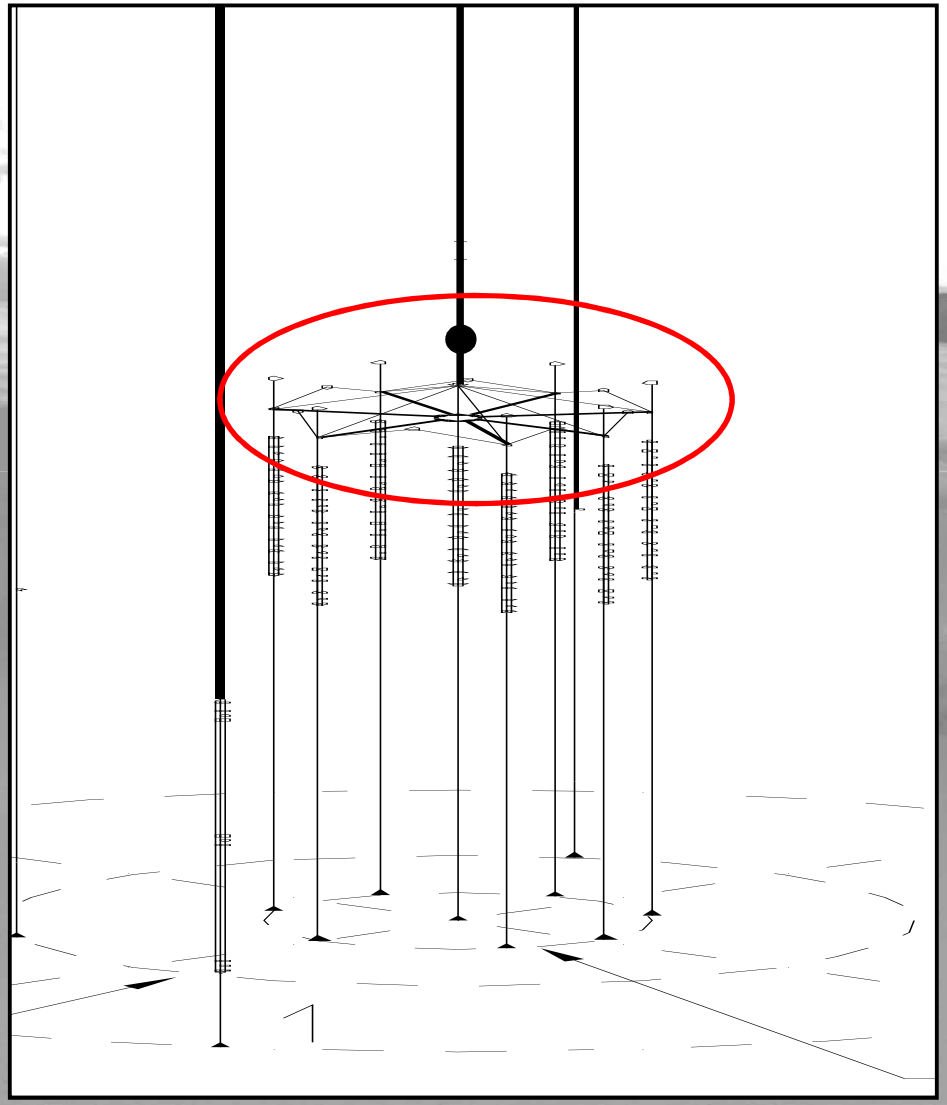
- **NEUTRINO TELESCOPE: in standard bottom position (1100 m depth)**

- **ACOUSTIC ANTENNA: placed under ice surface (9 m depth)**



The exact information about string positions / telescope orientation was not given before test started („blind“ test)

Baikal Neutrino Telescope / bottom arrangement

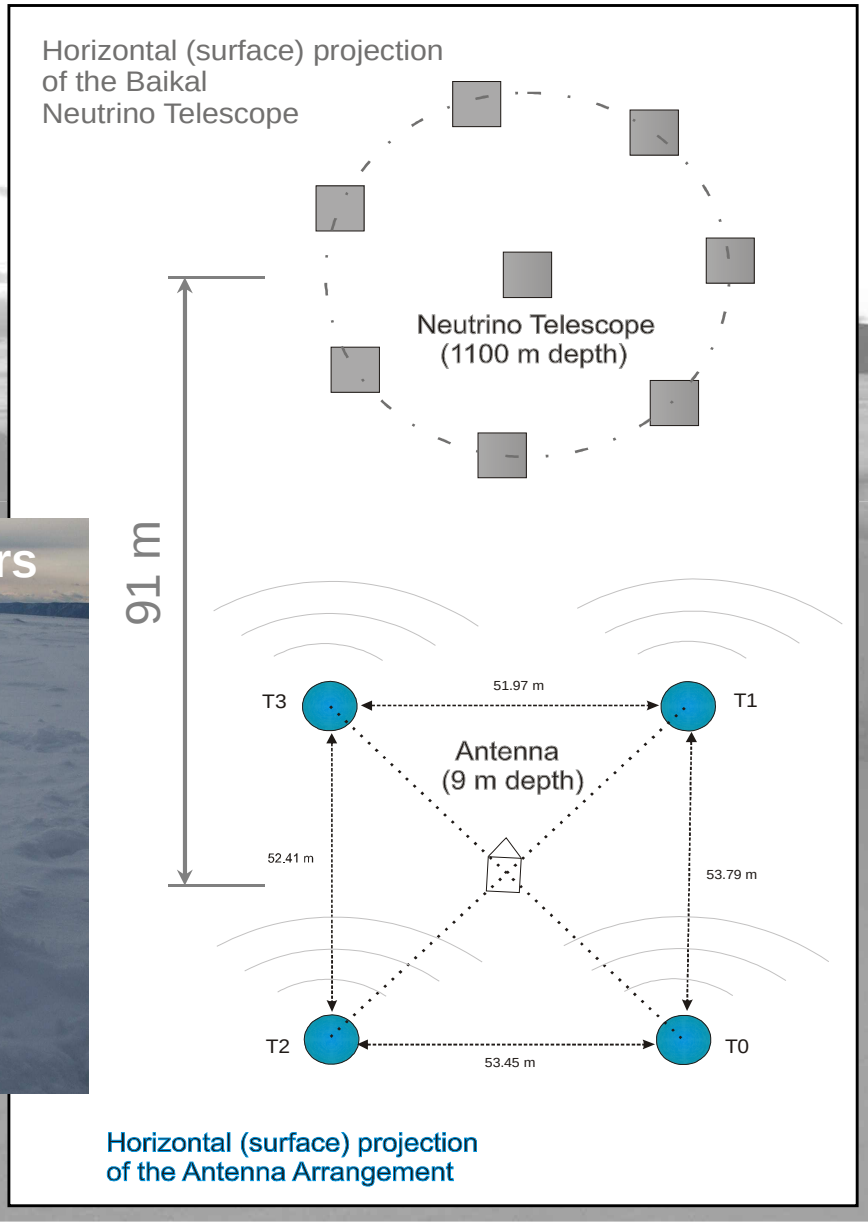


Reference marks: objects with large target strength, such as the end buoys located above the peripheral strings or the central electronics module above the central string

end buoys
(above strings)

central electronics module

Sketch of the measurement setup
Neutrino Telescope (1000m depth) and antenna (9 m depth)



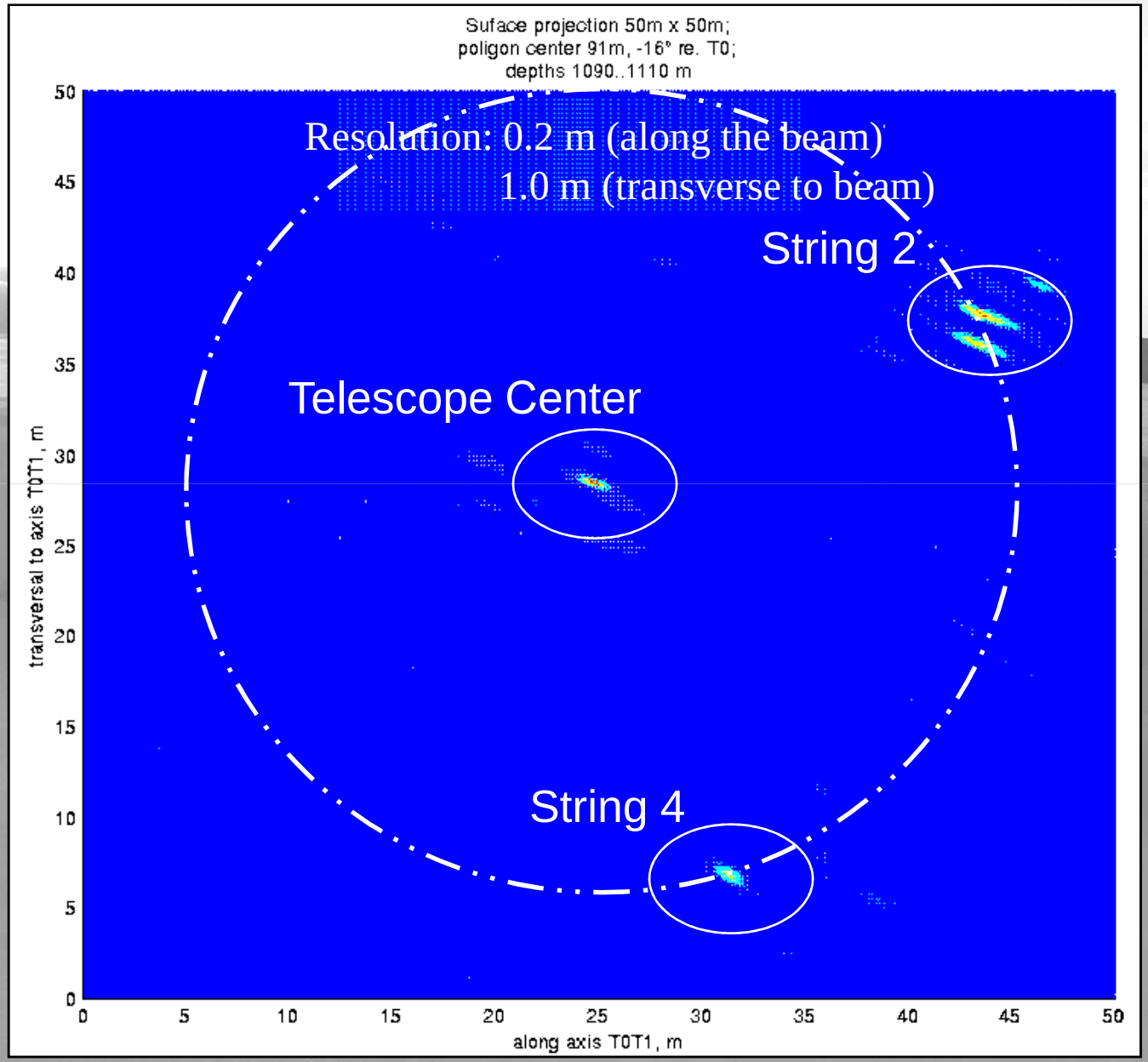
Acoustic signals / technology

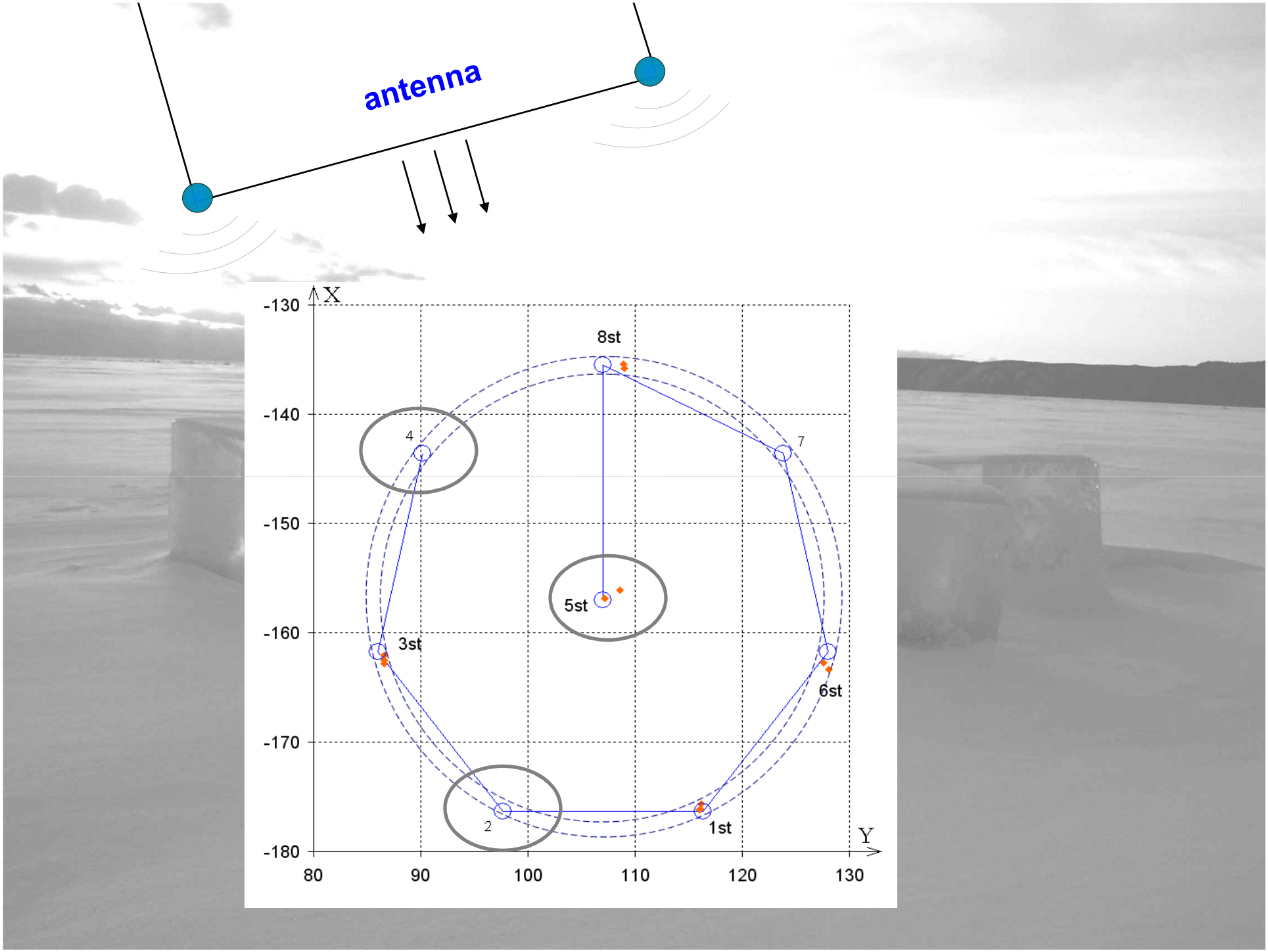
- **multiple modulated wide-band acoustic signal sequences in conjunction with S2C processing technology**

  S2C means Sweep-Spread Carrier technology developed for data transmission by means of acoustic signals in highly reverberant propagation environments
  Such a carrier consists of a succession of sweeps/chirps - signals with continuous monotonous frequency change with time

- **frequency band: 12 – 22 kHz**
- **signal duration: 51.2 ms**
- **signal level: 195 dB re 1 µPa**
- **beam width: 60°**

Tomography results




antenna
X
Y
-130
-140
-150
-160
-170
-180
80
90
100
110
120
130
8st
4
7
5st
3st
6st
2
1st

Result of tomography:

Three largest objects (two double buoys and the central electronics module) localized

Visualization: evident (contrast) spots.

Localization accuracy: 0.2 m (along the beam)
1.0 m (transverse to beam)

Orientation estimation: due to asymmetry of double buoys arrangement possible

Conclusions/ Perspective

- **accurate 3D localization of large-size telescope objects (e.g. buoys) is possible from large distance (1100 m away)**

- **if increasing twice the energy content of acoustic signals, localization of smaller telescope buoys would be also possible**

verte!

Perspective

Bottom antenna with arbitrary spatial configuration:

Antenna elements combined with S2C acoustic modems for Acoustic Tomography (temporary or long term)

Keyword: **Bottom antenna for long-term autonomous deployment**

- no need for additional system elements to install on the neutrino telescope
- no depth limitation
- no need for exact antenna arrangement
- no special infrastructure for deployment

Example: antenna with arbitrary configuration