The Acoustic Module for the IceCube Upgrade

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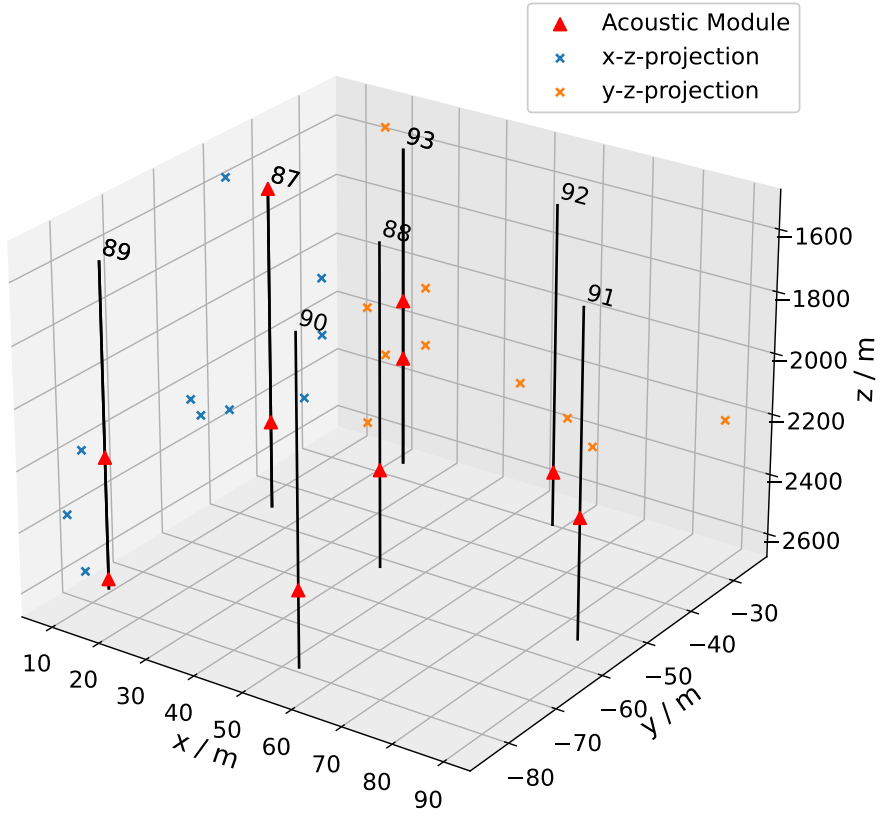
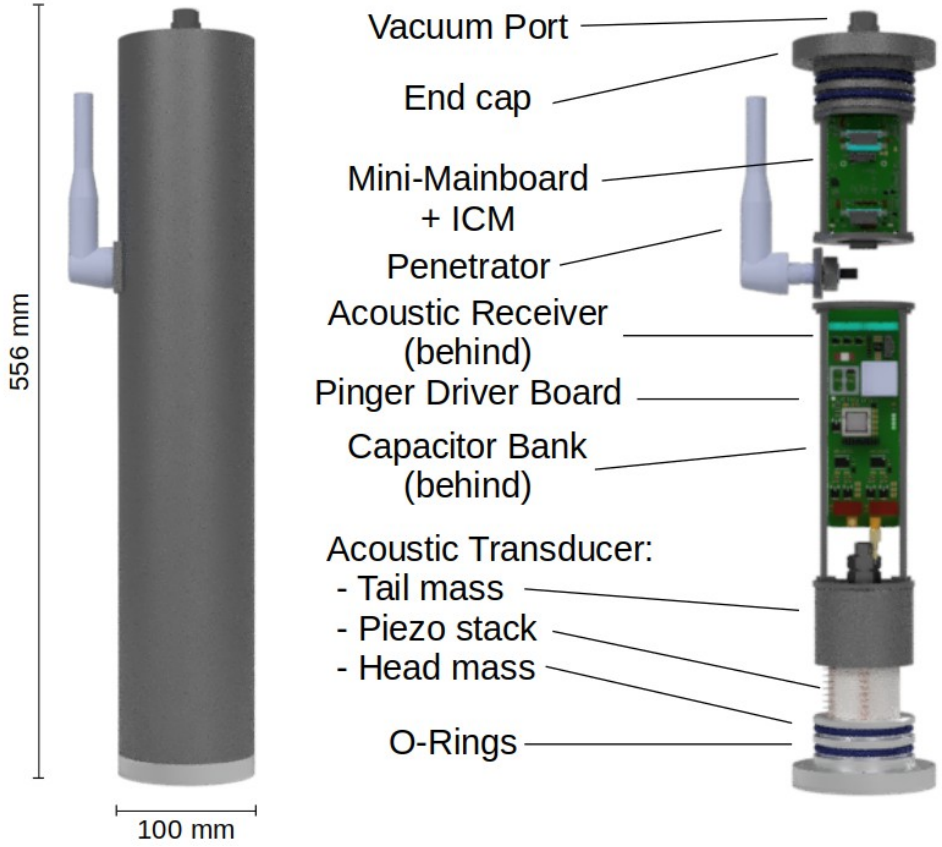
The IceCube Upgrade

- 7 new strings will be deployed at the center of the IceCube detector
- ~700 new modules including dedicated calibration modules will be deployed
- The Acoustic Module (AM) is a calibration device that aims to improve the geometrical calibration by trilateration of acoustic signals
- 10 standalone AMs will be distributed over the new strings (shown on the right)
- Acoustic sensors will be integrated into some of the optical modules



Design of the Acoustic Module

- The acoustic module functions as a high-power acoustic emitter or receiver
- Sine sweeps are generated to drive the piezo transducer via a full-bridge circuit
- In receiver mode the electric transducer signals can be digitized and recorded



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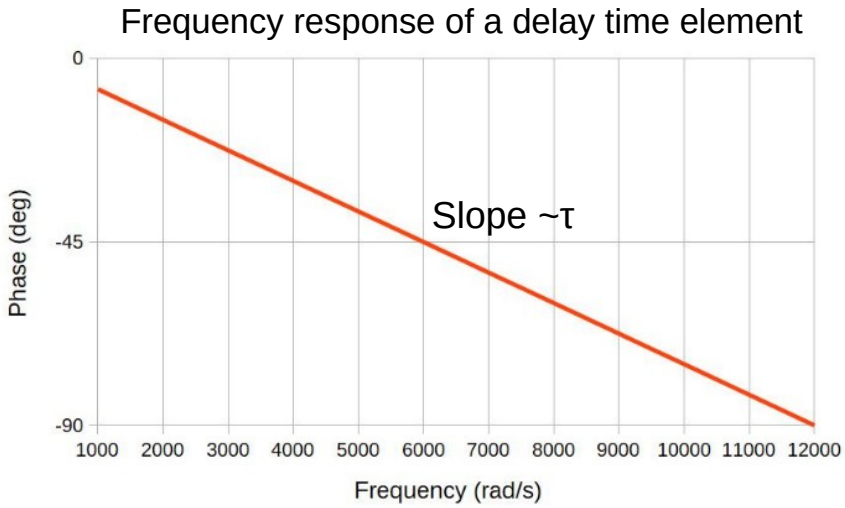
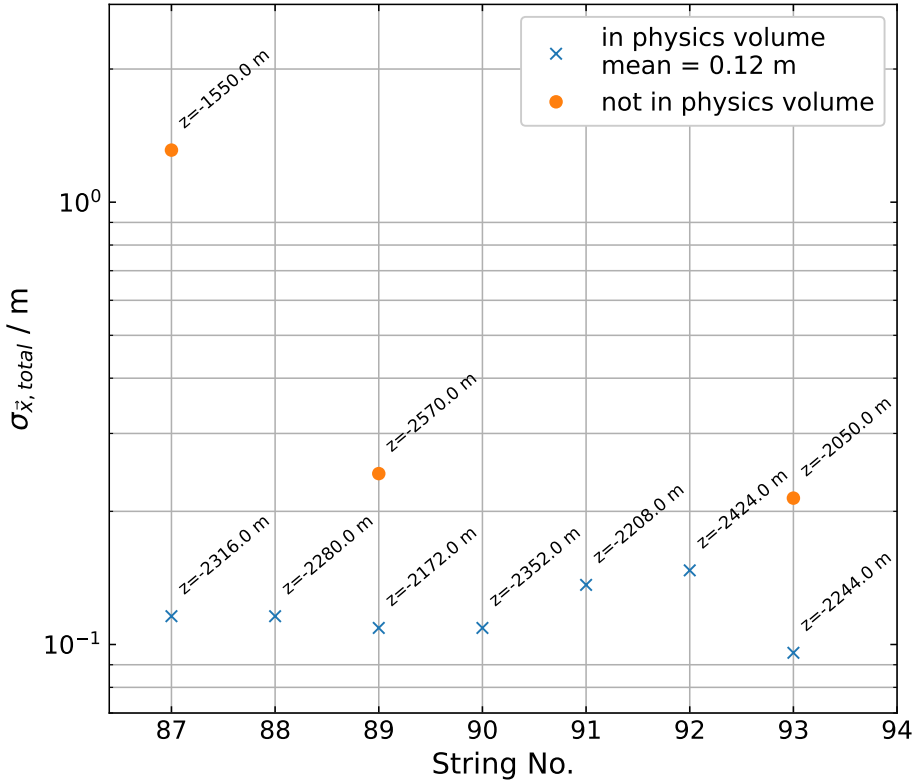
Phase Response Method

- Propagation time measurement of acoustic signals between two AMs in ice
- New method analyses the signals in frequency domain, information is found as group delay
- Measurement chain consists of three subsystems: emitter – medium (ice) - receiver
- Medium ice is modelled as a delay time element, where its delay τ is the signal propagation time between emitter and receiver
- Bode gain phase relation is used to calculate group delay τ from measured input signal (sine sweep) and receiver output



Simulation of the Array Performance

- Simulation of the localization performance for the individual AMs
- Uncertainty increases with distance due to attenuation (λ=300 m)
- For most AMs, the expected accuracy is within tens of centimeters
- More distant solitary AM (upper left) has a larger uncertainty but is important for measurements of the attenuation length



Conclusion

- Based on the SPATS measurements and the work within EnEx-RANGE, an acoustic system was developed which can be used in ice at depths of more than 2000m
- Simulation studys show that completing optical systems with acoustic modules is a promising concept for geometrical calibration of the IceCube detector
- Results from the Upgrade will help to gain experiences to improve the system for application in the upcoming IceCube Gen2 detector

Thank you for your attention!

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