Integration of Acoustic Detection Equipment into ANTARES

- The motivation for equipping the ANTARES neutrino telescope with acoustic sensors
- ANTARES and its data acquisition system
- Integration of acoustic sensors and their readout into the existing design
- Outlook and summary

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Acoustic detection: motivation

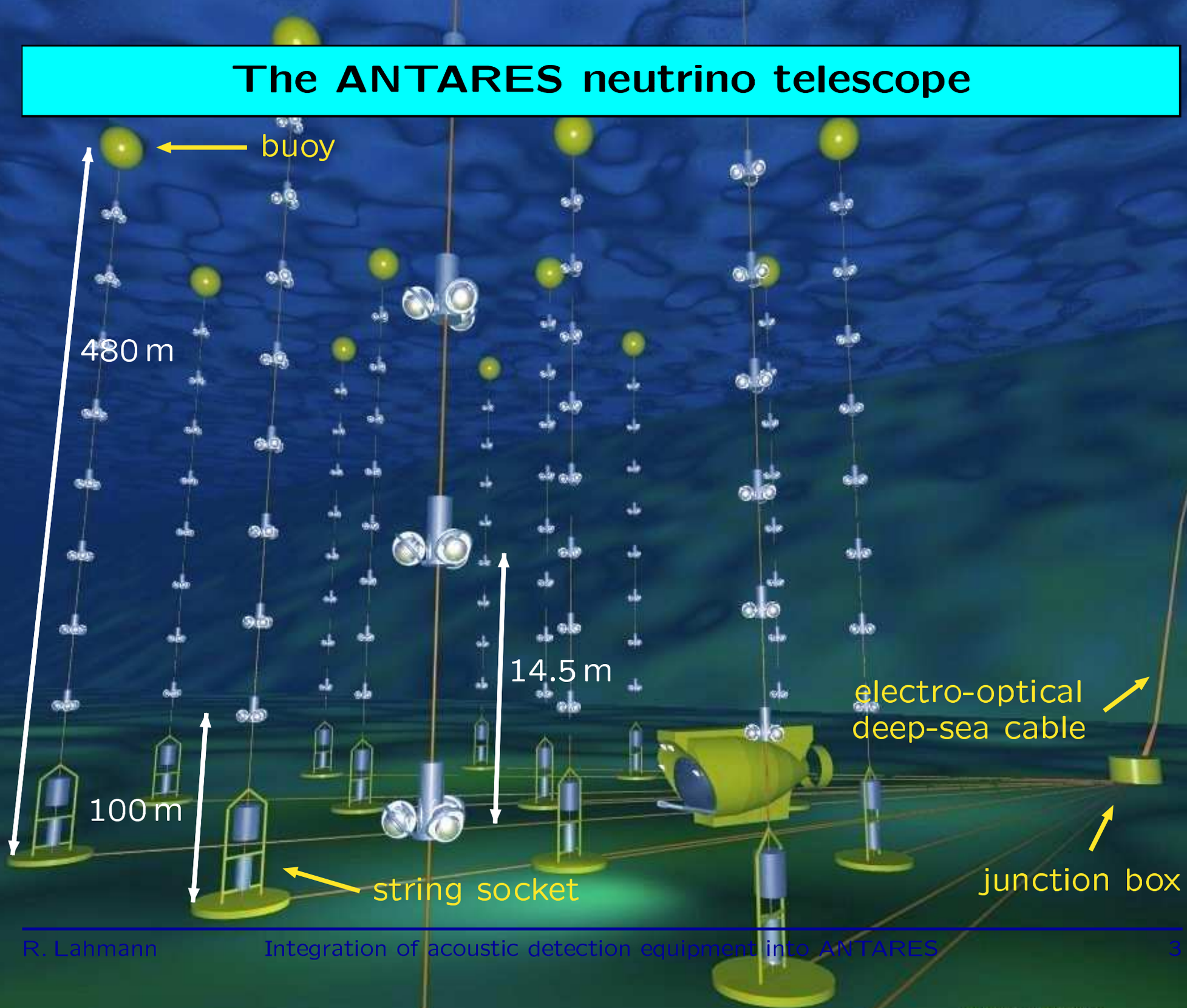
Potential of acoustic detection:

- Large range of sound in water
  $\rightarrow$ large-volume detectors.
- Detection of the hadronic/elm. shower
  $\rightarrow$ 4π acceptance.
- Sensitivity to all neutrino flavors.

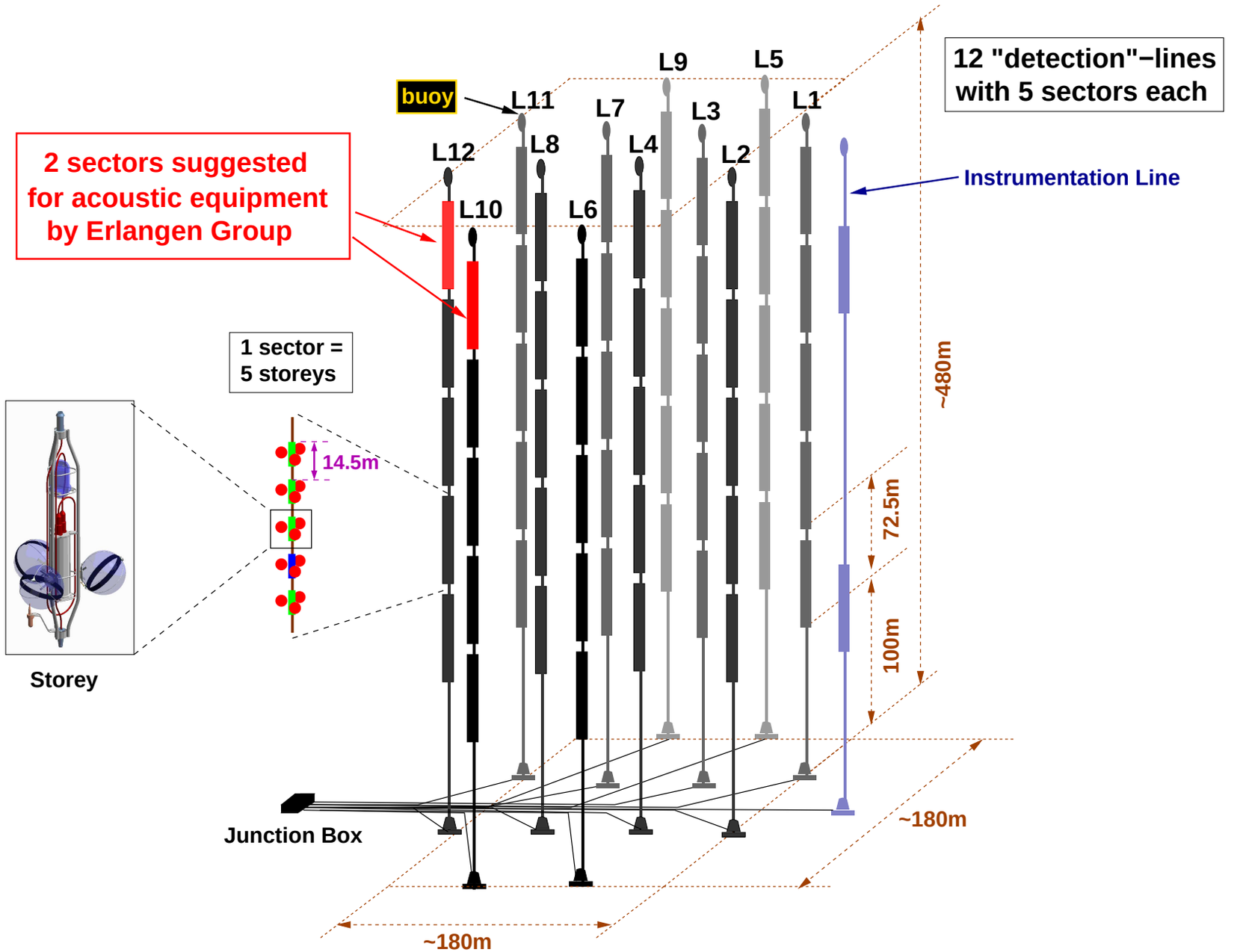
Goal of the Erlangen group:

Instrument a part of the ANTARES detector with acoustic sensors (hydrophones) for background studies and tests of acoustic particle detection methods.

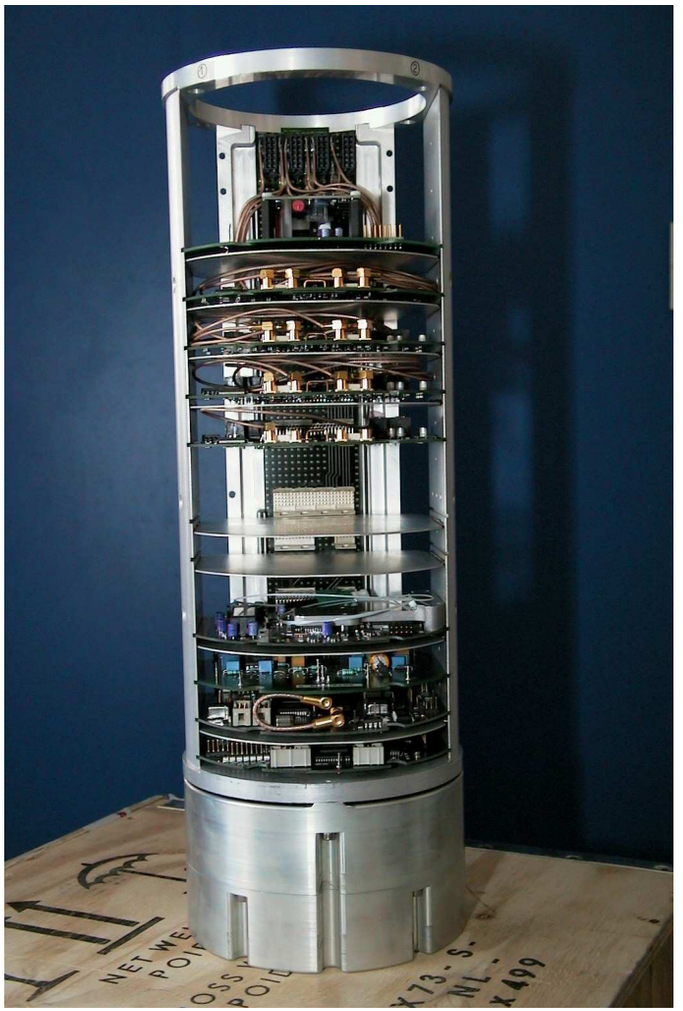
The ANTARES neutrino telescope



Acoustic detection in ANTARES



Set-up of a storey

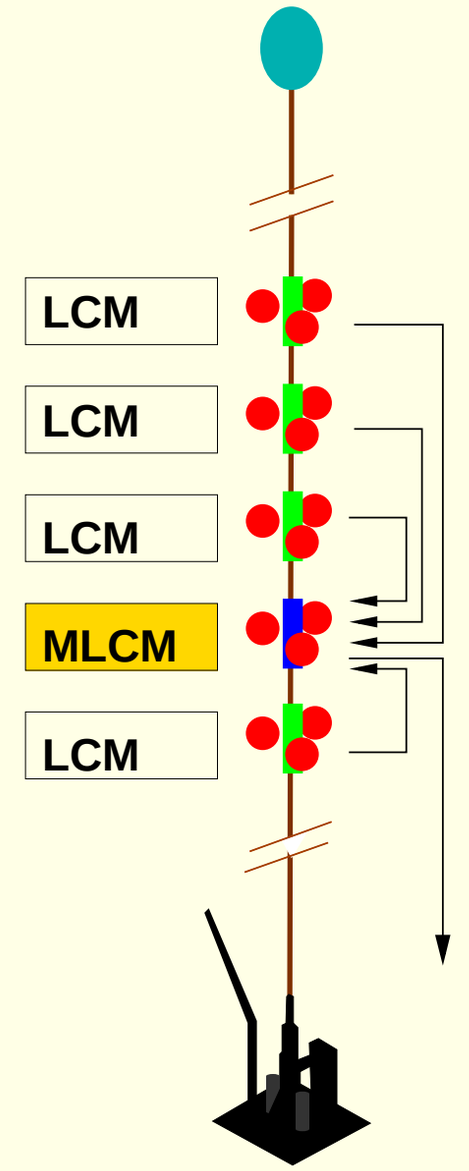


electronics container

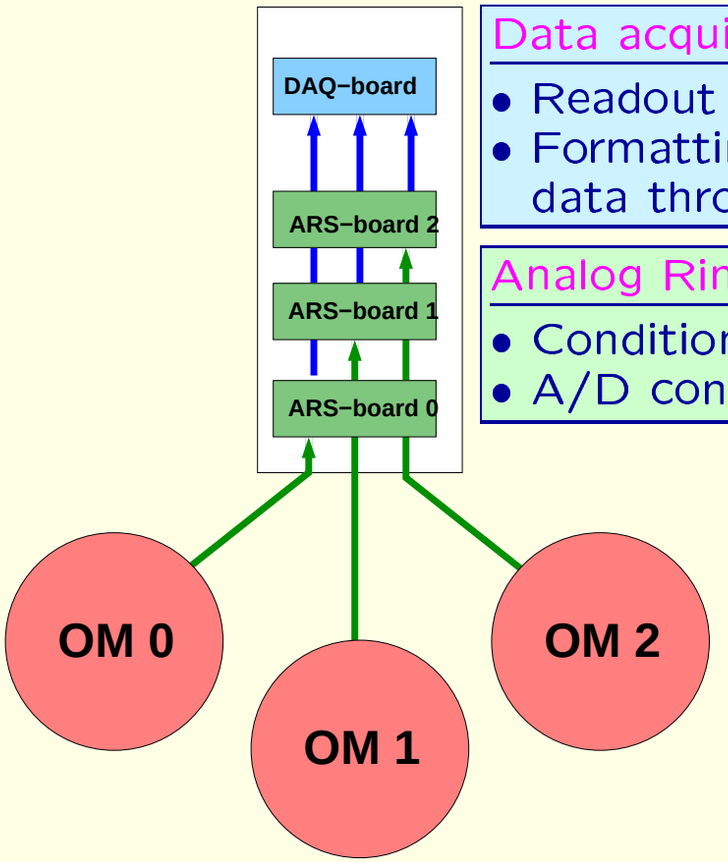
Optical Module (OM):

3 OMs per OMF, every OM contains a photomultiplier (PM)

Data flow within a sector



Data flow in
Local Control Module (LCM) and
Maser Local Control Module (MLCM)



Data acquisition (DAQ) board:

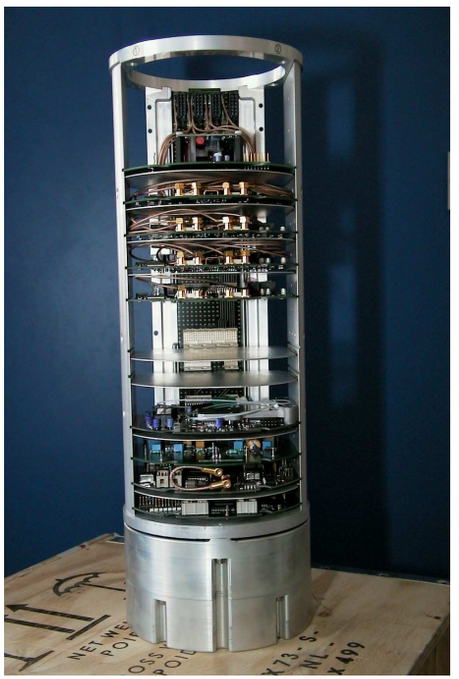
- Readout of ARS boards
- Formatting and transmission of data through ethernet

Analog Ring Sampler (ARS) boards:

- Conditioning of analog data
- A/D conversion

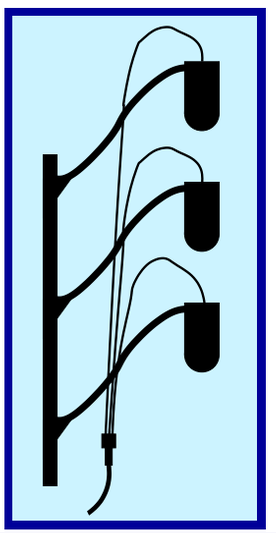
External prerequisites for acoustic integration I

The acoustic detection has to be integrated into the existing ANTARES design



Boards within the LCMs/MLCMs can be exchanged!

The OMs can be equipped with piezo elementes instead of PMs . . .



. . . or can be replaced by hydrophons.

Storeys equipped with acoustic sensors

External prerequisites for acoustic integration II

Requirements for the integration of acoustic detection equipment:

- suitability for deep-sea environment:

  no modification of titanium containers, connectors, etc.;

  use of commericial components

- power supply:

  electric power consumption is limited: ~ 8.5 W

  available for acoustics per electronics container

- data transfer:

  usage of the ANTARES standard protocols

- data rate:

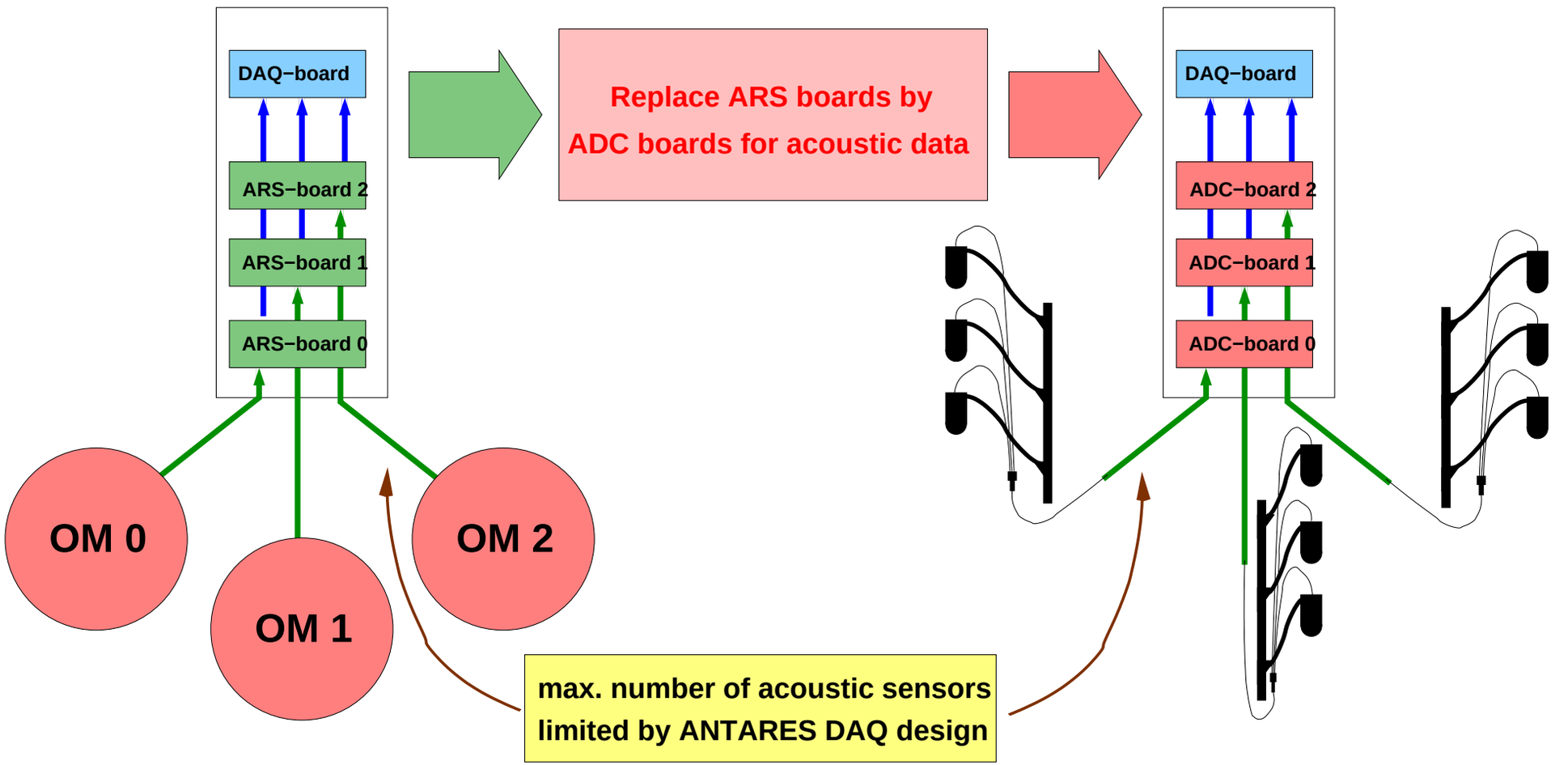
  limited

Data flow within an acoustic sector

optical data

acoustic data

No modifications to DAQ board or data transmission!



Acoustic data acquisition and data transfer

Design principles:

- development of acoustic ADC-boards: use of commercial components (no ASICs, instead FPGA + μC)
- continuous data sampling
- data transfer to shore with ANTARES standard protocols
- on-shore: dedicated PC-farm for acoustic data

data rate:

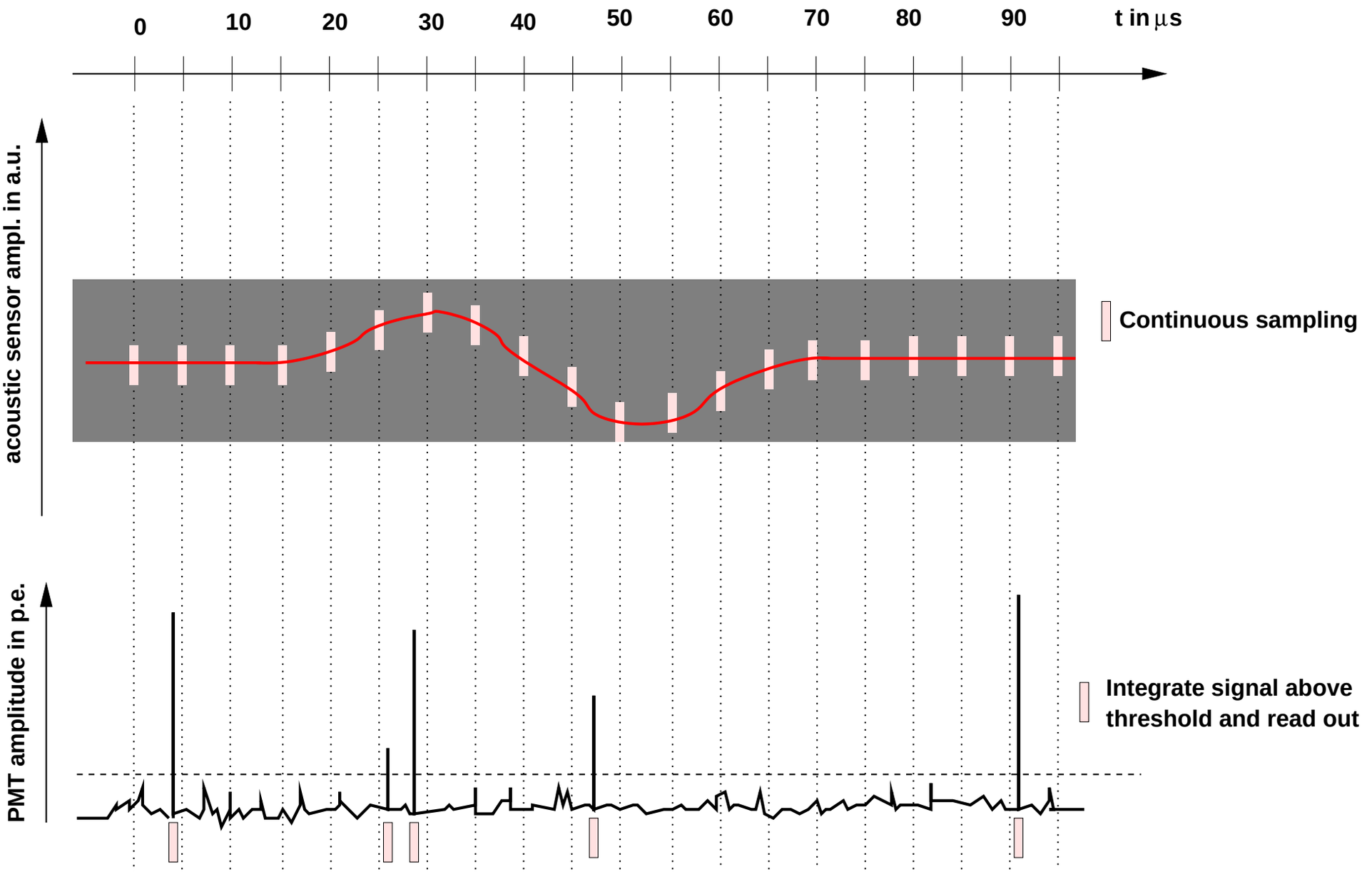
bottle neck:

data throughput of DAQ-board processor: ca. 20-25 Mb/s;

200 kHz sampling rate, 16-bit digitisation

$\Rightarrow$ 6 acoustic sensors per storey

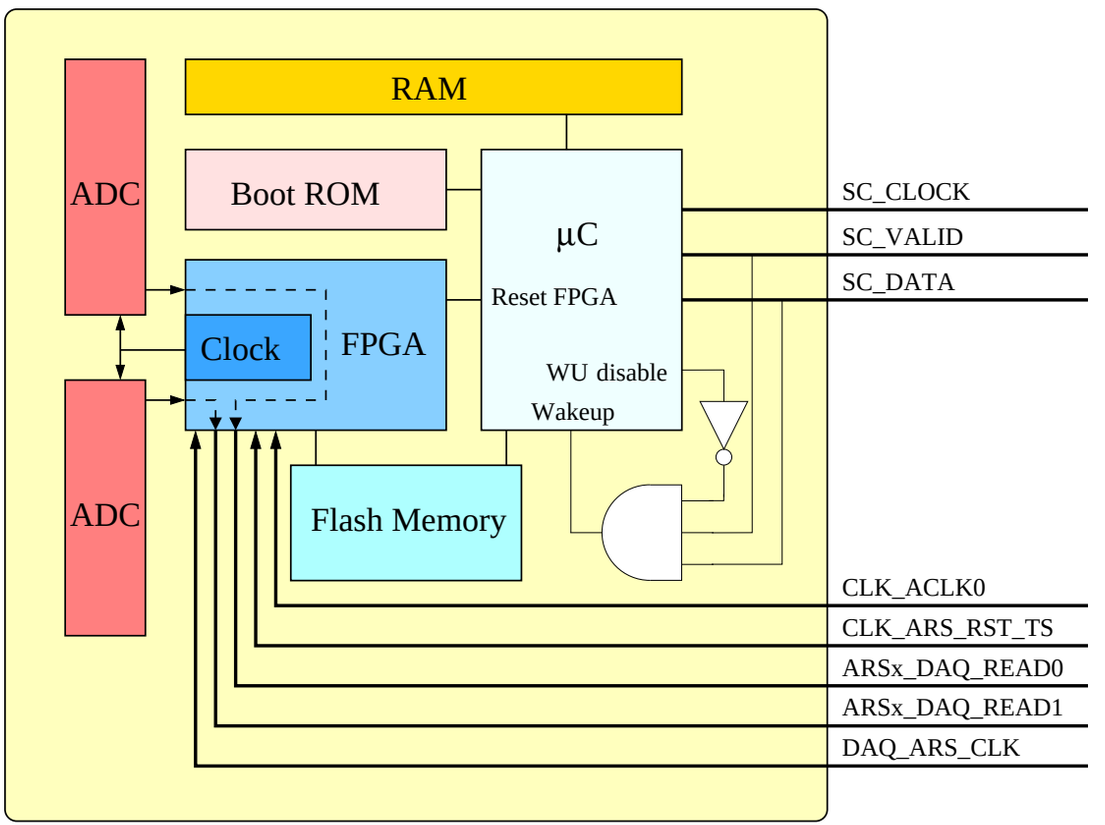
Comparison of readout of acoustic and optical data



Towards integration of acoustic sensing

Development of acoustic ADC-boards:

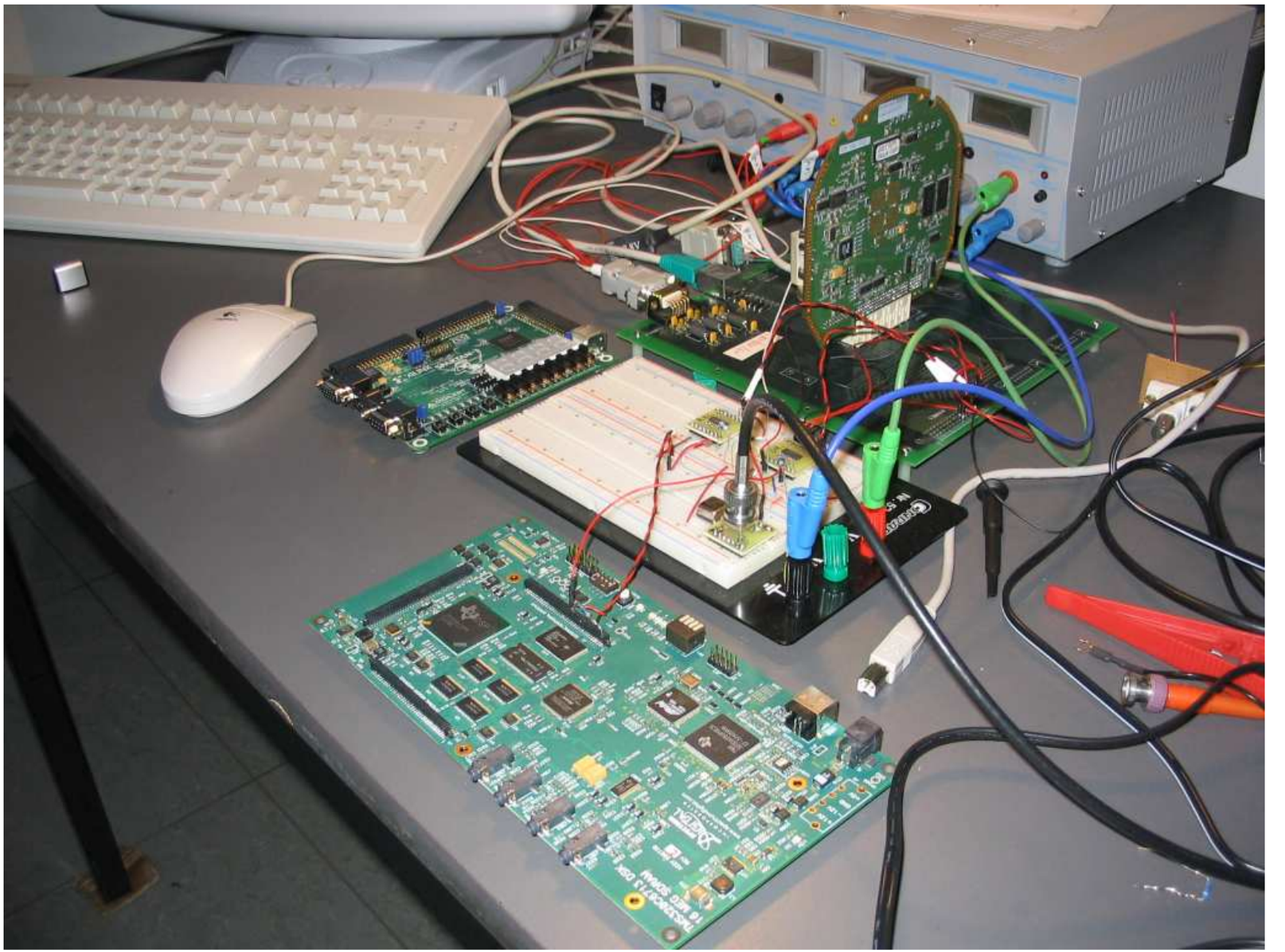
Combination of FPGA + μC will be used for readout of digitised data.



time schedule:

deadline for integration of acoustics into ANTARES: May 2006 !

The electronics test setup at Erlangen



Summary

- A conclusive concept for the integration of 60 acoustic sensors/hydrophones into the ANTARES detector has been devised by the Erlangen group.

- The development of "acoustic ADC-boards" in Erlangen is progressing.

Thank you for your attention!