GVD OPTICAL MODULES AND OTHER MECHANICS: EXPERIENCE AND PROGRESS

ALEXANDER DOROSHENKO, INR RAS, FOR

VLVNT CONFERENCE, 2 OCT. 2018, DUBNA

Outline

Deepwater modules - experience and progress

- Improvements of the elements
- Production facilities progress

Deepwater cables - modernization

- New string configuration
- Communication and carrier cables production

Deployment equipment – evolution

- Mounting winches
- Ice works
- Bottom cable - double laying

Deepwater modules - experience

Overall design of the optical module and electronic modules of Baikal-GVD was developed mainly to 2015

Further refinements were based on the experience of operation of the telescope and mass production of the components

EXPEDITION-2017: SERIOUS PROBLEMS

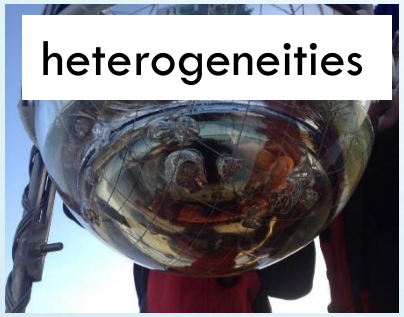
- Numerous leakages (water infiltration inside module housing) due to bad-quality commercial sealing tape, which was commonly used early
- Large number of defective brass nuts for fixing the modules

We had to do:

- express purchase another sealant (recommended) and perform **repeated sealing of all modules of Cluster 2 (**two weeks spent in EXP-2017)
- **extensive repair of Cluster 1 in EXP-2017** (replacement of 30 Oms) **and EXP-2018** (replacement of 45 OMs, drying and testing of 15 electronic modules at 7 strings), replacement of all brass nuts by stainless steel ones with a copper coating

Need purchase serial products only from reliable suppliers (sometimes this leads to long waiting times)

PROBLEMS ASSOCIATED WITH OPTICAL COMPOUND (SILGEL 612)



EXPEDITION 2016: We found ~15 such OMs, exfoliation effects were correlated with low ambient temperatures.

CHANGES to THE PROCESS:

- The component mixing ratio A/B shifted from 1.5 to 1.4 for better adhesion
- The special clamp fixtures designed for positioning of the PMT in hemisphere
- The regulations introduced for the preparation and mixing of the components
- The environmental conditions control performed
- Treatment with a special primer applied for a permalloy shield (since 2018)

EXP – 2017, 2018: no exfoliation, but a few bubbles (~2% OMs)

PROBLEMS CAUSED BY MECHANICAL PROPERTIES OF THE GLASS SPHERES

Until 2016 we used buoyancies VITROVEX ® 17”x14mm and made all the holes ourselves. Later we began to buy such spheres with 2 holes and 2 connectors SubConn™ installed.

2016: found a lot of cracks around the holes due to bearing stress from connectors.

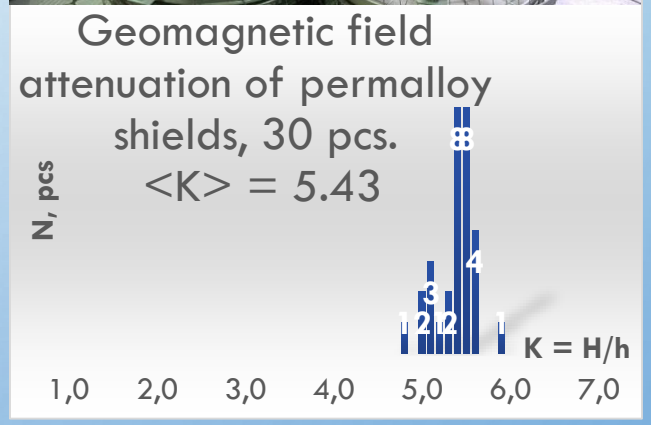
Glass cracking tests showed: for the same quality of grinding surfaces around the holes old spheres withstand tightening torque of the connector up to15 Nm without cracking, while the new ones begin to crack at 6 Nm (30% holes cracked at 15 Nm).

- **Had to use the adapter washer** recommended for the case, with slightly changed design: less thickness, better centering
- **Had to find a high-skilled manufacturer** to produce them

EXP – 2017, 2018: no cracks, no leakages

PREPARING OF MAGNETIC SHIELDS

Since **2016** we establish successfully cooperation with a small company in Ryazan to produce the wire meshes from permalloy and simultaneously with a large aircraft building plant for their annealing



Now we have in stock
~2000 shield sets ready to annealing
~500 sets ready to use

Reserves of crucial hardware components are forming

HOUSINGS FOR ELECTRONIC MODULES PRODUCTION

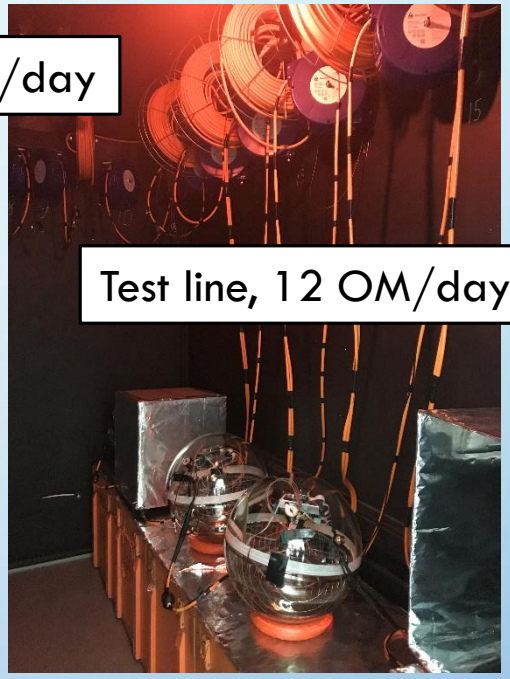
2016-2017: The special automated 4-coordinates drilling-grinding machine for the 17” glass hemispheres was designed and built.

- It drills the hole and forms the plane at any point of the envelope that you need
- The holes have a high quality and accuracy, exceed the established demands
- Manual finishing remains for the grinding plane and the chamfers
- Installation of connectors and two-sided darkening of the glass housings is performed by one trained specialist

Now we have in stock
~ 150 drilled hemisphere
~ 50 housings ready to use

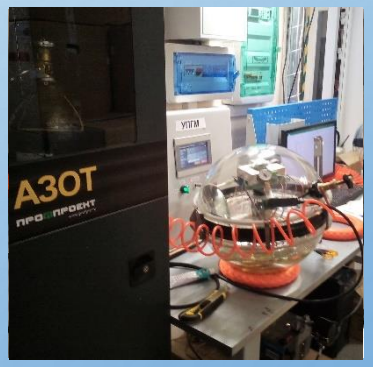
Reserves of crucial hardware components are forming

JINR FACILITIES FOR THE OPTICAL MODULES PRODUCTION

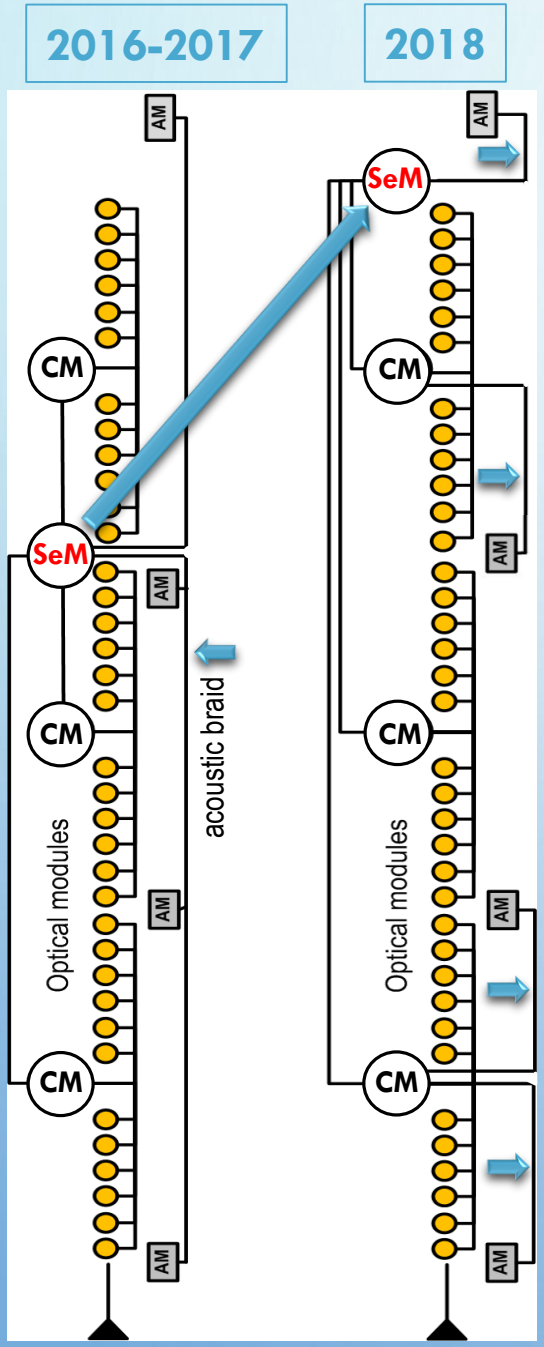


- PMT clamp fixtures: 12 sets
- Dozing and mixing system
- Central vacuum, air
- Nitrogen drying system for OM

Now we have
~ 450 OMs ready to use



Equipment allows to cope with the irregular supply of components



STRING CONFIGURATION

In the sector from the anchor to the String electronic Module (**SeM**), all deep-water equipment is held on the steel geophysical cable of a small diameter.

For the sector above **SeM** up to buoy, we use a special carrier cable containing a coaxial pair and supply line.

CHANGES in 2018:

1. SeM moved to the top of the string

\+ unification and acceleration of the string assembling

\+ simple access to **SeM** for adjustment

– longer (heavier-to-handle) some of the patch cables between Central Modules (**CM**) and **SeM**

2. Acoustic Modems (AM) connected to CM and SeM by the separate cables instead of "acoustic braid"

\+ increasing reliability of acoustic positioning system

\+ acceleration of the string assembling

String structure is significantly optimized

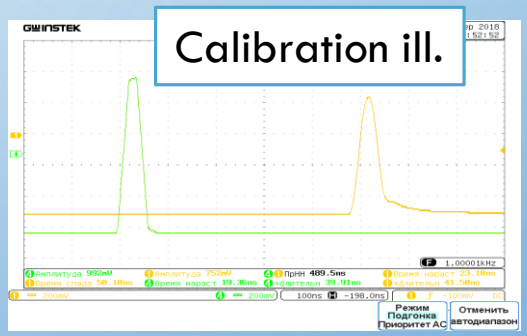
CABLES PRODUCTION - OM

Until recently, the whole assortment of linear underwater cable for Baikal-GVD was produced exclusively by PskovGeocabel' factory.
Further processing to obtaining required hermetic kits was made by our Irkutsk group.

OM cable - most common cable of Baikal-GVD
Connects **OM** with **CM**, is part of the spectrometric channel
Includes coaxial pair, power supply, slow communication line
Has 2 hermetic connectors, 2 hermetic sleeves, length 90 m

2017: Pilot batch of 16 OM cables fabricated at the plant **Expocabel'** (Podolsk)
- successfully tested in Expedition-2018 and installed in Telescope

2018:
- Calibration technique agreed with the plant
- Technical Documentation approved
- Facility for the mass production and calibration created at the plant
- **Production contract on 350 pcs prepared**



Calibration ill.

Ready-to-use industrial products are created

CABLES PRODUCTION - CARRIER

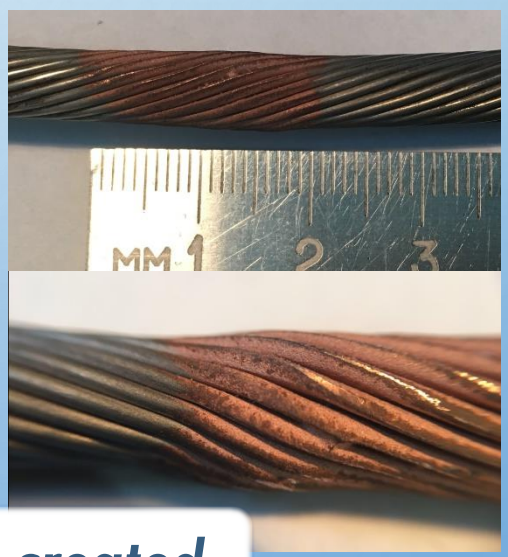
String carrier - stainless steel armored geophysical cable
The bottom part of the buoy rope of a length ~700 m
Consist of the core with 7 electrical lines and 2 armoring layers of stainless steel wires
Diameter 9.3 mm, breaking load 43 kN

2017: We placed order for the production at the plant **PermGeocabel'** (Perm')

- The batch produced covered the needs of 2 Clusters. Cluster #3 is assembled on it.
- Tests in Expedition-2018 showed the better resistance against twisting under load in comparison with the previous cable.

2018:

- Design slightly modified for the higher stability to low ambient temperatures
- Plant began work on applying the reliable marking to the cable with a cold gas-dynamic copper sprinkling



Production contract on the batch for 2 Clusters prepared

Ready-to-use industrial products are created

Deployment resources - evolution

MOUNTING WINCHES

2018: 6 winches from the basic 10 were equipped with universal reels and sheaves.
Now they can be used with both parts of the carrier cable: thing geophysical steel cable and thick one, with plastic sheath, equipped with hermetic end sleeves.

Working height 5m and 6m
2-speed transmission
PS ~3x220V, 7 kW
Working load to 20 kN,
Weight ~3500 kg

Ice work productivity increasing

ICE WORKS

Auxiliary works in the expedition takes up most of the time and human resources

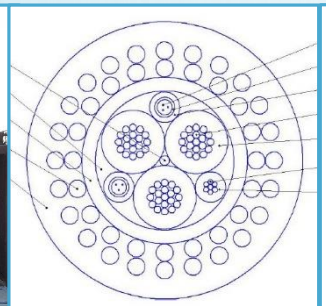
Some steps to avoid work that can be avoided:

- Single-use cable reels and cassettes (realized)
- Carrier cable marking by the plant (in process)

Ice work productivity increasing

BOTTOM CABLE - DOUBLE LAYING TO BE IN 2019

Cable was specially designed in 2015 to meet demands of Baikal-GVD project.
It is produced by PskovGeocabel'. One cable serves one Cluster.



Hybrid optical-electrical carrier cable with plastic sheath
3 single-mode optic fibers in stainless tube (x2)
3+1 electric lines of total section ~16 mm²
Working load to 18kN, breaking load 65 kN
Diameter 19.2 mm, length ~6,5 km

2011, 2016, 2017 - Made cabling, one in expedition
2018, status:

- Maintenance and repair of the laying equipment performed
- Second laying winch and cable transporter prepared
- Reserve cutting machine prepared
- Two bottom cables produced (at the factory now)

There is a willingness of the team to do this work

Deployment resources - evolution

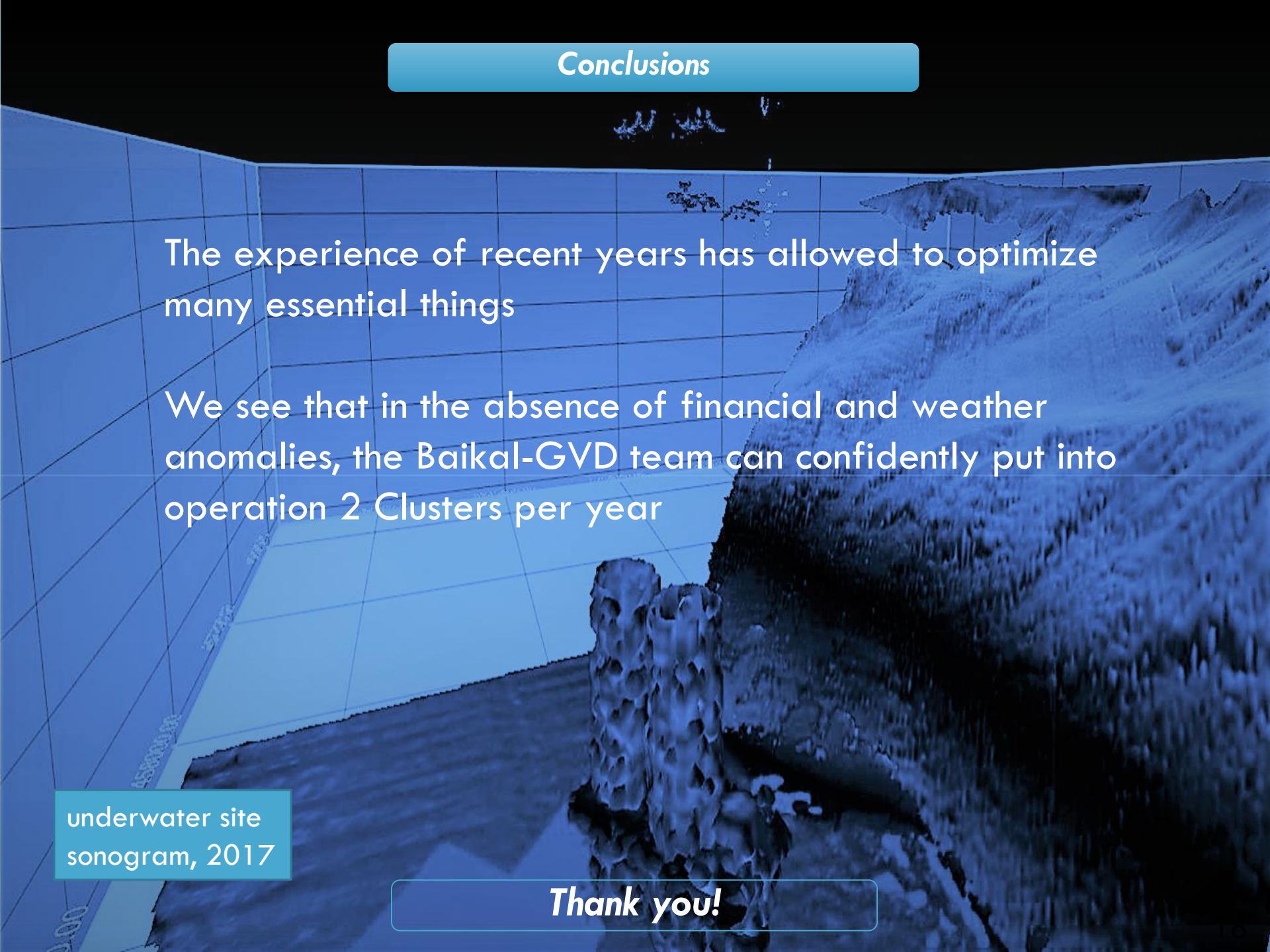
New technical capabilities
New living modules

possibilities for attracting of manpower are growing up

Conclusions

The experience of recent years has allowed to optimize many essential things

We see that in the absence of financial and weather anomalies, the Baikal-GVD team can confidently put into operation 2 Clusters per year



underwater site sonogram, 2017

Thank you!