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— CLEVER SOLUTIONS
FOR DAM SAFETY
AND MONITORING

Gianfranco Iannaccone

— INDEX

- o *Why dam monitoring?*
- o *TEL-310 **submersible** pendulum*
- o *MEXID **miniaturized** MPBX*
- o *BH **profile** inclinometers*
- o *DEX-S automatic **extenso-inclinometers***
- o *OMNIAlog **network** data acquisition system*

— WHY DAM MONITORING?

The most common causes of failure of operating dams are:

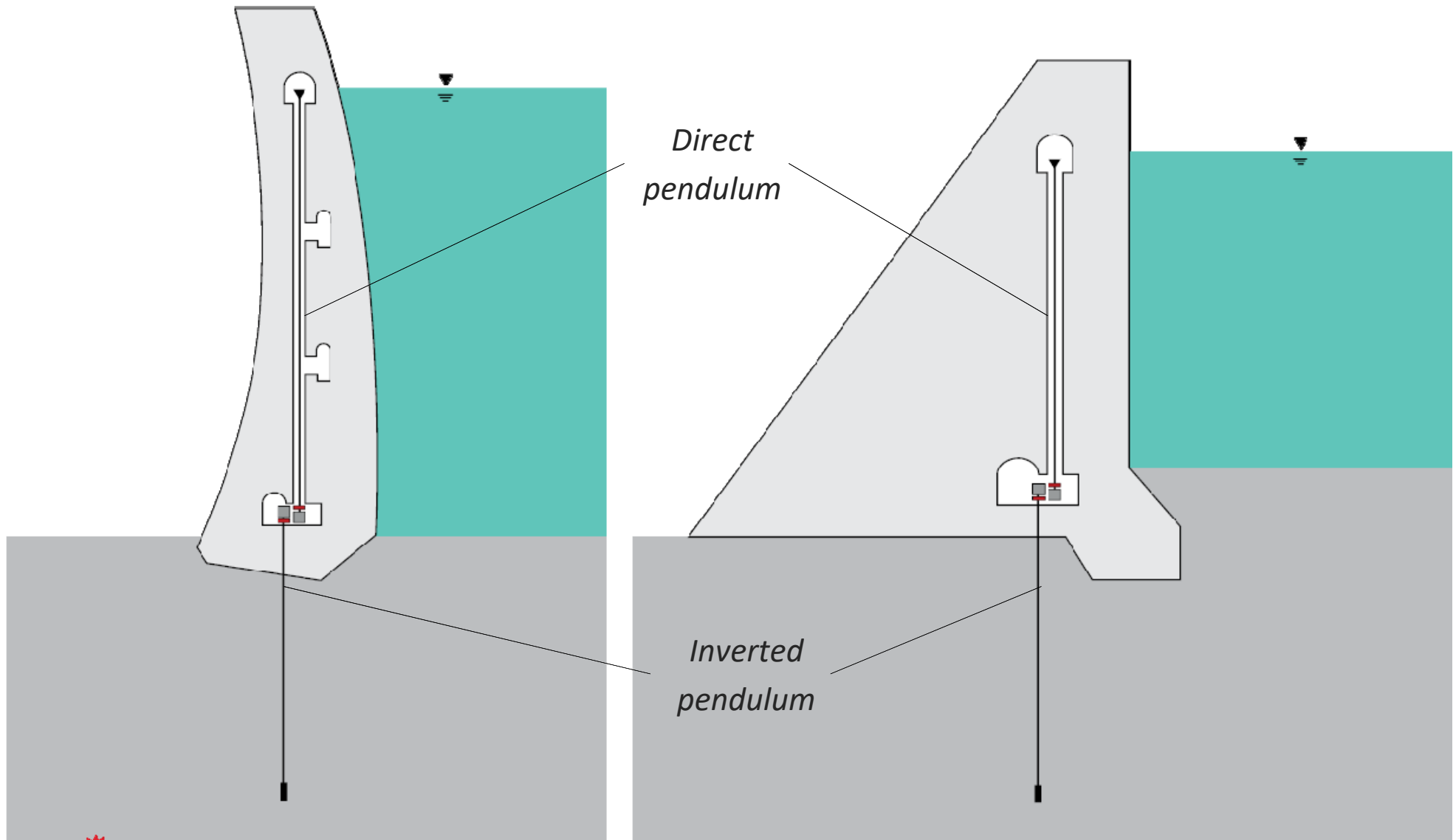
- poor construction materials
- geological instability
- landslide into reservoir
- poor maintenance
- human, computer or design error
- internal erosion (earth-fill dams)
- earthquakes

→ Inadequate monitoring system



Vajont Dam, Italy

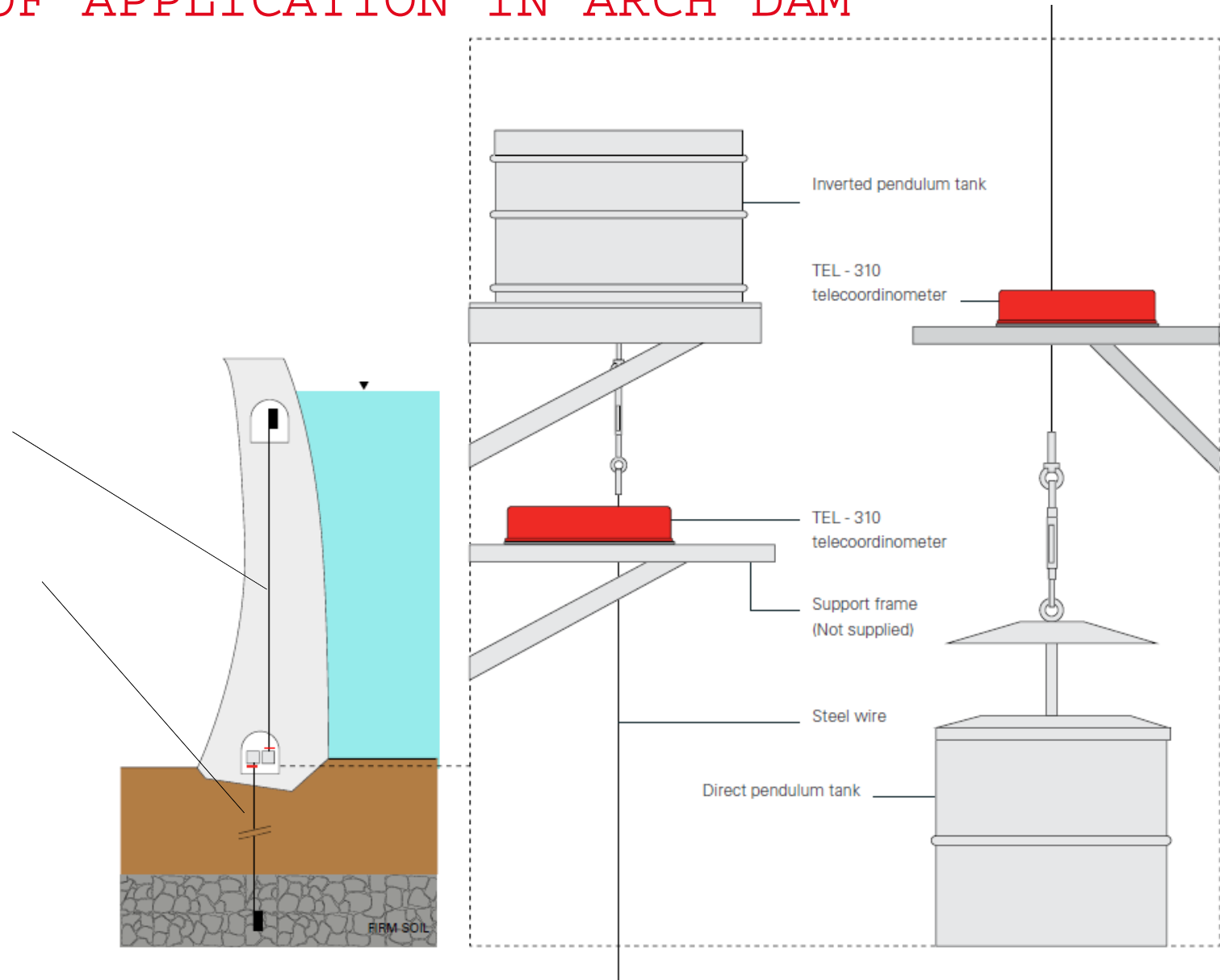
— PENDULUMS : APPLICATIONS IN ARCH AND GRAVITY DAMS



TEL-310 SUBMERGIBLE TELEPENDULUM: EXAMPLE OF APPLICATION IN ARCH DAM

Direct pendulum

Inverted pendulum



__ TEL-310 SUBMERGIBLE TELEPENDULUM

WHAT HAPPEN IN CASE OF FLOODING INTO THE GALLERIES??

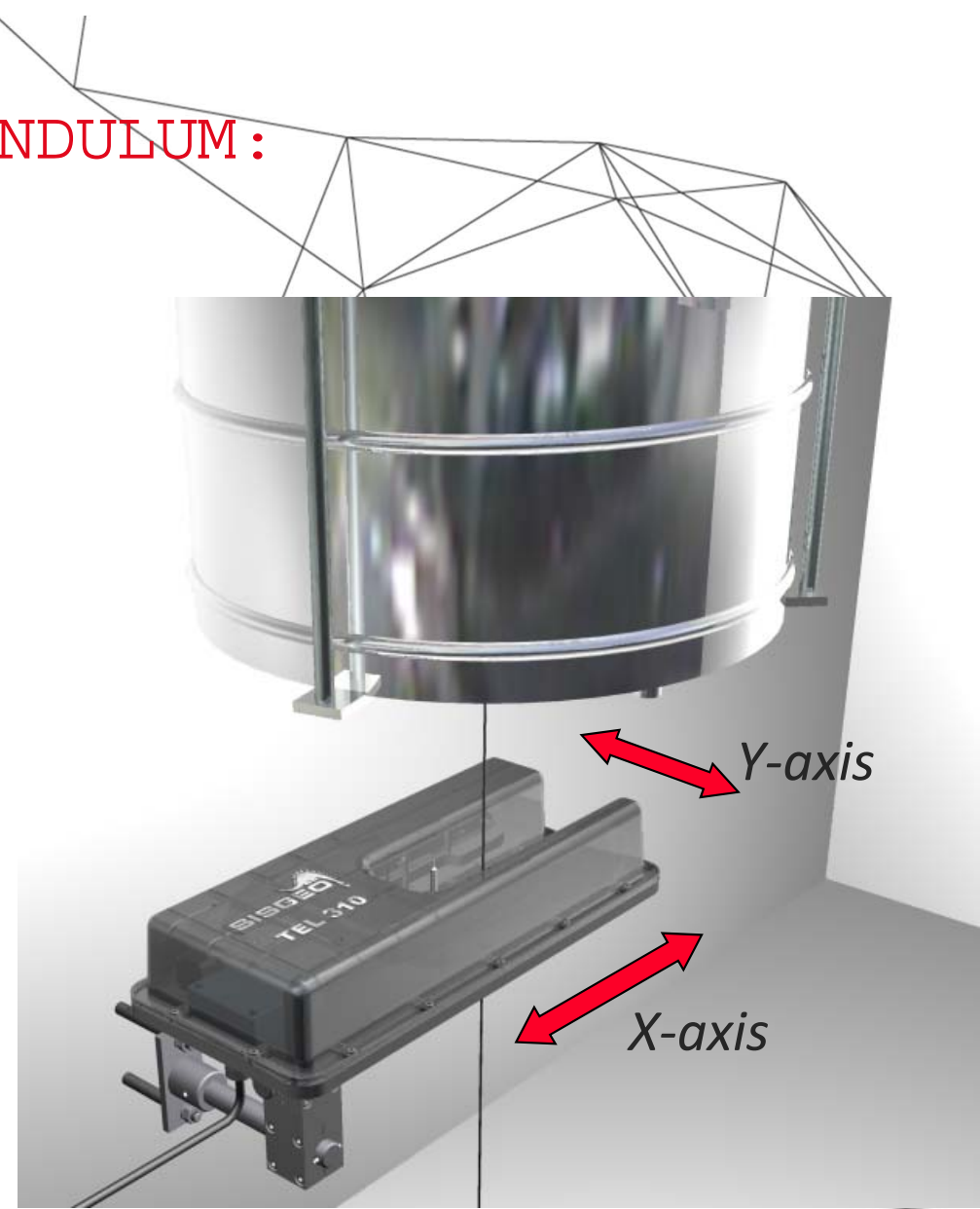
Telependulums and all their components will be submerged by water / mud

SISGEO TEL-310 telependulum is the ONLY ONE in the market with IP68 protection (waterproof).

After flooding just clean the optical unit and run!

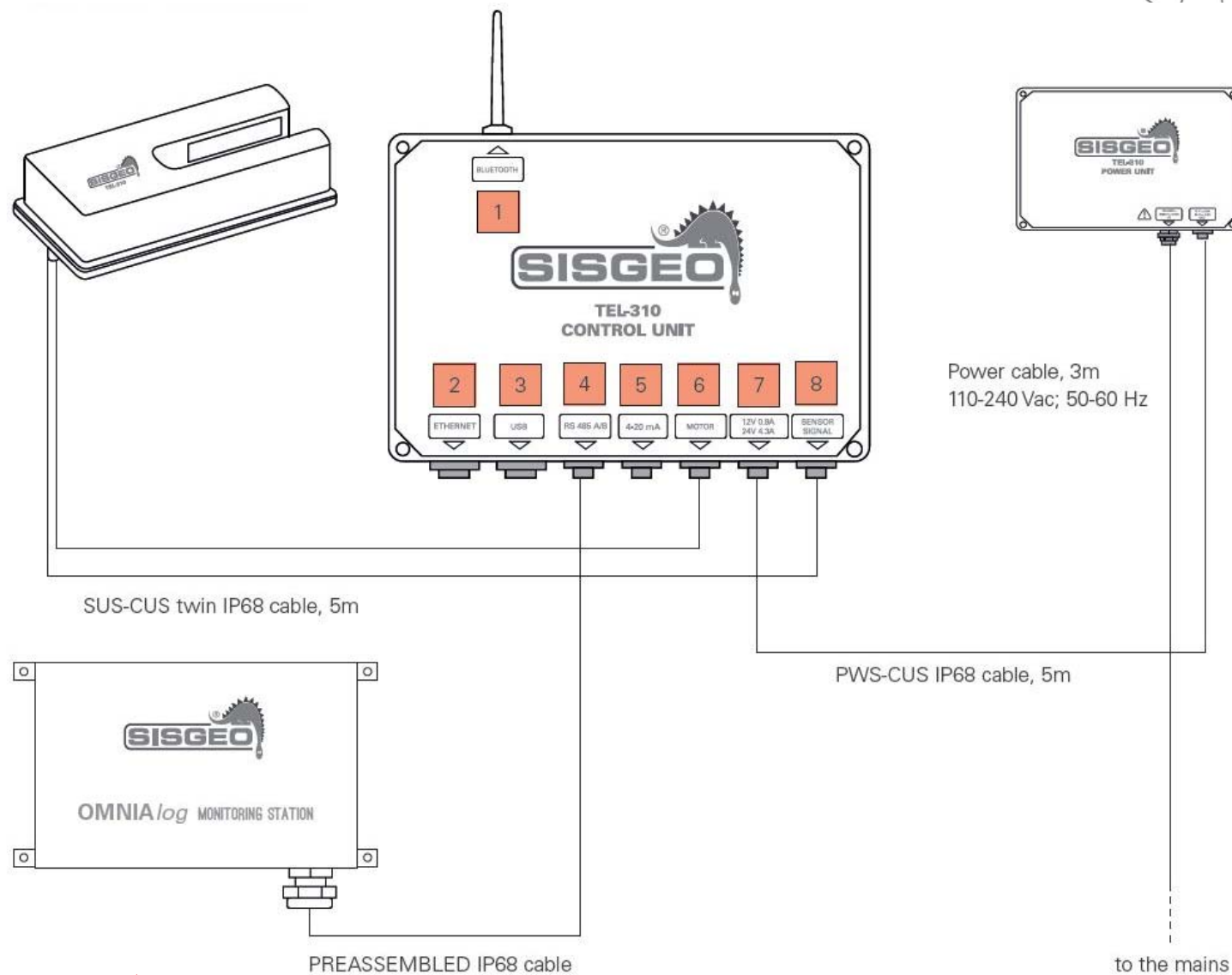
— TEL-310 SUBMURGIBLE TELEPENDULUM: MAIN FEATURES

- *Wide measuring range: 60x145mm;*
- *Waterproof components
IP68 until 50kPa (5m water head);*
- *Remote auto-diagnostic through
“log file”;*
- *High level built-in software
for data elaboration and validation.*



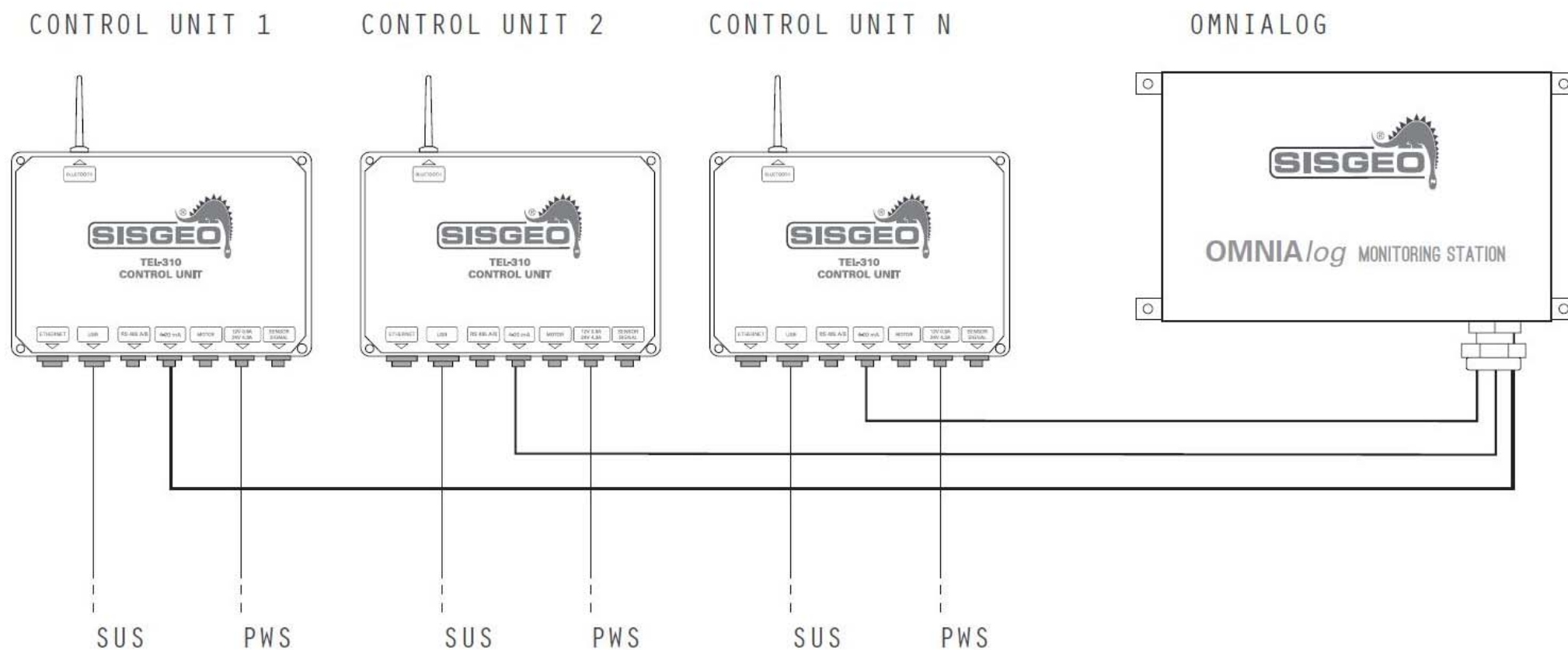
Datasheet: http://www.sisgeo.com/uploads/schede/schede/TEL310_EN_01_telependulum_telecoordinometer.pdf

TEL-310: WIRING SCHEME

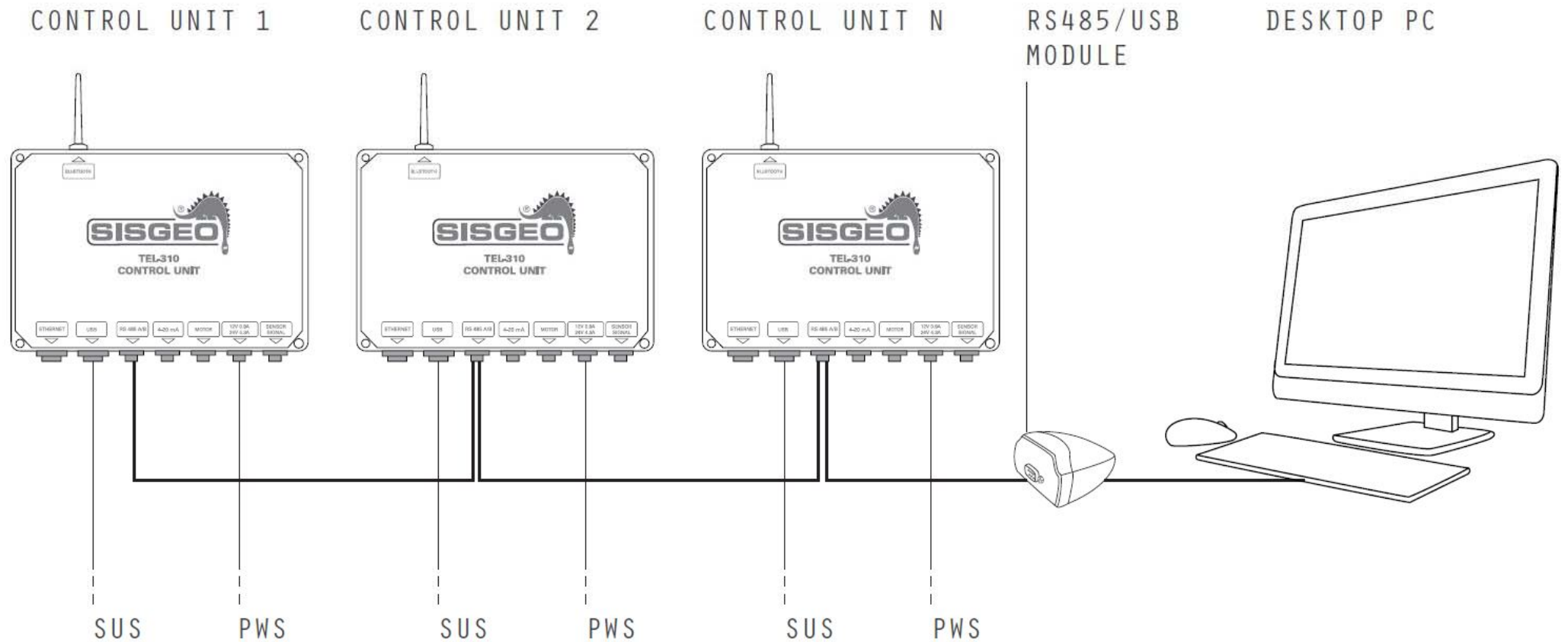


**ALL
the components
(boxes,
connectors,
cables) are
waterproof IP68
up to 50 kPa**

TEL-310: LOGGER ANALOGUE NETWORK



TEL-310: RS485-PC DIGITAL NETWORK

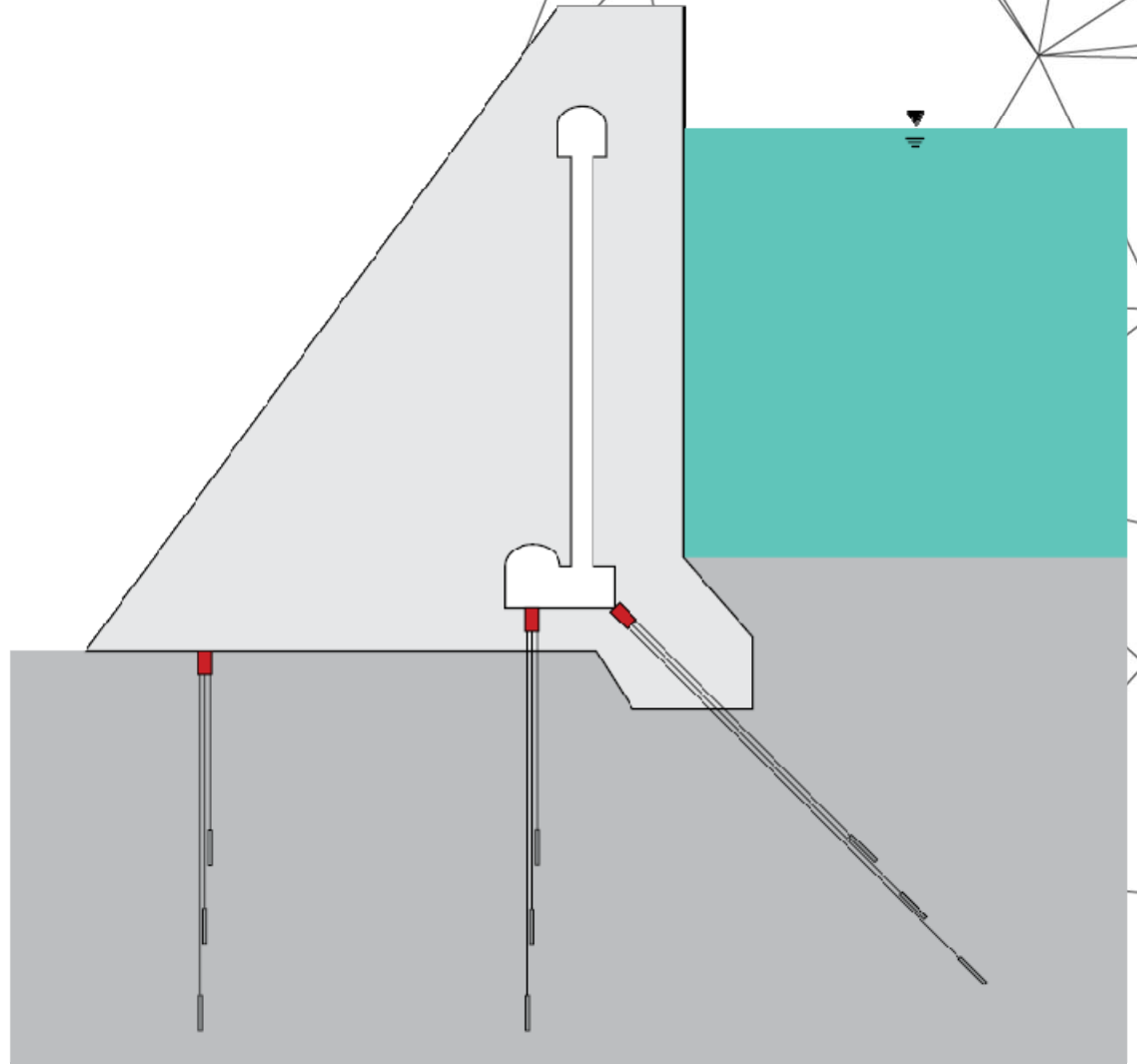
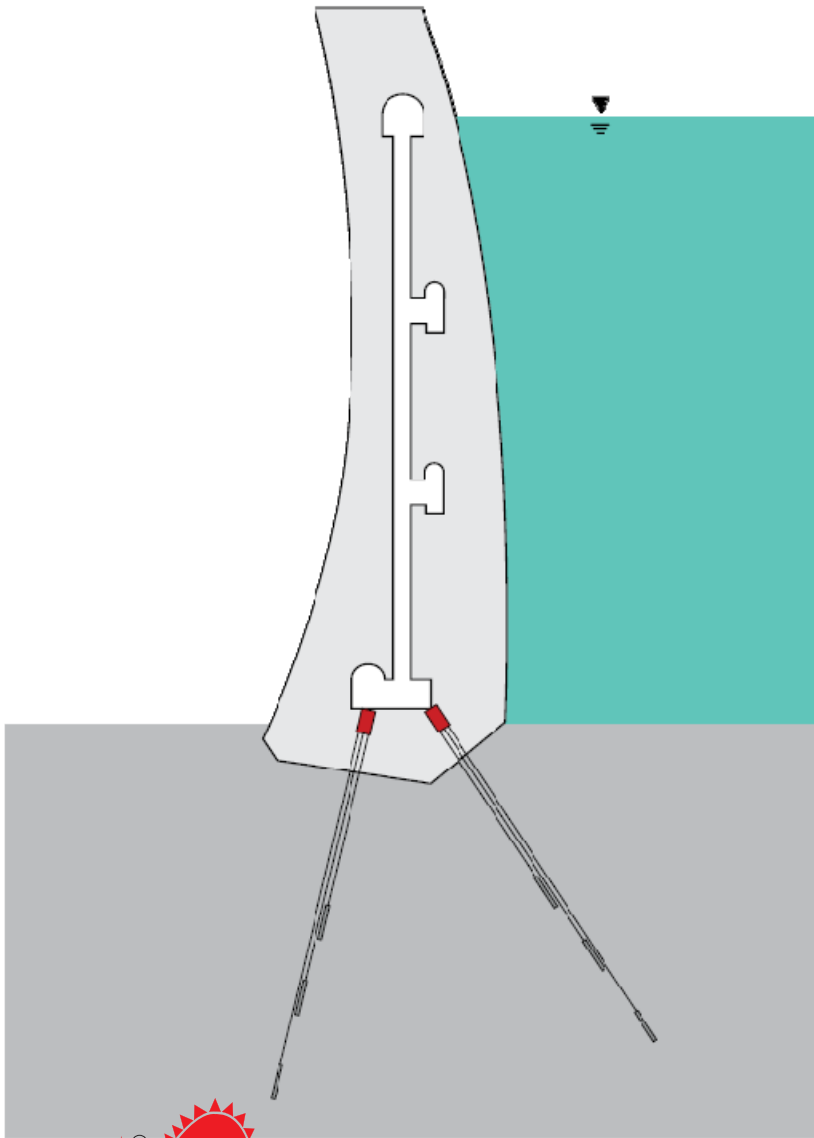


__ BOREHOLE EXTENSOMETERS (MPBX & MEXID) : APPLICATION AND AIM

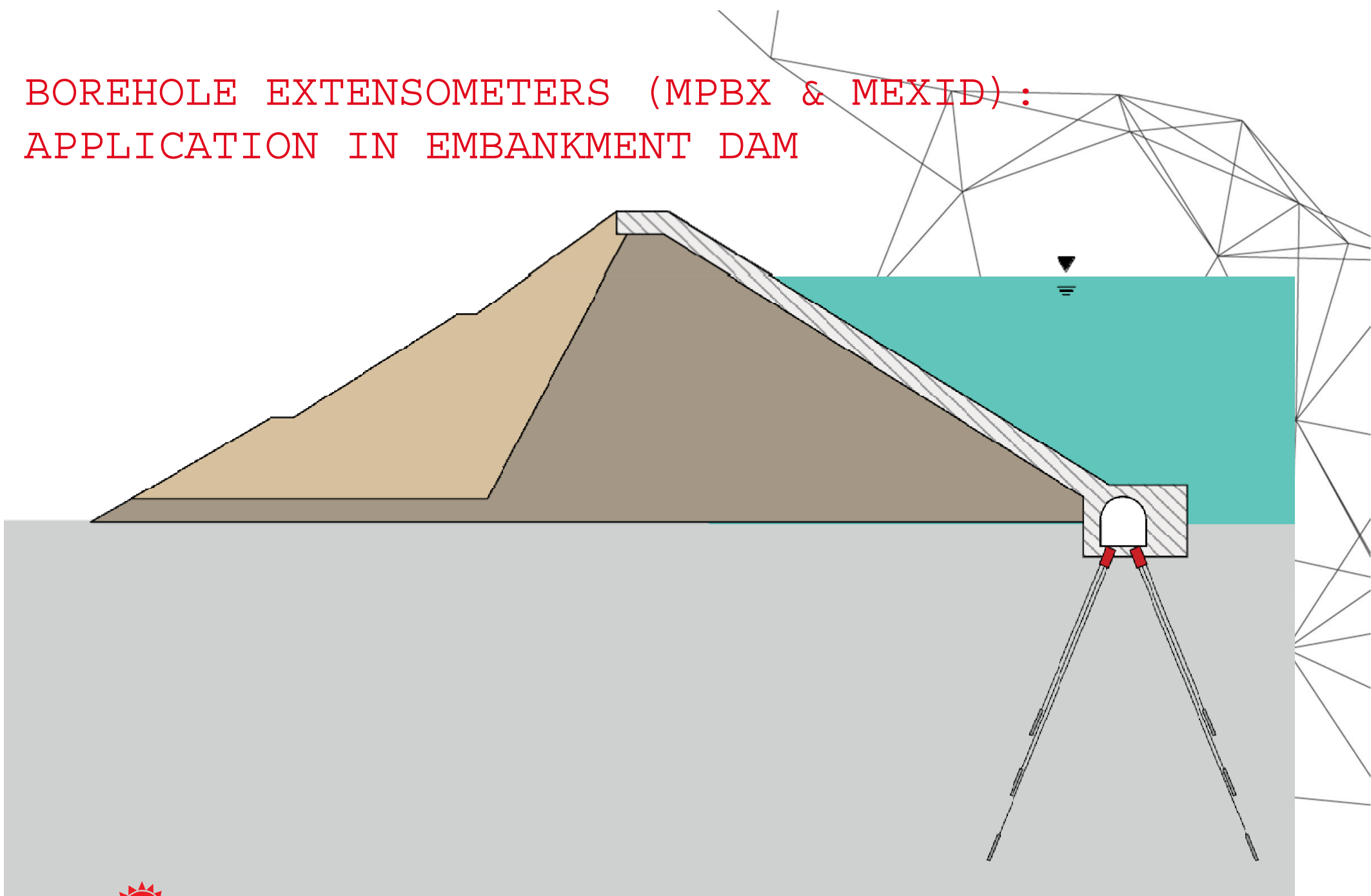
MPBX and MEXID can be installed in:

- *dam foundations*
- *dam abutments*
- *rockfall / topple landslide over the reservoir*

__ BOREHOLE EXTENSOMETERS (MPBX & MEXID) : APPLICATION IN ARCH AND GRAVITY DAMS



— BOREHOLE EXTENSOMETERS (MPBX & MEXID) :
APPLICATION IN EMBANKMENT DAM



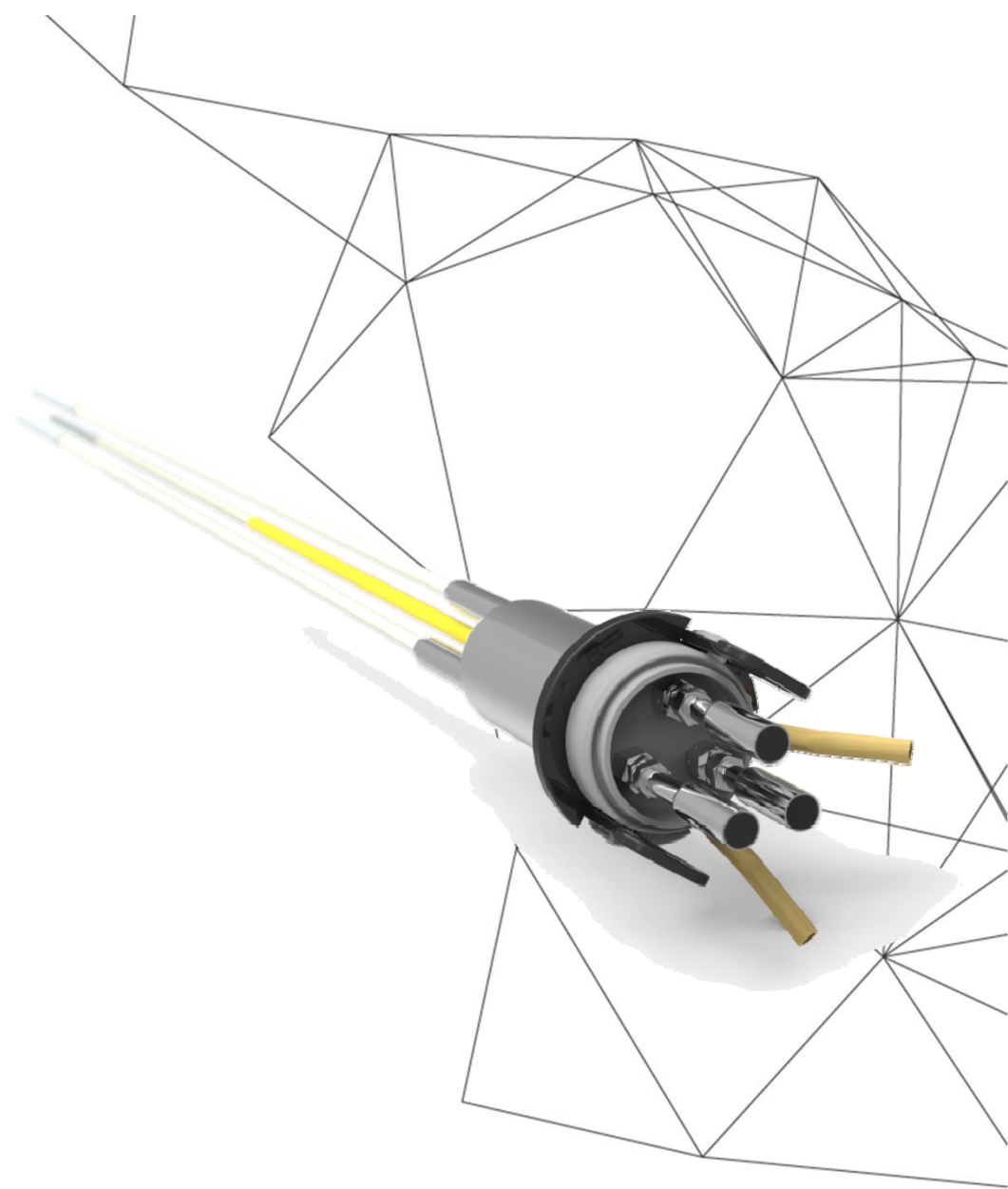
— BOREHOLE EXTENSOMETERS: WHY MEXID?

*Sometimes to drill the borehole for
MPBX become a problem or
impossible:*

Required drill hole:

Ø 101 mm (4"),

Ø140 mm (5.5") first meter



— BOREHOLE EXTENSOMETERS: MEXID SOLUTION

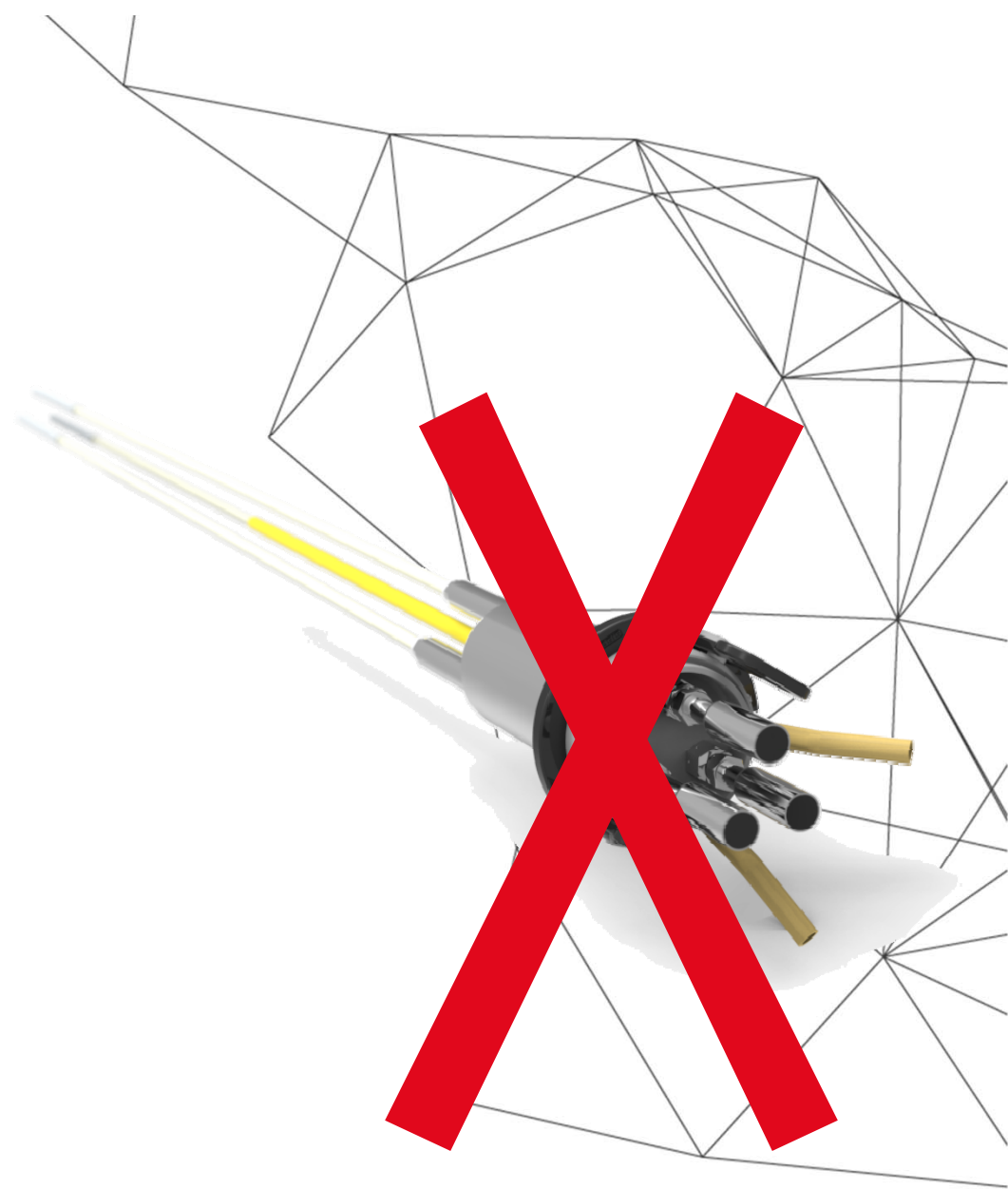
*Sometimes to drill the borehole for
MPBX become a problem or
impossible:*

Required drill hole:

Ø 101 mm (4"),

Ø140 mm (5.5") first meter

i.e.: DAM REHABILITATION



— BOREHOLE EXTENSOMETERS: MEXID SOLUTION

Required drill hole for MEXID:

Ø 50 mm (2"),

Ø 75 mm (3") first meter

***Portable and small drilling
machine can be utilized***

Datasheet:

http://www.sisgeo.com/uploads/schede/schede/D2MX_MEXID_EN_01_mexid_miniaturized_extensometer.pdf





ENGURI DAM - Georgia

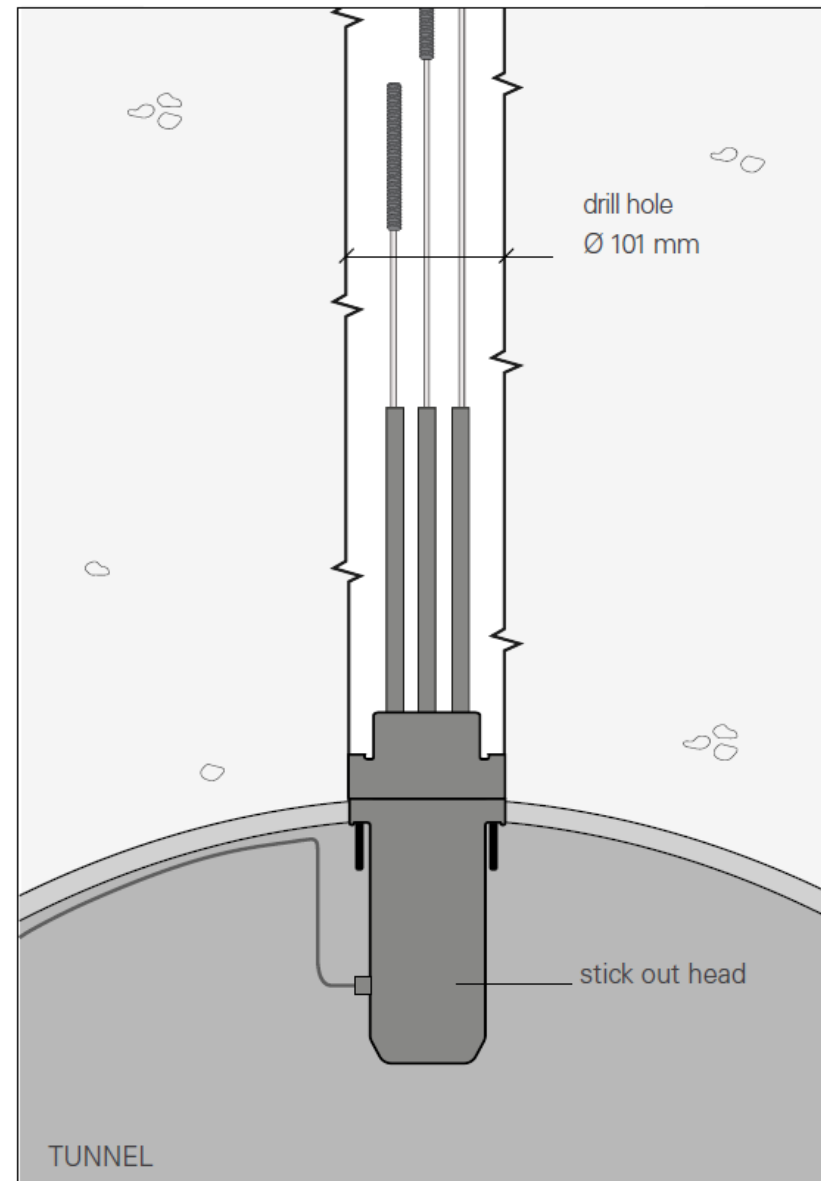
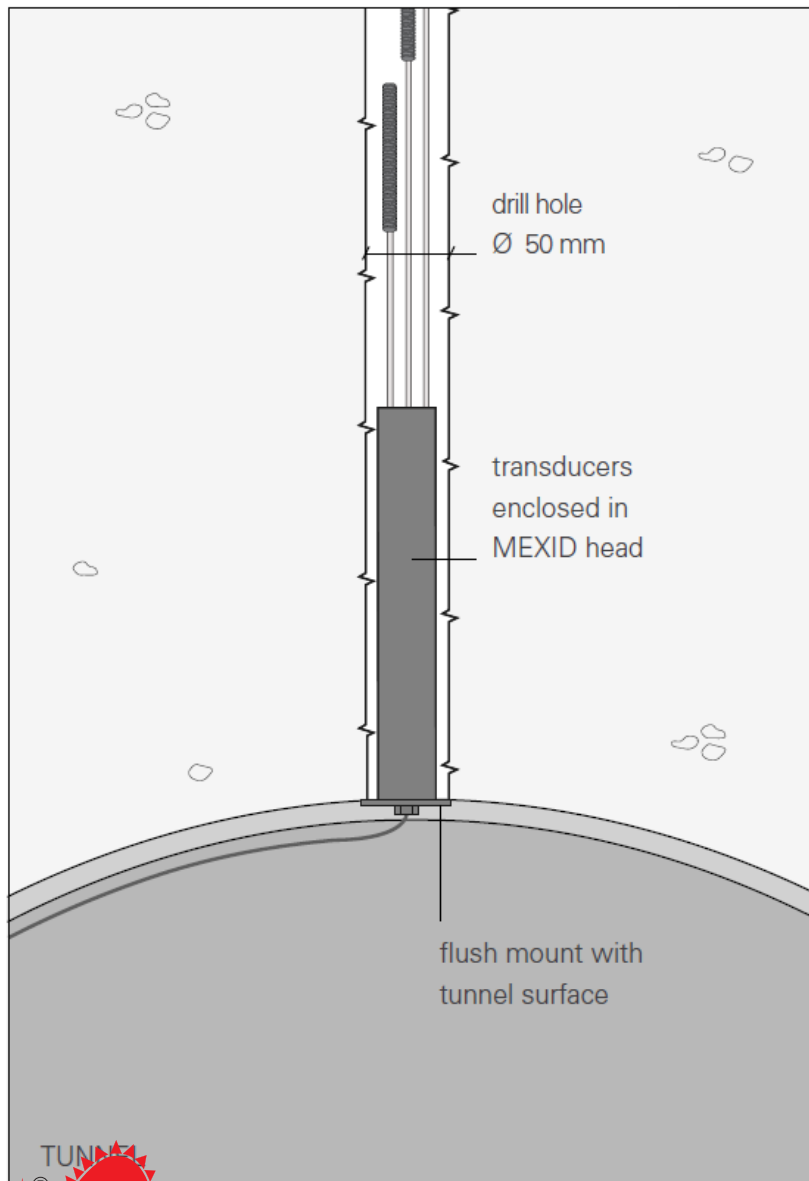


ENGURI DAM – Georgia – 2° highest arch dam in the World

MEXID

Vs

MPBX



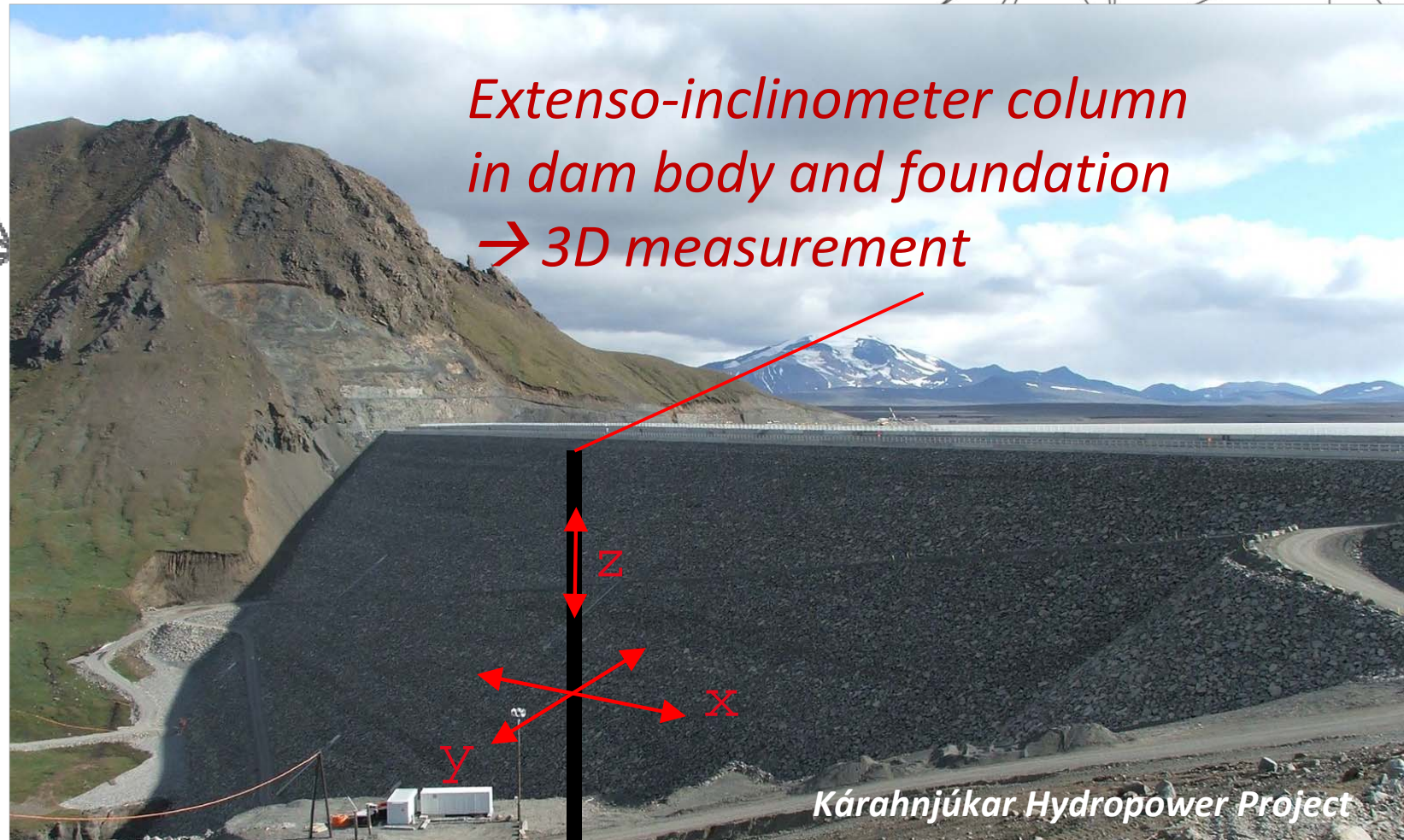
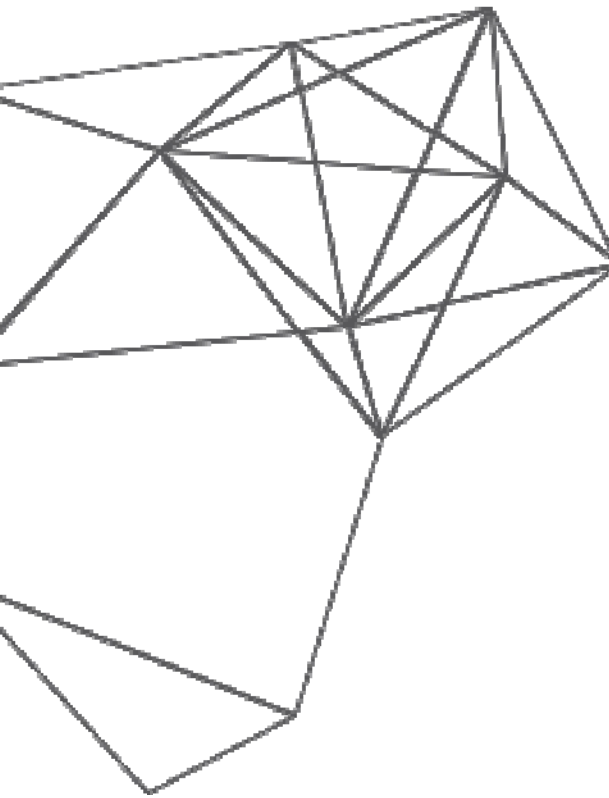
MEXID

Vs

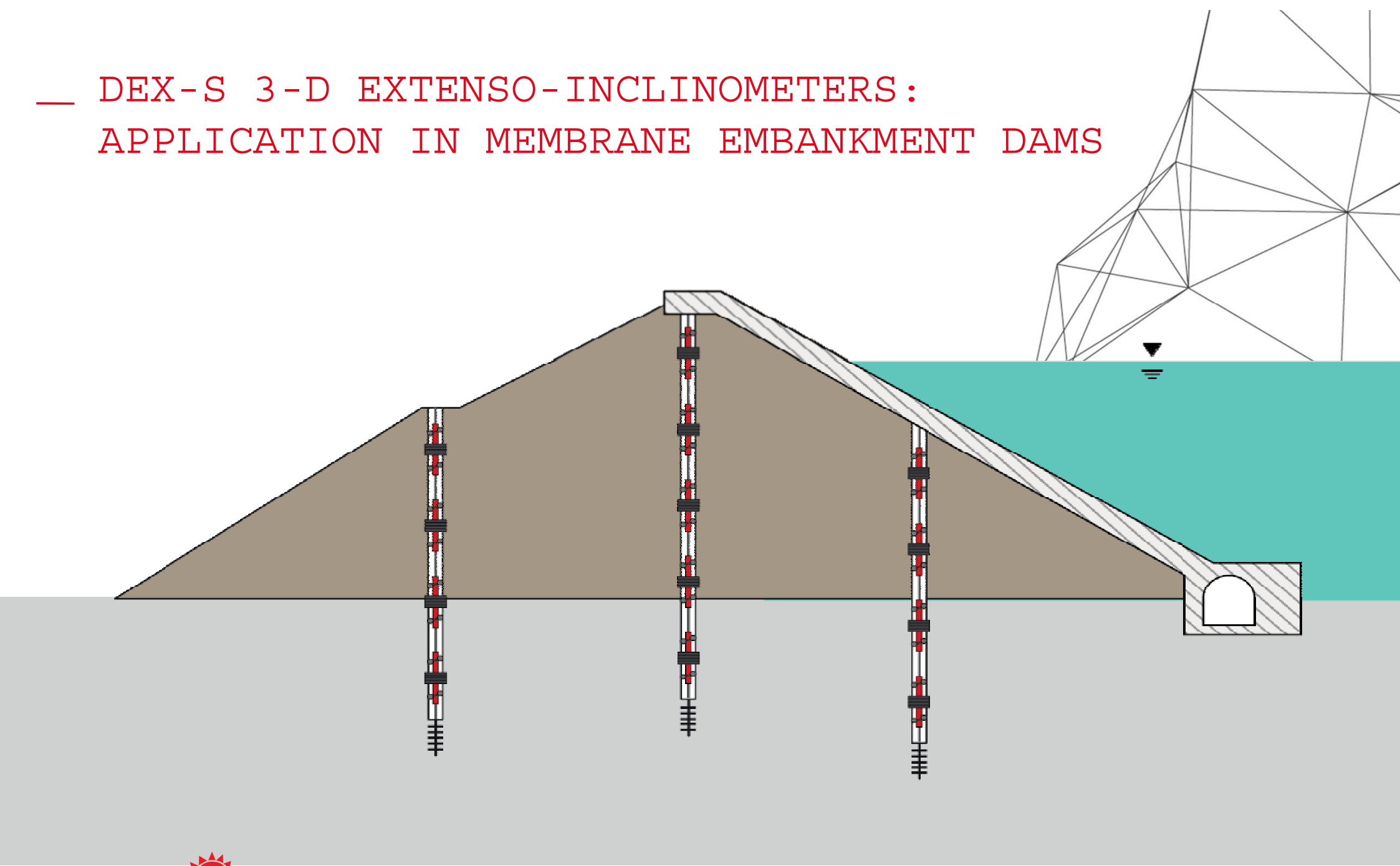
MPBX



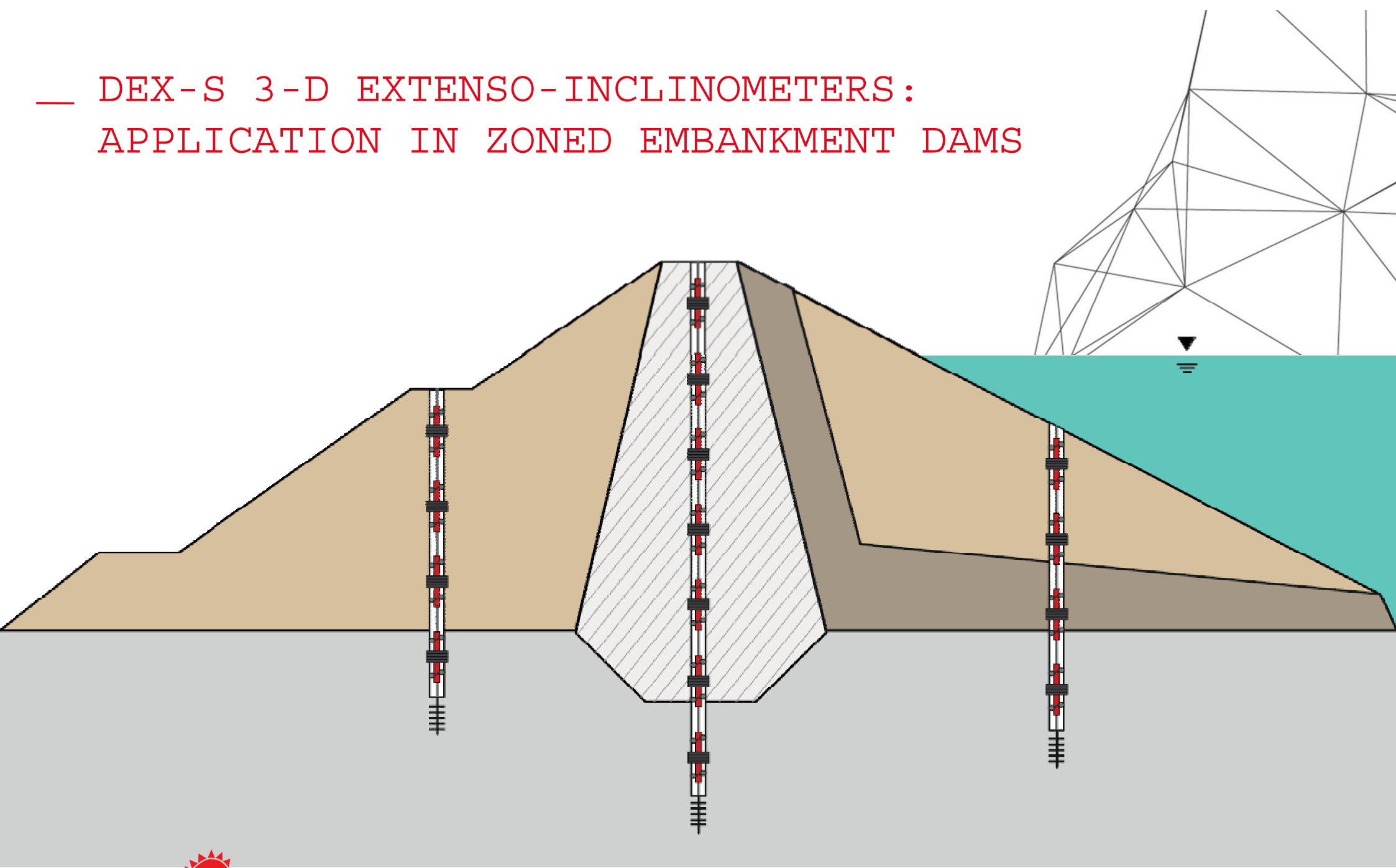
__ DEX-S 3-D EXTENSO-INCLINOMETERS



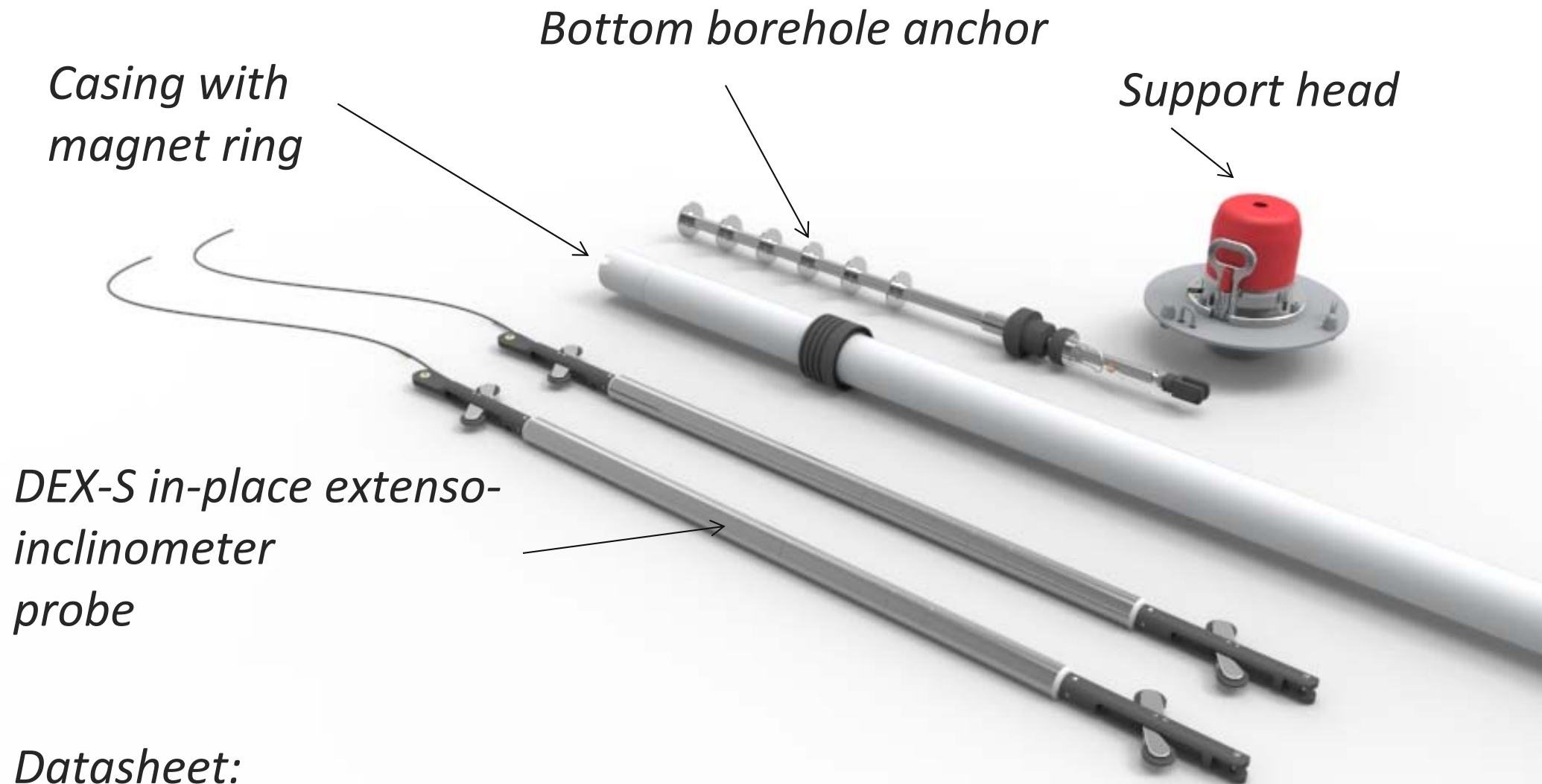
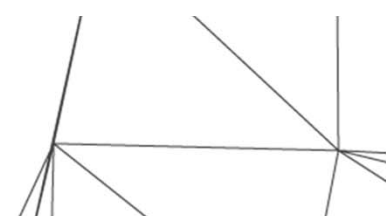
— DEX-S 3-D EXTENSO-INCLINOMETERS: APPLICATION IN MEMBRANE EMBANKMENT DAMS



— DEX-S 3-D EXTENSO-INCLINOMETERS: APPLICATION IN ZONED EMBANKMENT DAMS



__ DEX-S: MAIN COMPONENTS

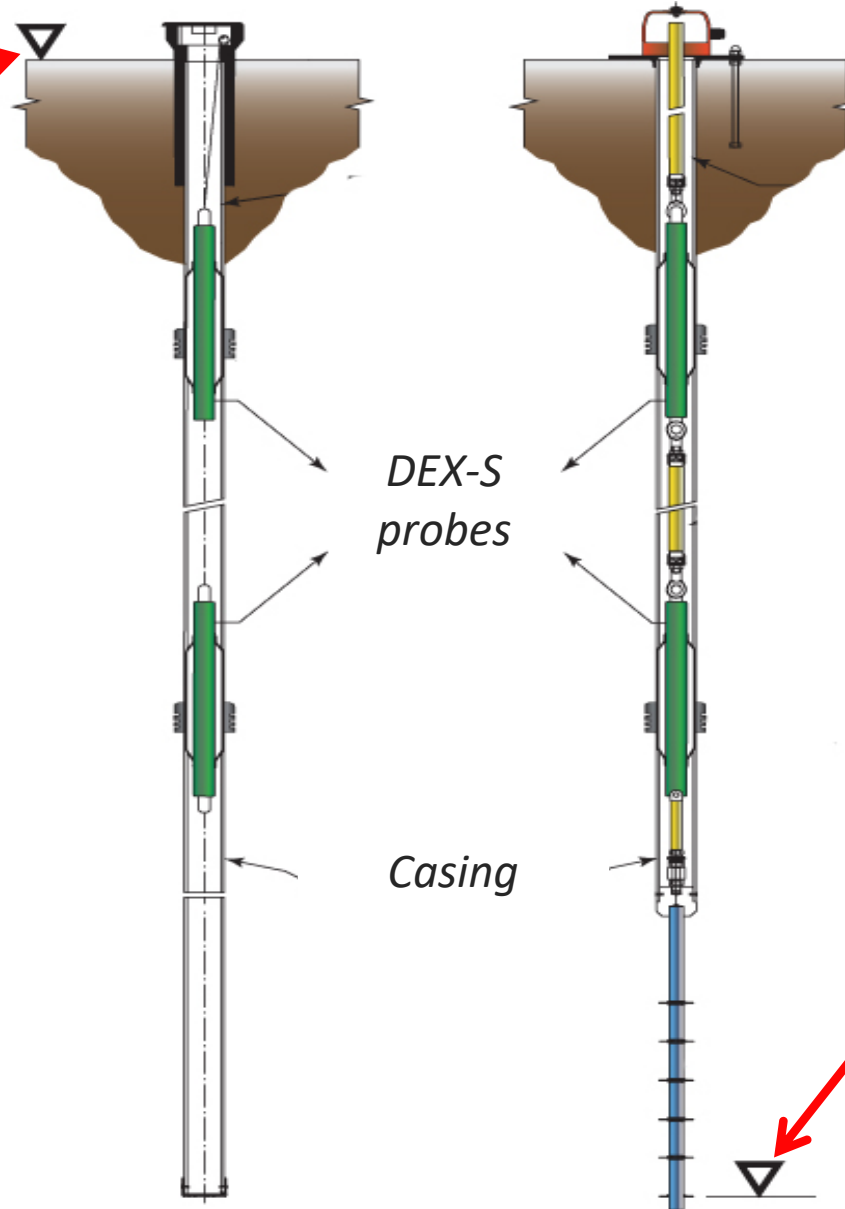


Datasheet:

http://www.sisgeo.com/uploads/schede/schede/dex_en.pdf

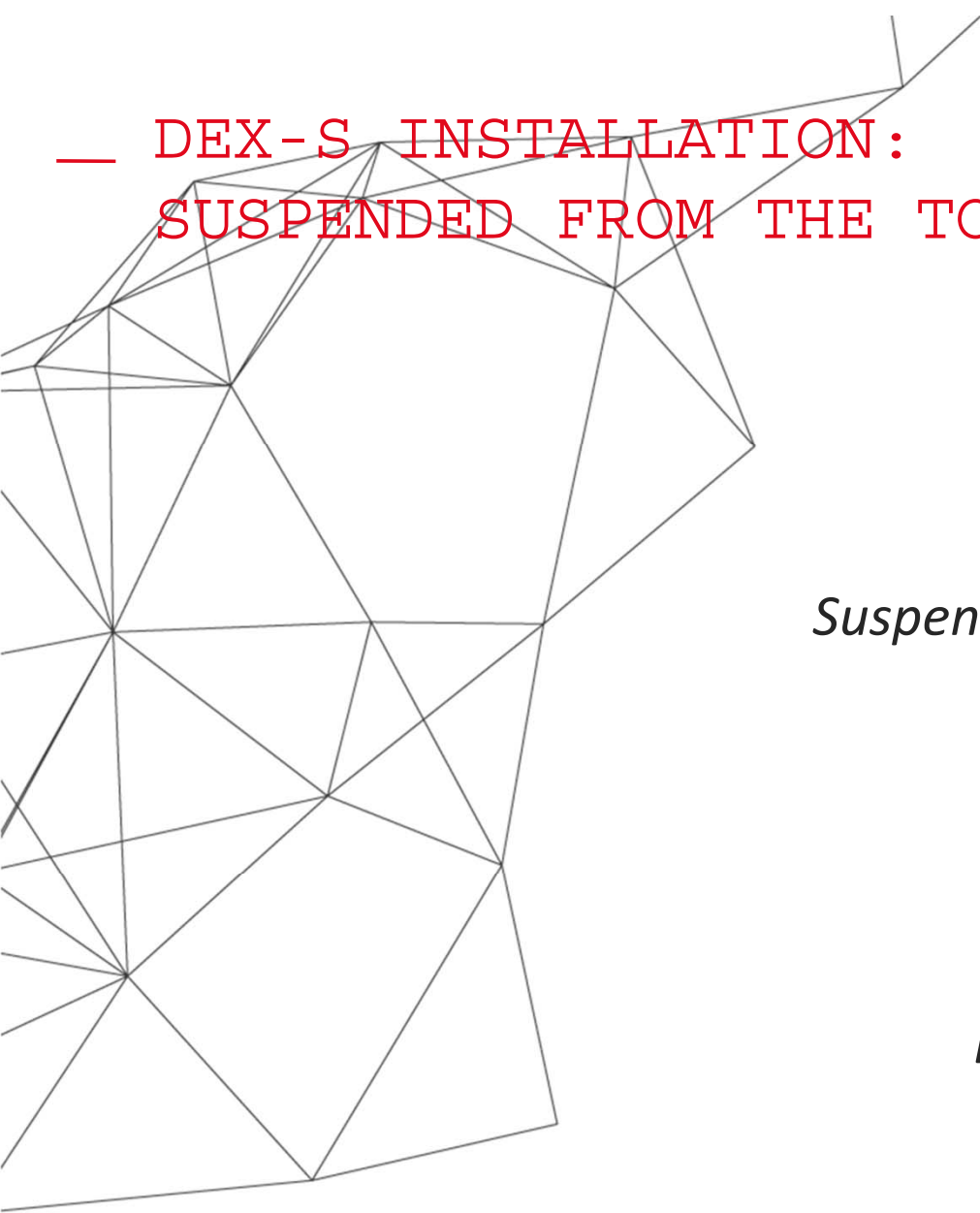
__ DEX-S: INSTALLATION METHODS

*DEX-S chain
with upper
reference
(hanging from
the top)*



*DEX-S chain
with lower
reference
(stiff chain
connected to the
bottom anchor)*

— DEX-S INSTALLATION:
SUSPENDED FROM THE TOP

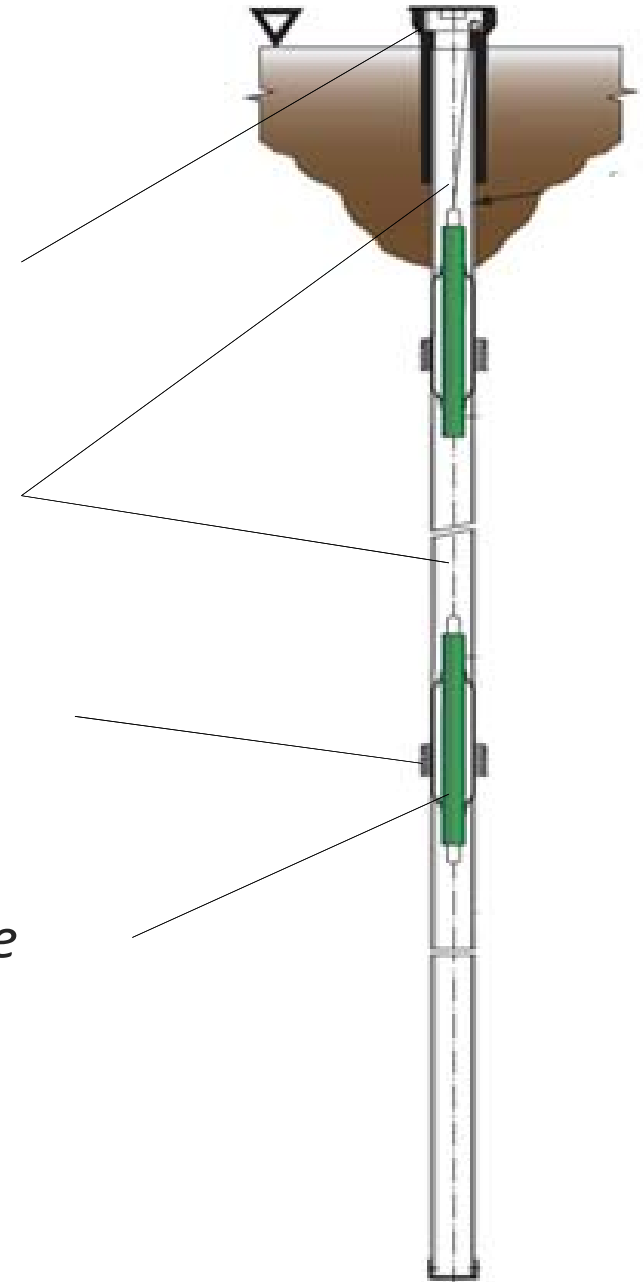


Top cap

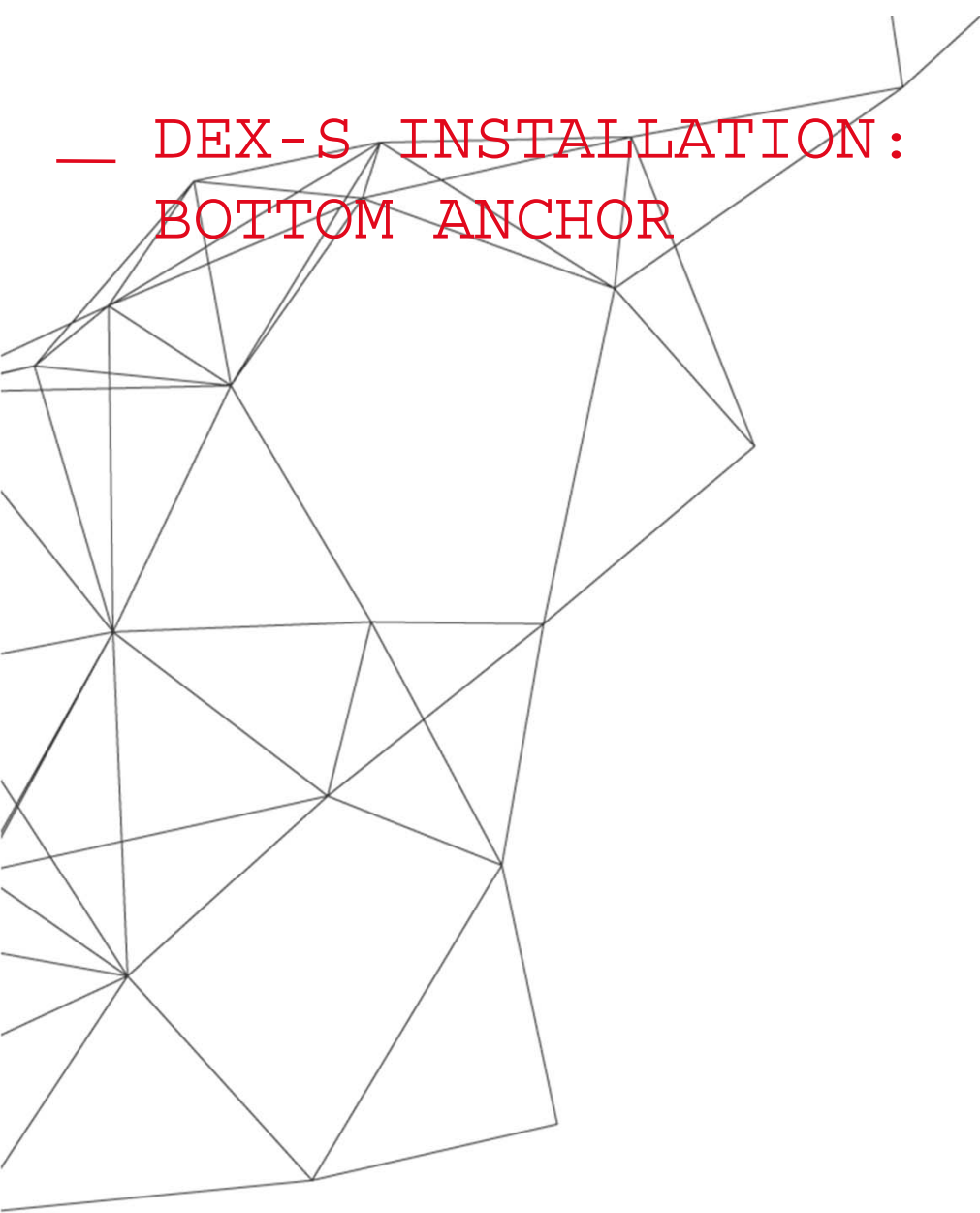
Suspending steel cable

Magnet ring

DEX or DEX-S probe



— DEX-S INSTALLATION:
BOTTOM ANCHOR

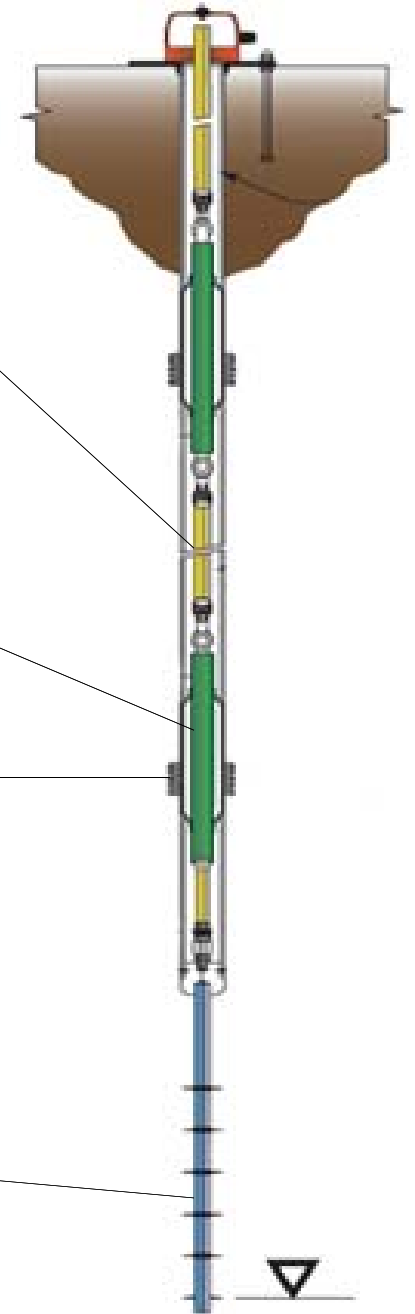


Steel placing rod

*DEX or DEX-S
probe*

Magnet ring

*Bottom anchor
reference*



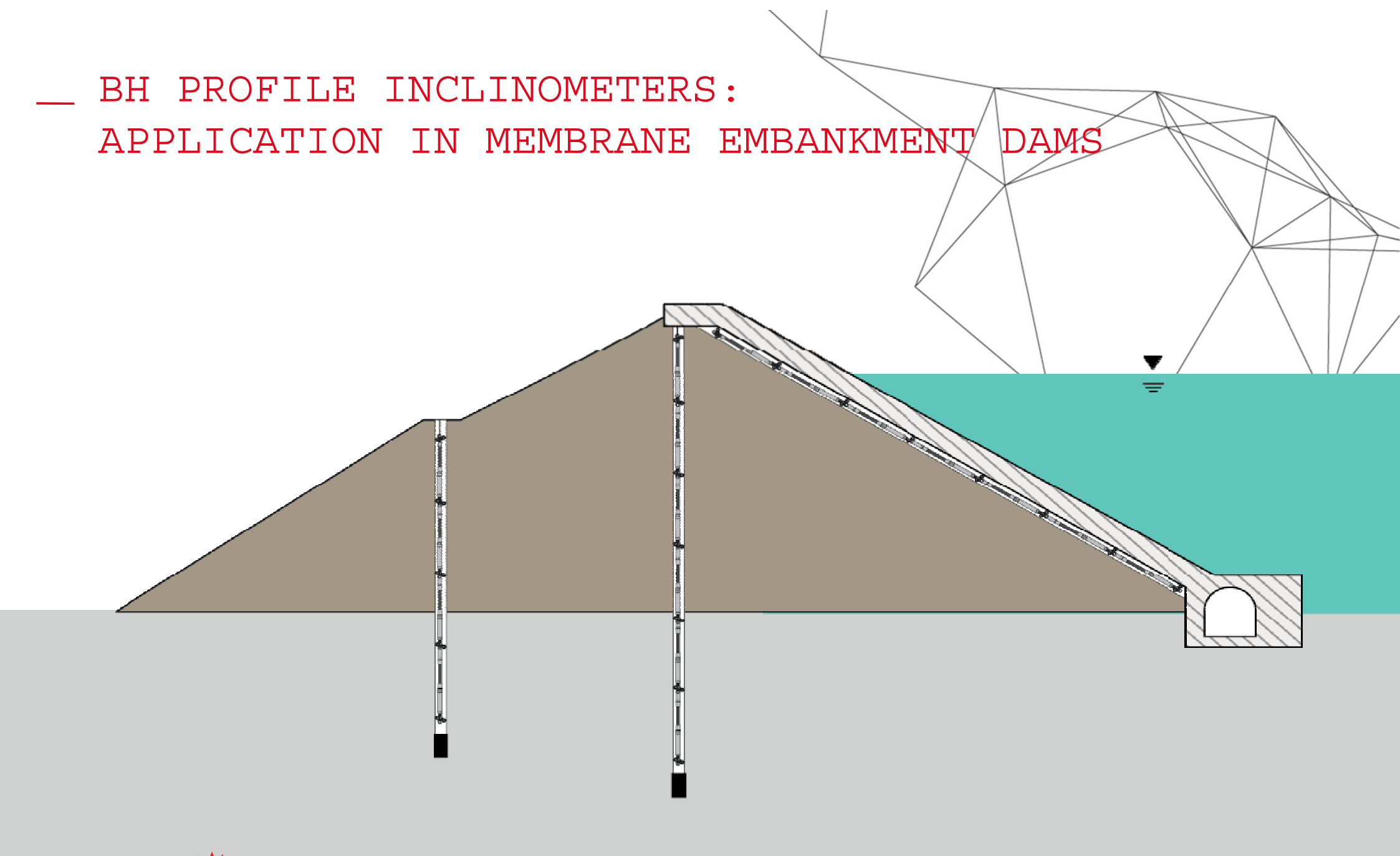
— BH PROFILE INCLINOMETERS: APPLICATION AND AIM

BH Profile inclinometers can be installed in:

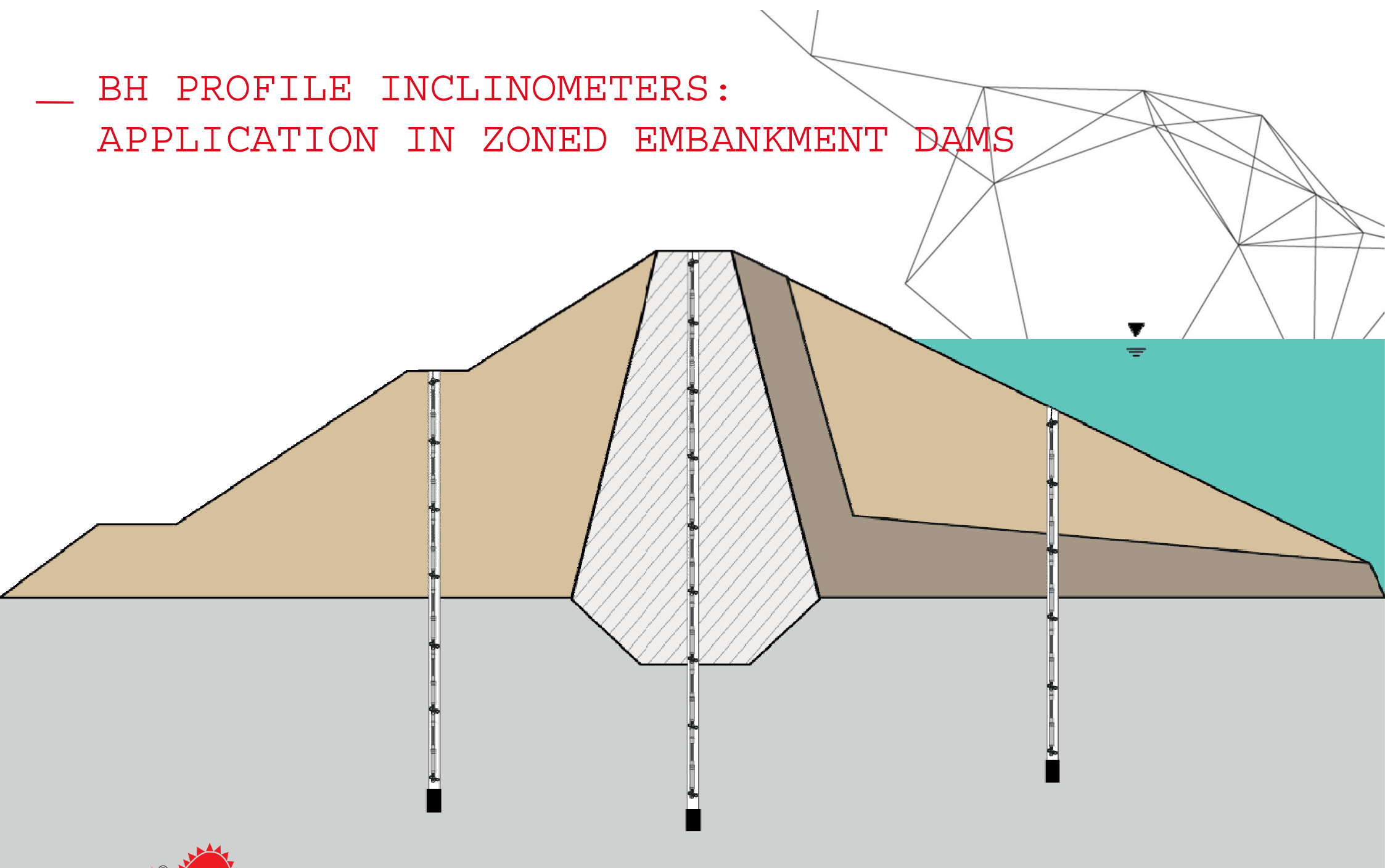
- *dam body*
- *dam upstream face*
- *dam abutments*



— BH PROFILE INCLINOMETERS: APPLICATION IN MEMBRANE EMBANKMENT DAMS



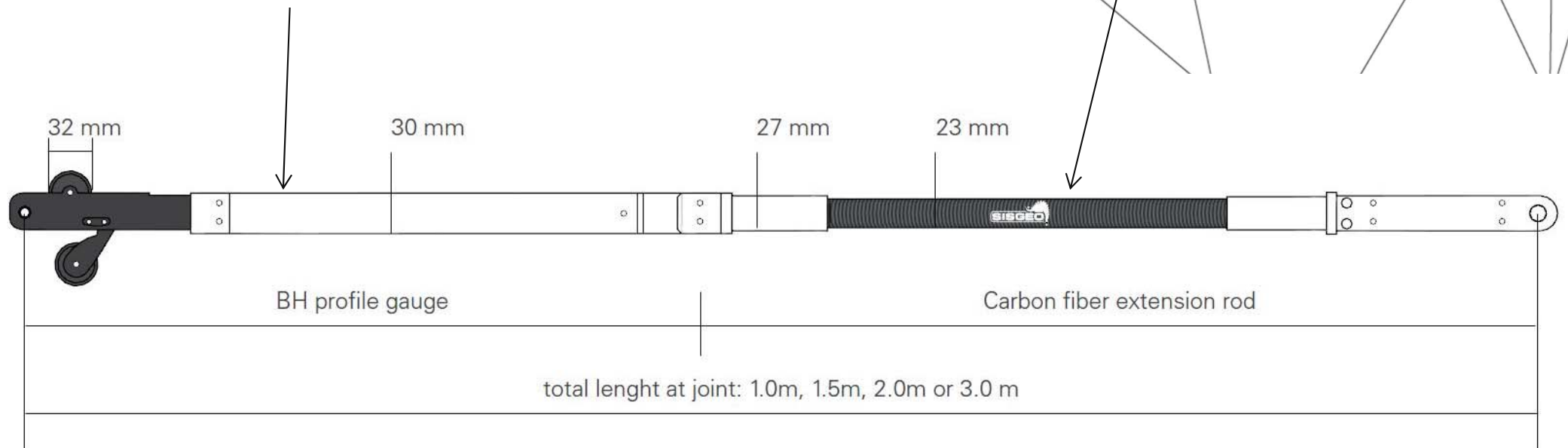
— BH PROFILE INCLINOMETERS: APPLICATION IN ZONED EMBANKMENT DAMS



__ BH PROFILE INCLINOMETERS: COMPONENTS

*Inclinometer sensor
(digital MEMS)*

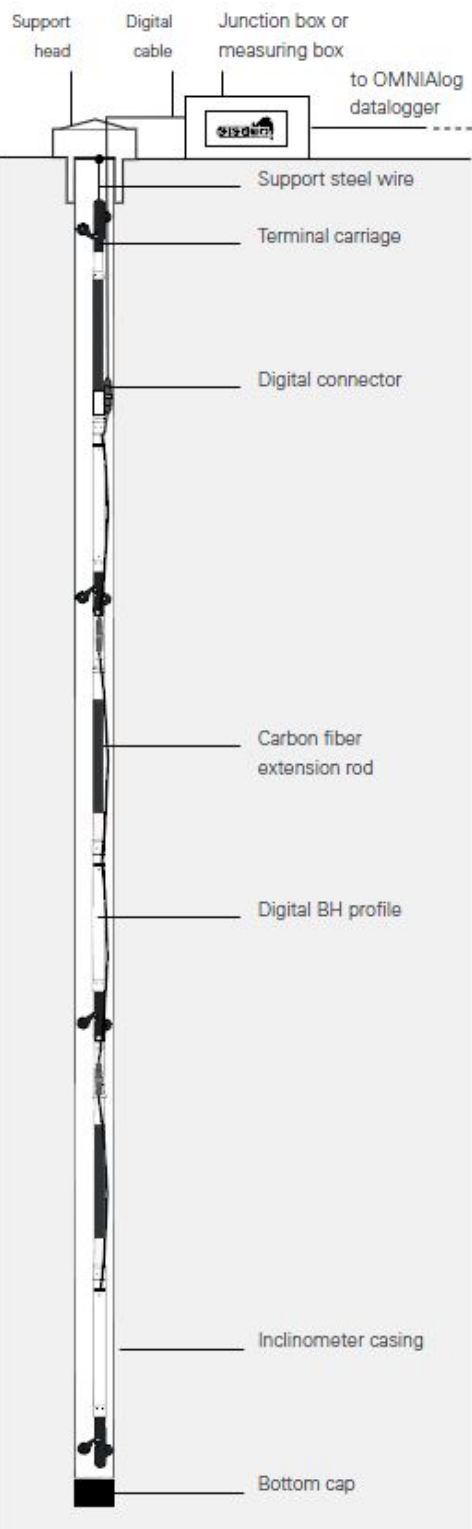
*Carbon fiber
extension rod*

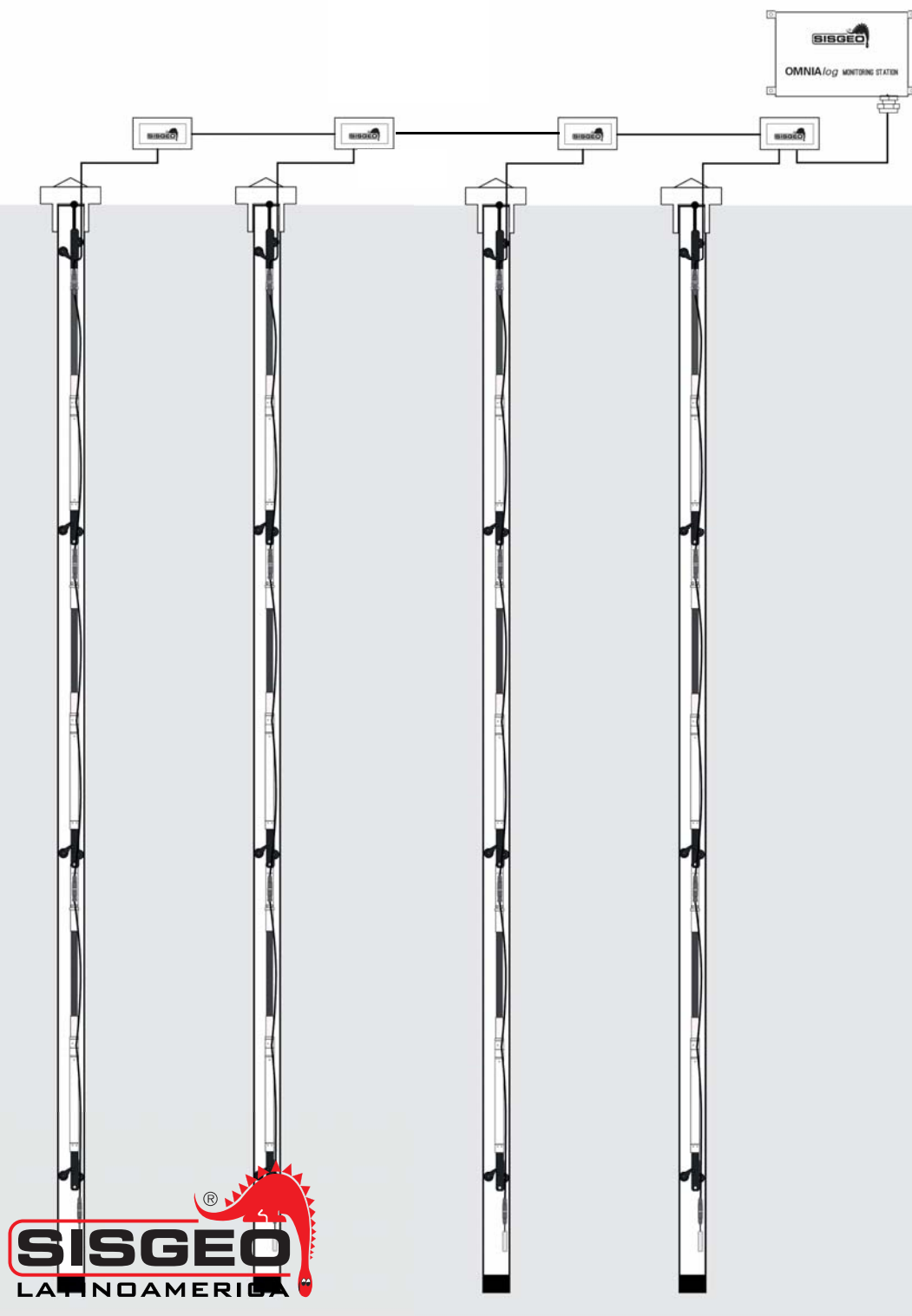


Datasheet:

http://www.sisgeo.com/uploads/schede/schede/S430_EN-00_BH_profile_inclinometer.pdf

BH PROFILE INCLINOMETERS: CONTINUOUS BOREHOLE PROFILING



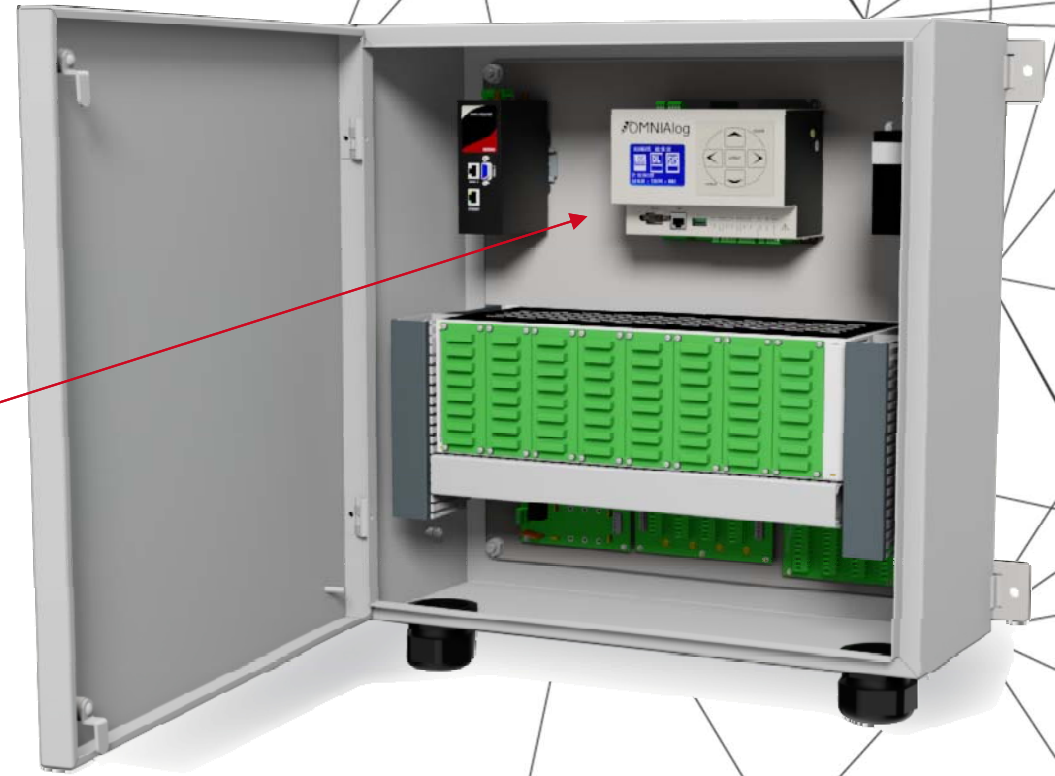


BH PROFILE INCLINOMETERS: DATALOGGER CONNECTION

*Connection of up to 250 BH Profile inclinometers to datalogger with **only one single signal cable** (RS485 technology)*



__ OMNIALOG DATALOGGER AND DATA ACQUISITION SYSTEMS



— OMNIALOG DATALOGGER

Display

Keyboard

Standard LAN port

USB port

On-board channels

Alarm output



__ OMNIALOG DATALOGGER PERFORMANCE

ACCURACY	<i>0.01% FS, 24-bit A/D</i>
TEMP. RANGE	<i>-30° .. +70° (constant performances all over the range)</i>
SAMPLING RATE	<i>high.. medium.. Low</i>
ON BOARD CHANN.	<i>8 (differential)</i>
TOTAL CHANNELS	<i>up to 391 analogue ch. up to 254 digital ch.</i>

Datasheet:

[http://www.sisgeo.com/uploads/schede/schede/OMNIALOG_EN_01 - OMNIAlog Datalogger.pdf](http://www.sisgeo.com/uploads/schede/schede/OMNIALOG_EN_01_-_OMNIAlog_Datalogger.pdf)



— OMNIALOG DATA ACQUISITION SYSTEMS

Stainless steel cabinet

Multiplexer expansion boards

Communication interface

Digital instrument input

External multiplexer input

Back up battery



Datasheet:

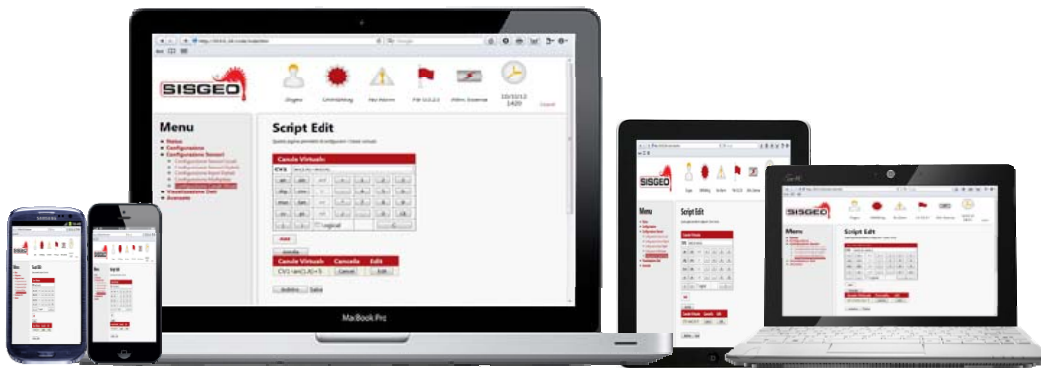
<http://www.sisgeo.com/uploads/schede/schede/OMNIA DAS EN 00 data acquisition system.pdf>

__ OMNIALOG DAS - THETA DAM, KENYA



__ OMNIALOG SYSTEMS: NO SOFTWARE NEEDED

- Independent OS platform
- No software installation is required



HTML

__ OMNIALOG SYSTEMS: WEB SERVER ON BOARD

The screenshot displays the SISGEO OMNIALog web interface. At the top, the browser address bar shows the URL `https://m2web.talk2m.com/rsmisgeo/OMNIALog_1/code/index.htm`. The interface includes a header with the SISGEO logo and a navigation bar with icons for Admin, OMNIALog, No alarm, FW 7.07.12, Ext.Pwr Supply 13.2 V, and the date/time 10/02/14 17:05. A 'Logout' and 'Reboot' button are also present.

On the left, a 'Menu' sidebar lists the following options:

- Status
- Configuration
- Channels Configuration
- Data Monitor
- Advanced

The main content area is titled 'Status' and contains a table with the following data:

Description	Value	Measure Unit
Free Memory	87	%
Temperature	20.3	°C
Humidity	30	%
OMNIALog status	Run	

Below the table, there are buttons for 'STOP', 'CONFIGURE', and 'START'. A section titled 'Download/Upload Configuration' includes a 'Configuration Download' button and a file selection area with a 'Configuration Upload' button. The file selection area shows 'Sfogliala' as the selected file and 'Nessun file selezionato' as the status.

— OMNIALOG SYSTEMS: WEB SERVER ON BOARD



AdminOMNIAlogNo alarmFW 7.07.12Ext.Pwr Supply 13.2 V10/02/14 17:05

LogoutReboot

Menu

- Status
- Configuration
- Channels Configuration
- Data Monitor
- Advanced

Status

This page shows OMNIAlog current status. If you upload a new configuration it will be necessary to re-insert the passwords because, for the privacy, these are not saved in the configuration file. The page automatically refreshes every 60 seconds.

Description	Value	Measure Unit
Free Memory	87	%
Temperature	20.3	°C
Humidity	30	%
OMNIAlog status	Run	

STOP

CONFIGURE

START

Download/Upload Configuration

Configuration Download

Select a configuration file:

Sfoglia...Nessun file selezionato.

Configuration Upload

Menu

- Status
- Configuration
- Channels Configuration
- Data Monitor
- Advanced

Description	Parameters
Input	A
Identification	NTC
Description	MUX01_03
Measure Type	Thermistor (NTC)
Power Supply	0.1mA
Acquisition	Default
Measure Unit	°C
Warm-Up [sec.]	5
Conversion	Nessuna
Zero Reading	0.000e+00
Sensibility	0.000e+00
Poly. Coeff. A	0.000e+00
Poly. Coeff. B	0.000e+00
Poly. Coeff. C	0.000e+00
Poly. Coeff. D	0.000e+00
Engineering Units	
Excitation	35
Delay	10
Range	Autorange
Start frequency	400

CLEVER SOLUTIONS FOR DAM SAFETY AND MONITORING

__ OMNIALOG SYSTEMS: WEB SERVER ON BOARD

The screenshot shows the SISGEO web interface in a Firefox browser. The address bar displays the URL: `https://m2web.talk2m.com/rsmisgeo/OMNIAlog_1/code/index.htm`. The interface includes a top navigation bar with icons for Admin, OMNIAlog, No alarm, and FW 7.0. A left sidebar contains a 'Menu' with links to Status, Configuration, Channels Configuration, Data Monitor, and Advanced. The main content area shows the 'Status' section, which includes a table of system metrics and buttons for configuration management.

Description	Value	Measure Unit
Free Memory	87	%
Temperature	20.3	°C
Humidity	30	%
OMNIAlog status	Run	

Buttons: STOP, CONFIGURE, START

Download/Upload Configuration

Configuration Download

Select a configuration file:

Sfogliala... Nessun file selezionato. Configuration Upload

Alarm Configuration

This page allows to configure actions in case of alarm for both configured sensor and OMNIAlog.

SENSOR

Enable	Action	Event Nr.	End
☐	SMS	1	2
☐	email	1	5
☐	FTP	1	5
☐	Digital Output	1	2
☐	Frequency Increase	1	2

OMNIAlog

Enable	Action	Event Nr.	End
☐	SMS	1	2
☐	email	1	5
☐	FTP	1	5
☐	Digital Output	1	2

Save Changes

Cancel

email Configuration

SMS Configuration

FTP Configuration

Parameters

A
NTC
MUX01_03
Thermistor (NTC)
0.1mA
Default
°C
5
Nessuna
0.000e+00
0.000e+00
0.000e+00
0.000e+00
0.000e+00
0.000e+00
0.000e+00
35
10
Autorange
Start frequency
400

__ OMNIALOG DAS: EXTERNAL MULTIPLEXERS

FASE 1:

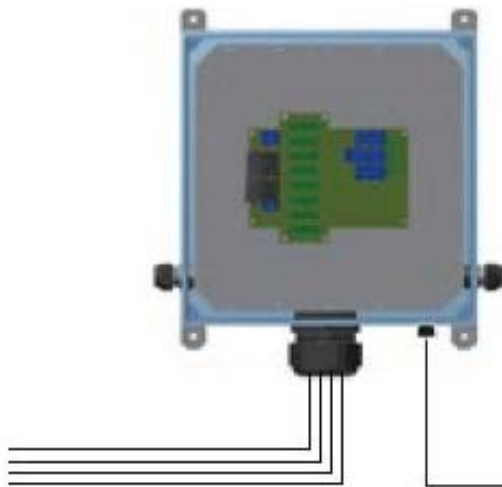
Instruments are wired to the external mux working as **temporary stand-alone junction boxes**. New Leonardo portable readout can read and store data of all the connected instruments simply clicking a button.

EXTERNAL MUX BOX
00MN24MUXB0

NEW LEONARDO
0CDL400N000

INSTRUMENTS AND
MULTICORE CABLES

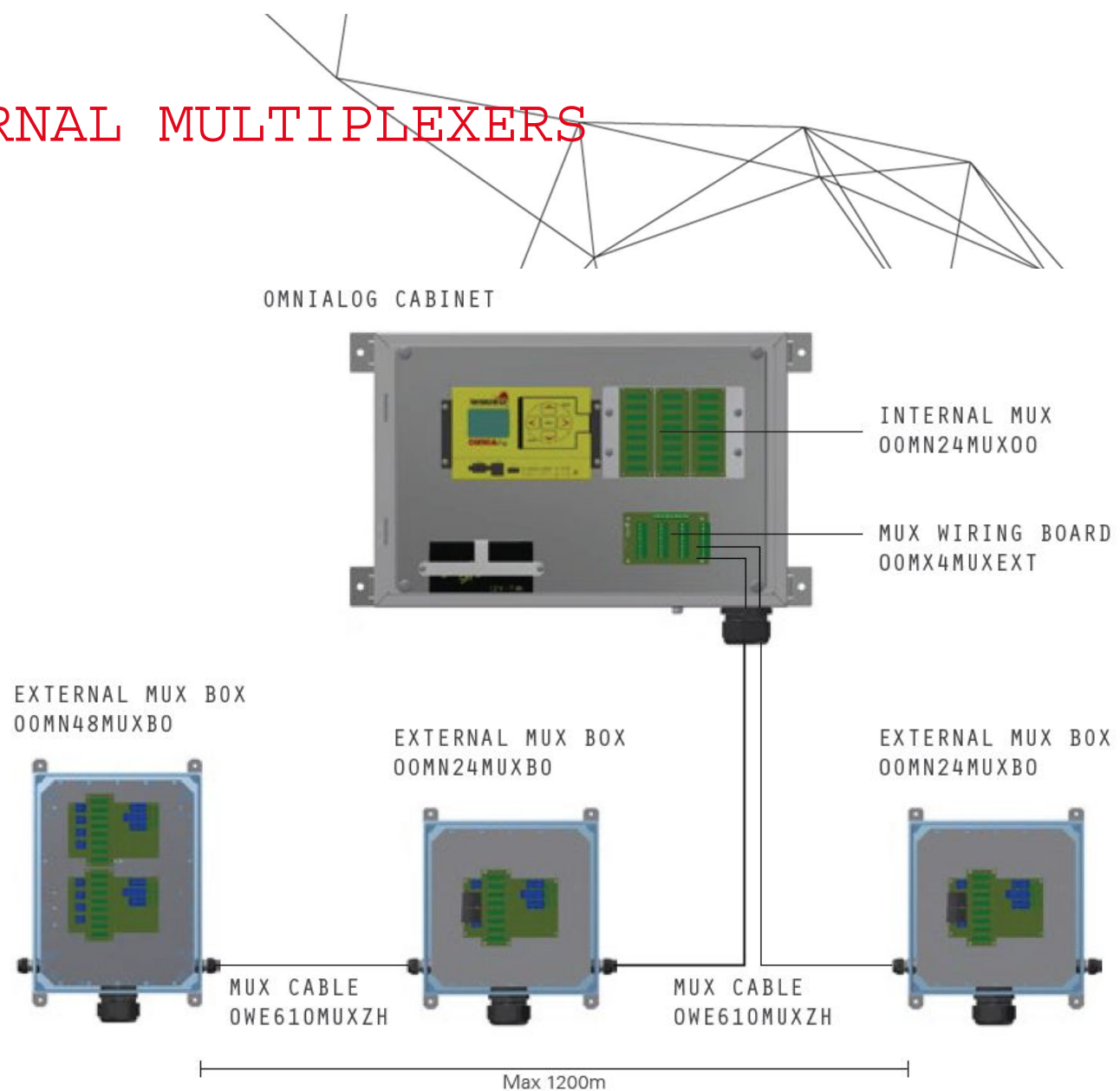
JUMPER CABLE
0ECAV10MUX0



__ OMNIALOG DAS: EXTERNAL MULTIPLEXERS

FASE 2:

Multiplexer boxes are connected to OMNIAlog cabinet in order to **automatically manage all the instruments** wired to the MUX boxes.





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