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— DEX-S IN PLACE EXTENSO-INCLINOMETERS FOR 3D BOREHOLE MONITORING

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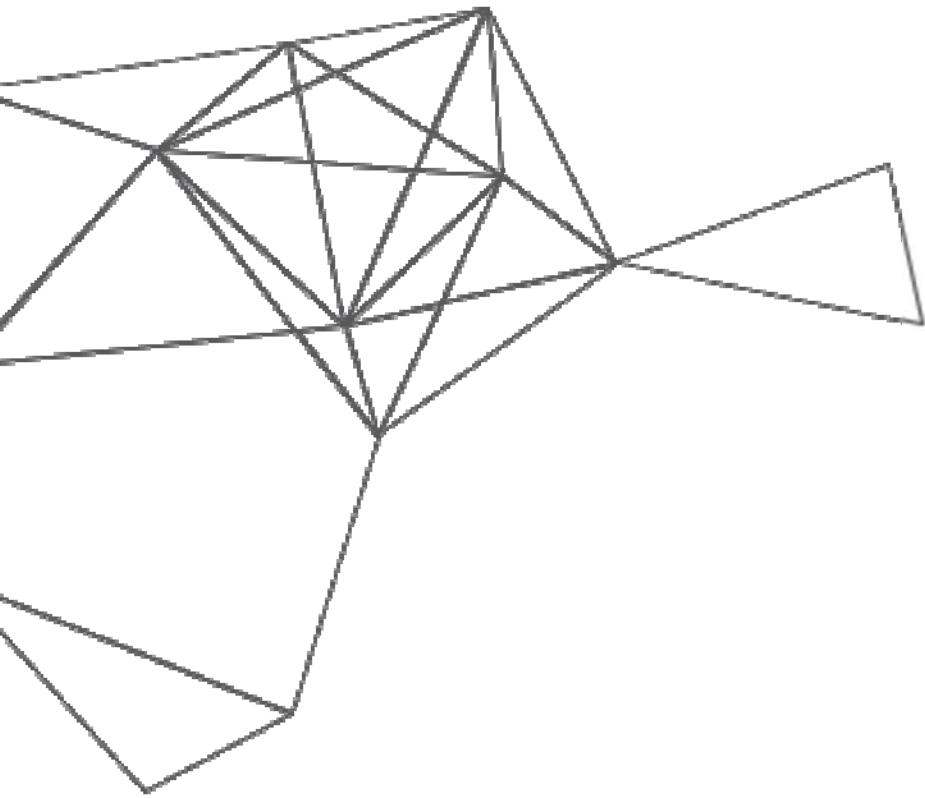
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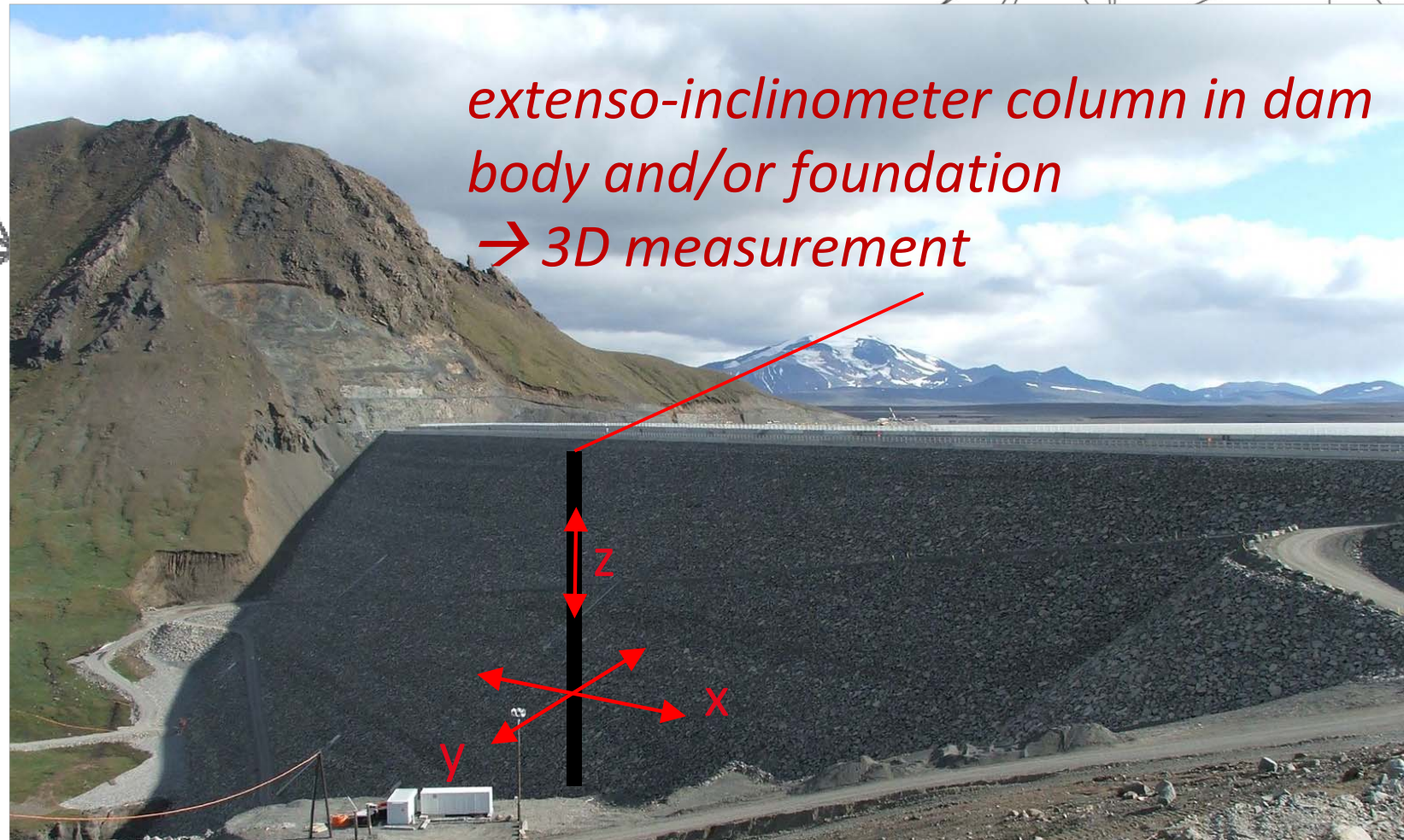
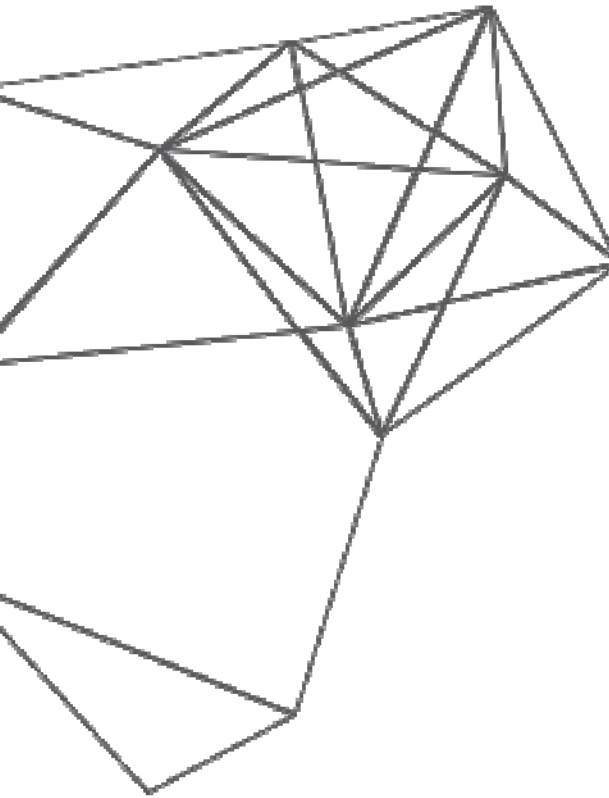
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— WHY SISGEO DEVELOP IN-PLACE EXTENSO-INCLINOMETERS?



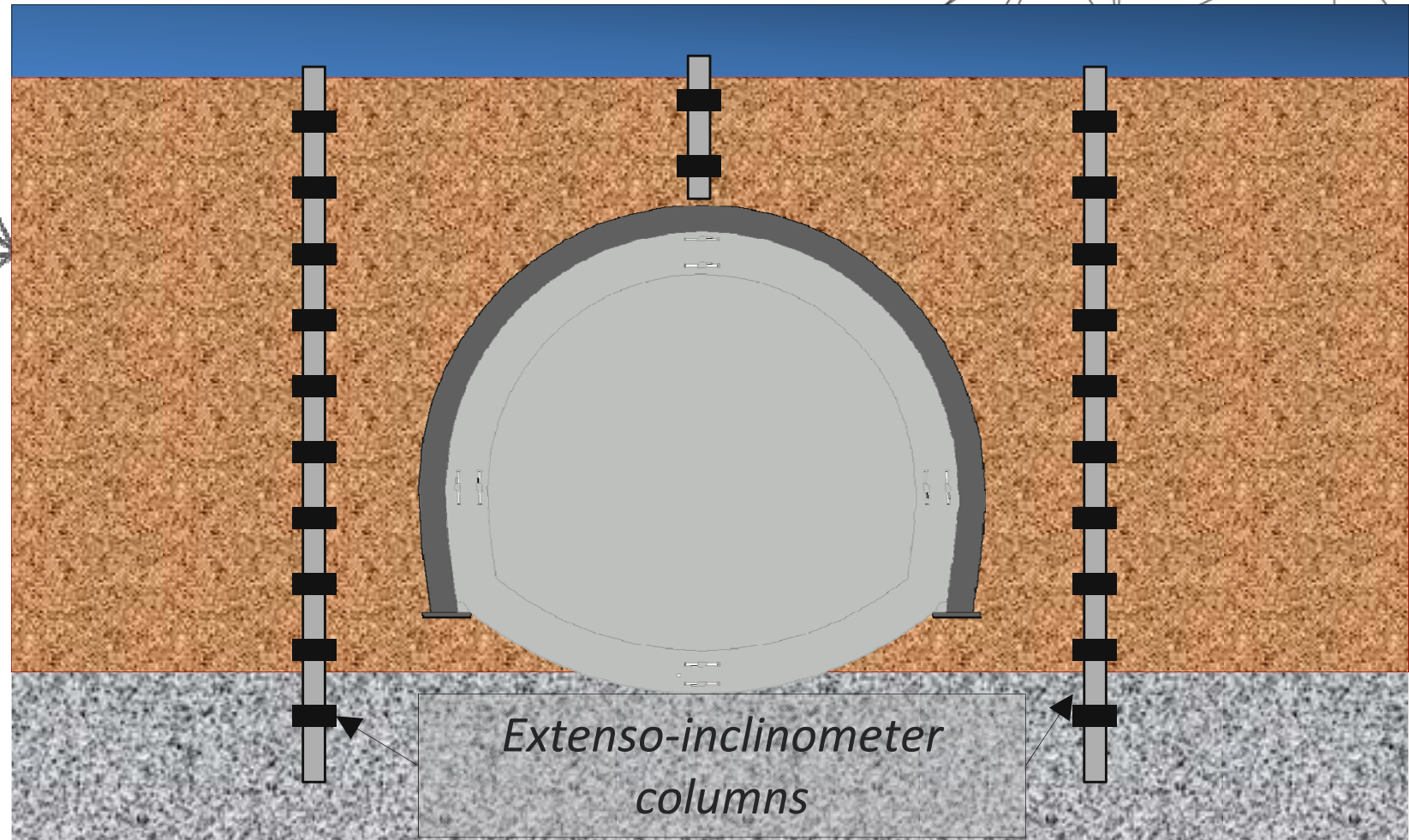
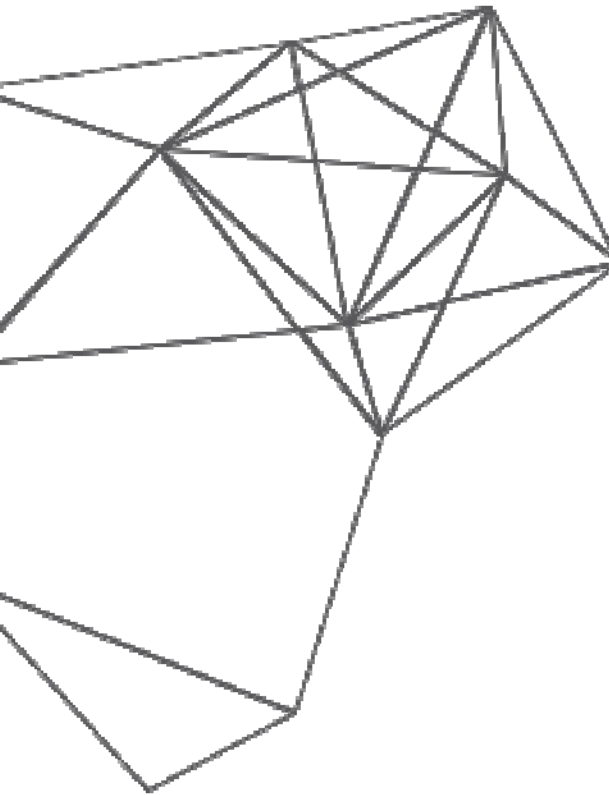
- *Automatic 3D monitoring of unattended boreholes*
- *High performances needed*
- *Cost-effective solution: single drilling for 3-D borehole monitoring*

— EXAMPLE:
APPLICATION IN EARTHFILL / ROCKFILL DAM

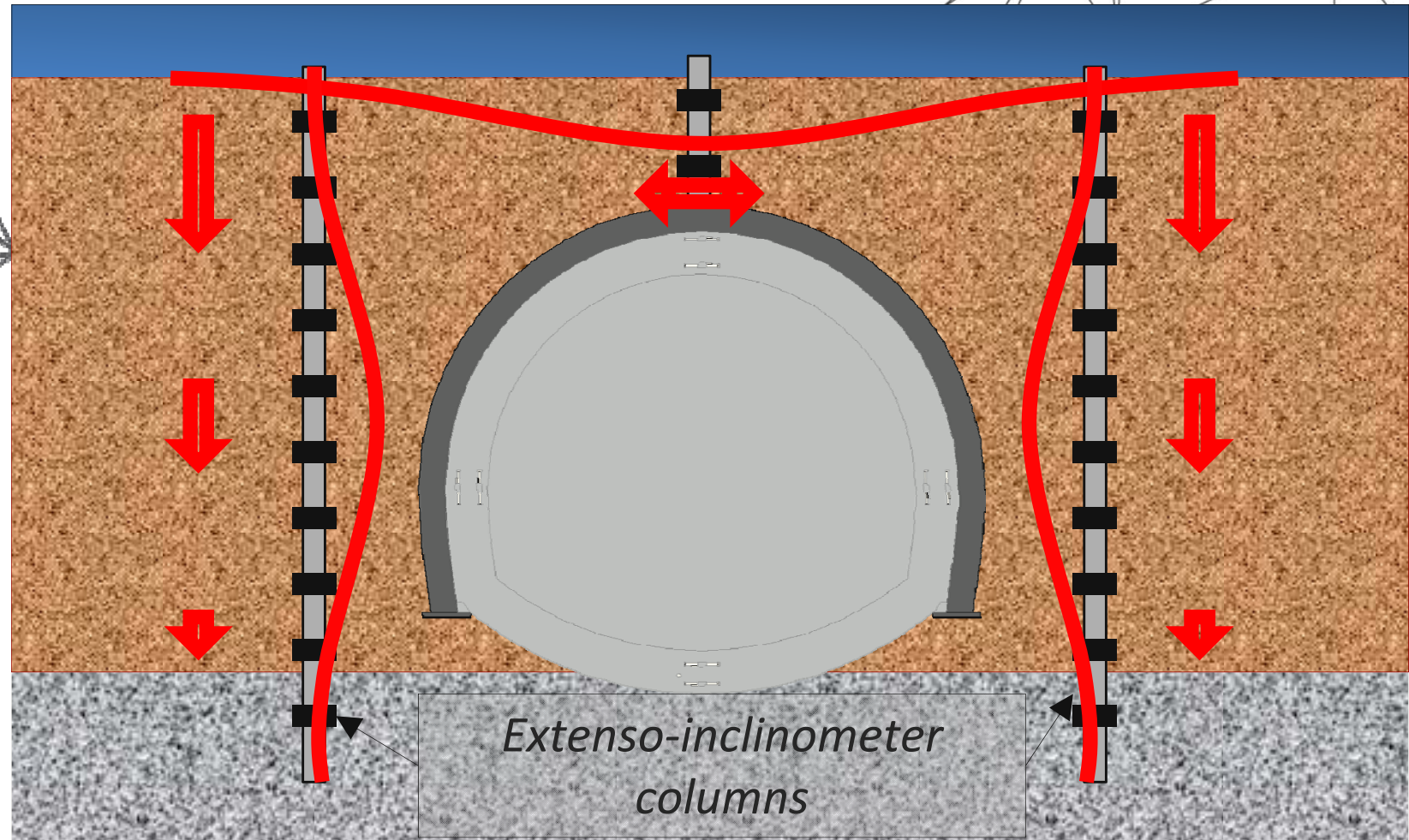
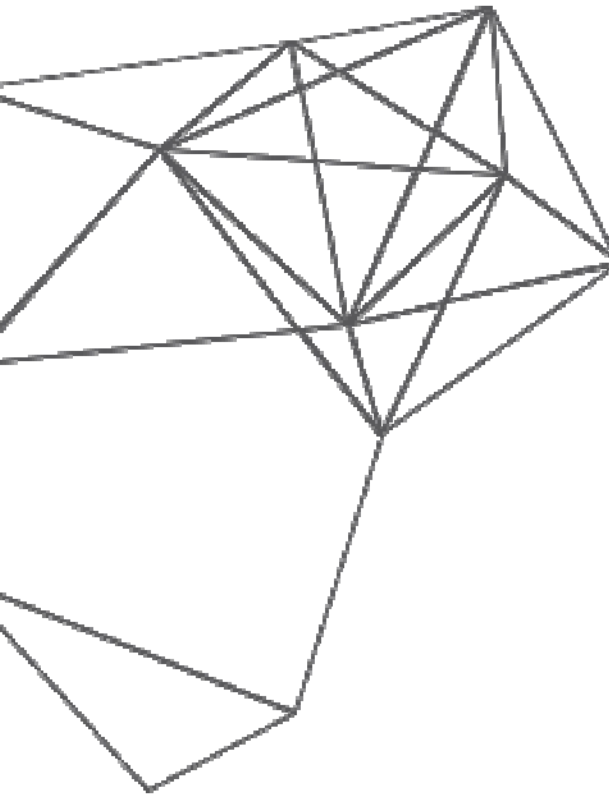


*extenso-inclinometer column in dam
body and/or foundation
→ 3D measurement*

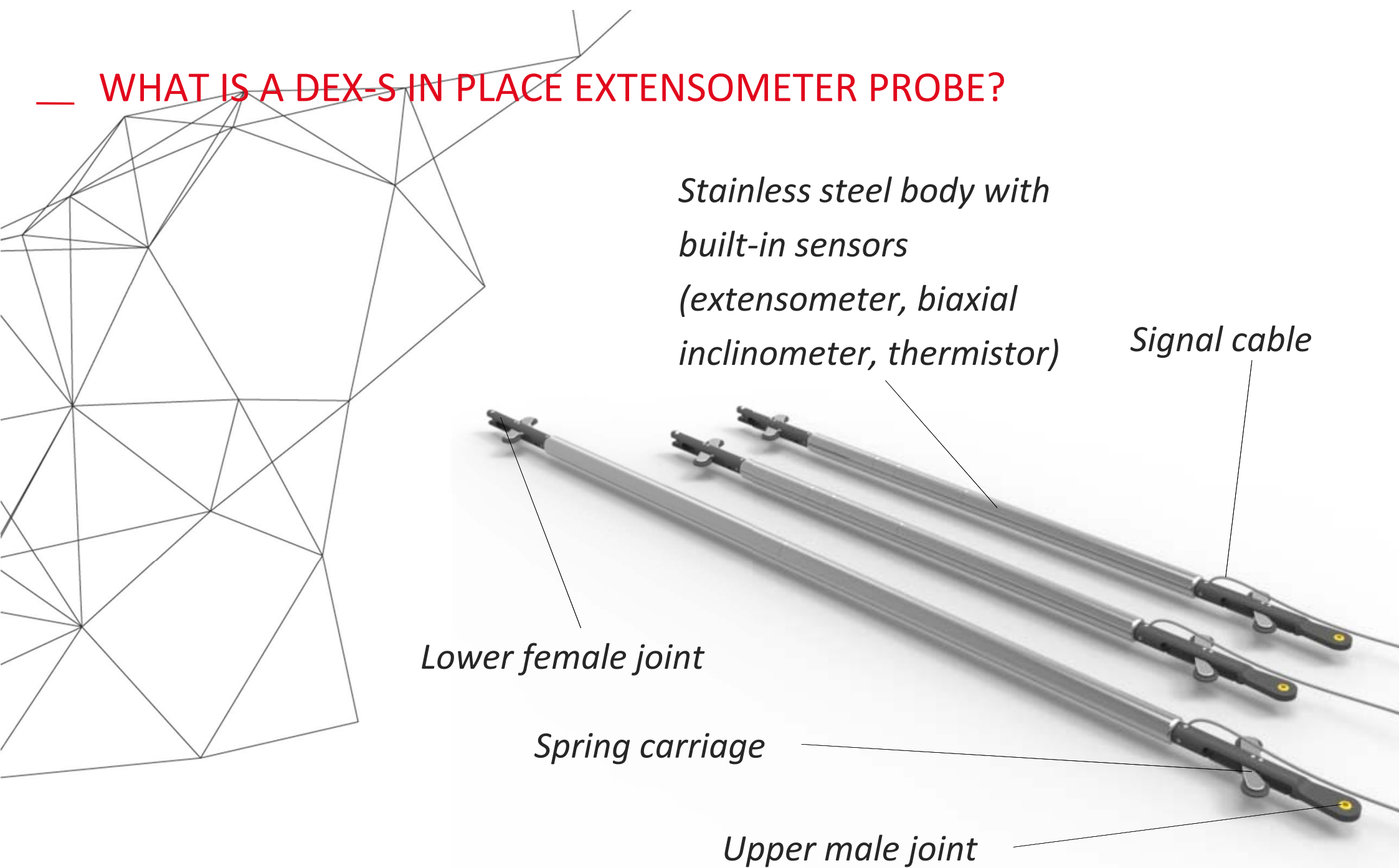
— EXAMPLE: APPLICATION IN TUNNELING



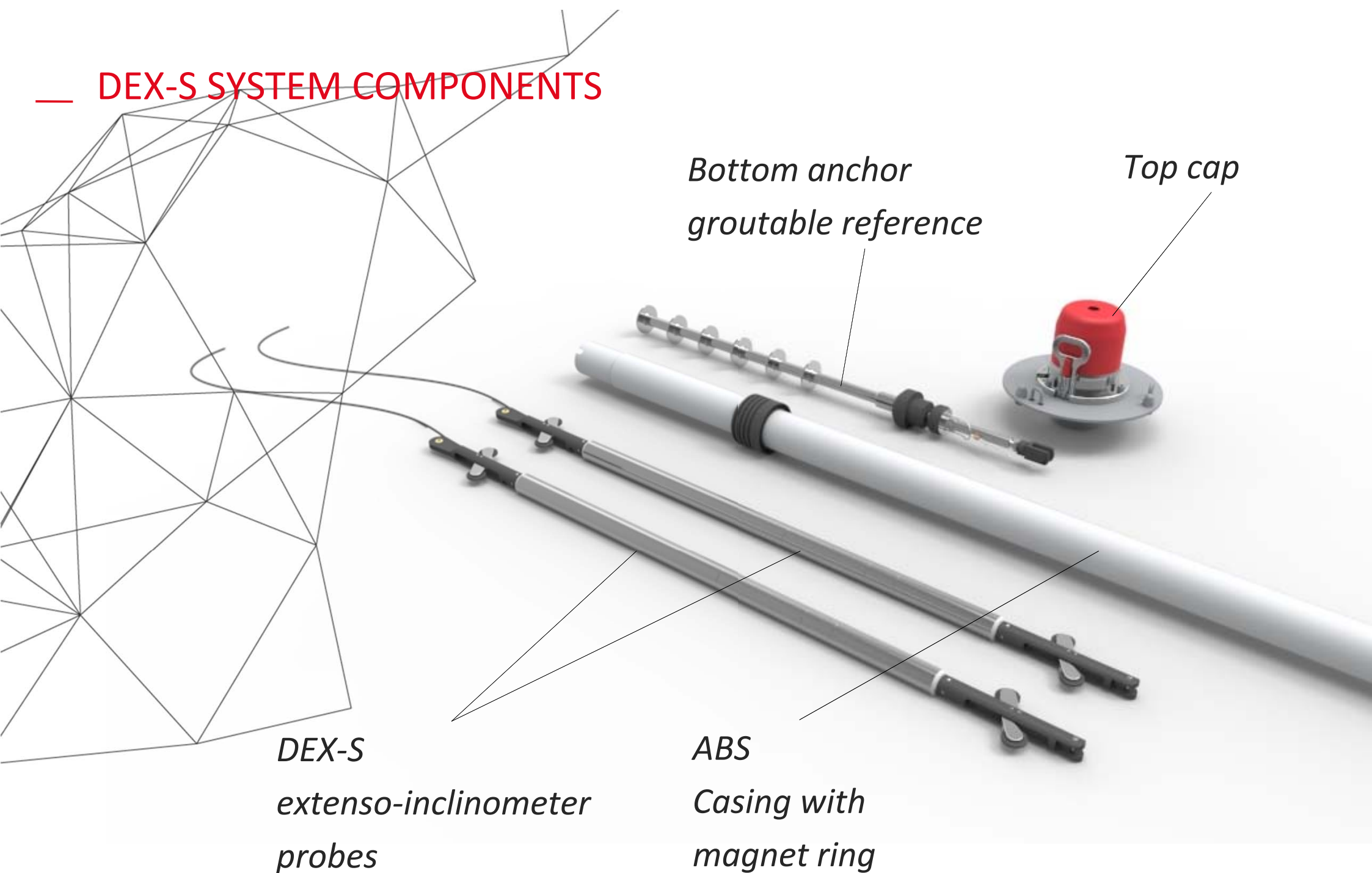
— EXAMPLE:
APPLICATION IN TUNNELING



__ WHAT IS A DEX-S IN PLACE EXTENSOMETER PROBE?



__ DEX-S SYSTEM COMPONENTS



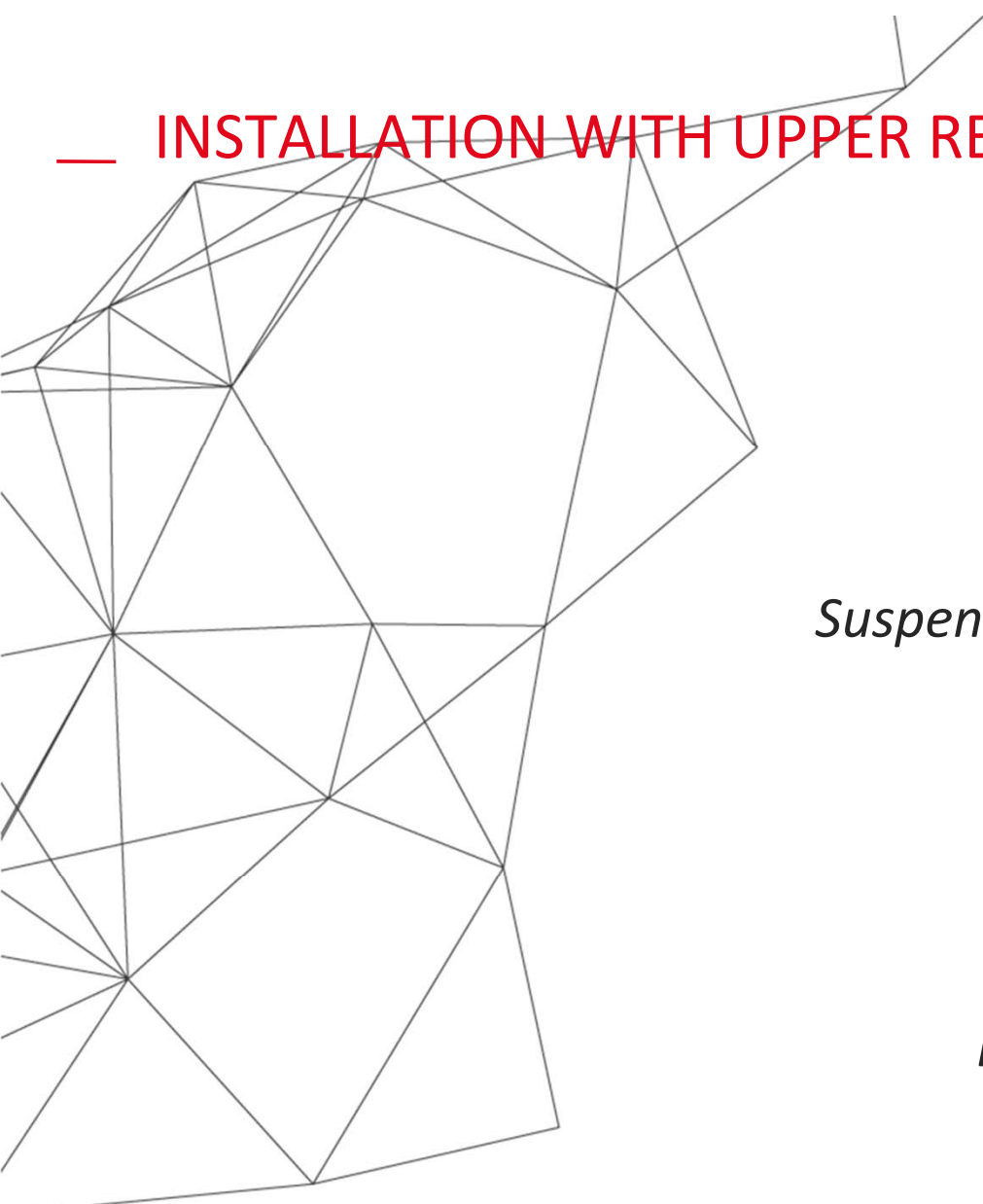
*Bottom anchor
groutable reference*

Top cap

*DEX-S
extenso-inclinometer
probes*

*ABS
Casing with
magnet ring*

__ INSTALLATION WITH UPPER REFERENCE

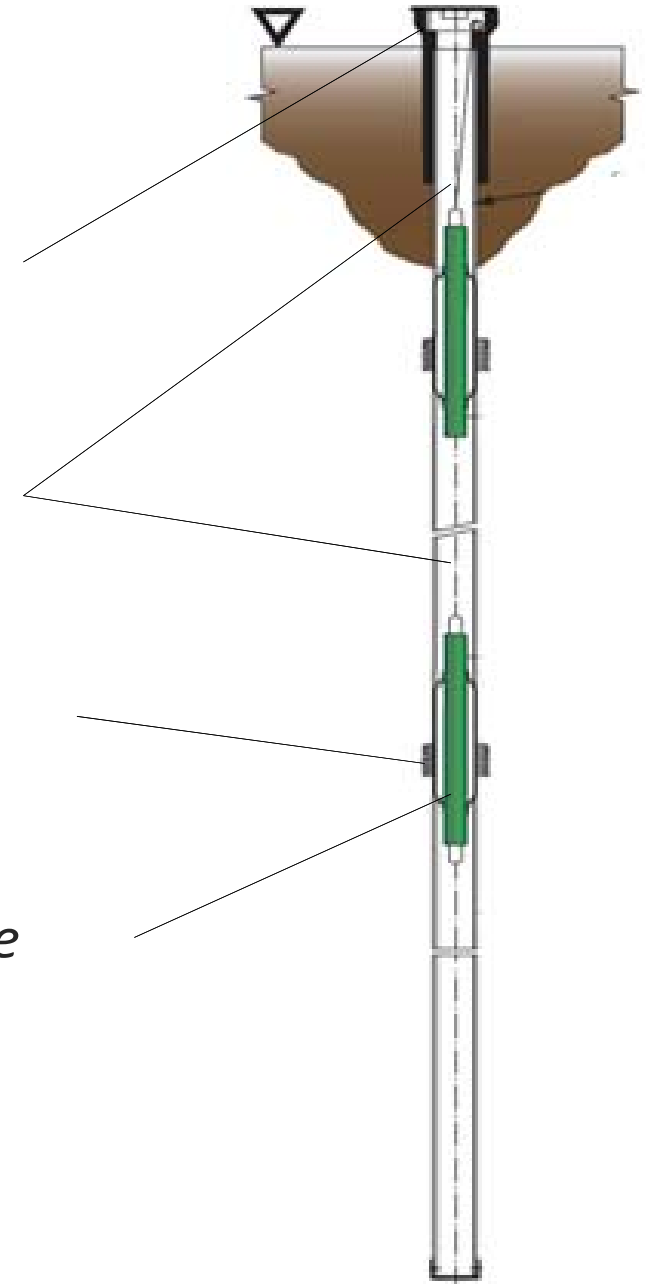


Top cap

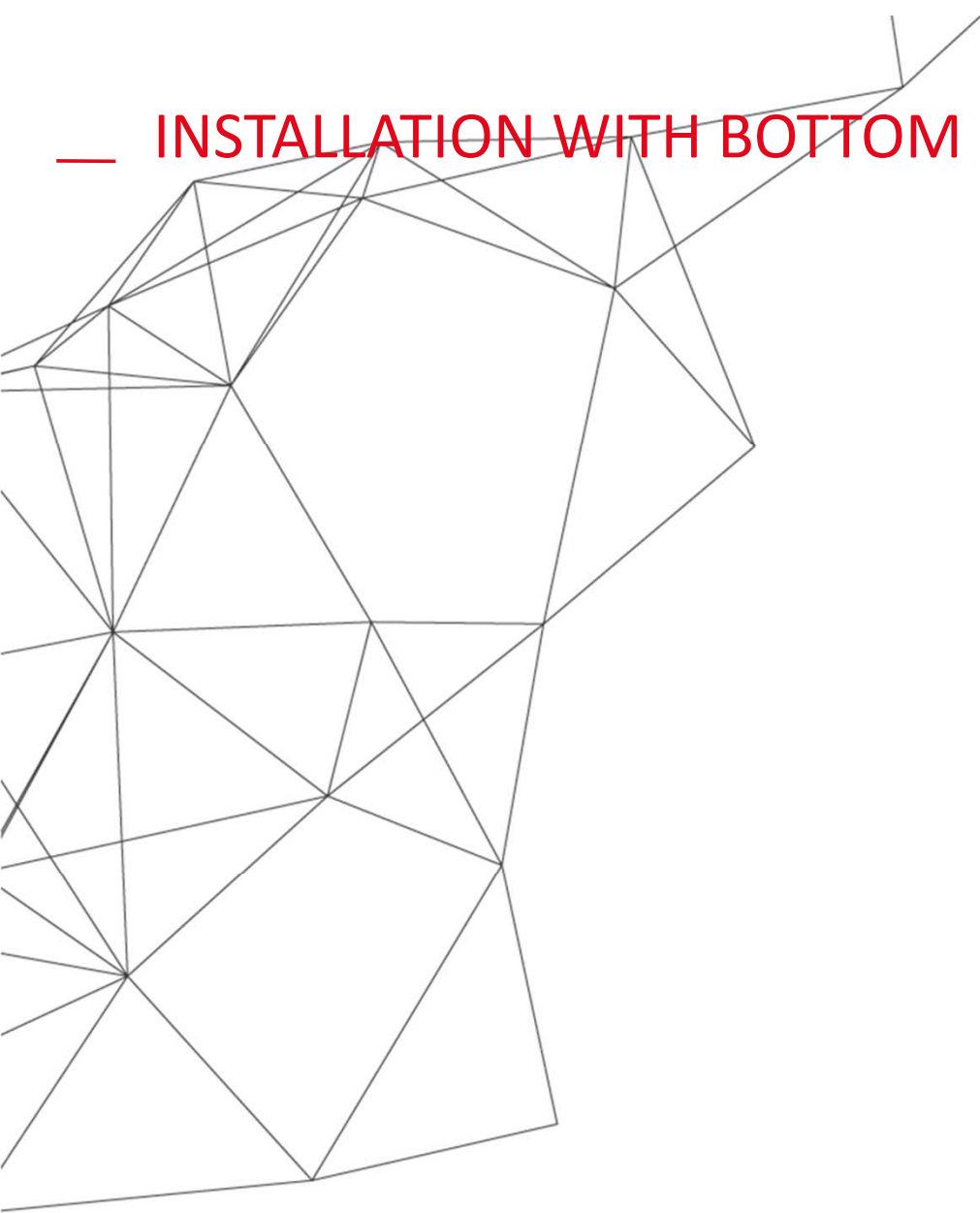
Suspending steel cable

Magnet ring

DEX or DEX-S probe



__ INSTALLATION WITH BOTTOM REFERENCE

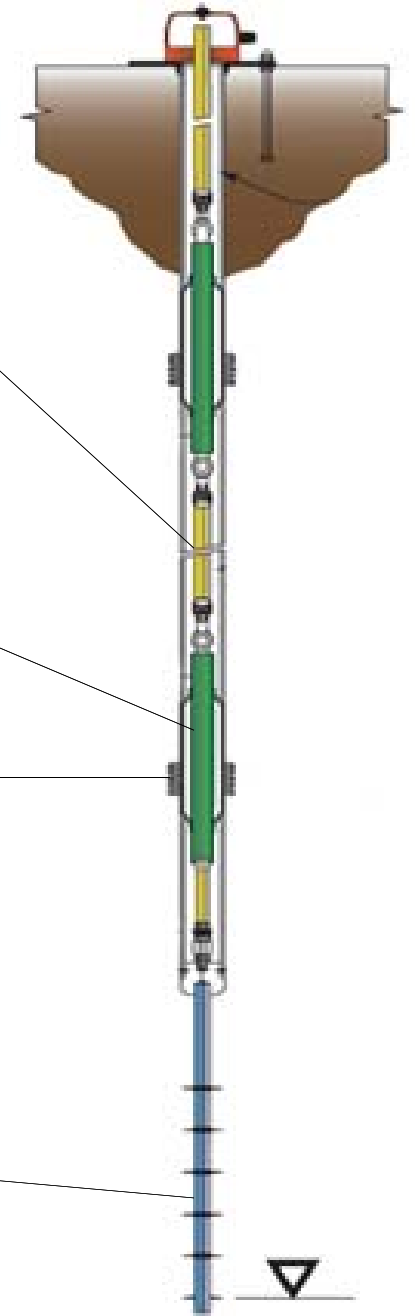


Steel placing rod

*DEX or DEX-S
probe*

Magnet ring

*Bottom anchor
reference*



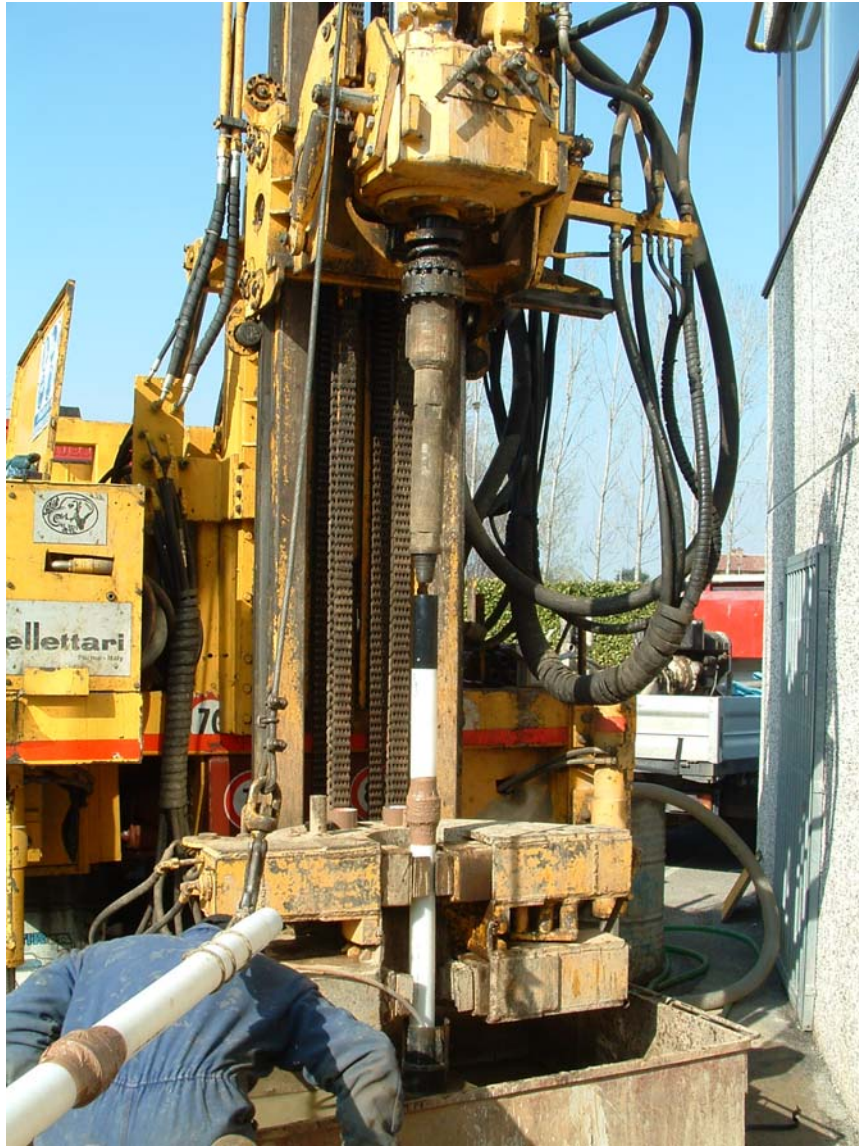
__ DEX AND DEX-S CASING



- *ABS inclinometer casings*
- *One magnet rings for each DEX or DEX-S probe*



__ VERTICAL INSTALLATION OF DEX-S CASING



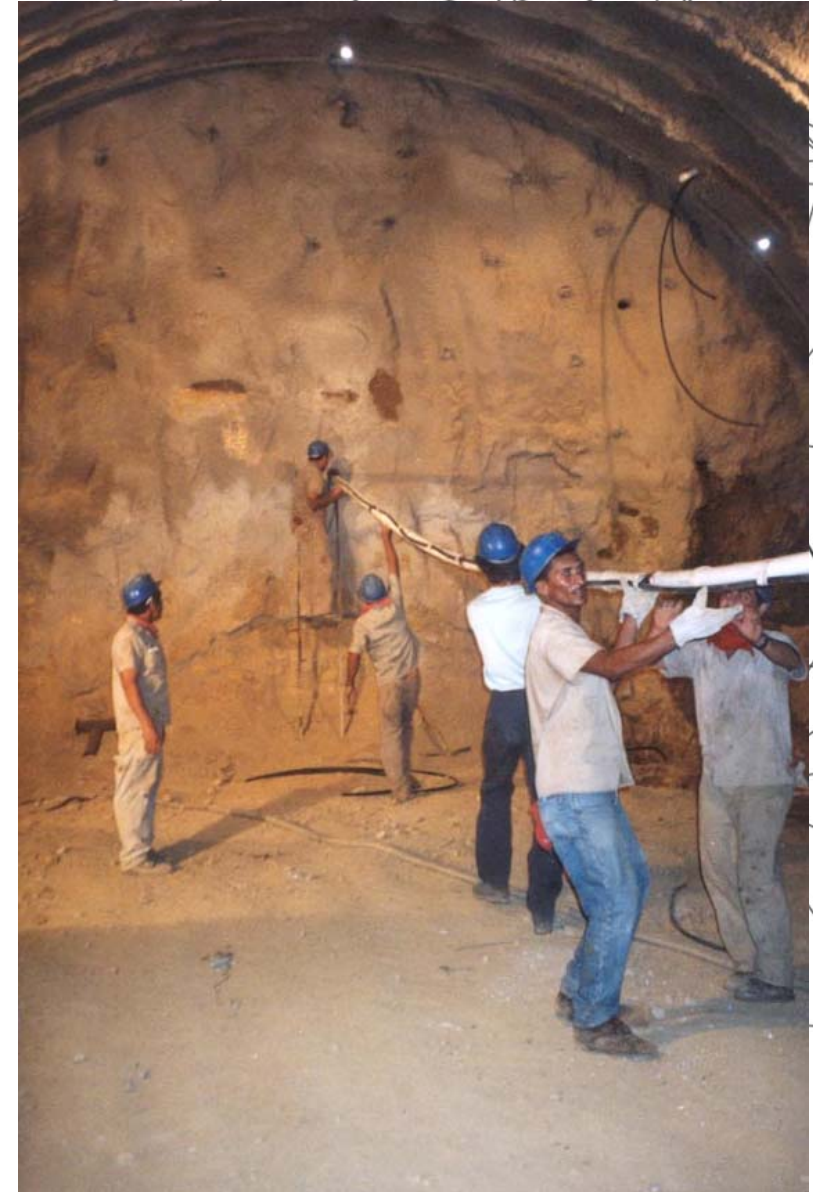
*Casing inserted step-by-step
into the borehole*



__ HORIZONTAL INSTALLATION OF DEX CASING



Commonly, the extenso-inclinometer tube is completely mounted outside borehole and then inserted in borehole and grouted.



__ SOME APPLICATIONS

- *Turin Metro*
- *Piscopio II tunnel*

TURIN METRO

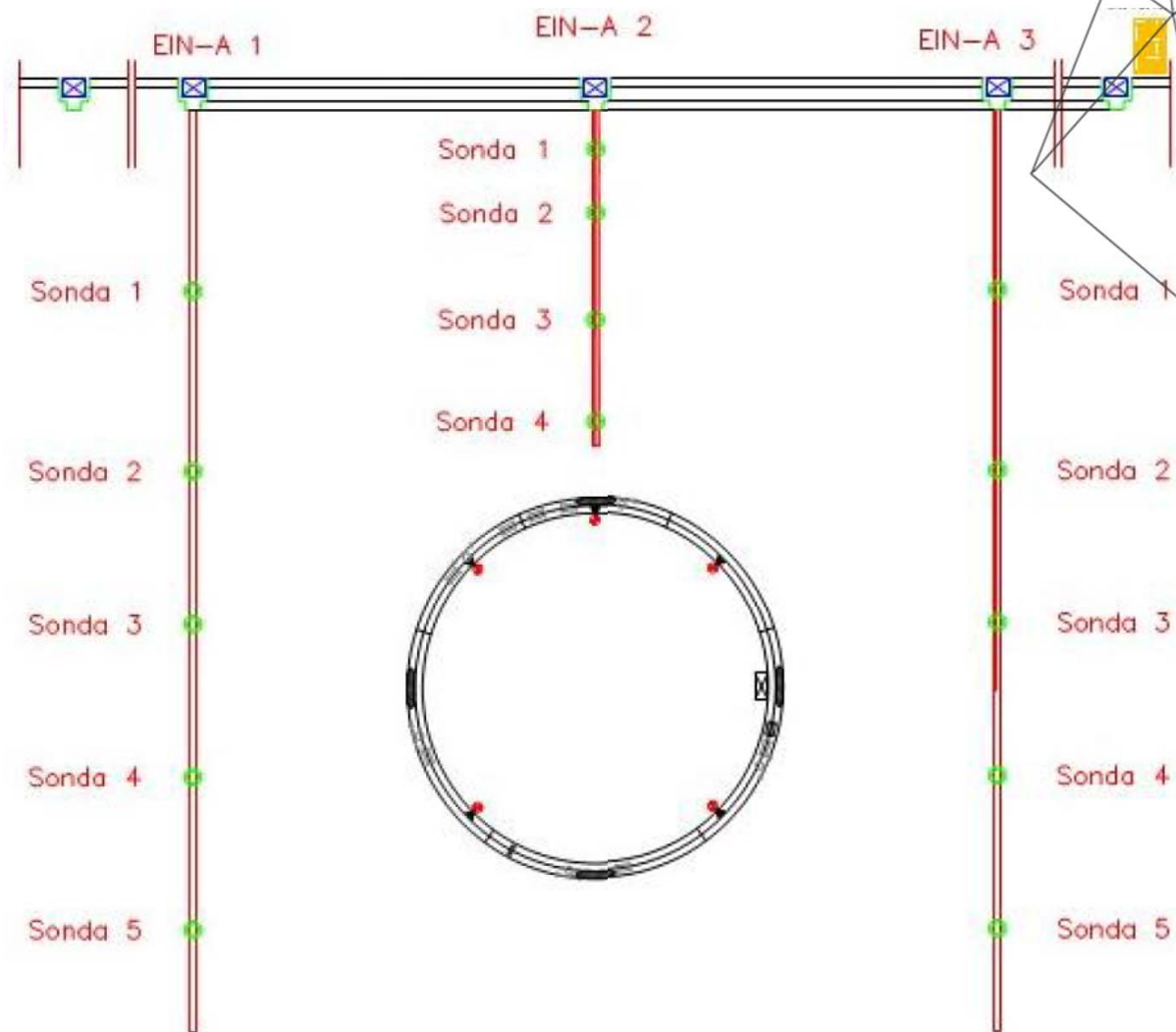
Courtesy of GD Test



TURIN METRO

Courtesy of GD Test

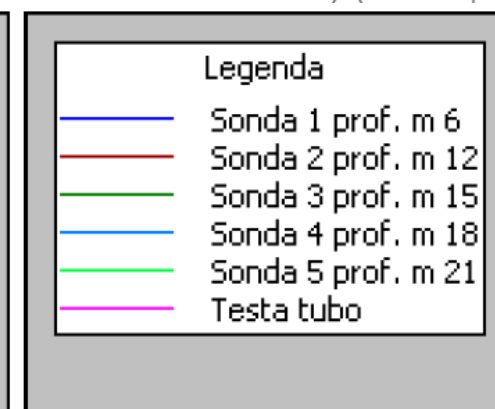
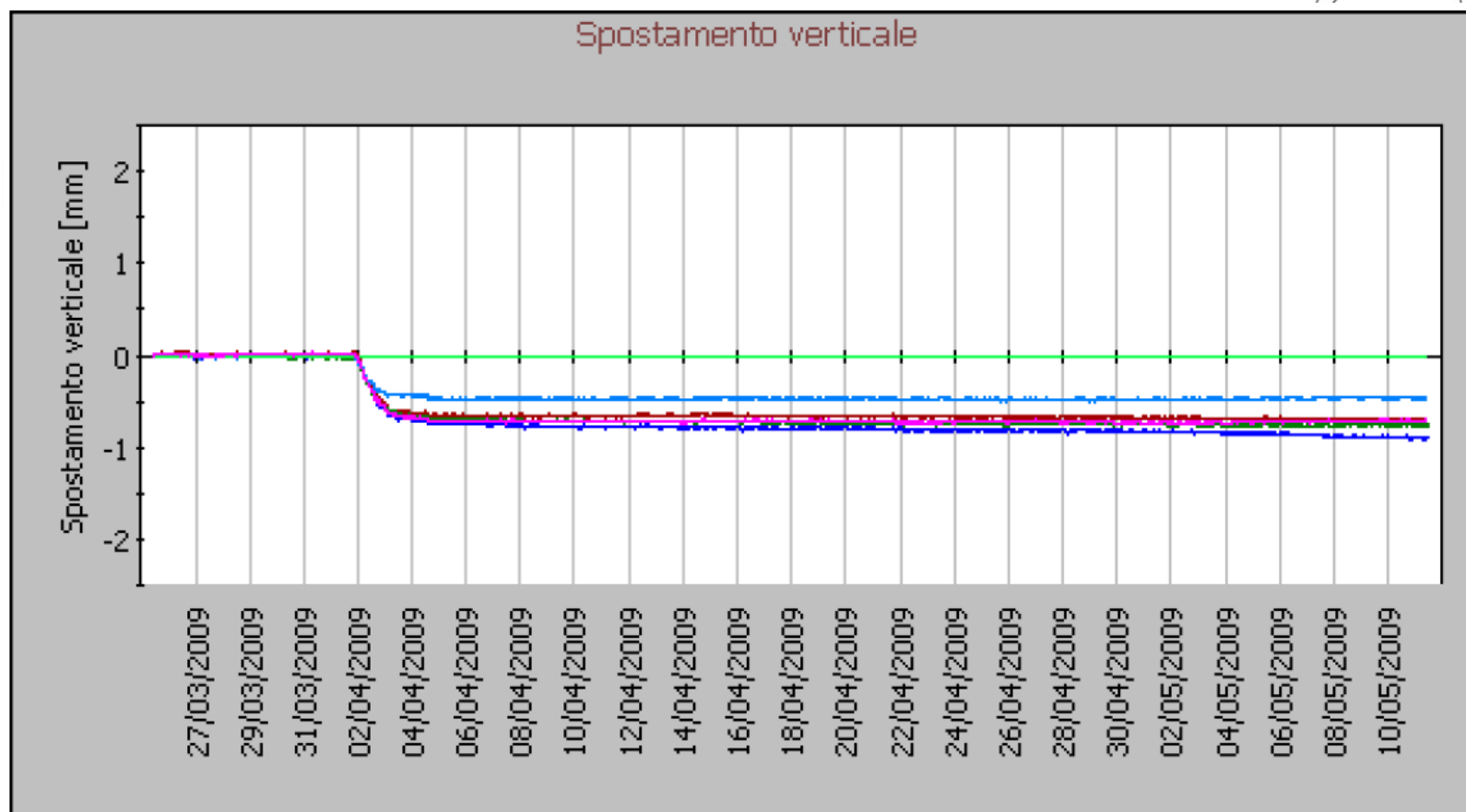
Railway
side



Po River
side

*DEX-S
probes*

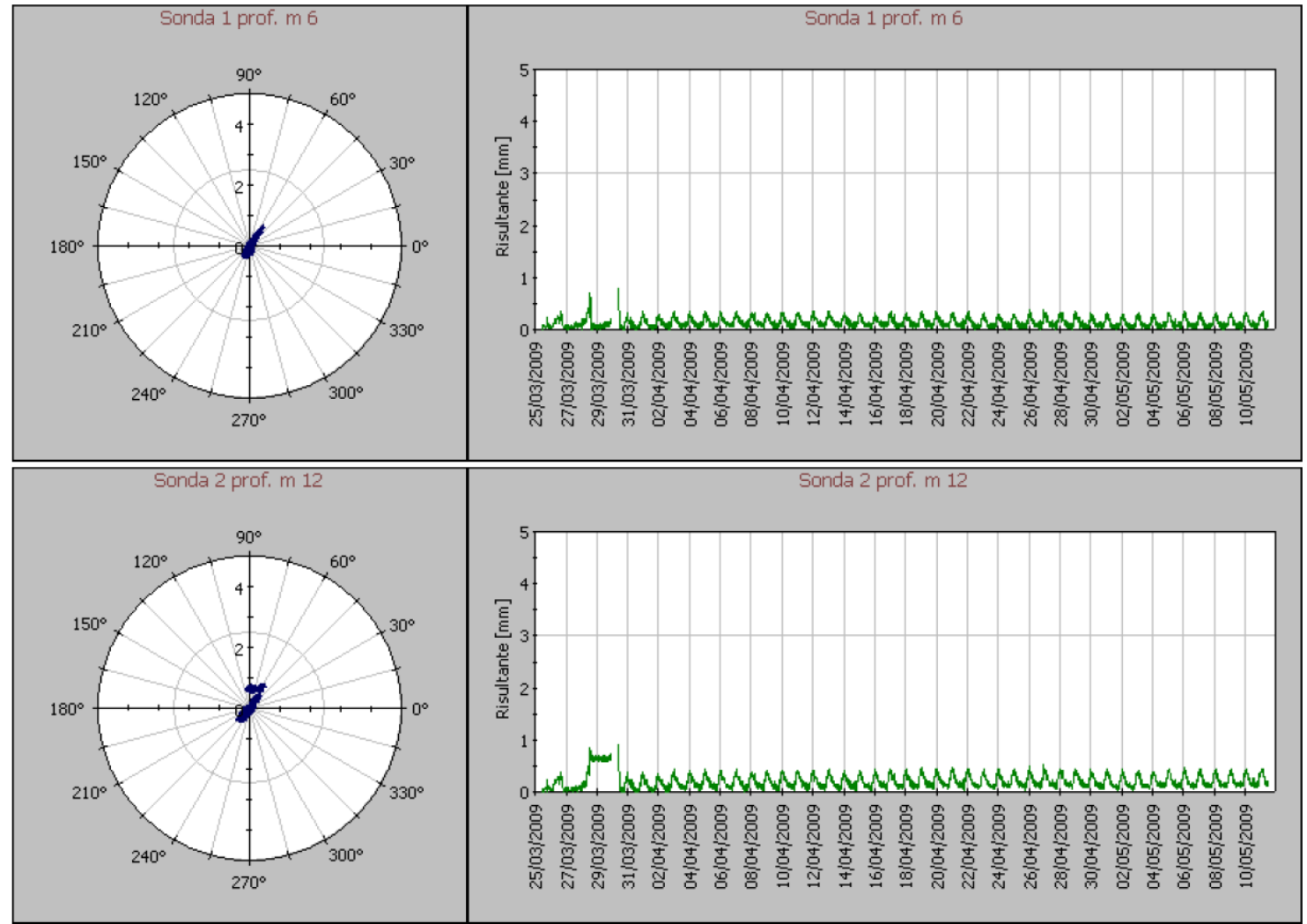
Vertical displacement for each probe



Total horizontal displacement for DEX 1 and DEX 2

*Polar graphs:
0° is the TBM direction*

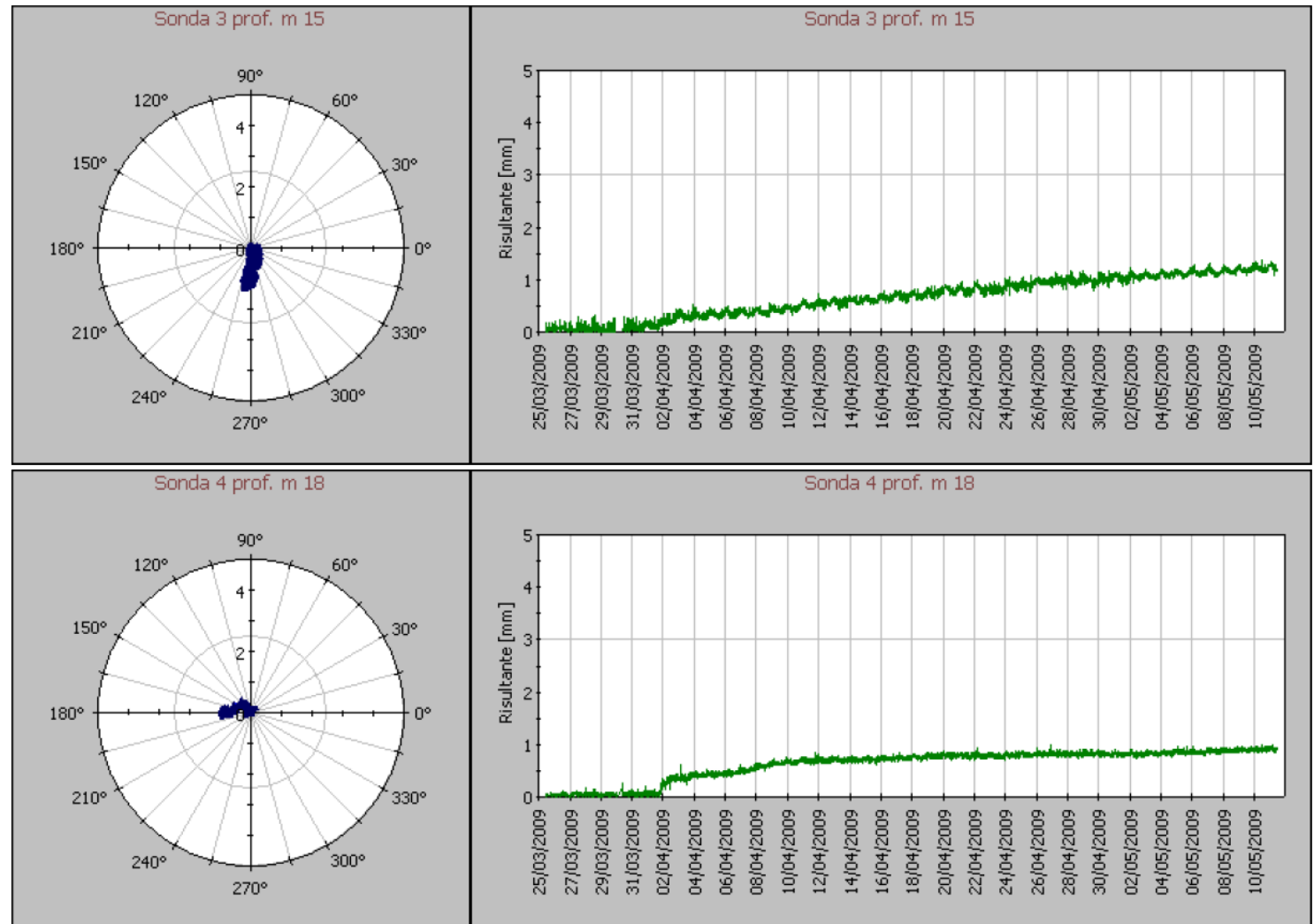
*Cartesian graphs:
Total displacement in mm/m*



Total horizontal displacement for DEX 3 and DEX 4

*Polar graphs:
0° is the TBM direction*

*Cartesian graphs:
Total displacement in mm/m*



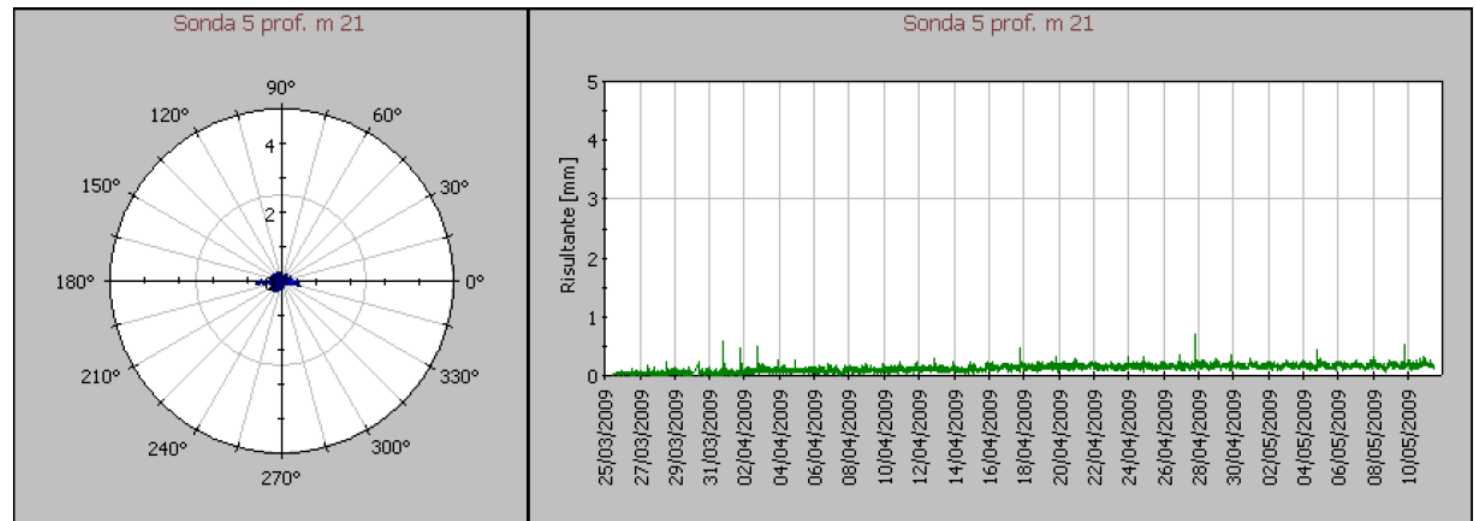
TURIN METRO

Courtesy of GD Test

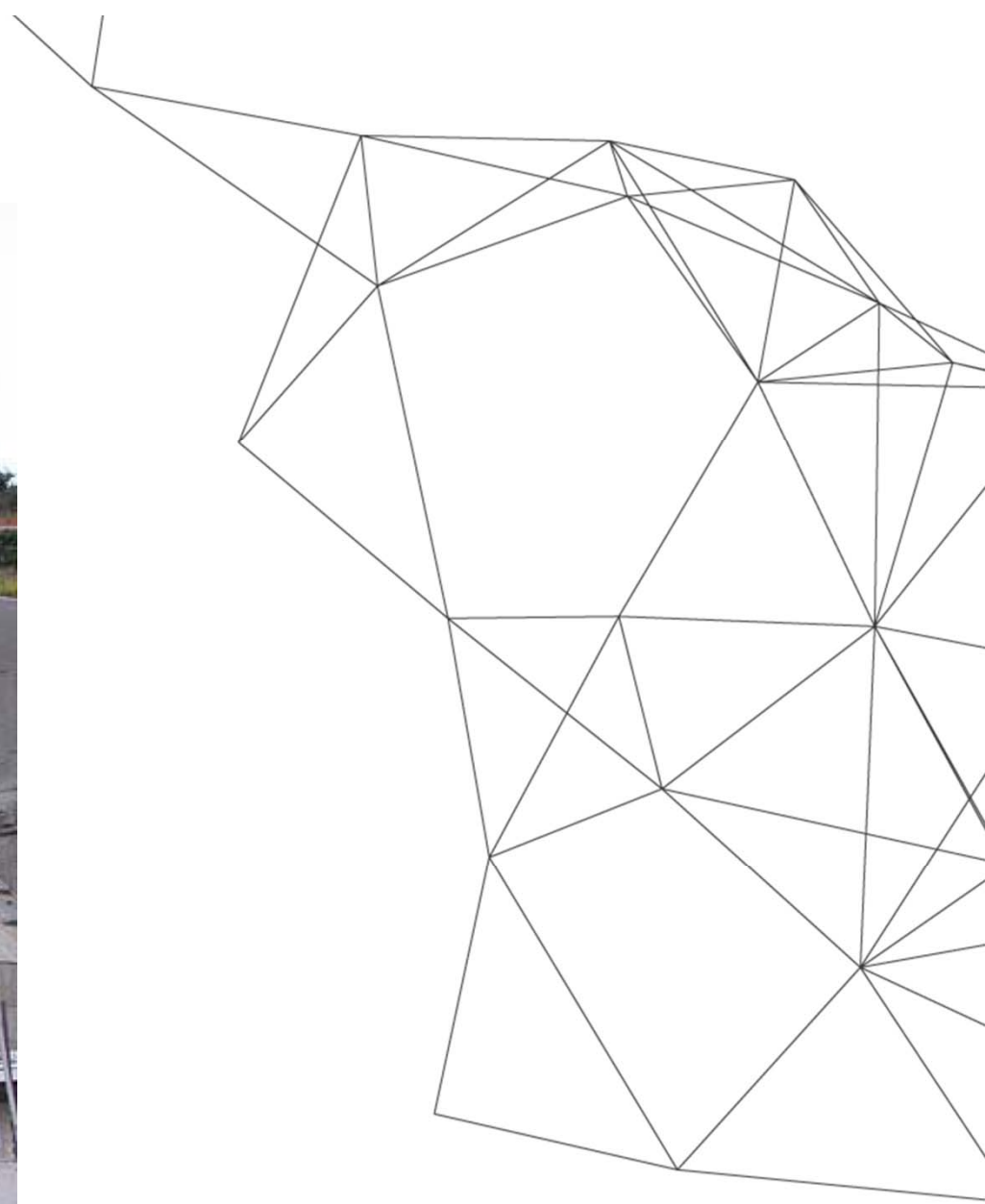
Total horizontal displacement for DEX 5

*Polar graphs:
0° is the TBM direction*

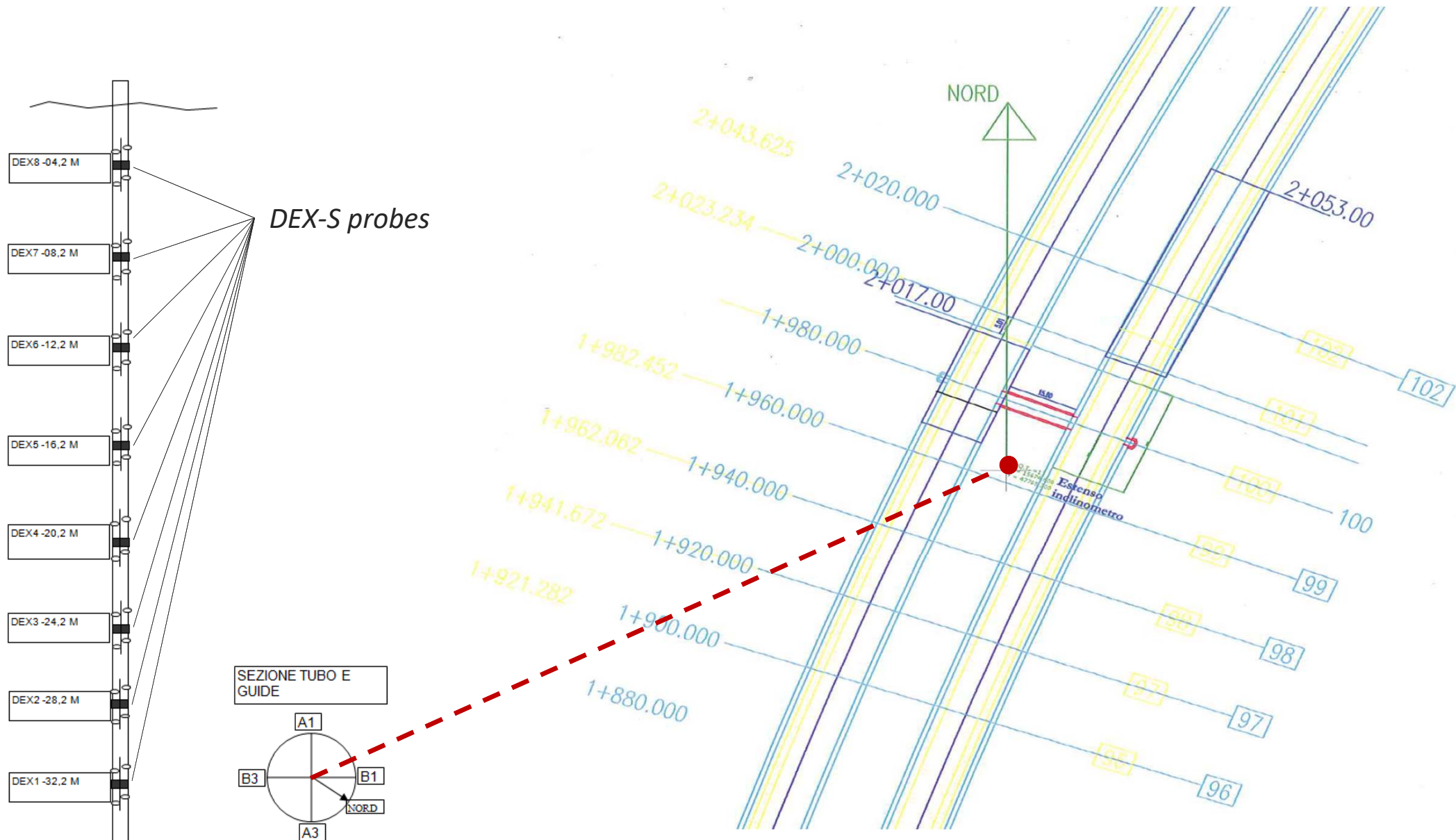
*Cartesian graphs:
Total displacement in mm/m*



__ PISCOPIO TUNNEL Courtesy of Astaldi Spa



__ PISCOPIO TUNNEL Courtesy of Astaldi Spa

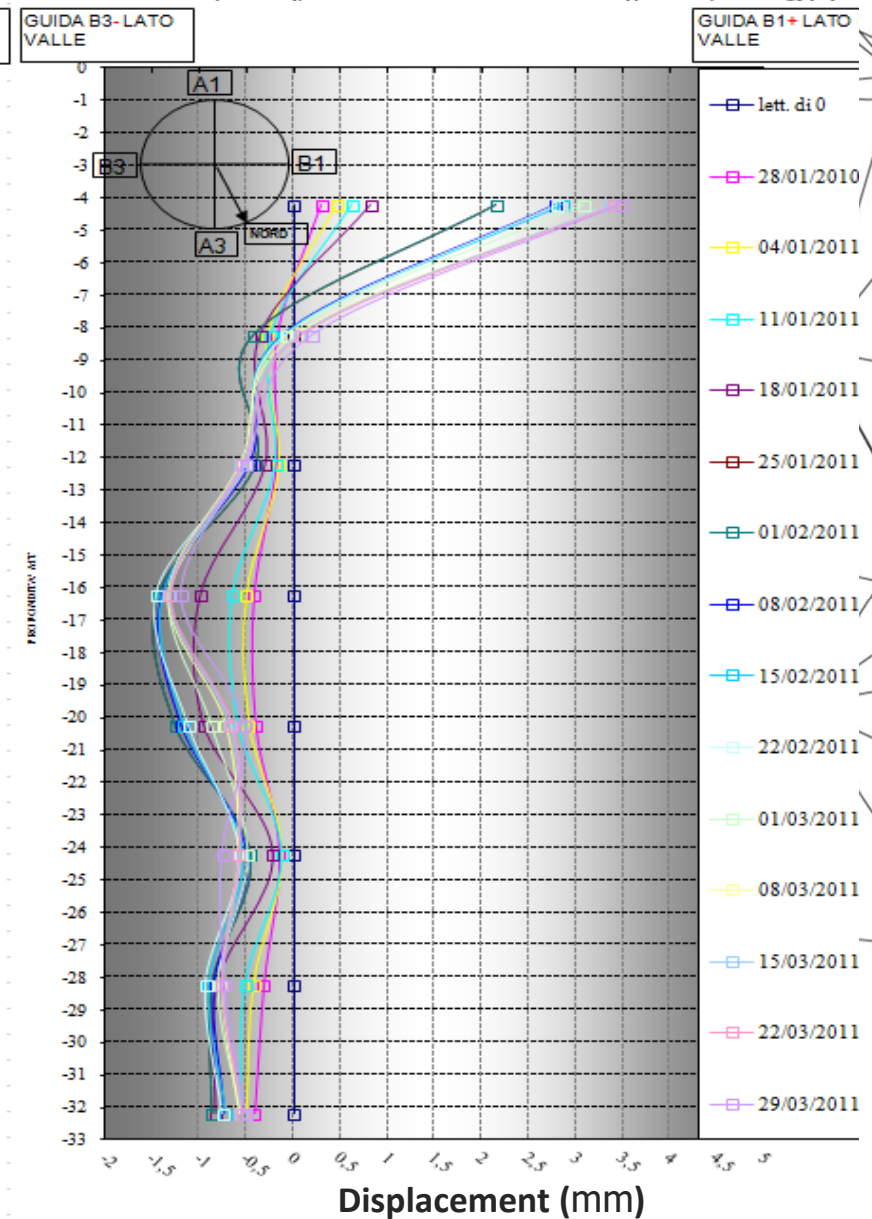
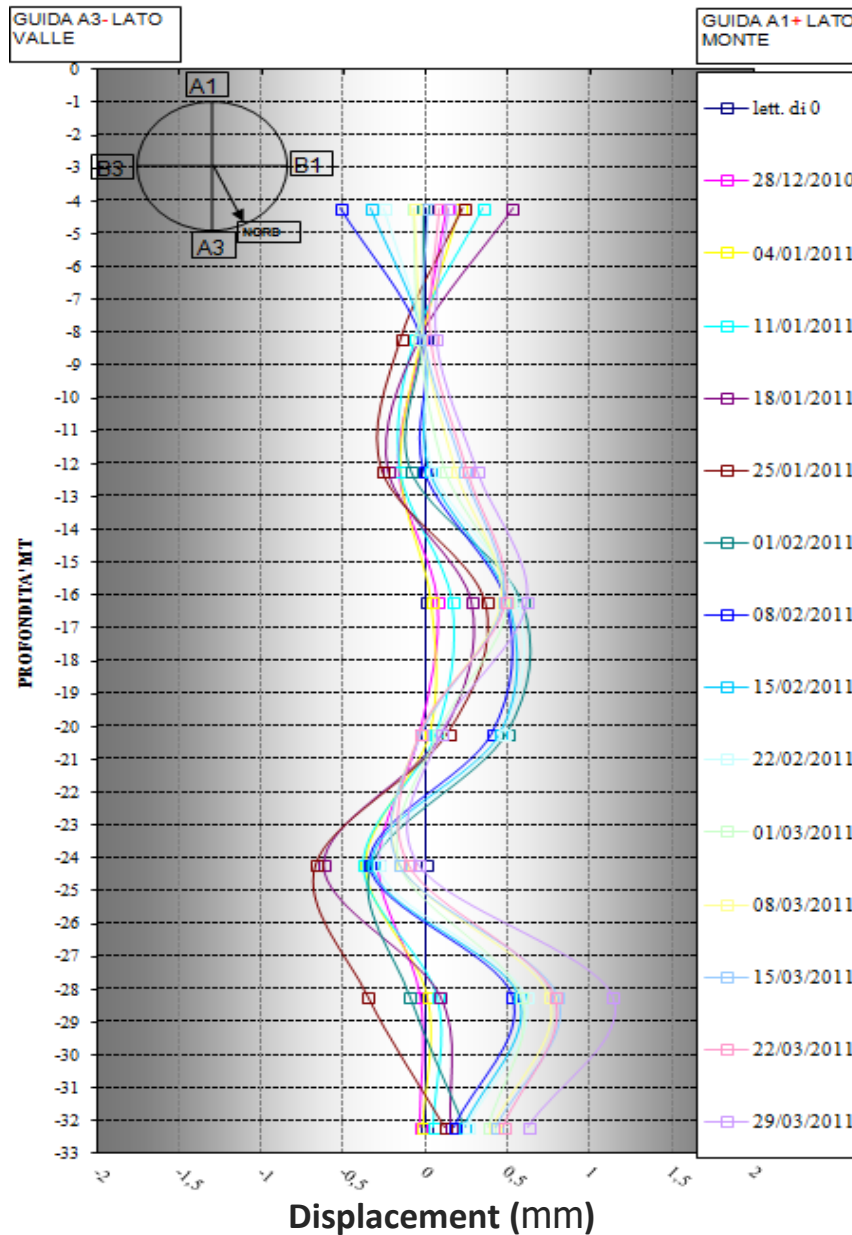


— PISCOPIO TUNNEL (Courtesy of Astaldi Spa)

Cumulative horizontal displacement

Left graph:
A1-A3 direction

Right graph:
B1-B3 direction

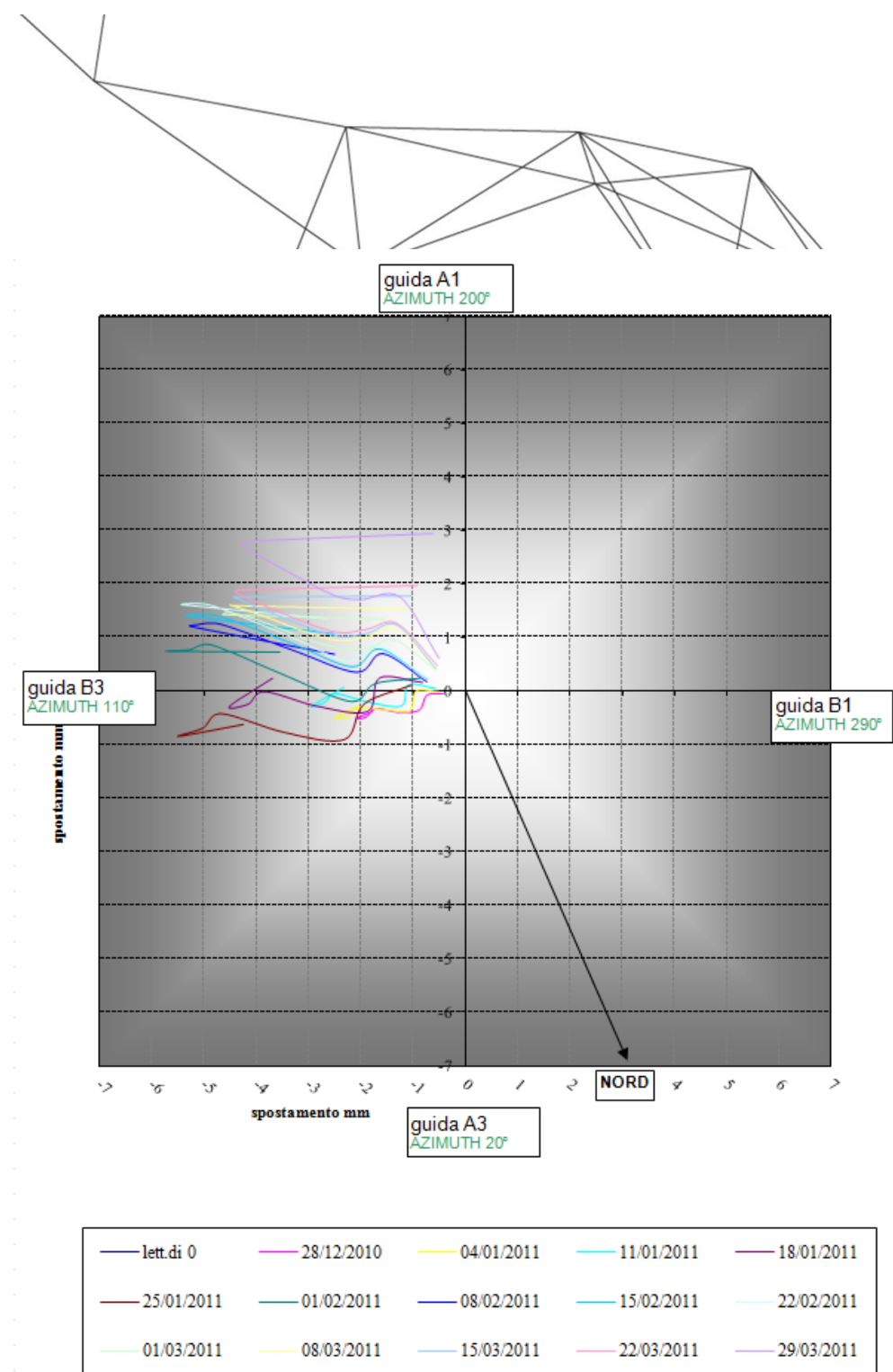
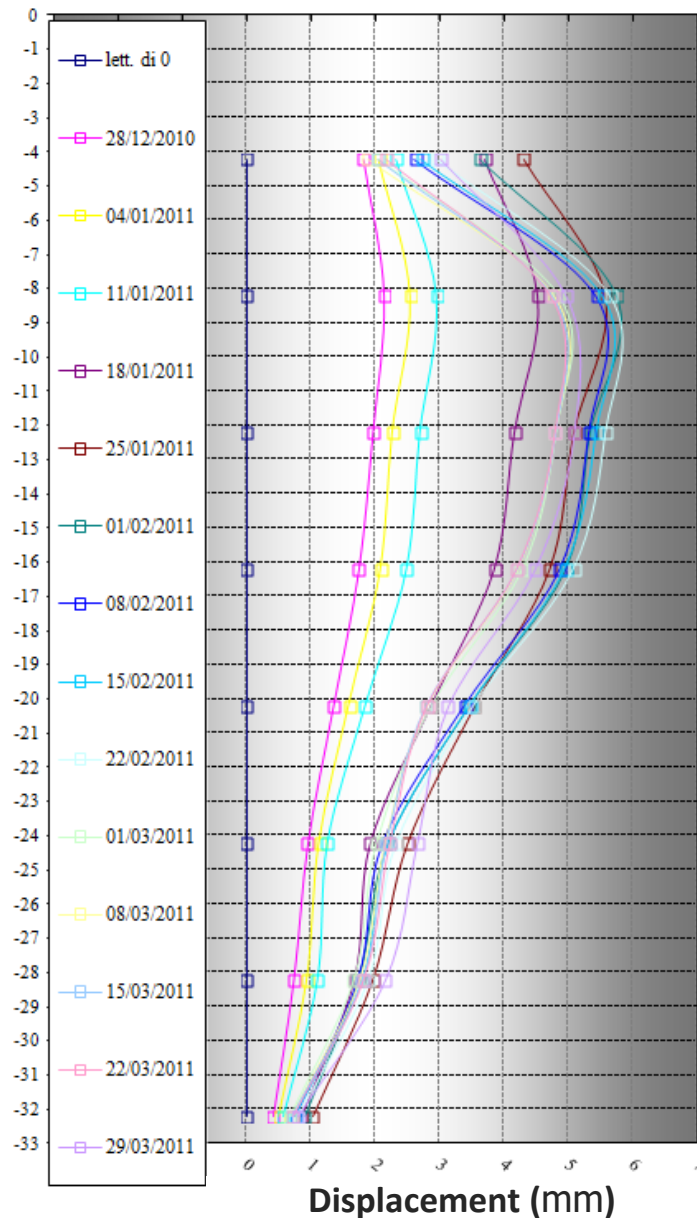


— PISCOPIO TUNNEL (Courtesy of Astaldi Spa)

Cumulative horizontal displacement

Left graph:
Cartesian total
cumulative
displacement

Right graph:
Polar total
cumulative
displacement



PISCOPIO TUNNEL (Courtesy of Astaldi Spa)

Cumulative vertical displacement

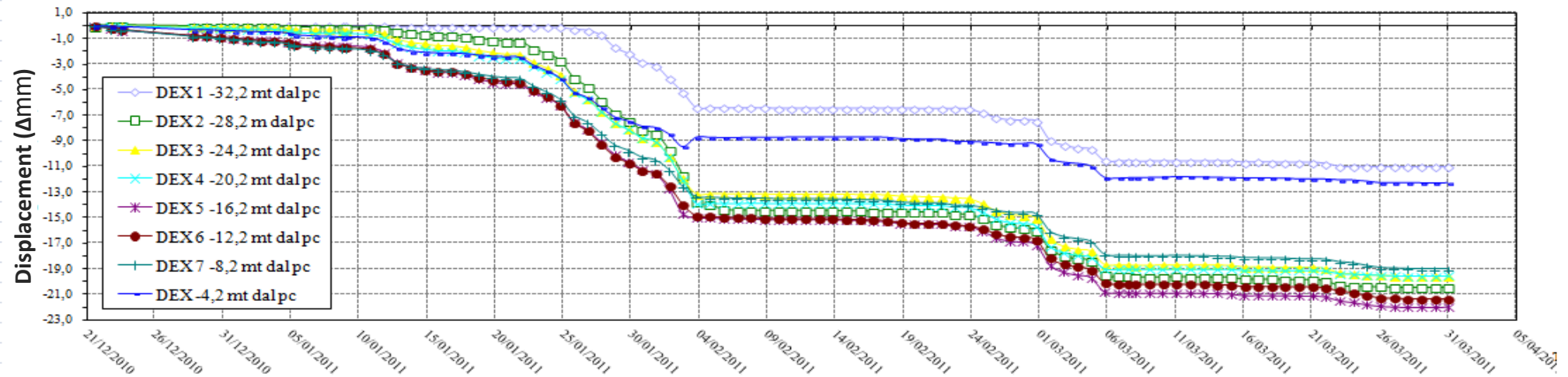
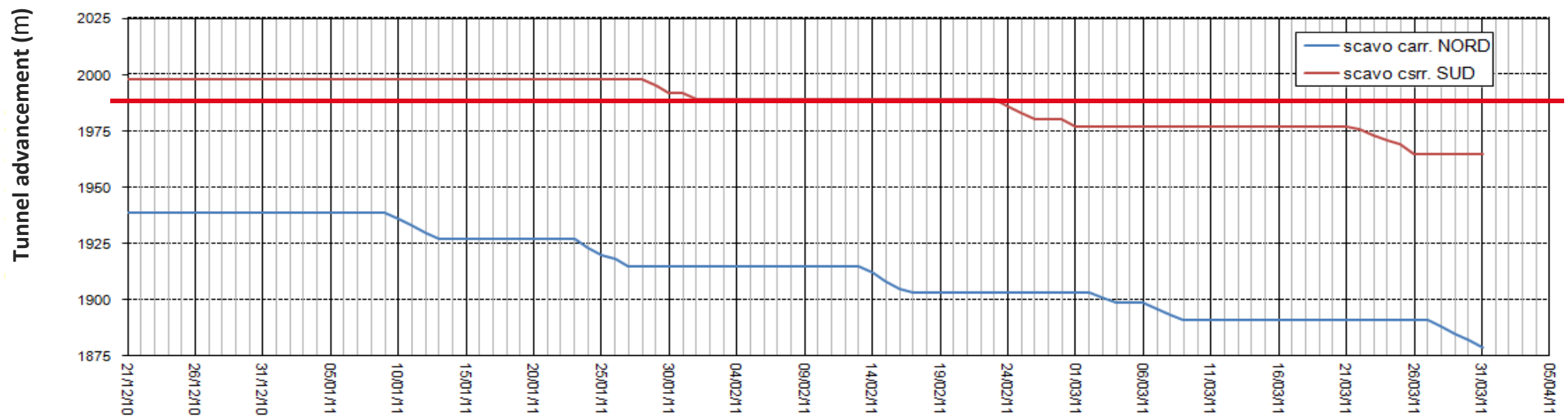
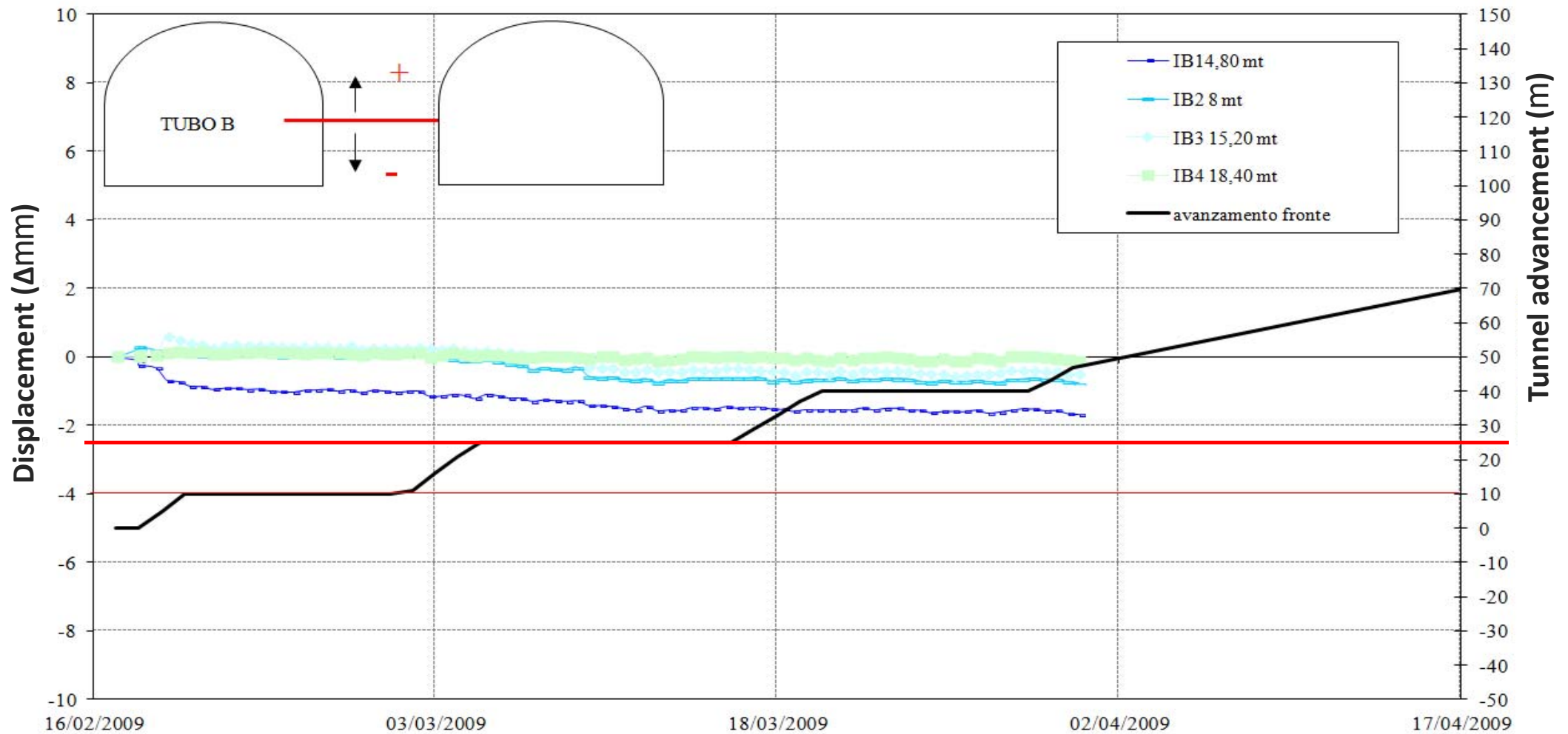


Diagramma Avanzamento Lavorazioni (fronte scavo - arco rovescio + murette - calotta)



SANTA MARIA SUD TUNNEL Courtesy of Astaldi Spa

Vertical displacements, tube B



__ CONCLUSIONS

- *DEX-S is a good solution for automatic 3D monitoring of unattended boreholes*
- *High performances*
- *Clear and direct data output*
- *Cost-effective solution: single drilling for 3-D borehole monitoring*



THANK YOU!

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