MEDUSA DMT

ONSHORE AND OFFSHORE SOIL TESTING

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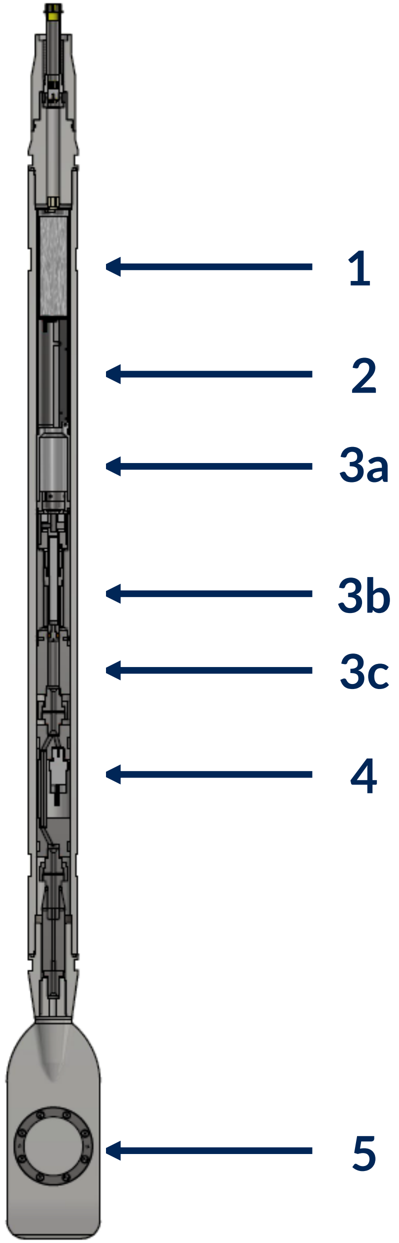
since 2019



patent no. 18457.0137.US0000

Automated Dilatometer Medusa DMT onshore & offshore

1. Battery Power Pack
2. Electronic Board
3. Hydraulic Motorized Syringe:
    a. Electric Engine
    b. Piston
    c. Cylinder
4. Pressure Transducer
5. DMT blade (standard dimensions)

Medusa DMT vs. Standard Pneumatic DMT

No Gas Tank

No Control Unit

No Pneumatic Cable

No manual inflation/deflation

Compact Equipment

Simple to transport

Air-shippable to test site

Medusa DMT blade with same dimensions

Same blade dimensions

Marchetti 1980 formulae

No correlations required

Medusa DMT membrane thickness

- Hydraulic pressurization is gradual and fully controlled, so accuracy of pressure readings does not depend on membrane thickness
- Medusa DMT employs always maximum thickness membranes of 0.30 mm
- Advantage 0.30 mm: maximum membrane resistance and durability in both soft and dense/hard soils

Pneumatic DMT – rate of pressurization

Pressure generated and measured *at surface*, although membrane is at depth → Pressure difference at opposite ends of pneumatic cable → Large error pressurizing too rapidly !!

In all DMT standards (ASTM, Eurocode, ISO, TC16, etc):

Inflation rate to A-reading: T_A = 15 s (± 5 s)

Inflation rate from A to B: T_{AB} = 15 s (± 5 s)

Medusa DMT – rate of pressurization

Pressure generated and measured at depth

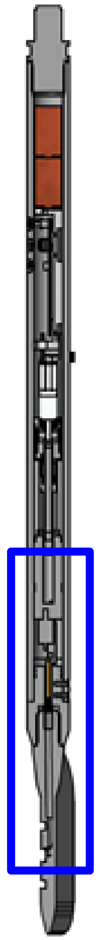
Oil incompressible

Oil volume minimal (no cable)

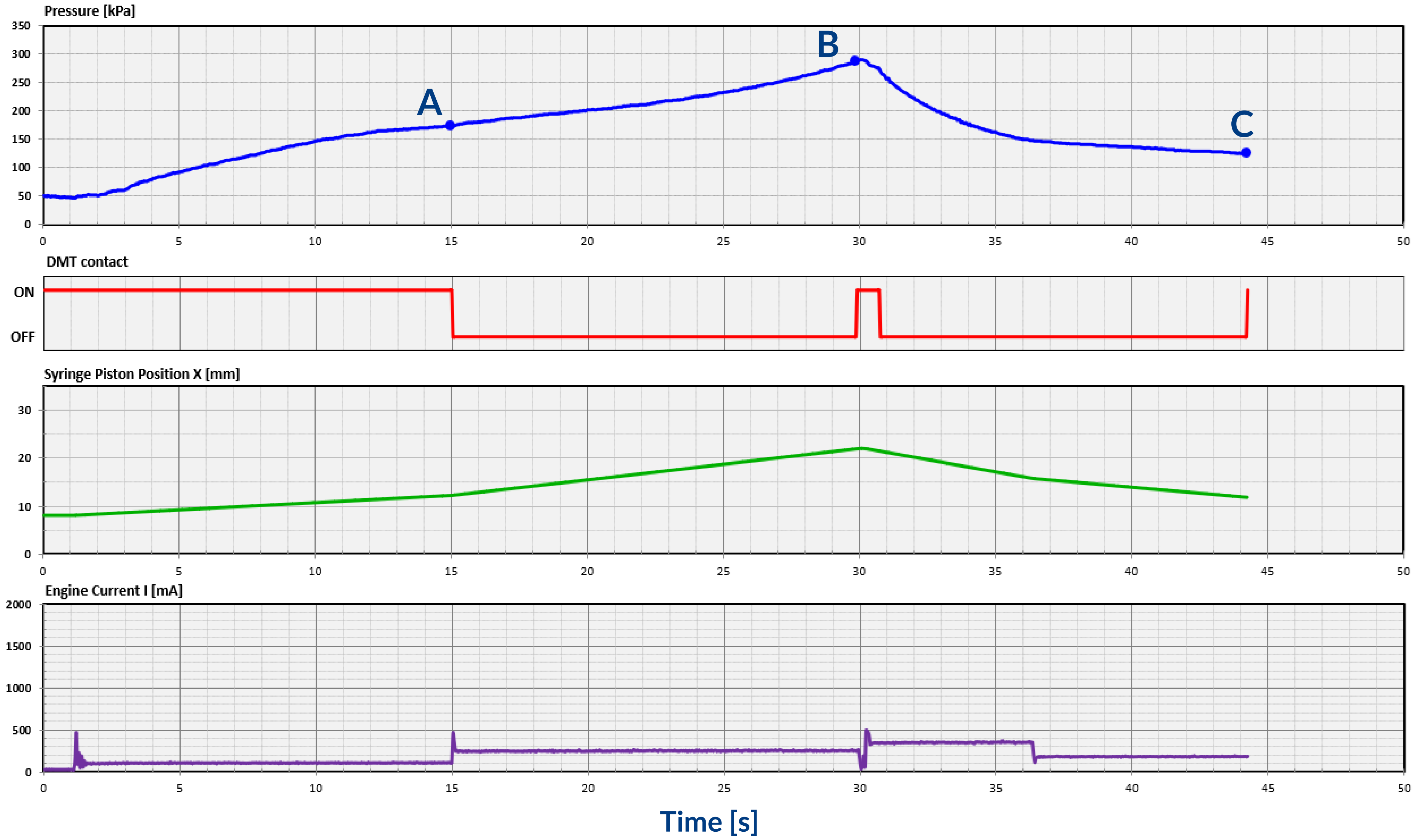
Readings of pressure acting on membrane highly accurate

Pressurization more rapid and very repeatable

T_A = 3 s (± 1 s), T_{AB} = 7 s (± 1 s)   3 times faster !!

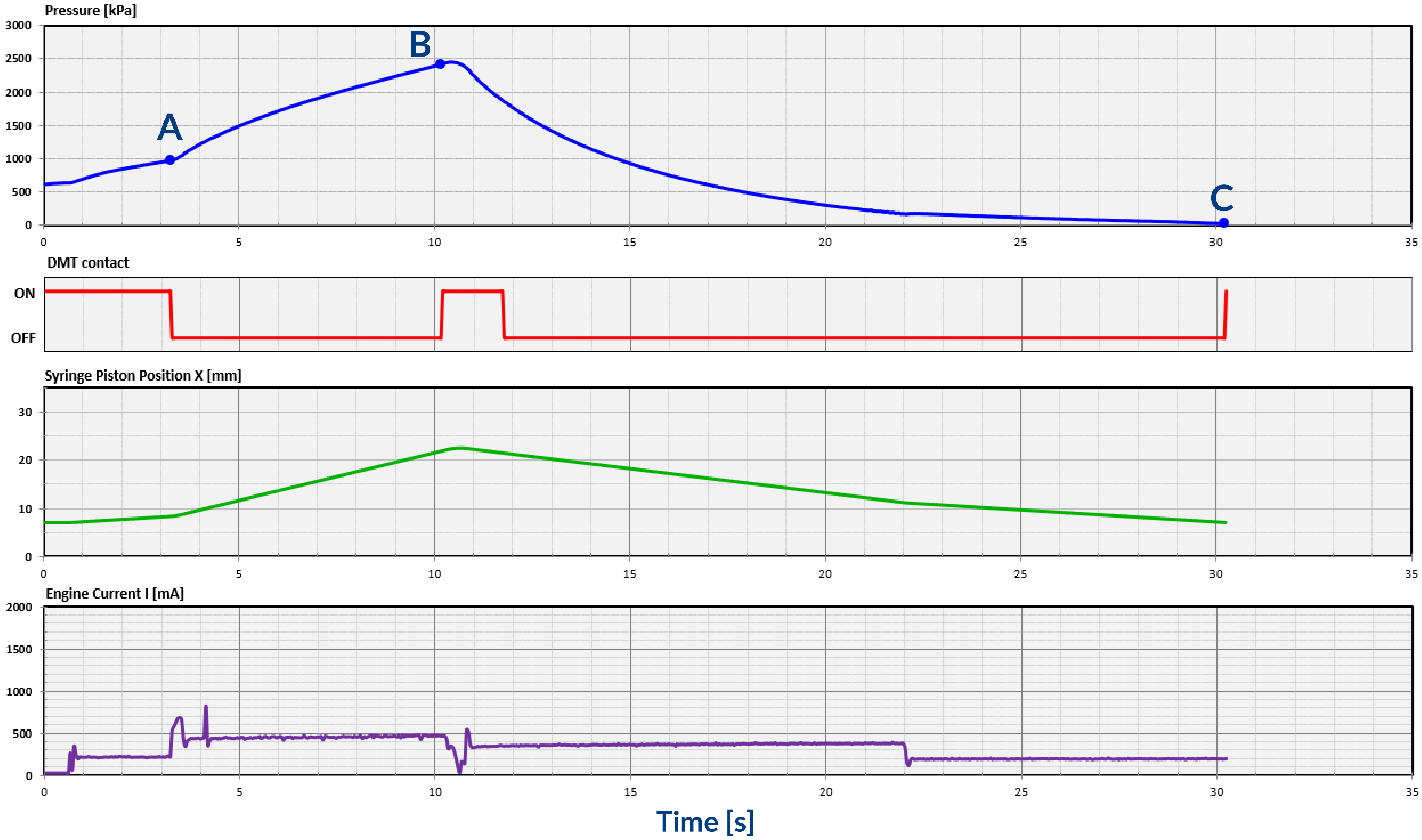


Medusa DMT: example of test cycle with T_A = 15 s, T_{AB} = 15 s



T = 0 when penetration stops and test cycle begins

Medusa DMT: example of test cycle with T_A = 3 s, T_{AB} = 7 s



T = 0 when penetration stops and test cycle begins

Pressurization: Medusa DMT vs Pneumatic DMT

Conclusion:

- Medusa DMT (A, B) readings are 3 times faster than Pneumatic DMT
- All Medusa DMT readings are more accurate than Pneumatic DMT
- Pneumatic DMT pressurization rate depends on soil and operator (not repeatable)
- Medusa DMT pressurization rate is programmable and repeatable

Reason:

Medusa DMT: hydraulic pressure generation and measurement at depth

Pneumatic DMT: gas pressure generated and measured at surface using a pneumatic cable to membrane at depth

DMT tests in Partially Drained Geomaterials

DMT tests in Partially Drained Geomaterials

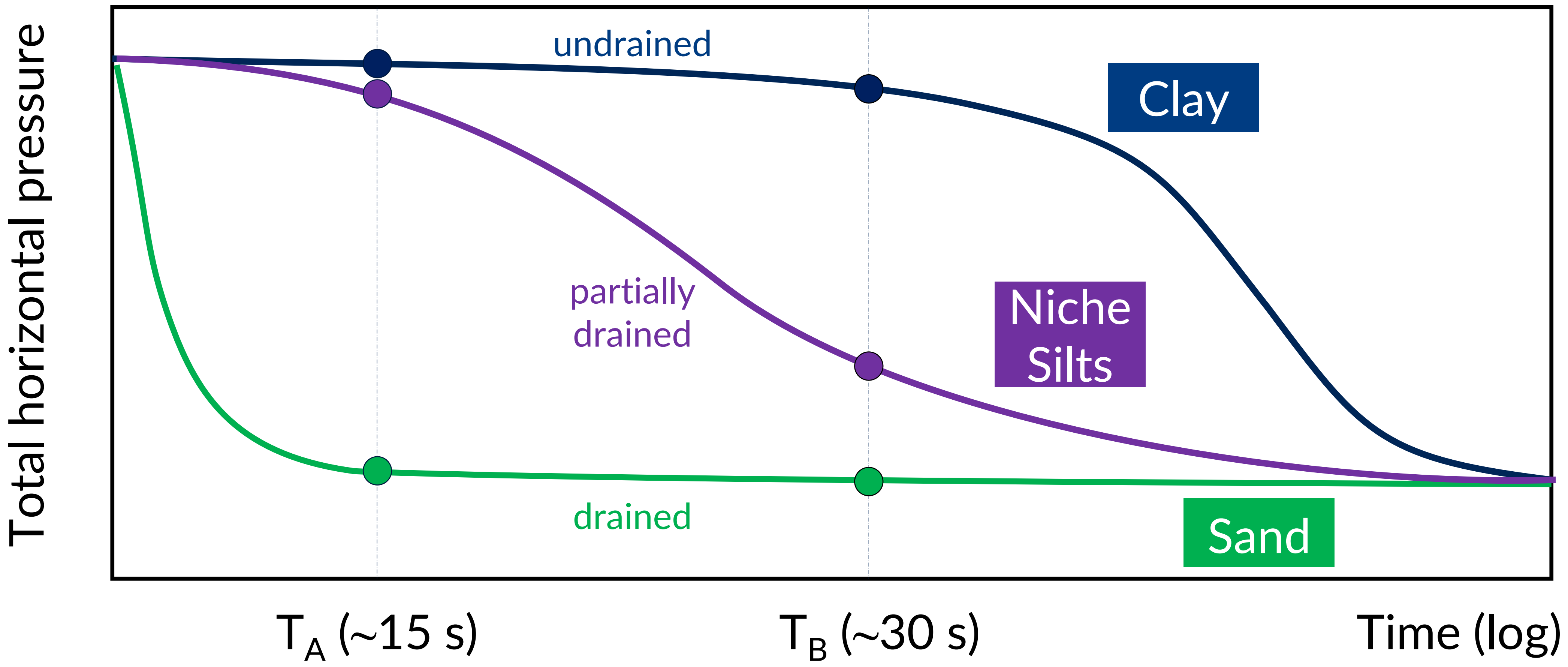
SAND (all): A & B fully **drained** → ok

CLAY (all): A & B fully **undrained** → ok

SILTS (most): A & B partially **drained** → ok

Niche Silts (S. Marchetti 2015): small family of silts where A & B are partially drained to a different extent → B – A too low → I_D & E_D= f (B-A) → M_{DMT} = f (E_D, I_D) → underestimated !

Partially Drained Geomaterials



Partially Drained Geomaterials

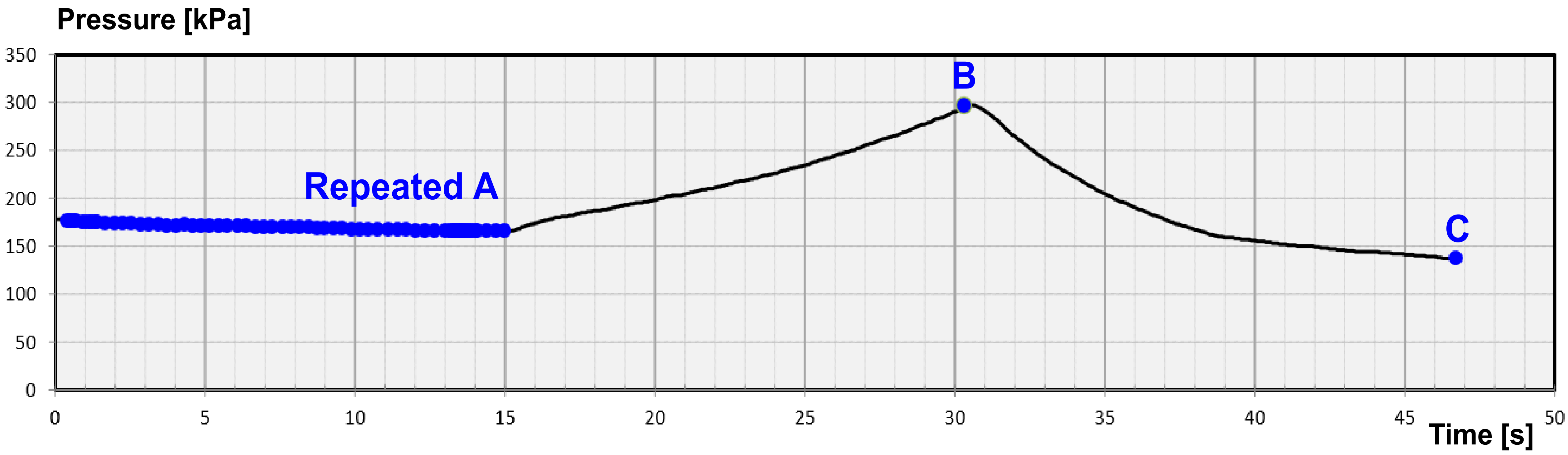
DMT may detect partial drainage with short dissipation tests in the first 15 seconds (before standard A reading)

If no appreciable A drainage → standard 15 s for A and B

If appreciable A drainage → wait (1-2 minutes) for dissipation before expanding to B (Schnaid 2019, 2021)

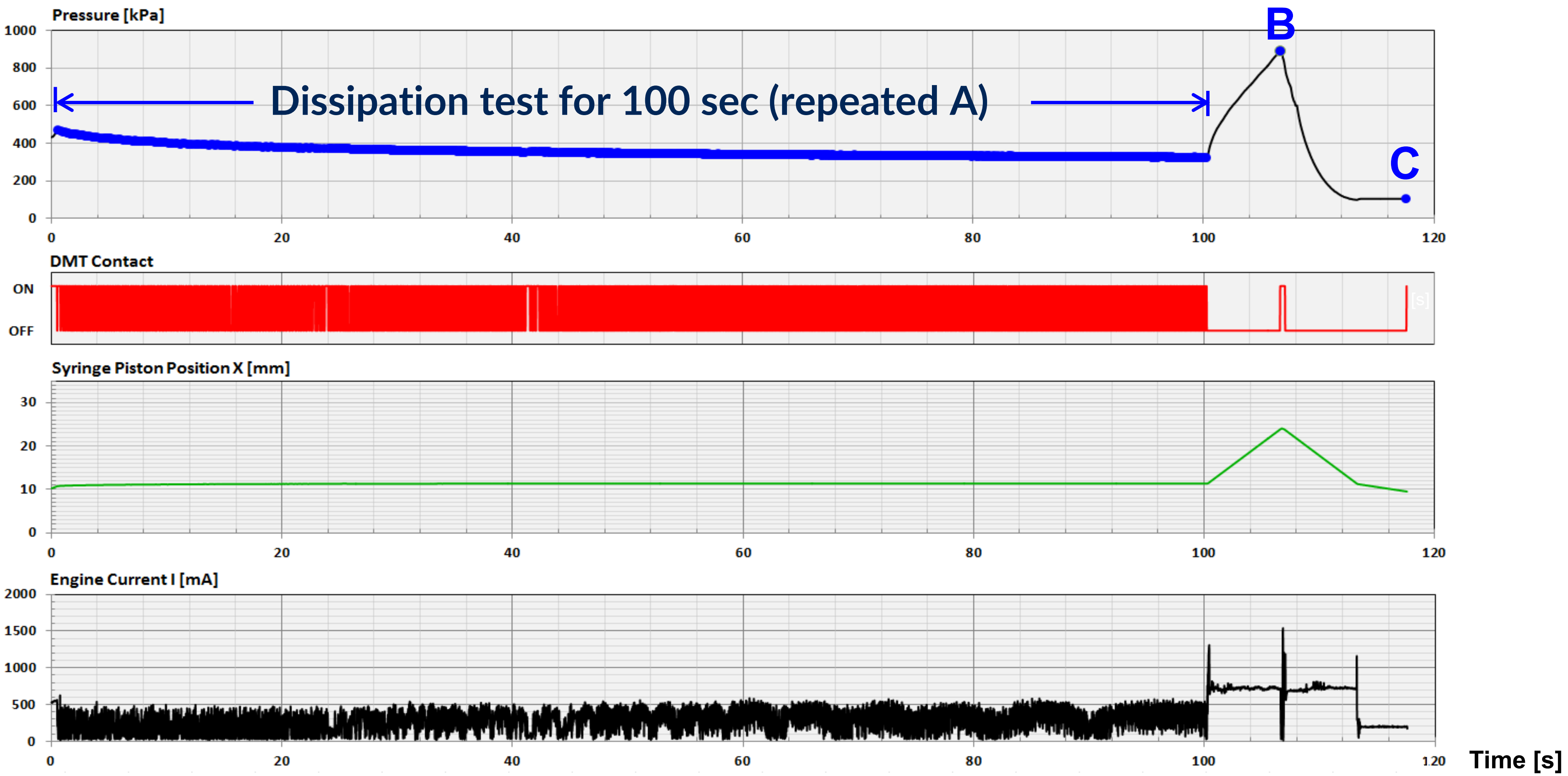
Short dissipation with negligible partial drainage

Monaco et al. (Sydney 2021)

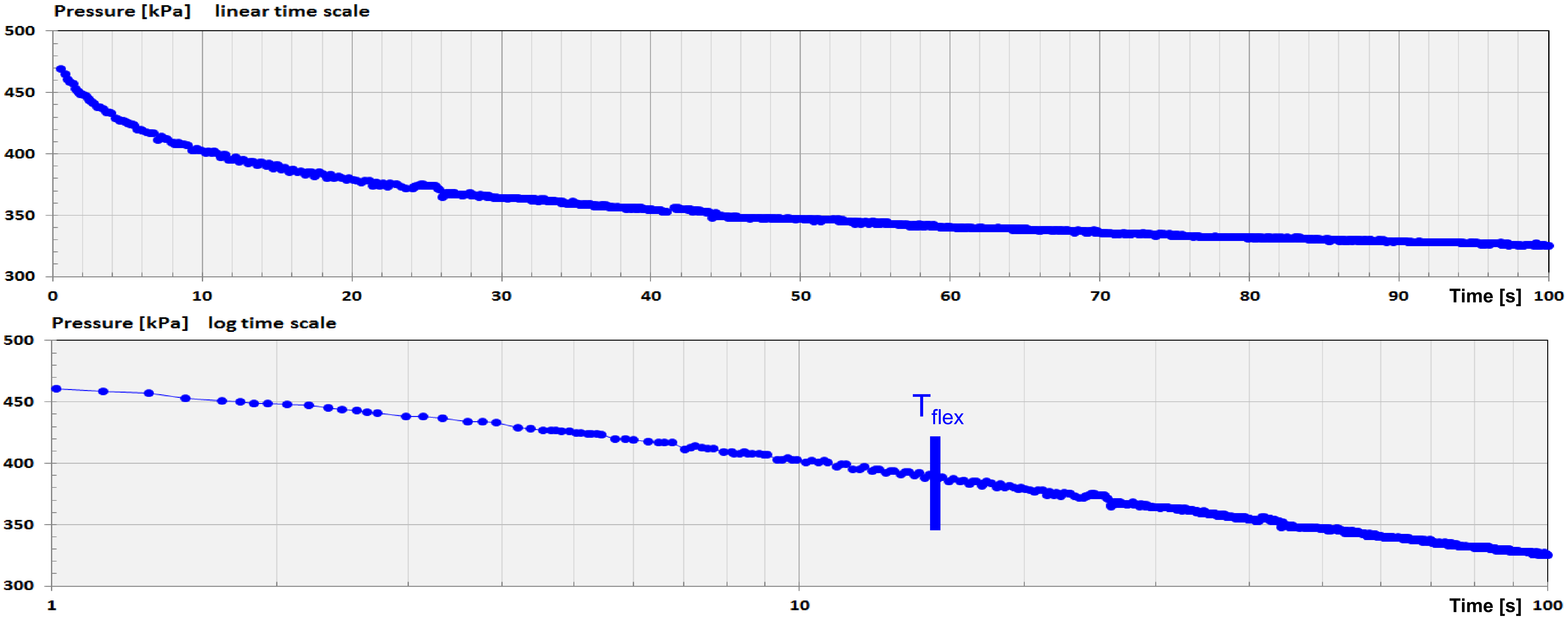


Telespazio Fucino (italy) – Medusa DMT 2, depth Z = 8.0 m (clay)

Short dissipation detecting partial drainage



Short dissipation detecting partial drainage



Plot log scale for Tflex identification → c_h and k_h

Family of partially drained geomaterials (niche silts)

Monaco et al. (ISC'6 2021 and ECSMGE 2024)

Data in the test site of Bondeno (Italy) and Halden (Norway) showed that:

Slower than standard penetration and/or membrane pressurization rates 'shift' the interpretation towards drained behavior.

Faster than standard penetration and/or pressurization rates 'shift' the interpretation towards undrained behavior

Short dissipation detecting partial drainage

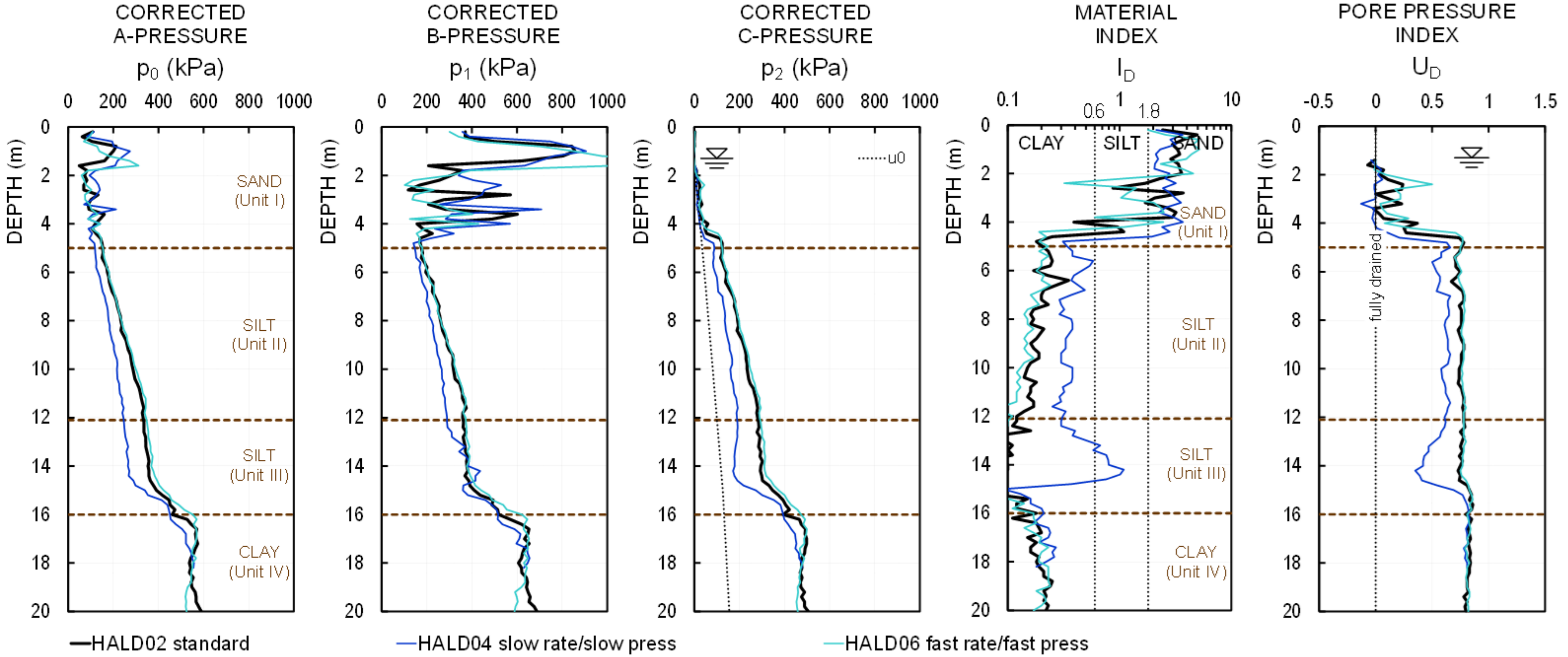


Figure 3. Combined effects of variable penetration and pressurization rates on Medusa (S)DMT results at the Halden test site (schematic soil stratigraphy after Blaker et al., 2019).

Characterization of intermediate soils by innovative in-situ testing procedures using Medusa DMT Monaco et al. (2024)

ECSMGE 24 XVIII EUROPEAN CONFERENCE ON SOIL MECHANICS AND GEOTECHNICAL ENGINEERING

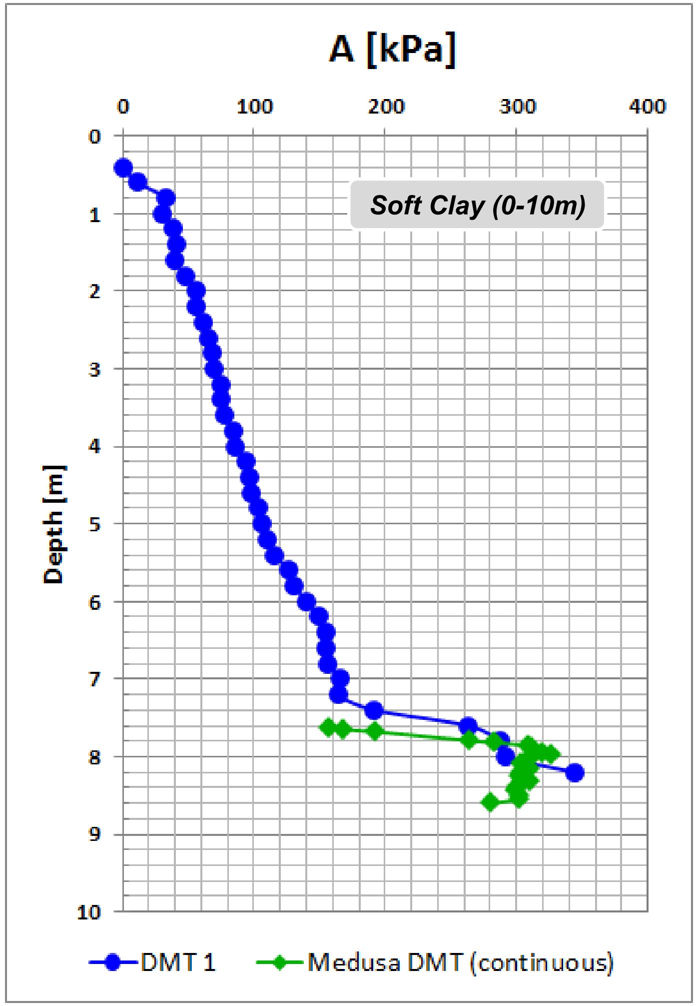
DMT-WP (while penetrating) procedure

Motorized syringe of Medusa is able to maintain membrane in equilibrium on A reading, balancing the total horizontal pressure of the soil against the membrane

New Test Procedure: DMT-WP

- Medusa DMT penetrates with membrane in equilibrium in the A position (total horizontal stress - undrained)
- A-Readings A plotted with depth
- B and C readings every 1 m at rod change

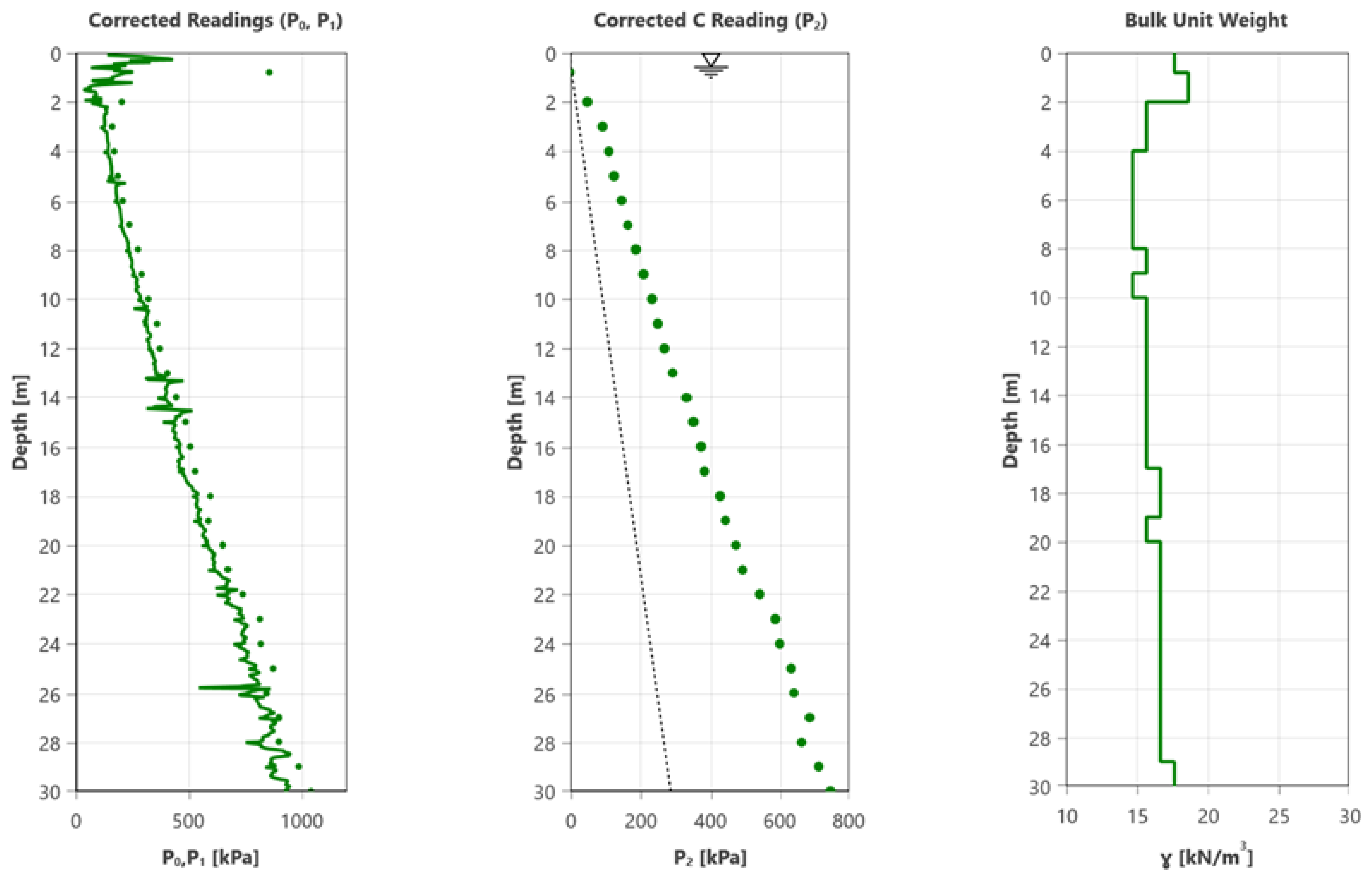
First comparison of DMT-WP test procedure



First preliminary result in 2019 appeared encouraging

***Sarapui II, Rio de Janeiro Brazil (2018)* - paper at ISC'6 Budapest 2021**

DMT-WP with B-readings every 1 meter



Telespazio Fucino clay (2020)

Monaco et al. (Sydney 2021)

DMT-WP – extremly high repeatability

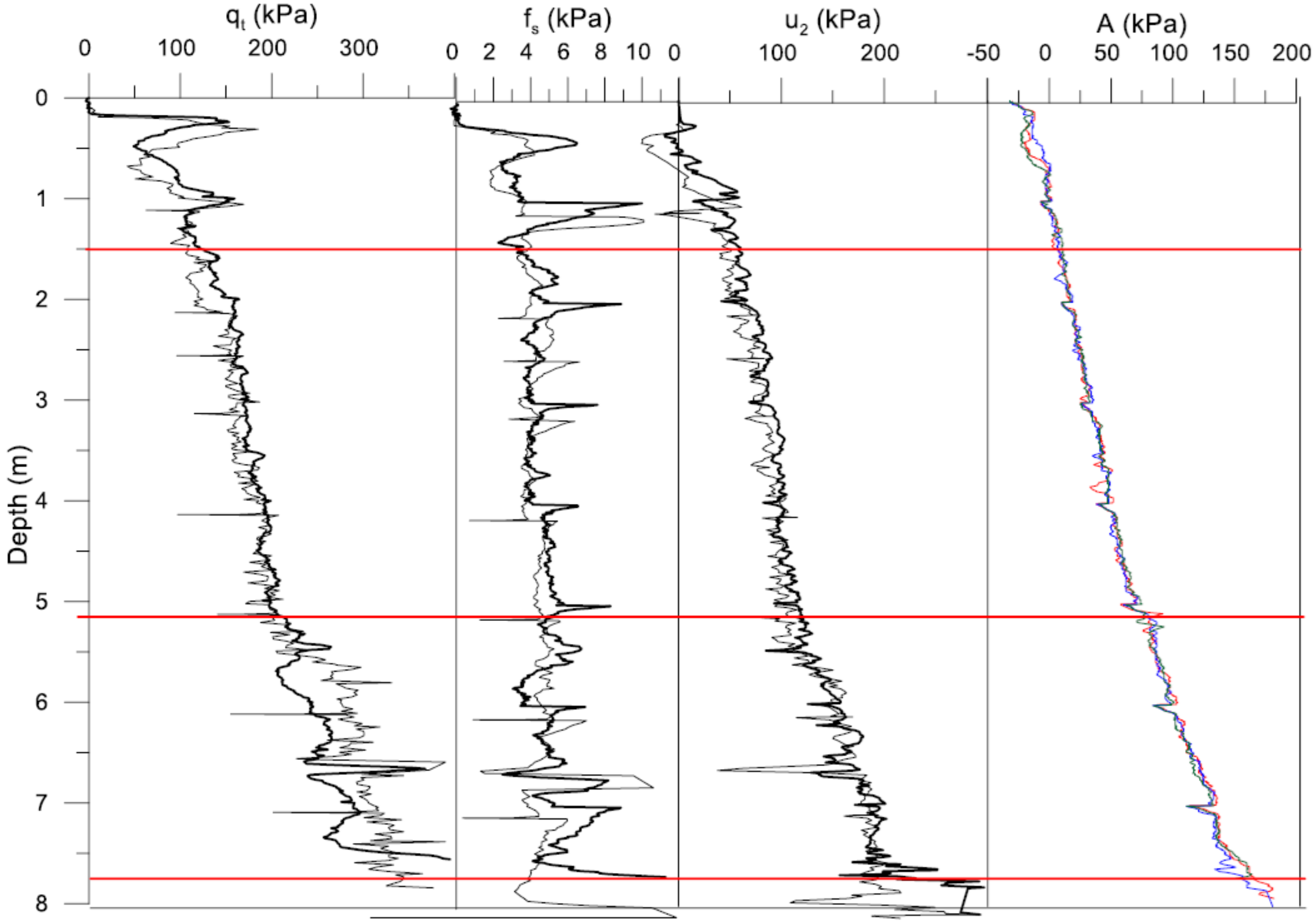


Figure 10. Cone resistance, q_t, sleeve friction, f_s, pore pressure, u_2, from piezocone tests, A from continuous Medusa DMT test.

ISC'7 Conference Barcelona June 18th – 21st 2024

Proceedings of the 7th International Conference on Geotechnical and Geophysical Site Characterization Barcelona, 18 - 21 June 2024

Continuous Medusa DMT tests in a very soft clay - Danziger et al. (2024)

In three distinct Medusa DMT-WP tests, the A readings provided excellent repeatability at very low pressure values, with less scatter than q_t, f_s and u_2 of two CPT tests

DMT-WP

With improved accuracy, repeatability and test velocity the Medusa DMT is rapidly increasing diffusion in the onshore and offshore industry.

Several Universities and Research Institutes are testing and publishing new findings, particularly on the new possible test procedures related to real time total horizontal stress measurements (dissipation test and DMT-WP).