Project: 902401 - Geo-Sense (2024)
Author: Denis Klimov (EE/ LSO)
Rev (2024-07-23): Initial Release

Meeting Notes 7/17/2024 Solifos - MBARI

Hello All,
I captured some notes that while not quarantined to be comprehensive, is still something. Summary:
(1) Essentially what Solifos/ Patrick is outlining, is that there is capability, and a knowledge, of building a load-bearing cable, capable of DTS (Distributed Thermal Sensing), DAS (Distributed Acoustic Sensing), DSS (Distributed Strain Sensing), as well as having Copper conductors for thermal measurements, all without compromising performance.
(2) However, use of all three modes (DTS, DAS, and DSS), require 3-channel interrogator.
(3) Patrick is requesting to build a prototype cable at first, especially for a more complex design involving strain measurement members.

Please see further details below, and please let me know if I got anything outrageously incorrect.

==========

Notes, meeting Solifos - MBARI, July 17, 2024, 09:00 PST
Solifos: Patrick Weissinger
MBARI: Aaron Micallef, Aaron Schinittger, Denis Klimov
Location: Zoom

Patrick: got specifications, worked with design engineers, pretty similar with some modifications. Screen sharing. Winch compatibility, 200 mm bend radius. Load, at least 50 kN, doable. 17 kN, working range. Working depth 2000 bar for inner tube; plus the outer armor; well specked for 2000 meters. Termination: will need some specifications or drawings.
Denis: what about torque balancing?
Patrick: should be torque balanced. Two layers, with different tensile strengths.
Denis: is it possible to do residual torque measurements?
Patrick: Can do the all tests per EAC-6794, can find out.
Denis: for ROV applications, sometimes vertical suspension in deep water is used to "un-twist" the cable, as it is going to be used in a similar (vertical) configuration. However, for our use, on the bottom, more or less horizontally, this method of untwisting does not work, so we are trying to gauge what the torque balance specs could be from the factory.
Patrick: ok this is interesting information, vertical suspension of the cable and all.
Denis: some companies such as TMT doing the cable termination, have capability of measuring parameters such as elongation and torque as a function of a load (and breaking strength) on a piece of a test cable.
Aaron S: what is the internal structure?
Patrick: Stress sensing element, DSS V4 diameter 2.4mm, optional V4 element. BRUsens Strain Sensing Cable. BRUsens DSS 3.2mm V4 Metallic. For a more complex design cable, especially, building first a prototype cable is needed.
Aaron M: can it be used for acoustic sensing, not just strain sensing?
Patrick: yes, it can be. The fiber must be in contact with the tube. Metal members are blocking acoustic waves, so outer layers are better for sensing, that is where DAS fiber should be located
Aaron M: AcoustoSense?
Patrick: Fibercore fiber is a competitor to OFS.
Denis: what about the final cable configuration? How many sensing fibers?
Patrick: yes, one sensing element for acoustic. LT Acoustic Sensing in the outer layer. Multi-purpose cable in the day of the day. Fiber tube in the middle.
Aaron M: what about thermal sensing fiber?
Patrick: yes, temperature sensing element is needed for use with strain sensing, to decouple thermal effects from strain effects.
Denis: what about a simplified, specific cable for sensing only, could it be higher performance potentially, compare to load-bearing cable?
Patrick: not really, a cable with strength elements can be made as sensitive, if done right. With a simple cable, deployment will be more difficult. The cable design can be optimized by placing elements in right locations. Also, possible copper elements for heating the cable, and measure the temperature, too, to measure thermal coupling.

Denis: thermal load measurement is an interesting option.
Aaron S: how long could the cable last underwater?
Patrick: example of the cable lasting 12 years. Bitumen, hydrogen absorption gel around the fiber. 6-7 euro / meter
Denis: can we selected the options for the cable, then?
Patrick: choice between DTS, DAS, DSS (Distributed Thermal Sensing; Distributed Acoustic Sensing; Distributed Strain Sensing), as well as Copper conductors.
Aaron S.: ok we will discuss those options and will get back to you.
==========

Denis Klimov

Attached: x6 frame grabs

/// End of text

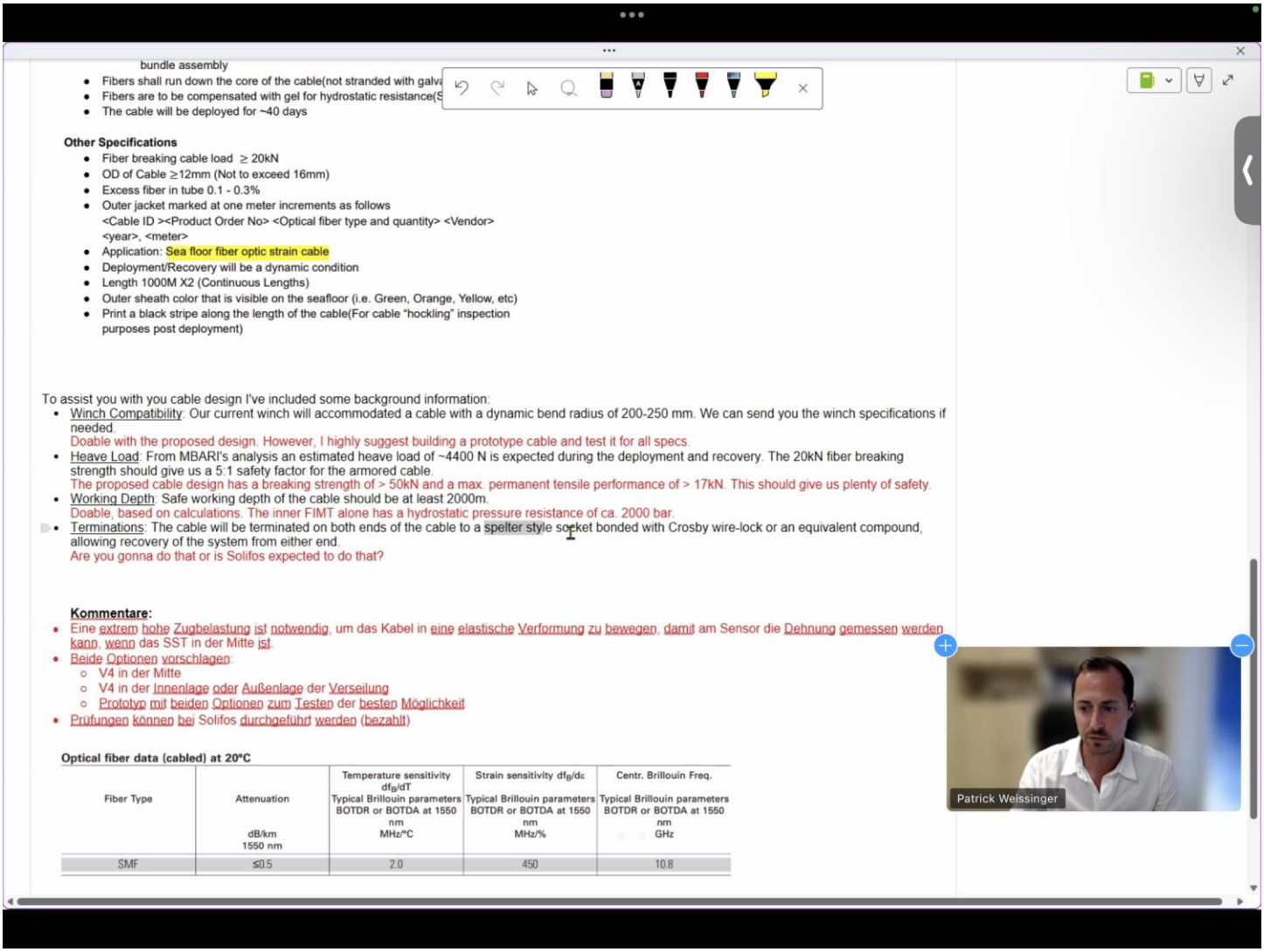
bundle assembly
Fibers shall run down the core of the cable(not stranded with galv
Fibers are to be compensated with gel for hydrostatic resistance(S
The cable will be deployed for ~40 days
Other Specifications
Fiber breaking cable load ≥ 20kN
OD of Cable ≥12mm (Not to exceed 16mm)
Excess fiber in tube 0.1 - 0.3%
Outer jacket marked at one meter increments as follows
<Cable ID ><Product Order No> <Optical fiber type and quantity> <Vendor>
<year>, <meter>
Application: Sea floor fiber optic strain cable
Deployment/Recovery will be a dynamic condition
Length 1000M X2 (Continuous Lengths)
Outer sheath color that is visible on the seafloor (i.e. Green, Orange, Yellow, etc)
Print a black stripe along the length of the cable(For cable "hockling" inspection purposes post deployment)
To assist you with you cable design I've included some background information:
Winch Compatibility: Our current winch will accommodated a cable with a dynamic bend radius of 200-250 mm. We can send you the winch specifications if needed.
Doable with the proposed design. However, I highly suggest building a prototype cable and test it for all specs.
Heave Load: From MBARI's analysis an estimated heave load of ~4400 N is expected during the deployment and recovery. The 20kN fiber breaking strength should give us a 5:1 safety factor for the armored cable.
The proposed cable design has a breaking strength of > 50kN and a max. permanent tensile performance of > 17kN. This should give us plenty of safety.
Working Depth: Safe working depth of the cable should be at least 2000m.
Doable, based on calculations. The inner FIMT alone has a hydrostatic pressure resistance of ca. 2000 bar.
Terminations: The cable will be terminated on both ends of the cable to a spelter style socket bonded with Crosby wire-lock or an equivalent compound, allowing recovery of the system from either end.
Are you gonna do that or is Solifos expected to do that?
Kommentare:
Eine extrem hohe Zugbelastung ist notwendig, um das Kabel in eine elastische Verformung zu bewegen, damit am Sensor die Dehnung gemessen werden kann, wenn das SST in der Mitte ist.
Beide Optionen vorschlagen:
V4 in der Mitte
V4 in der Innenlage oder Außenlage der Verseilung
Prototyp mit beiden Optionen zum Testen der besten Möglichkeit
Prüfungen können bei Solifos durchgeführt werden (bezahlt)
Optical fiber data (cabled) at 20°C
Fiber Type
Attenuation
dB/km
1550 nm
Temperature sensitivity dfB/dT
Typical Brillouin parameters BOTDR or BOTDA at 1550 nm
MHz/°C
Strain sensitivity dfB/dε
Typical Brillouin parameters BOTDR or BOTDA at 1550 nm
MHz/%
Centr. Brillouin Freq.
Typical Brillouin parameters BOTDR or BOTDA at 1550 nm
GHz
SMF
≤0.5
2.0
450
10.8
Patrick Weissinger

Fig 1.

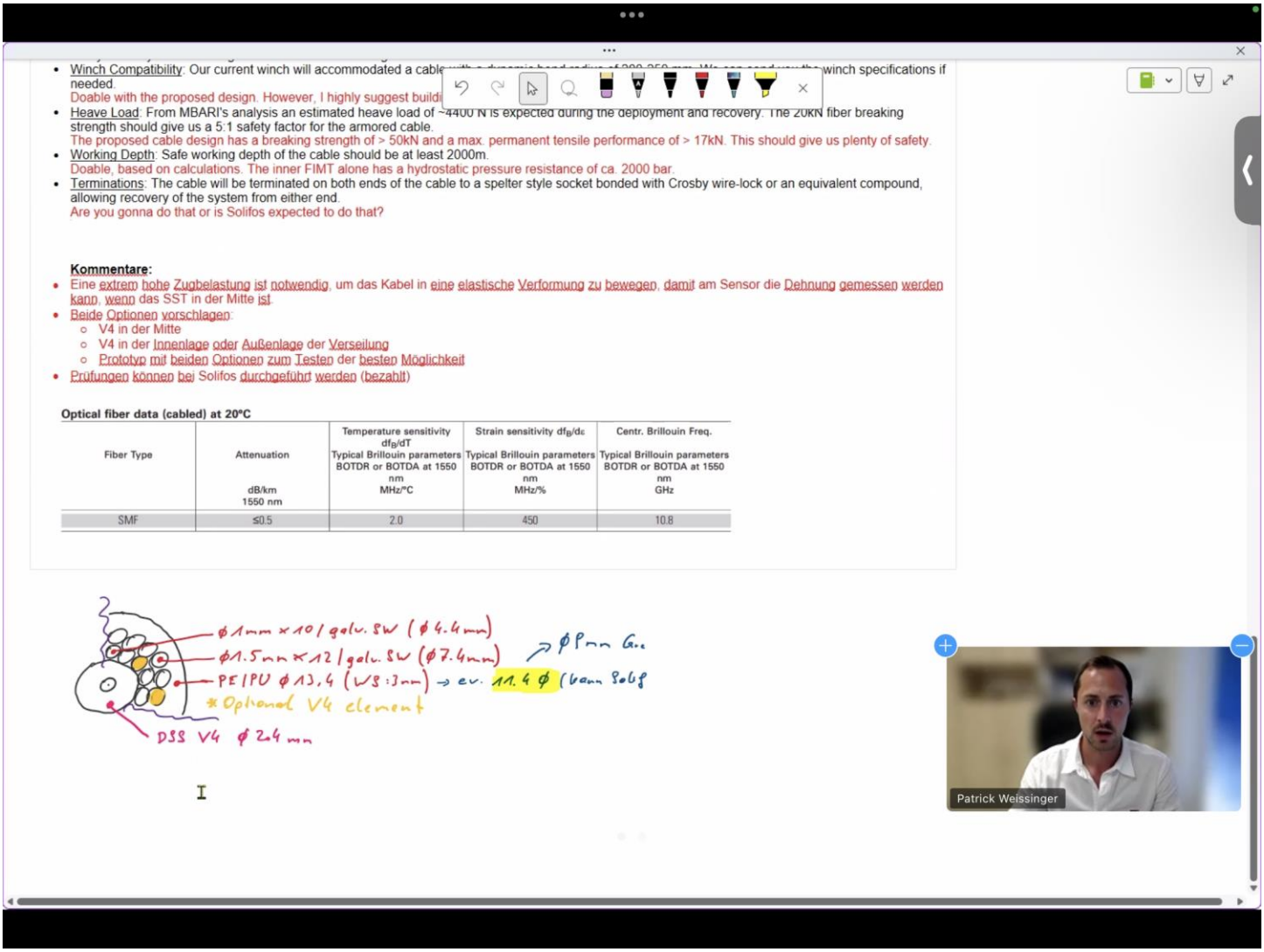
Winch Compatibility: Our current winch will accommodated a cable
needed.
Doable with the proposed design. However, I highly suggest build
Heave Load: From MBARI's analysis an estimated heave load of ~4400 N is expected during the deployment and recovery. The 20kN fiber breaking strength should give us a 5:1 safety factor for the armored cable.
The proposed cable design has a breaking strength of > 50kN and a max. permanent tensile performance of > 17kN. This should give us plenty of safety.
Working Depth: Safe working depth of the cable should be at least 2000m.
Doable, based on calculations. The inner FIMT alone has a hydrostatic pressure resistance of ca. 2000 bar.
Terminations: The cable will be terminated on both ends of the cable to a spelter style socket bonded with Crosby wire-lock or an equivalent compound, allowing recovery of the system from either end.
Are you gonna do that or is Solifos expected to do that?
winch specifications if
Kommentare:
Eine extrem hohe Zugbelastung ist notwendig, um das Kabel in eine elastische Verformung zu bewegen, damit am Sensor die Dehnung gemessen werden kann, wenn das SST in der Mitte ist.
Beide Optionen vorschlagen:
V4 in der Mitte
V4 in der Innenlage oder Außenlage der Verseilung
Prototyp mit beiden Optionen zum Testen der besten Möglichkeit
Prüfungen können bei Solifos durchgeführt werden (bezahlt)
Optical fiber data (cabled) at 20°C
Fiber Type
Attenuation
dB/km
1550 nm
Temperature sensitivity
df_B/dT
Typical Brillouin parameters
BOTDR or BOTDA at 1550 nm
MHz/°C
Strain sensitivity $df_B/d\varepsilon$
Typical Brillouin parameters
BOTDR or BOTDA at 1550 nm
MHz/%
Centr. Brillouin Freq.
Typical Brillouin parameters
BOTDR or BOTDA at 1550 nm
GHz
SMF
≤0.5
2.0
450
10.8
ϕ1mm x 10 / galv. SW (ϕ4.4mm)
ϕ1.5mm x 12 / galv. SW (ϕ7.4mm)
PE/PU ϕ13,4 (WS:3mm)
* Optional V4 element
DSS V4 ϕ24mm
Patrick Weissinger

Fig 2.

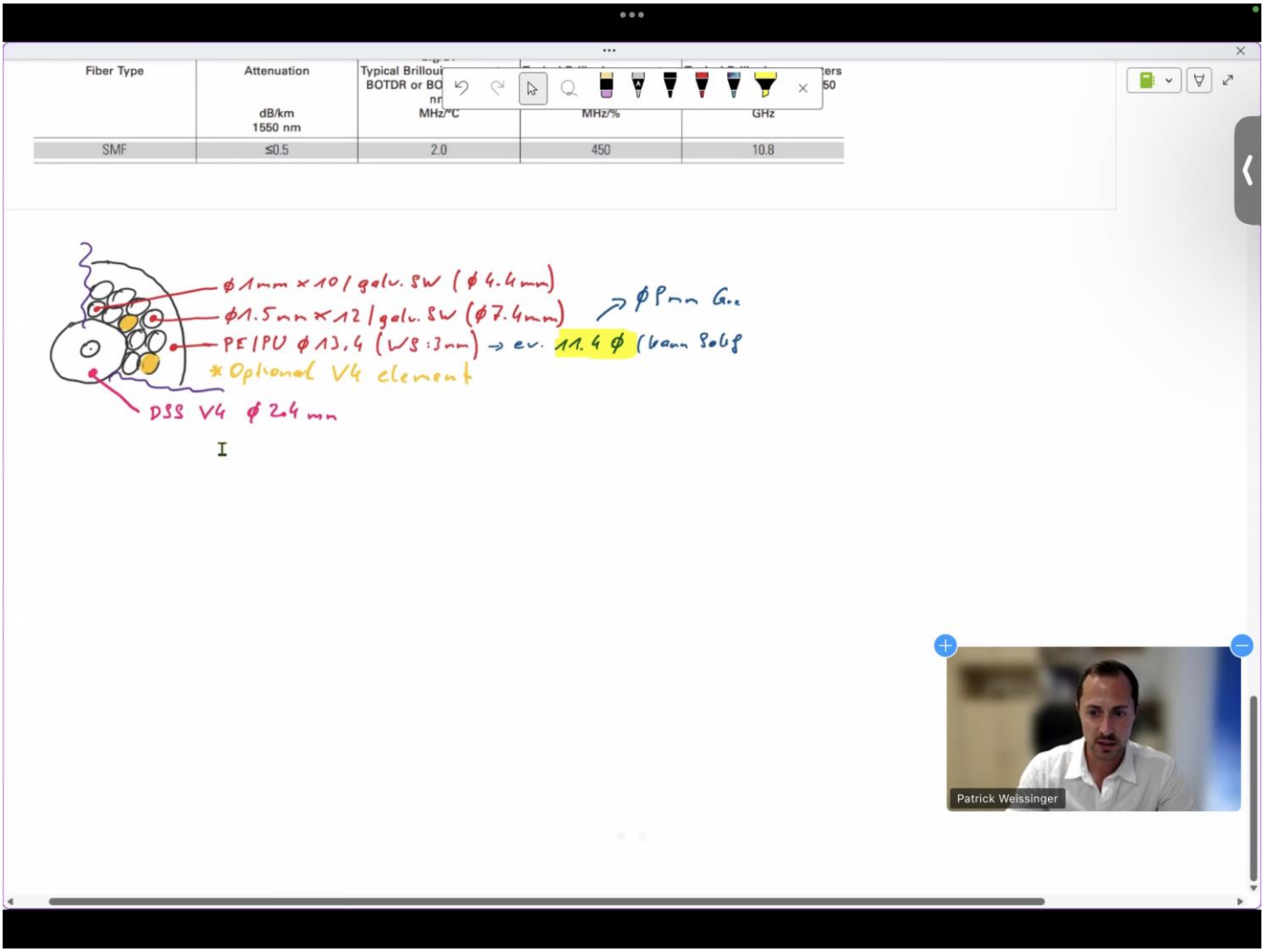
Fiber Type
Attenuation
dB/km
1550 nm
MHz/°C
MHz/%
GHz
SMF
≤0.5
2.0
450
10.8
ϕ1mm x 10 / galv. SW (ϕ4.4mm)
ϕ1.5mm x 12 / galv. SW (ϕ7.4mm)
PE/PU ϕ13,4 (WS: 3mm) → ev. 11.4 ϕ
* Optional V4 element
DSS V4 ϕ2.4 mm
Patrick Weissinger

Fig 3.

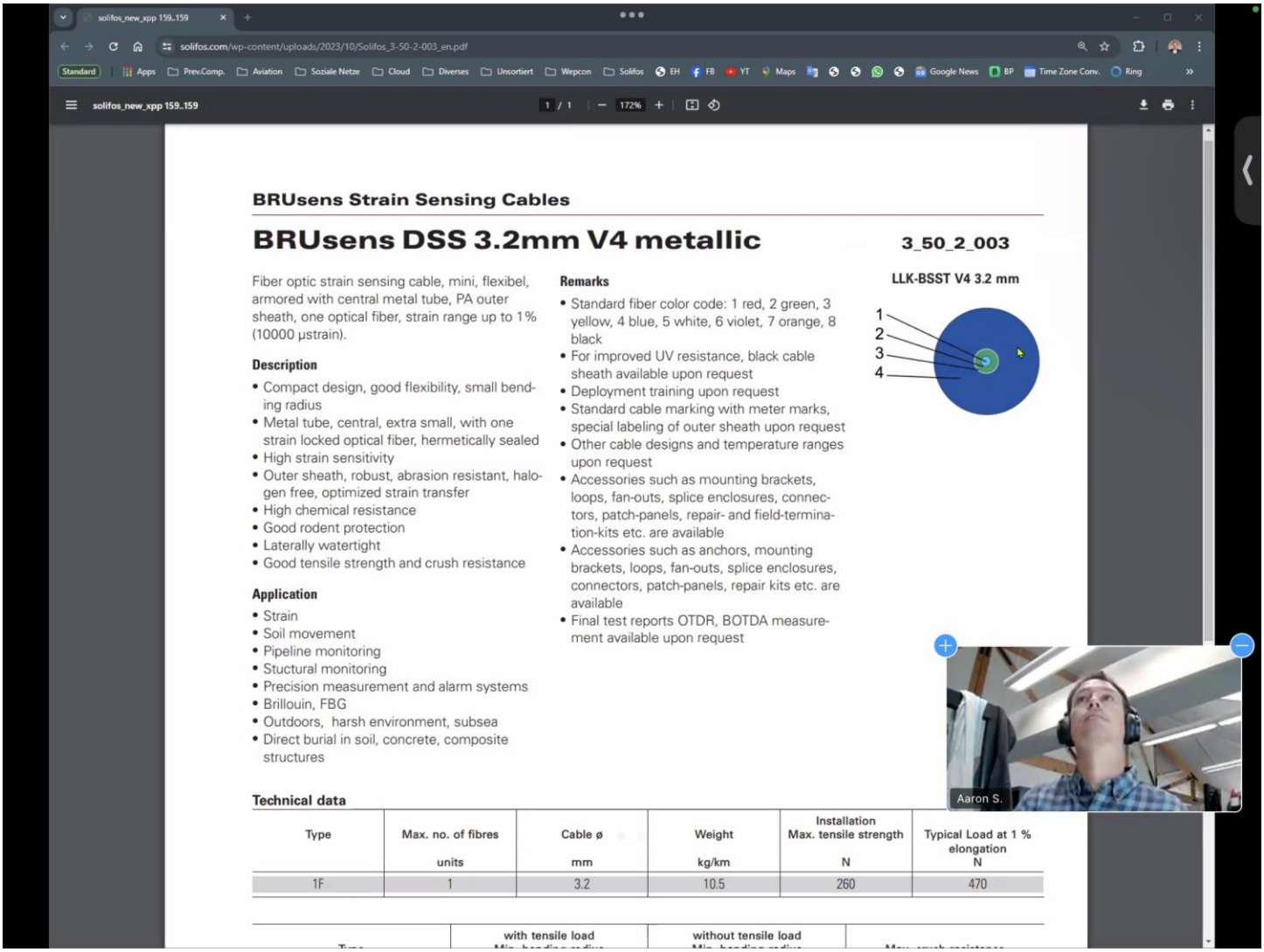
solifos_new_xpp 159..159
solifos.com/wp-content/uploads/2023/10/Solifos_3-50-2-003_en.pdf
BRUsens Strain Sensing Cables
BRUsens DSS 3.2mm V4 metallic
3_50_2_003
Fiber optic strain sensing cable, mini, flexibel, armored with central metal tube, PA outer sheath, one optical fiber, strain range up to 1% (10000 µstrain).
Description
• Compact design, good flexibility, small bending radius
• Metal tube, central, extra small, with one strain locked optical fiber, hermetically sealed
• High strain sensitivity
• Outer sheath, robust, abrasion resistant, halogen free, optimized strain transfer
• High chemical resistance
• Good rodent protection
• Laterally watertight
• Good tensile strength and crush resistance
Application
• Strain
• Soil movement
• Pipeline monitoring
• Stuctural monitoring
• Precision measurement and alarm systems
• Brillouin, FBG
• Outdoors, harsh environment, subsea
• Direct burial in soil, concrete, composite structures
Remarks
• Standard fiber color code: 1 red, 2 green, 3 yellow, 4 blue, 5 white, 6 violet, 7 orange, 8 black
• For improved UV resistance, black cable sheath available upon request
• Deployment training upon request
• Standard cable marking with meter marks, special labeling of outer sheath upon request
• Other cable designs and temperature ranges upon request
• Accessories such as mounting brackets, loops, fan-outs, splice enclosures, connectors, patch-panels, repair- and field-termination-kits etc. are available
• Accessories such as anchors, mounting brackets, loops, fan-outs, splice enclosures, connectors, patch-panels, repair kits etc. are available
• Final test reports OTDR, BOTDA measurement available upon request
LLK-BSST V4 3.2 mm
1
2
3
4
Technical data
Type
Max. no. of fibres
units
Cable ø
mm
Weight
kg/km
Installation
Max. tensile strength
N
Typical Load at 1 % elongation
N
1F
1
3.2
10.5
260
470
with tensile load
without tensile load
Aaron S.

Fig 4.

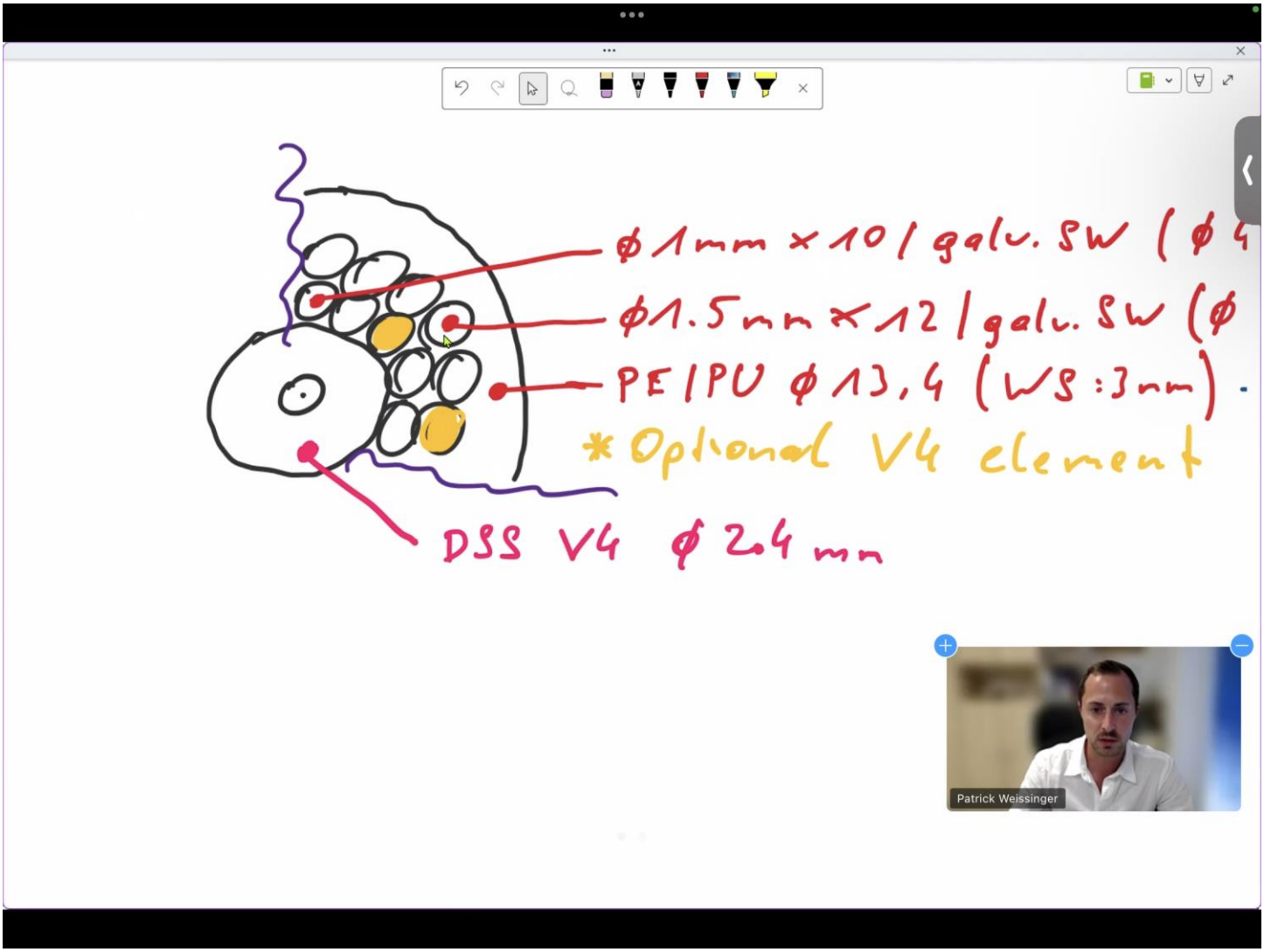
ϕ1mm x 10 / galv. SW (ϕ 4
ϕ1.5mm x 12 / galv. SW (ϕ
PE/PU ϕ 13,4 (WS: 3mm)
* Optional V4 element
DSS V4 ϕ 2.4 mm
Patrick Weissinger

Fig 5.

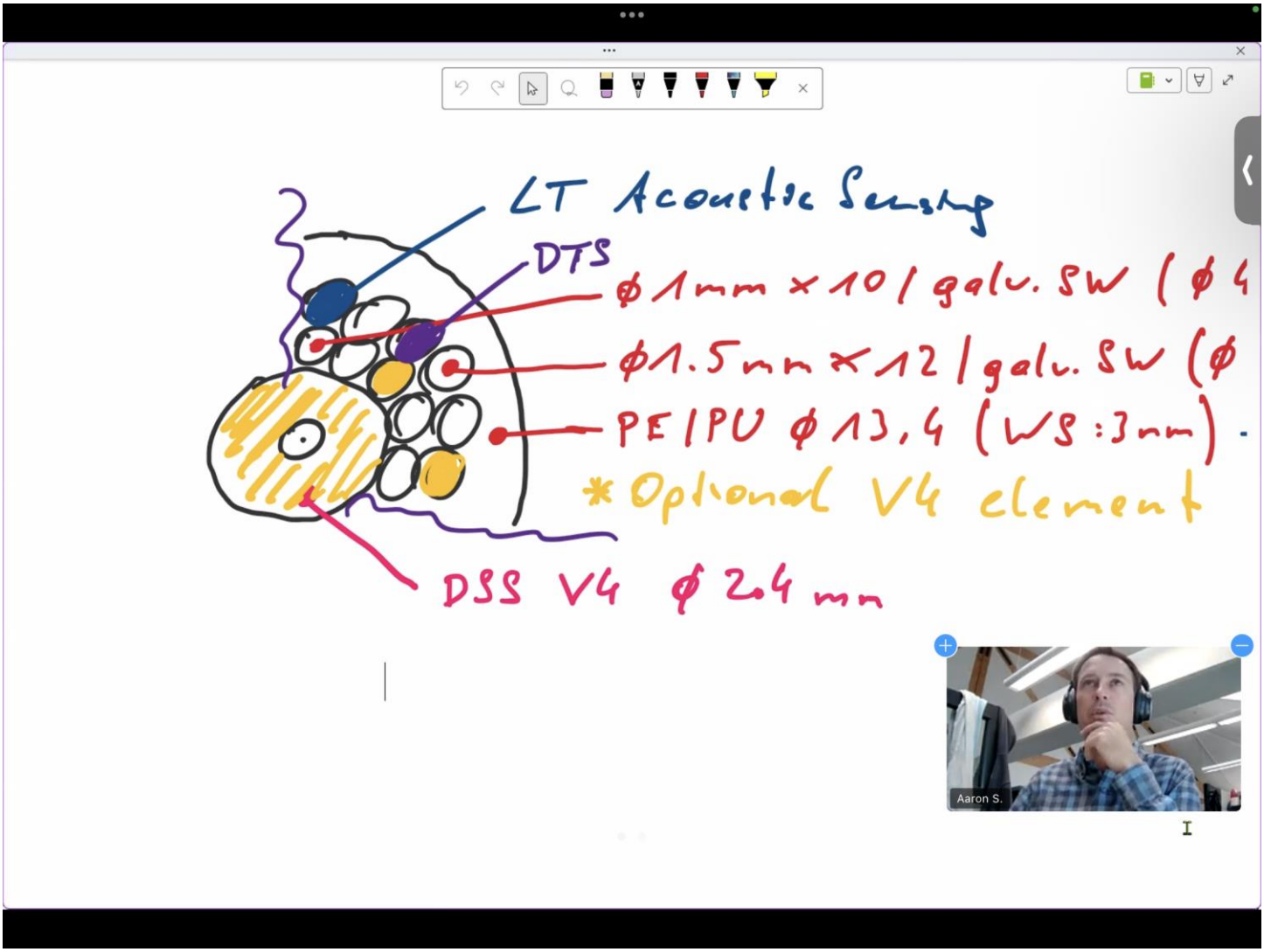
LT Acoustic Sensing
DTS
ϕ1mm ×10 / galv. SW (ϕ 4
ϕ1.5mm ×12 / galv. SW (ϕ
PE/PU ϕ13,4 (WS:3mm) .
* Optional V4 element
DSS V4 ϕ 2.4 mm
Aaron S.

Fig 6.