

PERFORMANCE TEST AT HEIGHT OF THE I4S FUSION SPLICER BY TELMARK

OBJECTIVE

This report was conducted to demonstrate the performance of the I4S fusion splicer at high altitude; therefore, splicing tests were carried out in Abra de Anticona (Ticlio), Province of Huarochirí – Lima, at an altitude of 4,818 meters above sea level.

CONTEXT

On the day the tests were conducted, Thursday, August 8, Ticlio experienced winds and the temperature ranged between -3°C and 7°C .



Fig.1. Landscape of the environment in Ticlio where the splicing tests were conducted

Fig.2. Development of the splicing tests with the M9 fusion splicer

BACKGROUND

The I4S is a core alignment fusion splicer with a portable design, featuring a 5" high-resolution color LCD touch screen with an intuitive and easy-to-use GUI (graphical user interface) that provides users with large and clear fiber images, with up to 320X zoom. The fusion time in super-fast mode is 4 seconds, and the heating time is 9 seconds. It is equipped with one battery, allowing up to 400 splicing cycles (fusion + heating).



Operating Conditions:

- Altitude: 0 ~ 5000 meters above sea level
- Relative humidity: 0 ~ 95%
- Temperature: -10 ~ 50 °C
- Wind: 15 m/s max.

Fig.3. I4S Fiber Optic Fusion Splicer. Brand: INNO

TEST DEVELOPMENT

Start date: 08/08/2024, 9:00 hrs.

End date: 08/08/2024, 12:00 hrs.

Location: Abra de Anticonca (Ticlío)

Environment conditions: Altitude: 4,818m above sea level, Temperature: -3 °C to 7°C, Wind: 4.1 m/s

Equipment: I4S Fusion Splicer, OTDR

SET UP CONFIGURATION

To verify the performance of this fusion splicer at high altitude, we used the following materials:

- 02 fiber reels of 100 meters with SC/APC connectors
- 02 SC/APC pigtails of 8 meters
- 02 SC/APC simplex adapters

The network consists of 2 fiber optic reels, 2 pigtails, and 1 fusion splice. The splice will be performed using the I4S fusion splicer by the brand INNO.

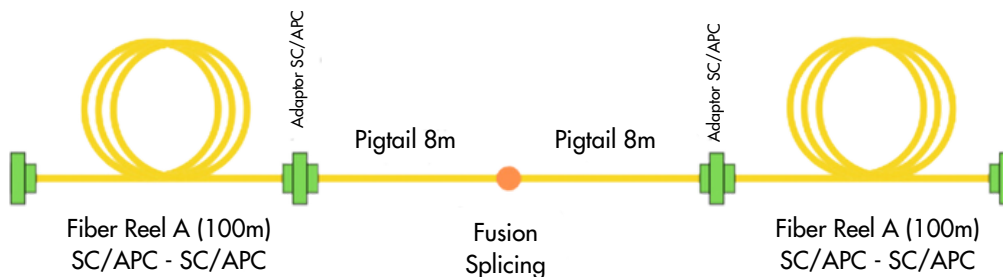


Fig. 4. Initial setup after the fusion splice

To measure the attenuation of the splices made with the I4S fusion splicer, an OTDR is used, following the current recommendation ITU-T Rec. G.650.3 (08/2017). Two measurements will be taken for each splice in both directions for a bidirectional report.

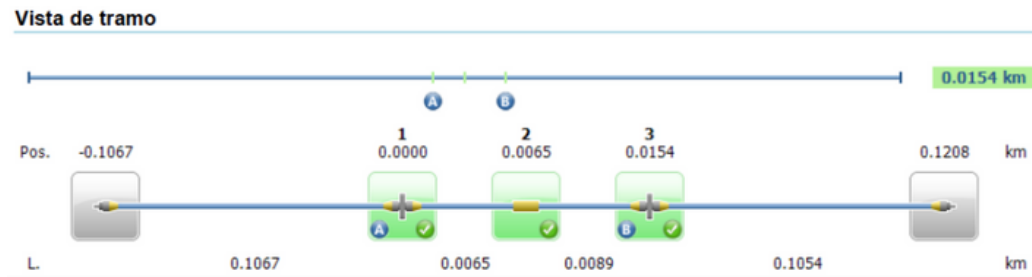


Fig. 5. Example of a report

To evaluate the attenuation quality of the splice, the current recommendation 'ITU-T L.12/L.400 (02/22) Optical Fibre Splices' will be followed, which establishes the requirements for fusion splices performed with a splicer using core alignment technology.

≤0.1 dB max

Note: Value taken from Table 1 on page 11 of the ITU-T L.12/L.400 (02/22) Optical Fibre Splices recommendation.

DIRECT SPLICING (Before the test)

Before performing the arc calibration, we tested whether the I4S splicer is capable of splicing the optical fibers by automatically recognizing the fiber type and without calibrating the arc. In the following image, it is shown that the splicer can indeed fuse the fibers under the specified conditions.



Fig.6. Fusion performed without arc calibration

TEST DEVELOPMENT

Before performing the fusion splices, we executed electrode stabilization and arc calibration on the I4S splicer, but during the tests, this calibration could not be completed. Despite this issue, the equipment was able to perform optimal fusion splices.

A total of 5 fusion splices were made and tested bidirectionally at 1310nm and 1550nm.

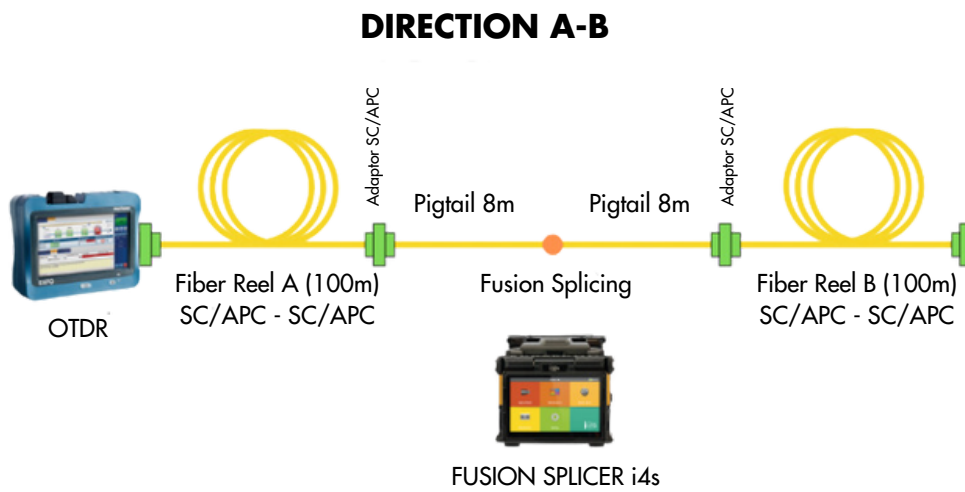


Fig. 7. Network diagram under test in direction A-B

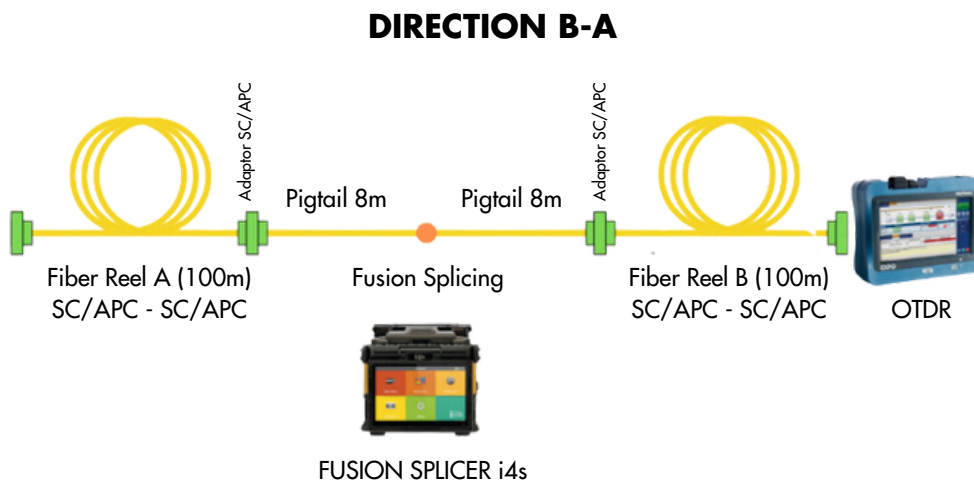


Fig. 8. Network diagram under test in direction B-A

The following is a summary table of the results:

Splice No.	ATTENUATION AT 1310nm			ATTENUATION AT 1550nm		
	A-B	B-A	Average	A-B	B-A	Average
Splice 1	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB
Splice 2	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB
Splice 3	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB
Splice 4	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB
Splice 5	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB

Table 1. Measured splice values

RESULT OF THE MEASUREMENTS

SPLICE 1

- Direction A-B

Vista de tramo

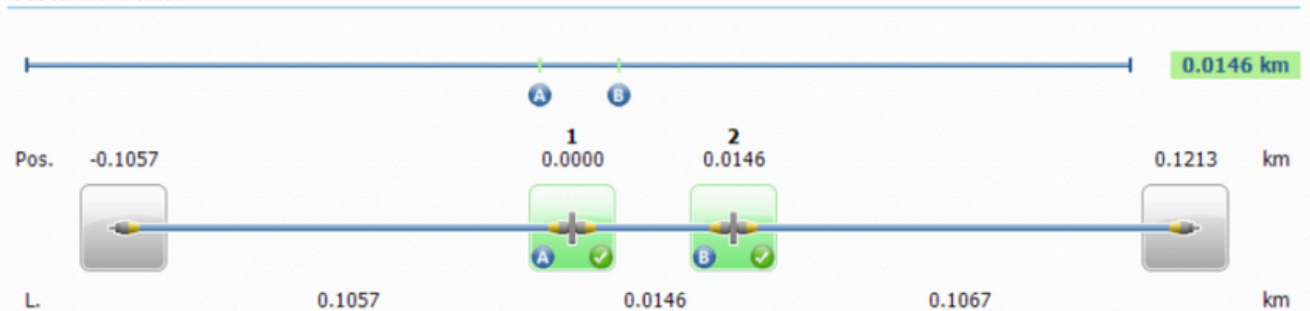


Tabla de elementos

Tipo	N.º	Pos./L. (km)	Pérdida (dB)		Ref. (dB)		At. (dB/km)	
			1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm
Conector		-0.1057	0.285	0.276	-45.3	-46.7		
Sección		0.1057	0.036	0.037			---	---
Conector	A 1	0.0000	0.086	0.190	-67.8	-68.3		
Sección		0.0146	---	---			---	---
Conector	B 2	0.0146	0.181	0.177	-59.2	-68.5		
Sección		0.1067	0.045	0.016			---	---
Conector		0.1213	---	---	-45.5	-47.2		

• **Direction B-A**

Vista de tramo

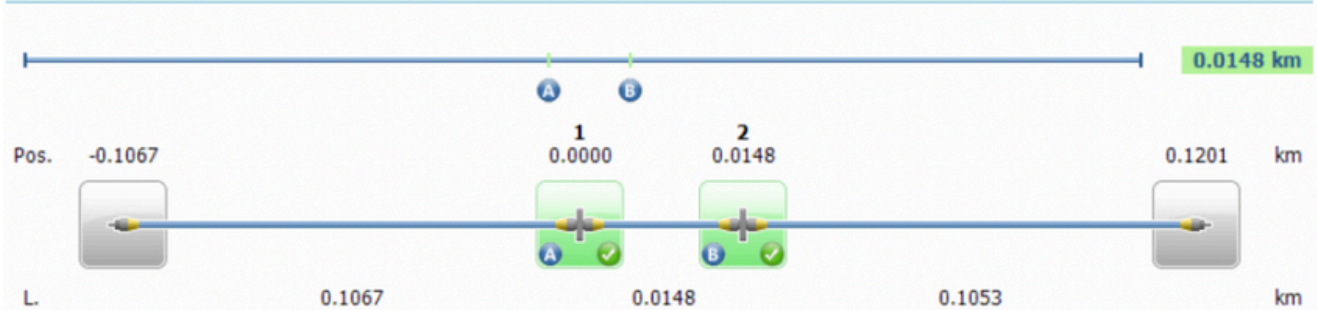


Tabla de elementos

Tipo	N.º	Pos./L. (km)	Pérdida (dB)		Refl. (dB)		At. (dB/km)	
			1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm
Conector		-0.1067	0.497	0.454	-56.7	-56.7		
Sección		0.1067	0.033	0.020			---	---
Conector	A 1	0.0000	0.067	0.097	-58.4	-64.2		
Sección		0.0148	---	---			---	---
Conector	B 2	0.0148	0.208	0.264	-65.6	-68.0		
Sección		0.1053	0.037	0.026			---	---
Conector		0.1201	---	---	-36.2	-34.3		

SPLICE 2

• **Direction A-B**

Vista de tramo

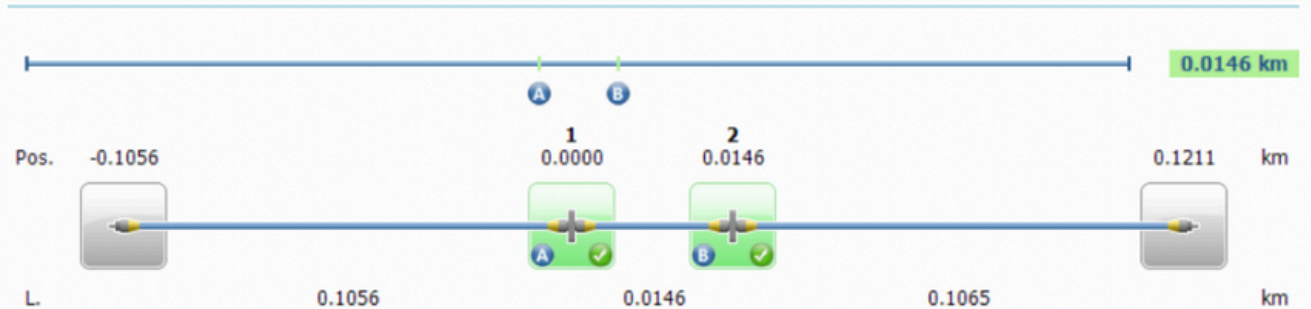


Tabla de elementos

Tipo	N.º	Pos./L. (km)	Pérdida (dB)		Refl. (dB)		At. (dB/km)	
			1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm
Conector		-0.1056	0.256	0.273	-47.7	-49.8		
Sección		0.1056	0.028	0.032			---	---
Conector	A 1	0.0000	0.095	0.211	-68.2	-68.9		
Sección		0.0146	---	---			---	---
Conector	B 2	0.0146	0.218	0.163	-59.3	-68.5		
Sección		0.1065	0.036	0.013			---	---
Conector		0.1211	---	---	-44.4	-47.1		

• **Direction B-A**

Vista de tramo

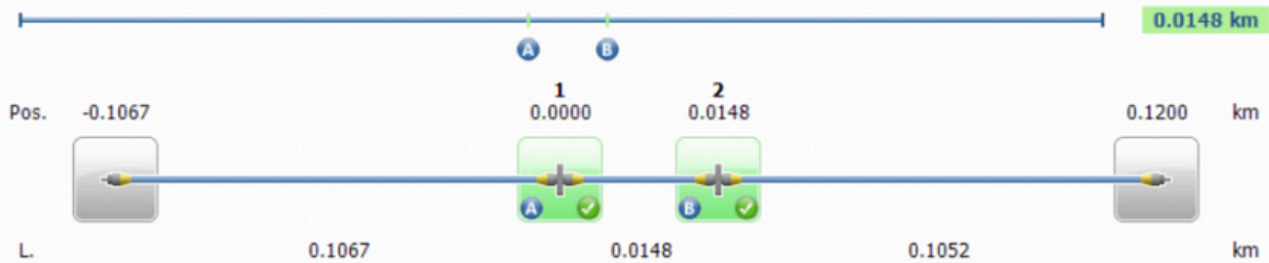


Tabla de elementos

Tipo	N.º	Pos./L. (km)	Pérdida (dB)		Refl. (dB)		At. (dB/km)	
			1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm
Conector		-0.1067	0.503	0.451	-56.6	-56.7		
Sección		0.1067	0.033	0.026			---	---
Conector	A 1	0.0000	0.084	0.088	-58.4	-64.2		
Sección		0.0148	---	---			---	---
Conector	B 2	0.0148	0.236	0.284	-66.0	-68.3		
Sección		0.1052	0.032	0.010			---	---
Conector		0.1200	---	---	-35.5	-33.8		

SPLICE 3

• **Direction A-B**

Vista de tramo

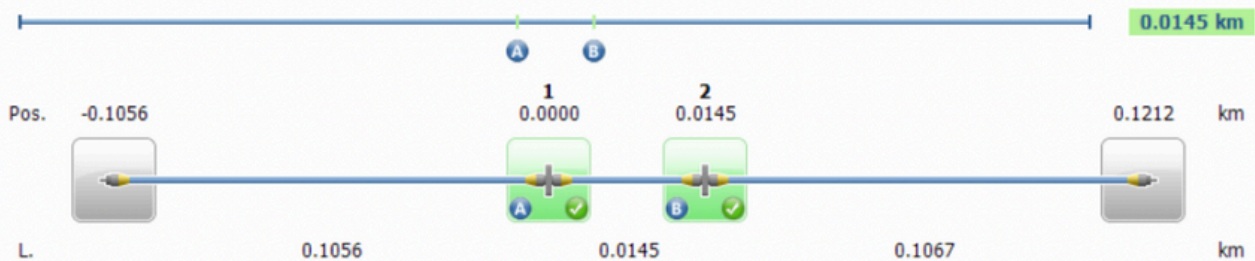
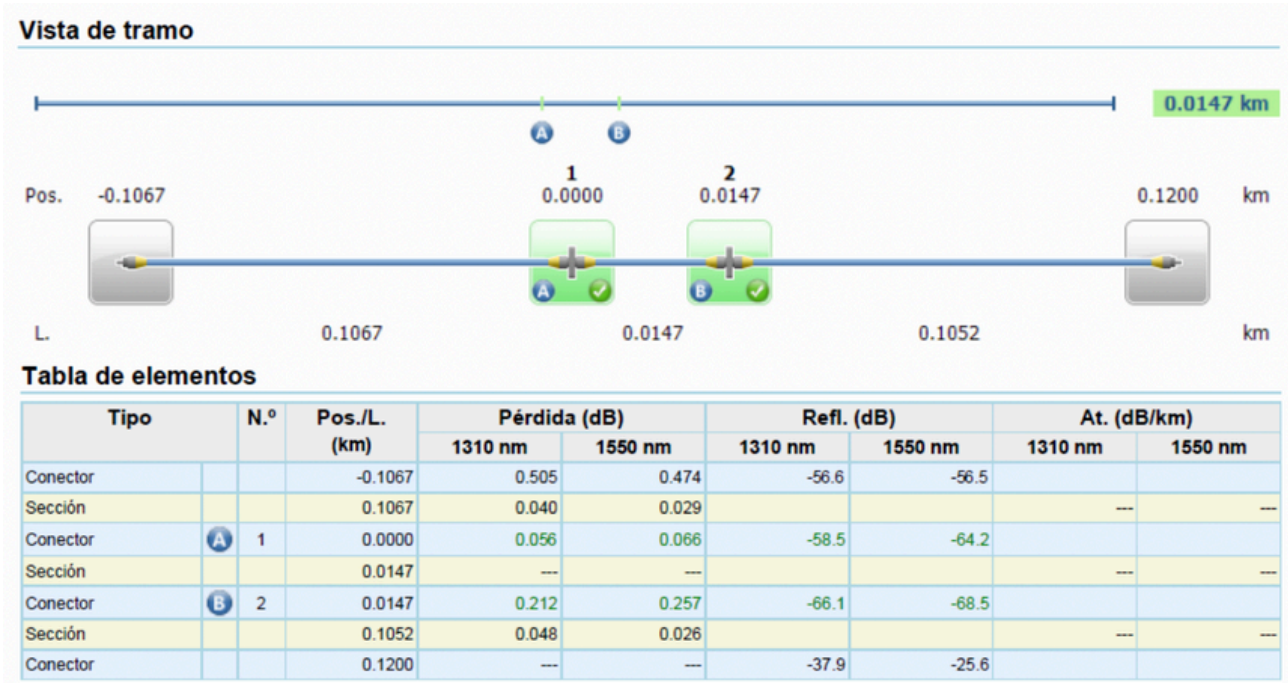


Tabla de elementos

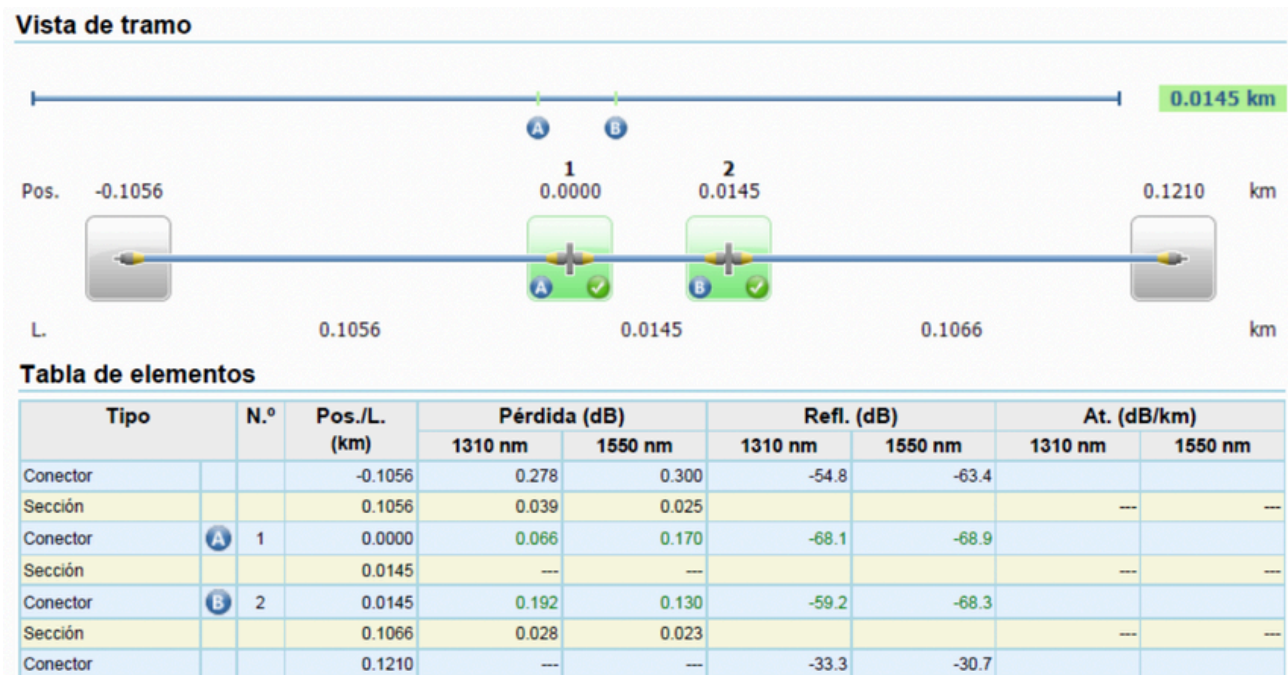
Tipo	N.º	Pos./L. (km)	Pérdida (dB)		Refl. (dB)		At. (dB/km)	
			1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm
Conector		-0.1056	0.263	0.283	-51.6	-53.9		
Sección		0.1056	0.034	0.033			---	---
Conector	A 1	0.0000	0.081	0.189	-67.9	-68.8		
Sección		0.0145	---	---			---	---
Conector	B 2	0.0145	0.184	0.150	-59.2	-68.4		
Sección		0.1067	0.051	0.013			---	---
Conector		0.1212	---	---	-44.4	-47.0		

• **Direction B-A**



SPLICE 4

• **Direction A-B**



• **Direction B-A**

Vista de tramo

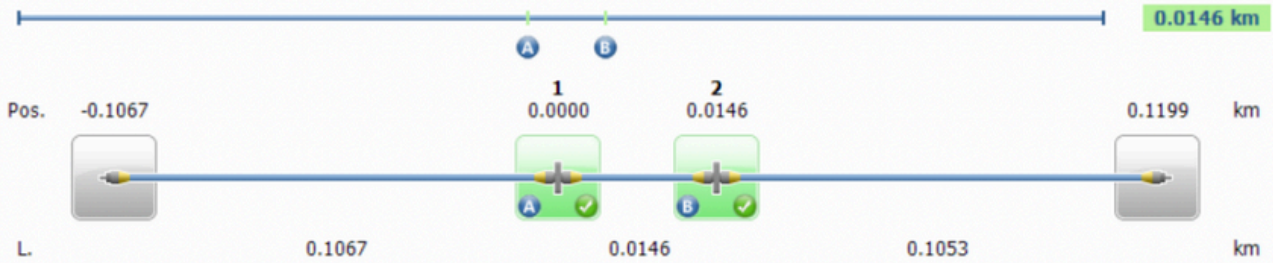


Tabla de elementos

Tipo	N.º	Pos./L. (km)	Pérdida (dB)		Refl. (dB)		At. (dB/km)	
			1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm
Conector		-0.1067	0.509	0.476	-56.5	-56.4		
Sección		0.1067	0.033	0.023			---	---
Conector	A 1	0.0000	0.047	0.050	-58.5	-64.2		
Sección		0.0146	---	---			---	---
Conector	B 2	0.0146	0.215	0.238	-66.1	-68.4		
Sección		0.1053	0.040	0.019			---	---
Conector		0.1199	---	---	-30.4	-26.2		

SPLICE 5

• **Direction A-B**

Vista de tramo

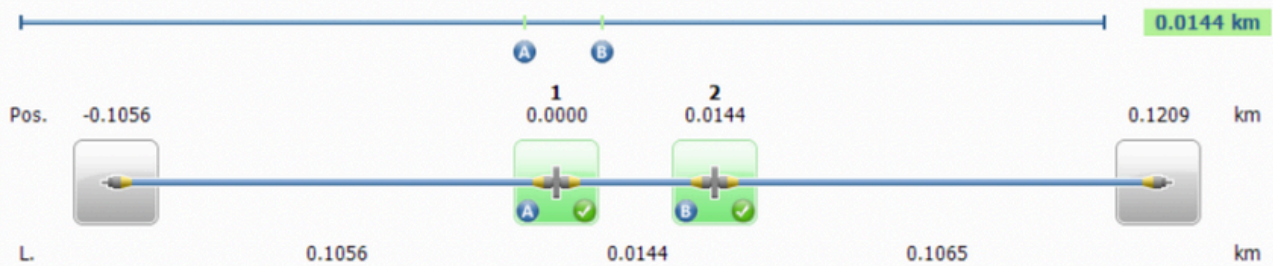
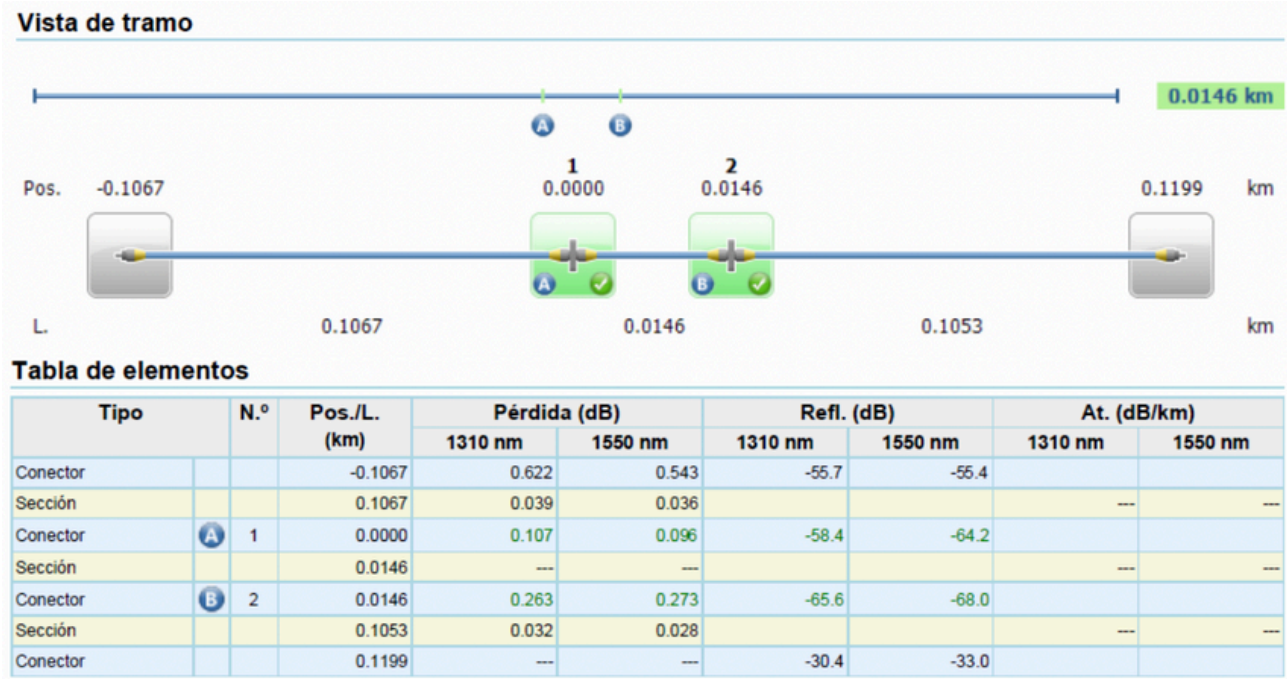


Tabla de elementos

Tipo	N.º	Pos./L. (km)	Pérdida (dB)		Refl. (dB)		At. (dB/km)	
			1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm
Conector		-0.1056	0.276	0.302	-54.2	-57.4		
Sección		0.1056	0.042	0.024			---	---
Conector	A 1	0.0000	0.115	0.226	-67.6	-68.5		
Sección		0.0144	---	---			---	---
Conector	B 2	0.0144	0.245	0.145	-59.3	-68.5		
Sección		0.1065	0.035	0.033			---	---
Conector		0.1209	---	---	-32.0	-30.3		

• **Direction B-A**



PHOTOGRAPHIC RECORD



Fig. 9 and Fig. 10. Photographic record of the I4S splicer test

CONCLUSION

Despite extreme environmental conditions, the I4S splicer managed to generate the electric arc without requiring prior arc calibration.

To achieve optimal fusion splicing results, it is essential to prepare a space that allows working in a controlled environment, such as a booth, tent, or even inside a truck.

To ensure the quality of the fusion splices, it is necessary to perform arc calibration at the worksite and follow a proper procedure for preparing the optical fiber. This includes using appropriate tools and materials such as fiber strippers, lint-free wipes, isopropyl alcohol, and a precision cleaver, the latter of which is included with the splicer.

The splicer demonstrated outstanding performance in adverse environmental conditions of high altitude, wind, and cold, achieving splices with a loss of 0.00 dB measured in both directions using an OTDR

This test was conducted by Telmark.



Thank you to Telmark for conducting this performance test on the i4s INNO Instrument Fusion Splicer