Delft Circuits

Hardware for quantum engineers

Cri/oFlex® io Flexible Cryogenic i/o

Cri/oFlex® platform

Applications

Datasheets

Cri/oSuite™

Case studies

About us

Last updated:
02/06/2022

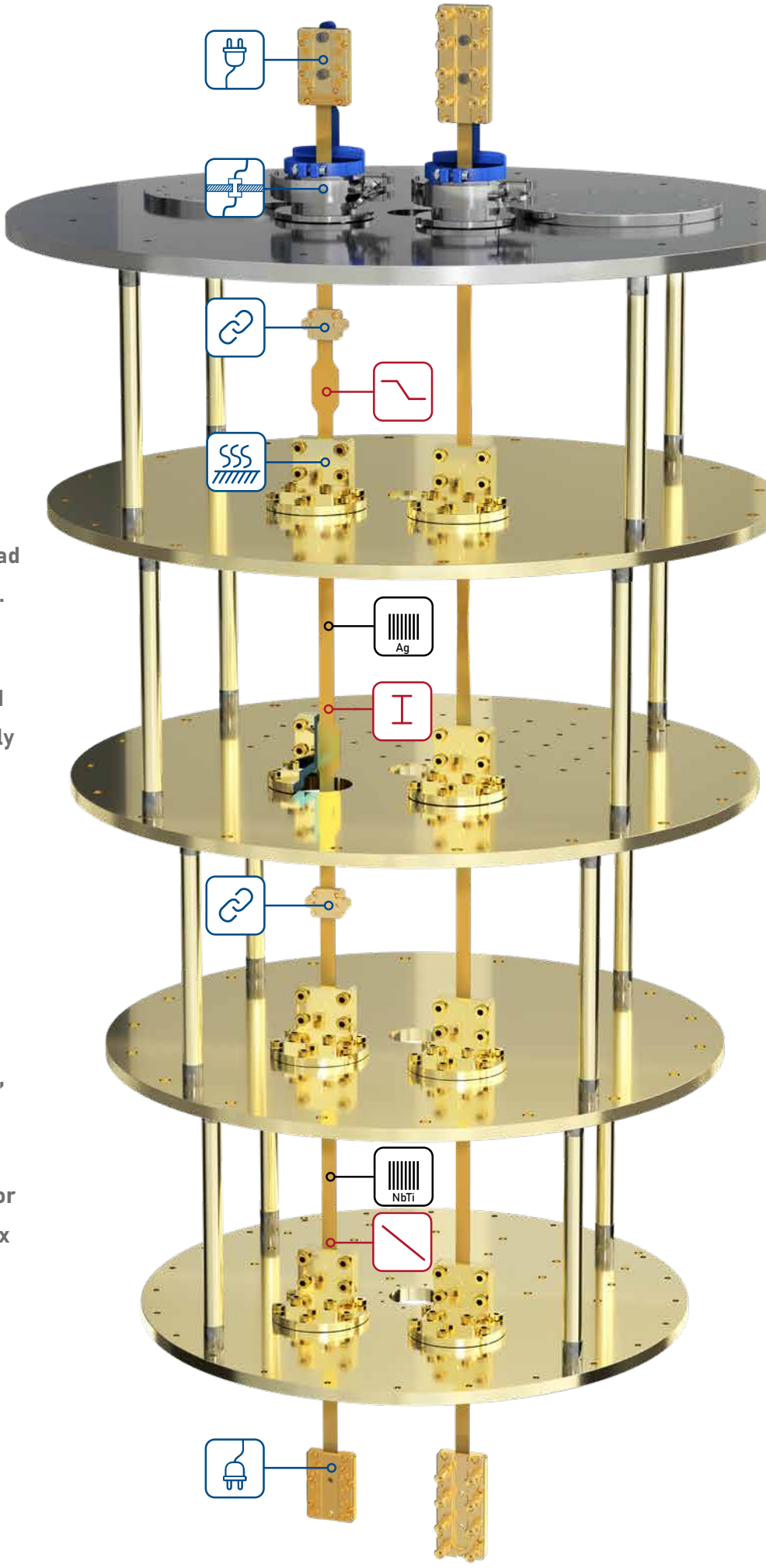
Cri/oFlex® io

The input/output (i/o) chains of cryogenic quantum computing, communication and sensing play an essential role in its performance. Especially in larger systems, cabling or component failure, passive heatload and limited space can be a challenge.

Cri/oFlex® is designed specifically for cryogenic (quantum) systems and provides a scalable platform with fully integrated filtering, a small footprint and low heatload.

At Delft Circuits, it is our vision to be a one-stop shop for cryogenic i/o assemblies. To that end, we have developed three modules. Firstly the *interconnect* module consisting of electrical- and microwave interfaces, as well as vacuum feedthroughs and thermal anchoring. Secondly, two *material platforms* (flex laminates) for signal transmission and lastly on-flex *integrated components* for signal conditioning.

With these three modules we can tackle every i/o challenge!



Interconnect

Microwave interfaces

Microwave / Electric interface nodes

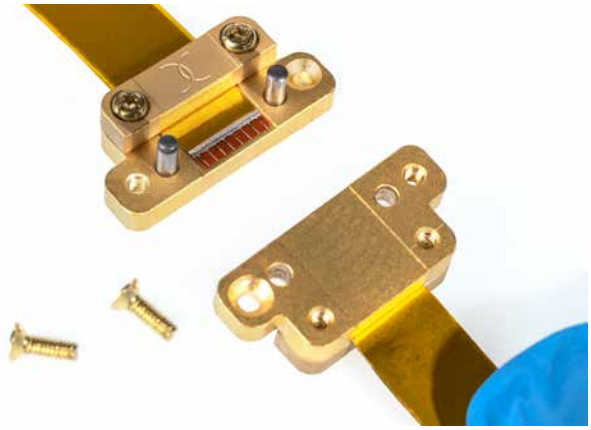
Interfacing has the following key requirements; proper impedance matching, mechanical- & thermal stability and a small form factor. As a first step, Delft Circuits has developed interfacing to conventional connectors (SMA & SMP) in 1, 8 or 16 channel configurations. In order to address 1000s of quantum devices and beyond, interfaces with reduced footprints are required. For direct interfacing to PCBs and quantum chips, ask our sales team.

Vacuum feedthrough

Cri/oFlex® can be provided with a vacuum feedthrough for standard ports. The hermetic seal has a leak-rate below $1.2 \cdot 10^{-9}$ mbar L/s, and an outgassing rate below $6 \cdot 10^{-8}$ mbar L/s. Furthermore, we have introduced a new ergonomic mounting system to securely mount our SMA/SMP breakouts at room temperature to the feedthrough for ease of use.

Tabbi/ ™

With the aim of removing bulky interconnects, while still allowing for modularity in your cryogenic chain, we have developed a flex-to-flex interface to connect two open-ended 8-channel Crio/Flex® 3. This ultra-high density microwave interconnect allows modular configuration of any Cri/oFlex® 3 i/o chain.



Thermal anchors

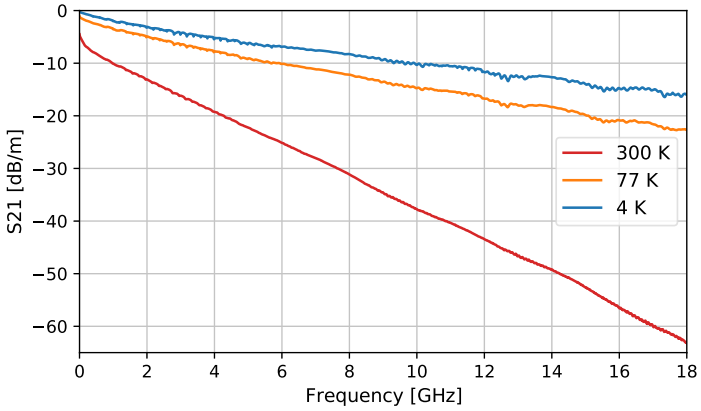
As a result of the planar nature of Cri/oFlex® the heat generated by attenuators and infrared filters is effeciently removed when properly clamped with our thermal anchors. Our default version is compatible with KF 40 feedthroughs, custom solutions are available.

Multi-channel flex

Material platforms

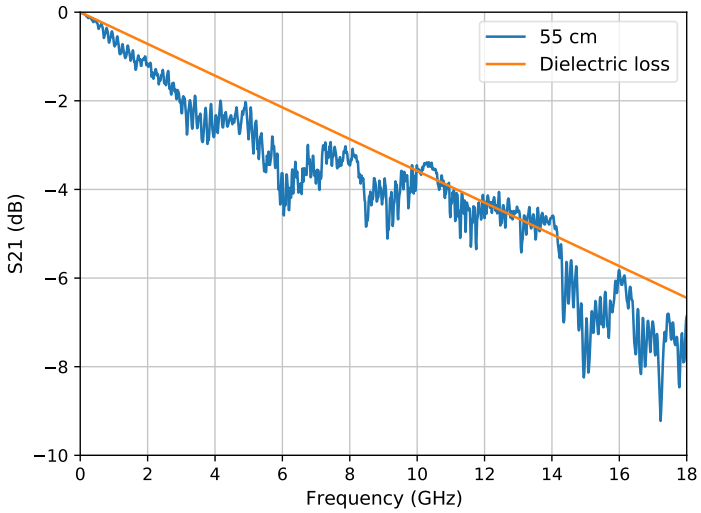
Silver Cri/oFlex®

Our workhorse material platform is silver (Ag). With the small cross-section we provide an optimal balance between low passive heat load and good transmission, well suited for temperatures that are too high for superconductors. Operating at 4K, the transmission losses at 10 GHz are 10 dB/m.



Superconducting Cri/oFlex®

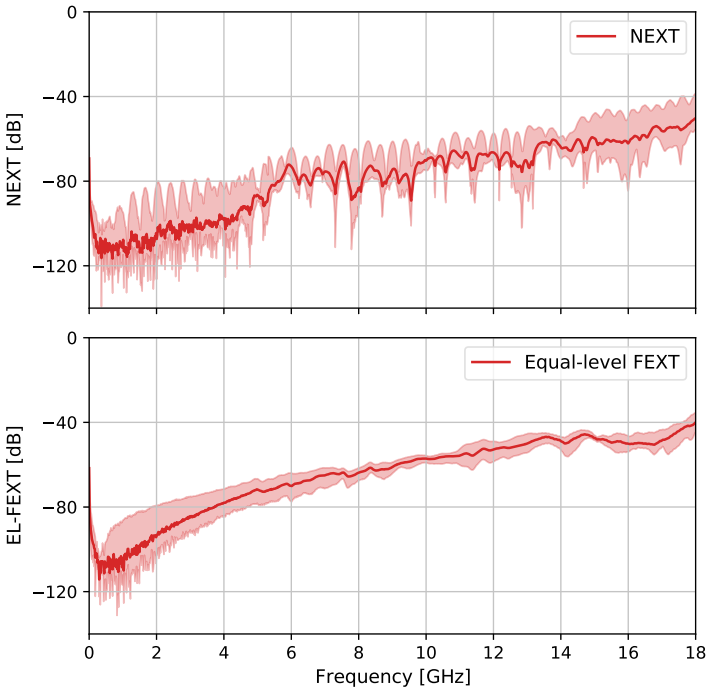
For applications requiring extremely low heat conduction and low dissipation, we are introducing superconducting Cri/oFlex® based on NbTi. These cables are designed to handle up to several tens of milliamps of continuous current while superconducting. In the figure on the right we show transmission data of a typical superconducting Cri/oFlex® measured in liquid helium (4.2 K). The critical temperature is around 9 K and the critical current over 150 mA.



Multi-channel isolation

A common concern for high-density microwave signaling is crosstalk. Our multi-channel Cri/oFlex® 3 allows for high line density with good isolation. On the right, the near-end S_{31} (NEXT) and equal-level far-end (EL-FEXT) crosstalk between channels in a room-temperature 20 cm long Ag Cri/oFlex® 3 with a 1 mm channel pitch are plotted. The solid line is the average of all channel combinations and the semi-transparent area shows the best (furthest) and worst case (nearest channels) of an 8-channel flex. Even in the worst case, crosstalk is below -60 dB for signals up to 10 GHz. NbTi Cri/oFlex® has comparable performance.

Equal-level FEXT is defined as S_{41}/S_{21}.



Microwave components

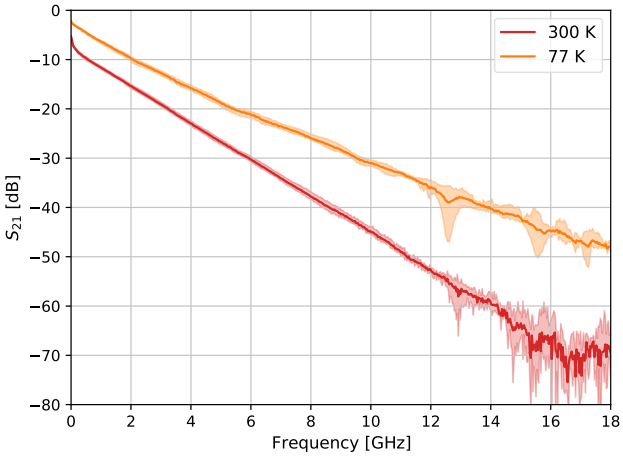
Integrated in multi-channel flex

Integrated filtering

A key feature of our Cri/oFlex® technology is the integration of cryogenic filtering components in the flex itself. This makes an uninterrupted i/o chain possible directly from room temperature to milliKelvin temperature, simplifying installation and removing points of failure. Our current library of filtering components includes: low-pass, infrared (IR) and attenuators.

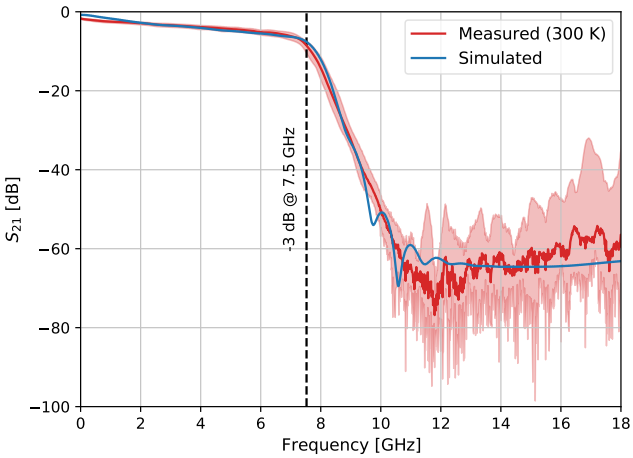
Infrared

In the top-right figure we plot transmission data from our IR filters. Specifically, the spread in an 8-channel Cri/oFlex® 3x.
The measured attenuation at 77 K is 2 dB/GHz.



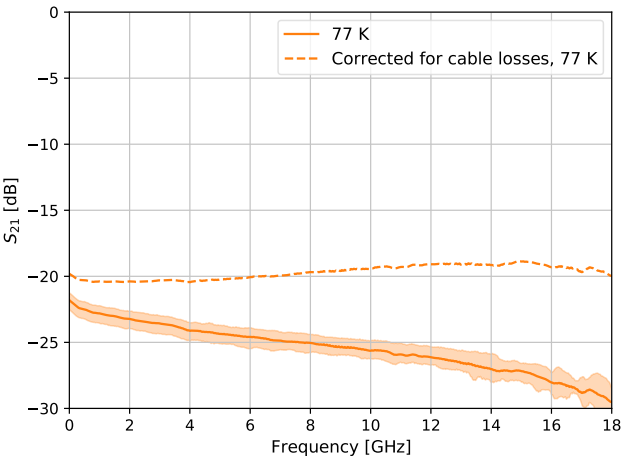
Low-pass

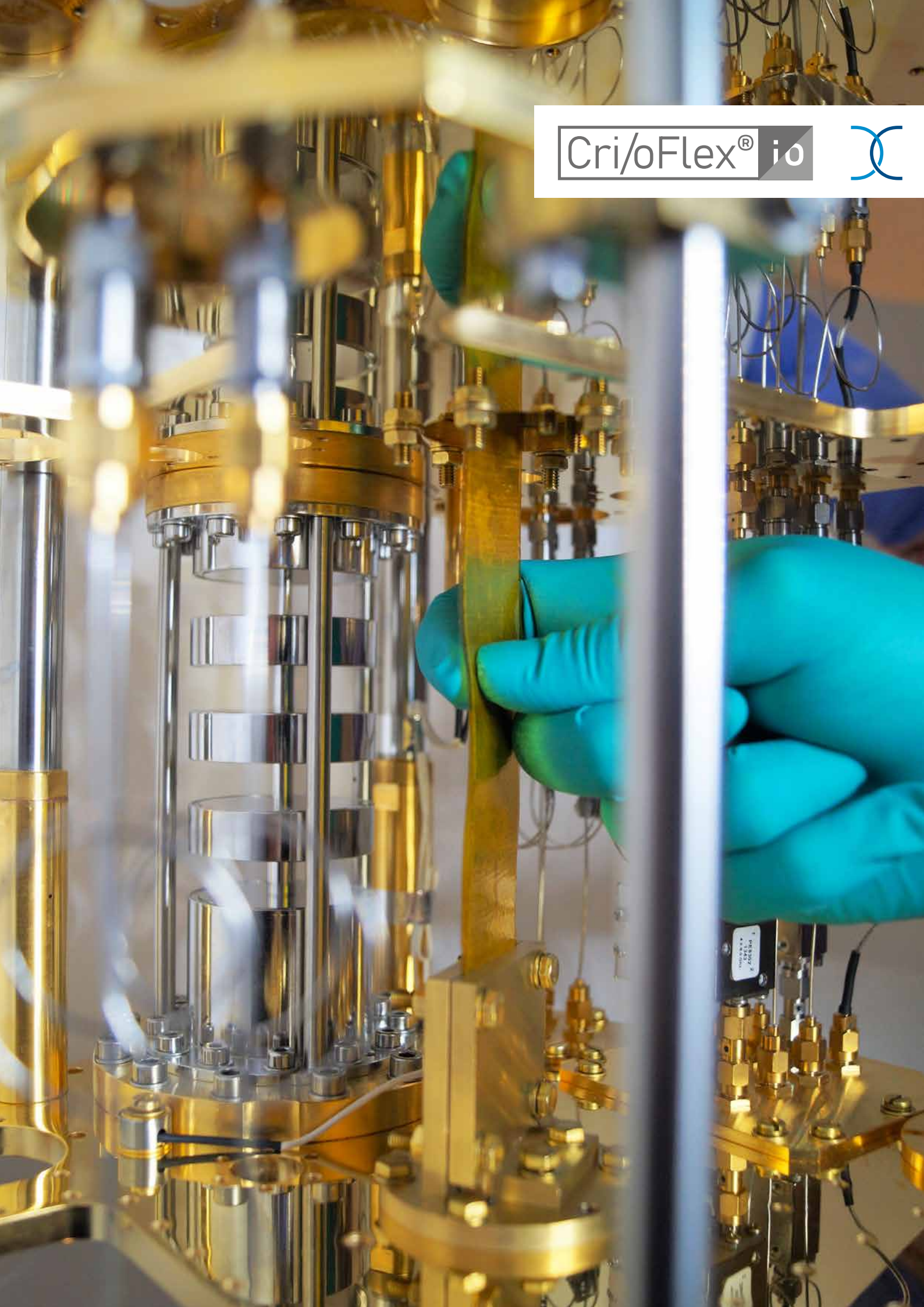
Our low-pass filters have a customizable cut-off frequency with flat roll-off in the pass band and 40 to 60 dB supression in the stop band. In the center-right figure we plot the typical spread of an 8-channel Cri/oFlex® 3x with this type of filter. Also showing the close matching between the measurents and our simulations



Attenuator

Our integrated attenuators can be specified in 5 dB increments.
The data shown in the bottom-right figure shows 4 K data of 20 dB attenuators, corrected for cable losses. The attenuation is flat at -20 ± 1 dB up to at least 10 GHz.




Cri/oFlex® io

Quantum Computing

Enabling the quantum revolution

The struggles of coax

The past decade has seen an explosive growth in research and industry dedicated to quantum computing, with a trend towards ever increasing qubit counts. While semi-rigid coax cabling has been sufficient to address and read out tens of qubits, it comes with several drawbacks that render it unsuitable as wiring for quantum computers of the future:

- Bulky form factor
- Significant heat conduction
- Installation effort

Our Cri/oFlex® solution

To tackle this problem, we have taken a radically different approach and started designing a cable from scratch, with the intention of creating the perfect cabling for quantum computing. The result is flexible microwave i/o that paves the way towards further upscaling of quantum computers by providing:

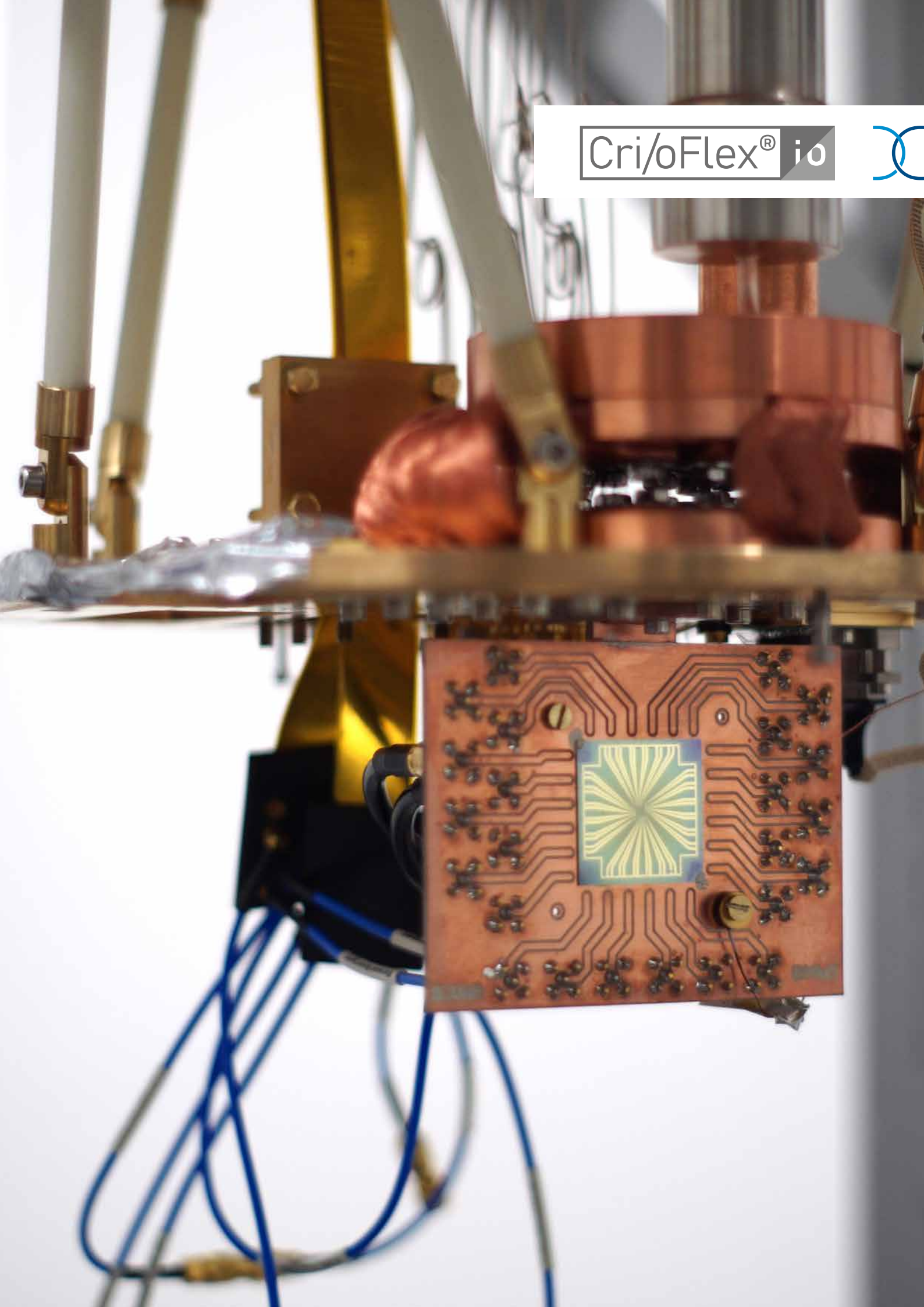
- Compact and scalable form factor
- Low thermal conductivity
- Ease of installation
- Integrated signal attenuation and filtering

Comparison of Cri/oFlex® integrated wiring scheme (left) and coaxial wiring scheme (right) with bulky filtering elements.

Andreas Wallraff
@AndreasAtETH

Good wiring for #quantum is surprisingly important. Check out @delft_circuits...

6 march 2021


Cri/oFlex® io

Quantum Internet

The future of secure communication

The challenge of scaling up

Quantum internet and quantum communication offer an intrinsically secure alternative to conventional cryptography. The single photons distributing entanglement between NV-centers inside such a network are measured by superconducting detectors. The trend in the field is to move towards faster entanglement rates, requiring a higher number of NV-centers and single photon detectors while being limited by:

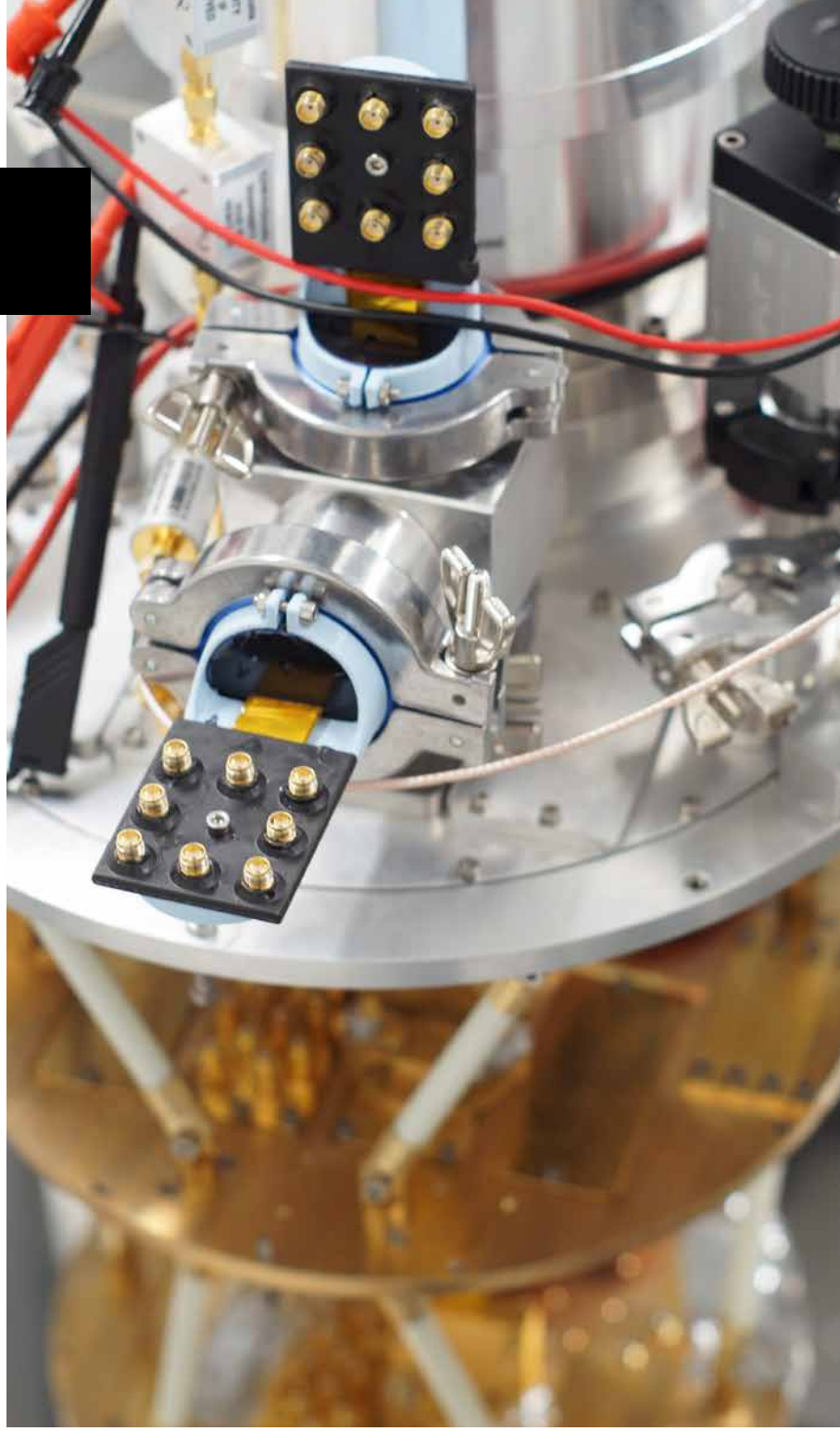
- Space constrained table-top cryostats
- Low cooling powers

Our Cri/oFlex® solution

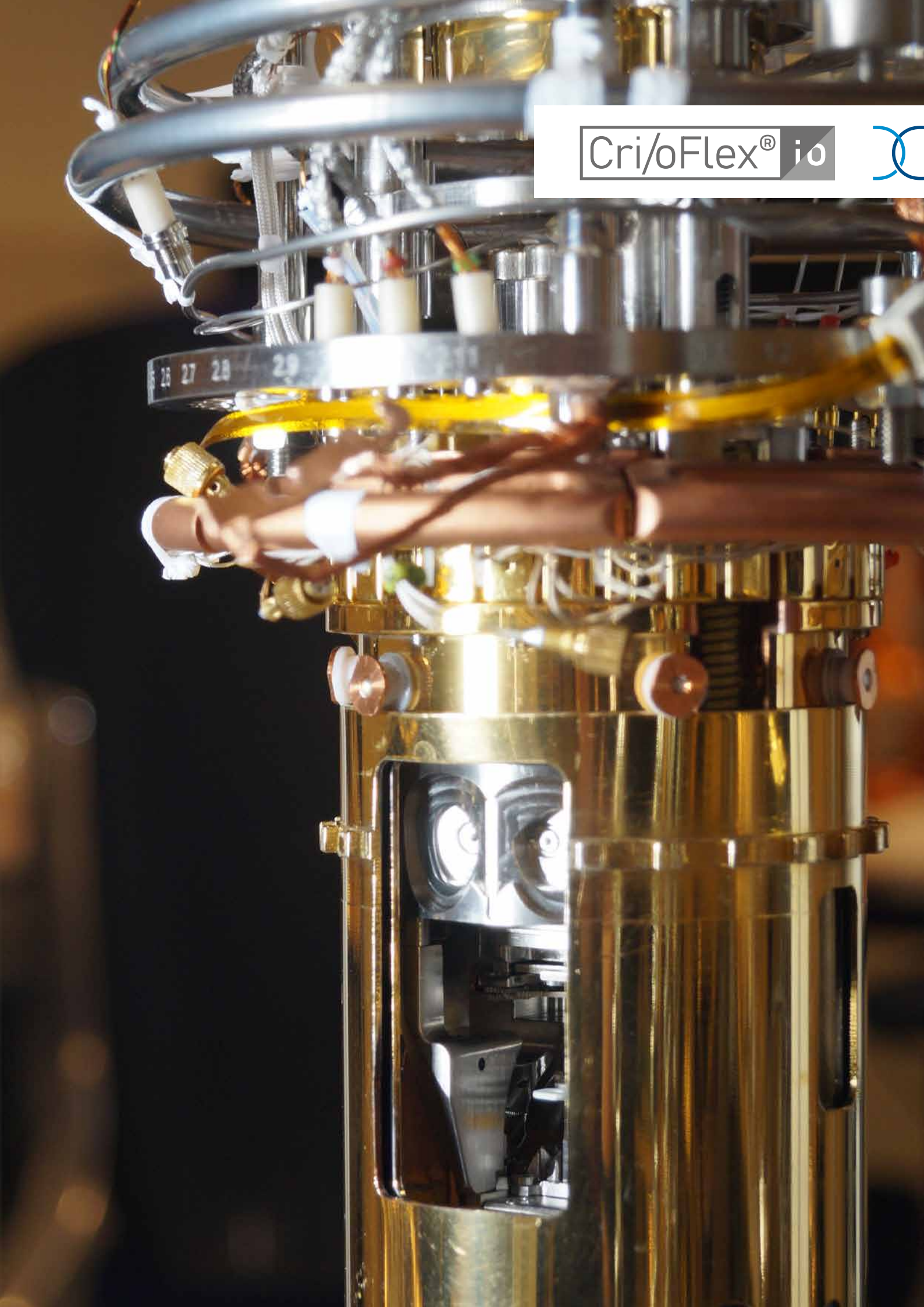
Our Cri/oFlex® 2 and Cri/oFlex® 3 products lines enable microwave signal input and output for quantum communication experiments of the future, by offering microwave cabling that is:

- Massively scalable for high-density lines
- Highly flexible
- Easy to install in compact spaces
- Low in thermal conductivity

Read our case study on page 25 to find out how the use of multi-channel Cri/oFlex® enabled one of our partners to perform their experiments in large-scale 64-detector array SNSPD read-out!



Room temperature SMA breakout for 16 Cri/oFlex® 3 microwave channels, running directly down to your sample at 4 K, with integrated vacuum feedthrough. This setup was used to connect an array of 16 SNSPD detectors.


Cri/oFlex® io

Vibration isolation and movable stages

When flexibility really matters

The problem of mobility

Many experiments, including scanning tunneling microscopy (STM) or NV-center magnetometry, involve physically scanning over surfaces with sub-micron resolution. As such, these are especially sensitive to mechanical vibrations. Using semi-rigid coax to apply microwave drive signals to a sample can result in:

- Undesired mechanical links to the environment
- Introduction of vibrations
- Phase noise

Our Cri/oFlex® solution

Thanks to our Cri/oFlex® 2 cables, vibration sensitive experiments requiring applied microwaves become easy to carry out due to their:

- High flexibility
- Compact form factor
- Vibration decoupling

In addition, our extremely flexible Cri/oFlex® 1 cables are specifically engineered for those use-cases in which an even higher degree of mechanical decoupling is required.

Here we illustrate the improved flexibility of our Cri/oFlex® products compared to a coax cable. From left to right: conventional coax, Cri/oFlex® 2 and Cri/oFlex® 1.


Cri/oFlex® io

Astrophysics and aerospace

Connecting your detector arrays.

Scaling up for space

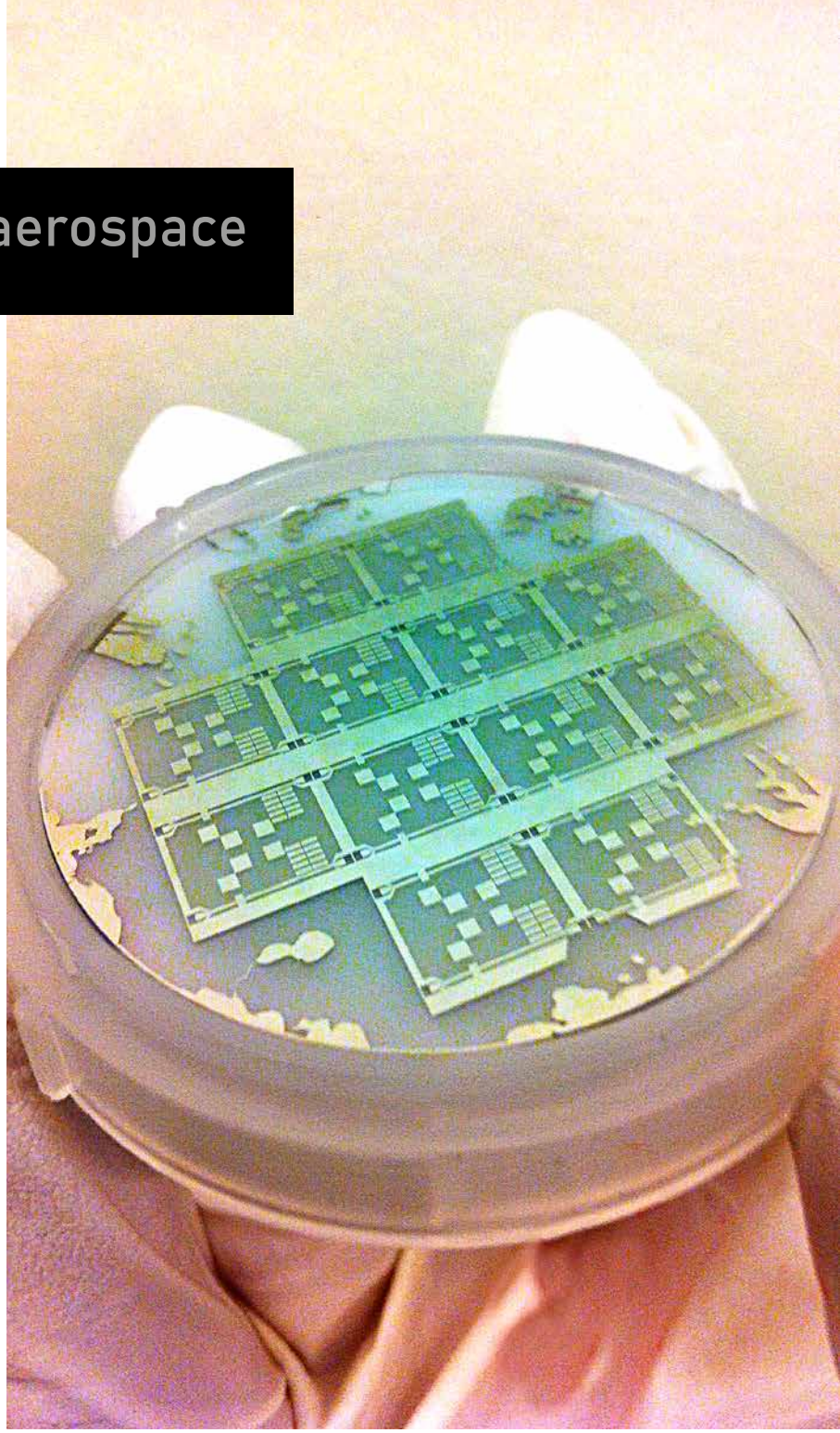
In astrophysics, microwave kinetic inductance detectors (MKID's) and transition edge sensors (TES) offer many advantages over conventional CCD technology, such as broad wavelength coverage and single-photon detection limits, as well as high energy and time resolution. Microwave multiplexing allows for impressive scaling of these detectors, but the custom-built cryostats which are required make semi-rigid coax readout lines a poor choice due to:

- Constrained cryostat space
- Limited cooling power

Our Cri/oFlex® solution

Our Cri/oFlex® 2 and Cri/oFlex® 3 products enable scaling of these detectors by offering an improvement over conventional coaxial cabling that is:

- Flexible and robust
- Easily installed in space-limited cryostats
- Low in thermal conductivity



Custom engineered superconducting circuits. Designed and fabricated by Delft Circuits.

Delft Circuits
Hardware for quantum engineers

Datasheet

Cri/oFlex® 1

Combine RF and vibration isolation in one solution!

Cri/oFlex® (CF) i/o channels enable high frequency microwave transmission on a flexible substrate. Our CF1 product line subsequently brings vibration isolation to the next level.
Driven by a strong focus on extreme flexibility, our CF1 products are the most flexible high frequency transmission lines on the market. Additionally it is UHV compatible, has low-thermal load, whilst maintaining a small form-factor, making the CF1 the perfect match for any vibration sensitive cryogenic setup.
Similar to our other CF products, we offer a selection of conventional connector types, as well as customizations to suit your specific setup upon request.

Features

- Exceptional vibration isolation
- Small form-factor
- Low thermal load
- High frequency bandwidth
- Resilient against thermal cycling
- Customizable connectors

General Properties	
Connector	
Connector Type	SMA, SMP, SMPM (all male)
Connector Material	Goldplated Brass/BeCu PEEK/PTPE
Housing	Stycast 2850
Flex	
Transmission Line Type	Stripline
Length	200 to 600 mm
Width	1 mm
Thickness	0.3 mm
Materials	Polyimide & Silver (Ag)

Comparison Cri/oFlex® 2 versus Cri/oFlex® 1

Thermal Properties	
Operating Temperature	10 mK → 400 K
Heat Load @ 50k (ΔT: 3 - 50 K), L = 0.2m	315 µW
Expected Heat Load @ 20 mK (ΔT: 20 -100 mK), L = 0.2m	4.4 nW

Electrical Properties	
Impedance	Designed for 50 Ω (Customizable)
Operating Frequency	0 to 18 GHz
Signal Isolation (Crosstalk)	-60 dB, line to line

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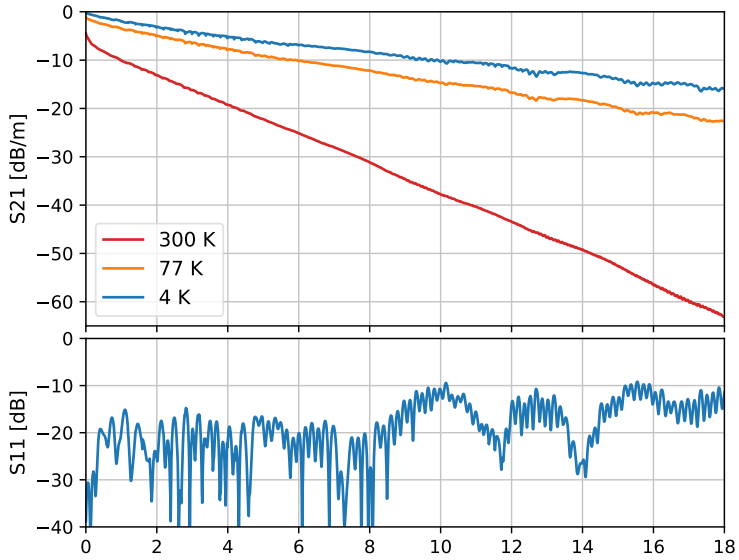
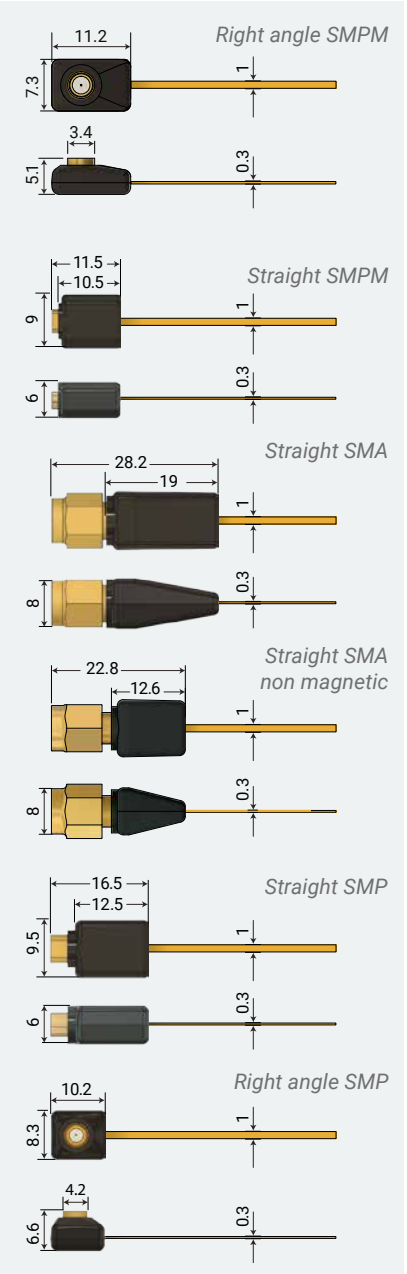
02/06/2022

Microwave Properties

The flex cables can be configured with different connectors at each end, for example an SMA-SMP hybrid. Other connector types or even custom PCB landing designs can be developed in-house to fit your setup. Bandwidth ranges may vary depending on the design constraints.

The figure below shows the transmission (S21) and reflection (S11) of a typical DC-18 GHz bandwidth flex cable. Depending on connector type the overall S-parameters may vary slightly.





Non-Magnetic

For customers with stringent demands on non-magnetic components in their set-ups we offer specialized non-magnetic products. The standard Cri/oFlex products can in most cases be considered low-magnetic already and sufficient for most applications involving magnetic fields. Contact Delft Circuits for specific information.

In the table below the readily available connector options and their respective frequency bandwidth options are shown, the icons indicate their current availability; ✔ readily available ✕ under development.

		Right angle SMP	Straight SMP	Straight SMA non magn.	Straight SMA	Straight SMPM	Right angle SMPM
Bandwidth options	0-6 GHz	✔	✔	✔	✔	✔	✔
	0-12 GHz	✔	✔	✔	✔	✔	✔
	0-18 GHz	✔	✔	✔	✔	✔	✔

Delft Circuits
Hardware for quantum engineers

Datasheet

Cri/oFlex® 2

Tackle your cryogenic cabling challenge!

Cri/oFlex® 2 (CF2) cabling combines the robustness and compatibility of standard SMA and SMP connectors with the versatility of a in-house developed transmission line platform on flexible substrates. Cri/oFlex® is specifically designed for cryogenic environments where thermal load, microwave performance, small form factor and phase stability are critical. Cri/oFlex® 2 comes as a standardized cable setup as described below, but can be highly customized upon request. Cri/oFlex® products are ideally suited for very compact and densely packed cryogenic environments. Providing very sturdy cables that can be bent countless times, Cri/oFlex® adresses your cryogenic cabling challenges!

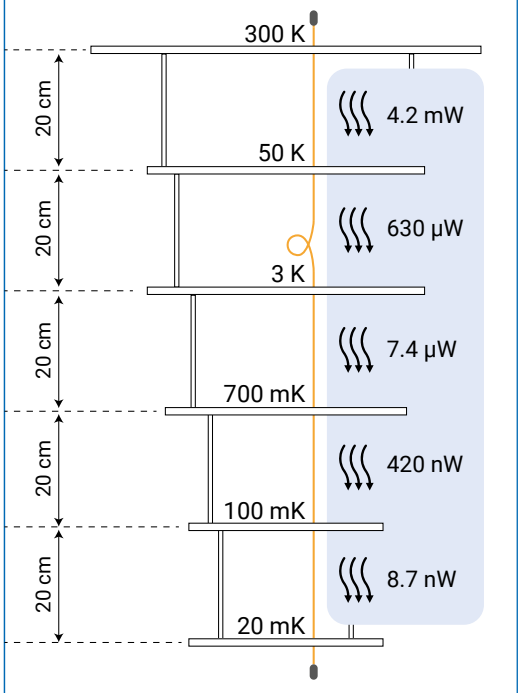
Features

- Extremely flexible
- Excellent phase stability
- Small form factor
- Countless bending and straightening cycles
- Resilient against thermal cycling
- Low thermal load

General Properties	
Connector	
Connector Type	SMA, SMP, SMPM (all male)
Connector Configuration	Straight and Right-angle
Connector Material	Goldplated Brass/BeCu PEEK/PTPE
Housing	Stycast 2850
Flex	
Length	150 to 1000 mm
Width	2 mm
Thickness	0.3 mm
Materials	Polyimide & Silver (Ag)
Transmission-line type	Stripline
Min. Bending Radius	1 mm
Required Length for Longitudinal Rotation	5 cm / 180° rotation

Electrical Properties	
Impedance	Designed for 50 Ω
Operating Frequency	DC to 26 GHz (dependent on connector type)
Signal Isolation (Crosstalk)	< -60 dB, flex to flex, for connector data contact us
Maximum power	10 W @ 3 GHz

Thermal Properties	
Operating Temperature	10 mK→400 K
Typical Heat Loads for a single CF2*	



Multi-channel (CF3) significantly reduces heat load per channel

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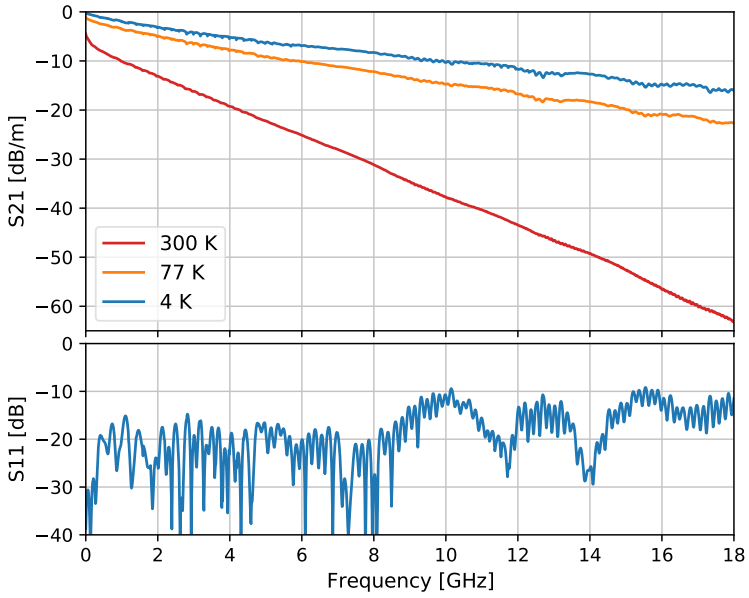
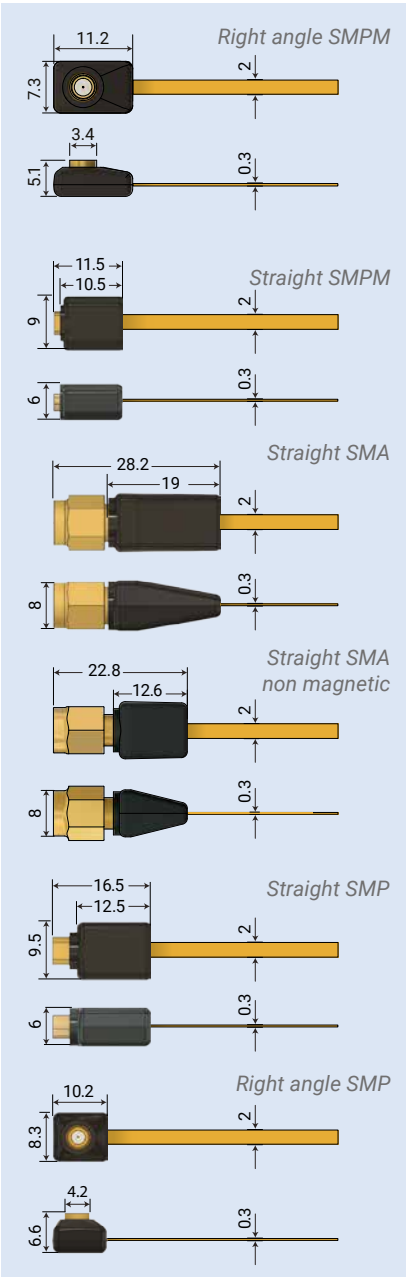
02/06/2022

Microwave Properties

The figure below shows the transmission (S21) and reflection (S11) of a typical DC-18 GHz bandwidth flex cable. Depending on connector type the overall S-parameters may vary slightly.





Non-Magnetic

For customers with stringent demands on non-magnetic components in their setups we offer specialized non-magnetic products. The standard Cri/oFlex® products can, in most cases, already be considered low-magnetic and sufficient for most applications involving magnetic fields. For all materials used in our products please consult the respective datasheets. In case of the non-magnetic options, the goldplated brass is replaced for goldplated beryllium copper.

Connectors

The table below shows the available connector options and corresponding frequency bandwidths; ✔ readily available, ✘ under development. All shown connectors are male. Cri/oFlex® cables can be configured with different connectors at each end.

		Right angle SMP	Straight SMP	Straight SMA non magn.	Straight SMA	Straight SMPM	Right angle SMPM
Bandwidth options	0-6 GHz	✔	✔	✔	✔	✔	✔
	0-12 GHz	✔	✔	✔	✔	✔	✔
	0-18 GHz	✔	✔	✔	✔	✔	✔
	0-20 GHz	✔	✔	✔	✘	✔	✔
	0-26.5 GHz	✘	✘	✘	✘	✘	✘

Delft Circuits
Hardware for quantum engineers

Datasheet

Cri/oFlex® 3

Tackle your cryogenic cabling challenge!

Cri/oFlex® 3 (CF3) is our multi-channel solution specifically designed as end-to-end i/o, providing high-density uninterrupted lines from room temperature down to millikelvin. It is especially well-suited for situations where small form factor, low thermal load and excellent microwave performance are critical. To fit your specific needs, options are available such as: vacuum feedthroughs, thermal clamps and a choice between SMA or SMP connectors. Cri/oFlex® 3 adresses your cryogenic cabling scaling challenges!

Features

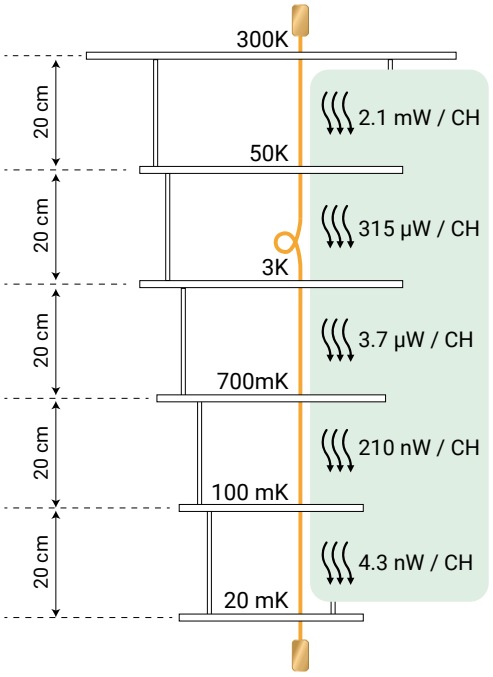
- High-density microwave channels
- Monolithic design from RT to millikelvin
- Resilient against thermal cycling
- Optional filtering & signal conditioning
- Integrated vacuum feedthrough
- Low thermal load

General Properties	
Connector	
Connector Type	Right-angle SMA (f/m) & SMP(m)
Connector Material	Goldplated Brass/BeCu PEEK/PTFE
Housing	Goldplated O_2-Free Copper
Flex	
Flex length	200 to 1100 mm
Amount of Channels	8 Channels
Thickness	0.3 mm
Materials	Polyimide & Silver (Ag) or NbTi
Transmission-line type	Stripline
Min. Bending Radius	5 mm
Required Length for Longitudinal Rotation	10 cm / 180° rotation
Vacuum Feedthrough	
Leak-rate	$<10^{-9}$ mbar L s^{-1}
Compatible Vacuum Connections	KF-25/40/50, Entropy System plates

Electrical Properties	
Impedance	Designed for 50 Ω
Operating Frequency	DC to 10 GHz
Maximum Crosstalk (channel-to-channel), L=200 mm	< -60 dB

Thermal Properties	
Operating Temperature	10 mK → 400 K

Passive Heat Loads for a single Ag CF3, per channel (CH)



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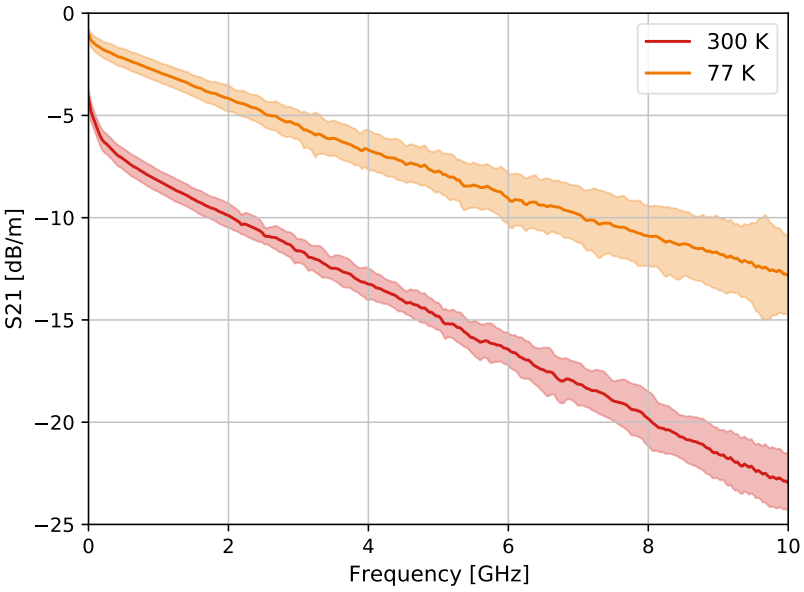
Last updated:
07/03/2022

Microwave Properties

The figure below shows the typical roll-off (S21) that can be expected from a DC-10 GHz bandwidth CF3. The solid line shows the average attenuation of 64 channels from a collection of several CF3 cables. From these channels, 90% (1.28 σ) fall within the semi transparent area around the solid lines.



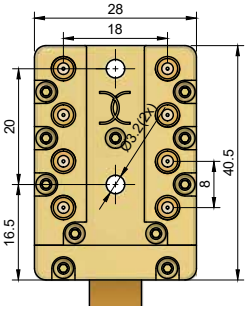
Peripherals

The CF3 platform doesn't just stop at the flexible cabling, we aim to provide a complete solution for your cryogenic i/o needs. Our current stock includes;

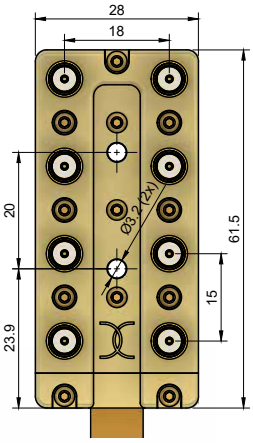
- Thermal Clamps for proper thermalization at every stage in your cryogenic system, we can supply different footprints based on your requests, do not hesitate to contact us!
- Vacuum Feedthroughs, a massively scalable solution to transfer a multitude of lines into the vacuum environments, currently based on KF flanges, but can be customized upon request.
- Brackets to properly secure the cables for your experiments we offer a variety of brackets for cryogenic, room temperature and vacuum environments.

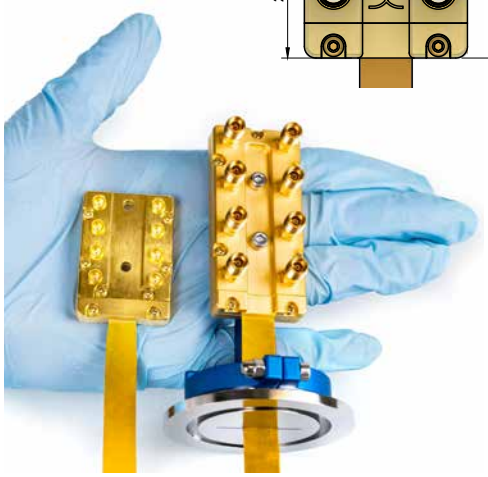
Peripherals	
Vacuum Feedthrough KF-40-VAC-FT	Bracket KF-40-Bracket
 Stainless steel with Stycast	 Anodized Aluminum
Thermal Clamp TH-CL-40.20	Bracket Fridge stages
 Gold plated OF-Copper	 Gold plated OF-Copper

CF3
8 Channels SMP



CF3
8 Channels SMA





Cri/oSuite™

Cryogenic i/o at your fingertips

Cri/oSuite® is a comprehensive software suite to design, analyse and characterise any cryogenic i/o system. With an expansive library of simulation models and algorithms, it can predict the signal, noise and heat flow through a cryogenic chain over the full temperature range. It can handle a variety of cryogenic system configurations, with coaxial and flexible transmission lines and many (microwave) components, to simulate the active and passive heat load, noise levels and expected pulse shapes and levels in each i/o chain.

The suite can present its results both in time and frequency domains, and can handle arbitrary circuits with (microwave) components. Analytical (temperature-dependent) models and measured data can be mixed to specify arbitrary circuits.

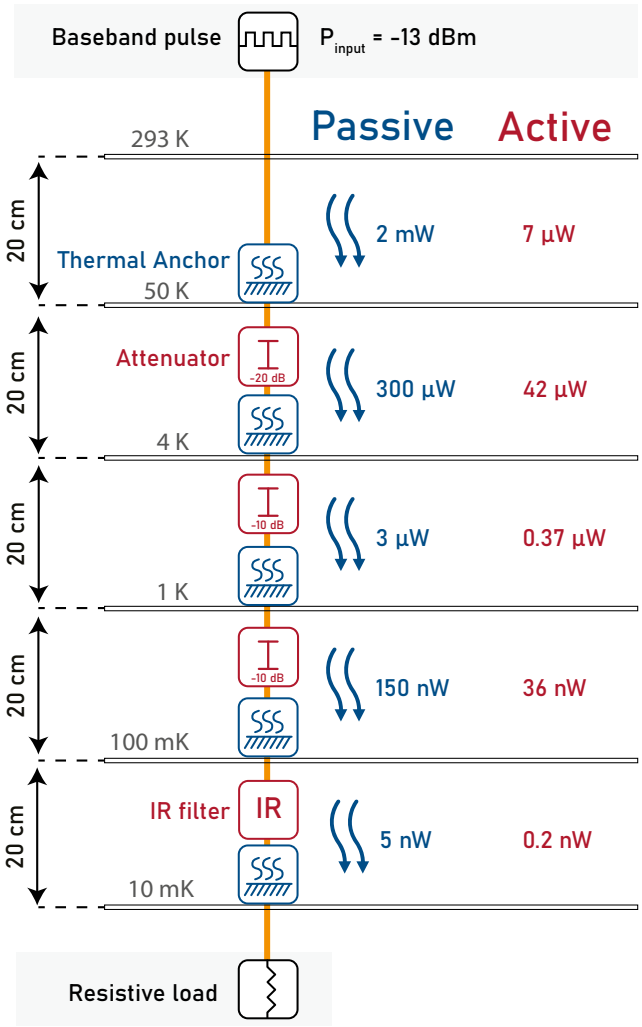
Next to design and analysis, it enables the user to proces Vector Network Analyser (VNA) measurements, and to shift the reference plane of your measurements to arbitrary locations via de-embedding and/or calibration.

The Cri/oSuite® technology is initially available through our design engineering services, whereby Delft Circuits assists in the design and analysis of the i/o configuration of the customer.

Power dissipation

To account for the thermal properties of your cryogenic i/o, we have included thermal conduction models, as well as local heating models due to power dissipation. Given a specific temperature profile in a cryostat, we can model the expected temperatures of the Cri/oFlex®, and other components, as well as the expected heat load on each stage.

In the example Cri/oFlex® configuration on the right, we show the simulated expected dissipative heat load for each segment between cryostat stages. The power dissipation from the baseband pulse generated by the room-temperature electronics depends heavily on the components and the signal power. In this example, the attenuator dissipates by far the most power, and should therefore be positioned at a location where the cryostat has sufficient cooling power. Performing these simulations allows our engineers to optimize a desired i/o chain to the customer's needs.



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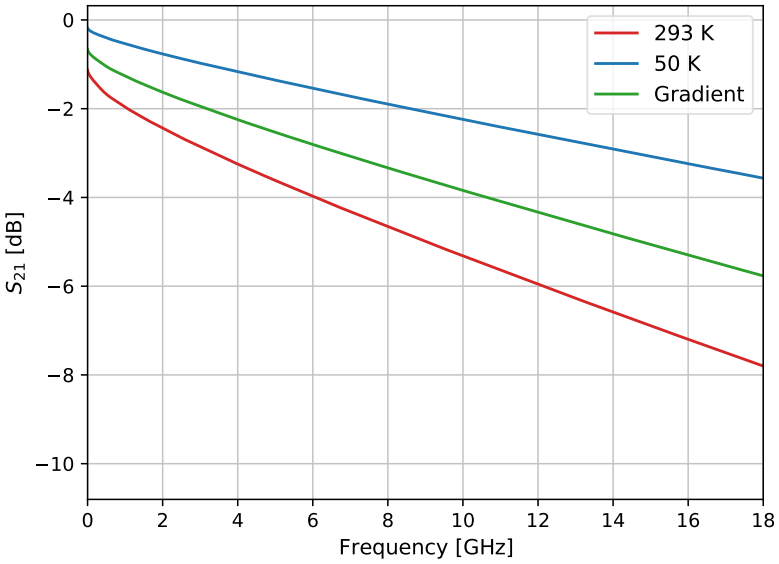


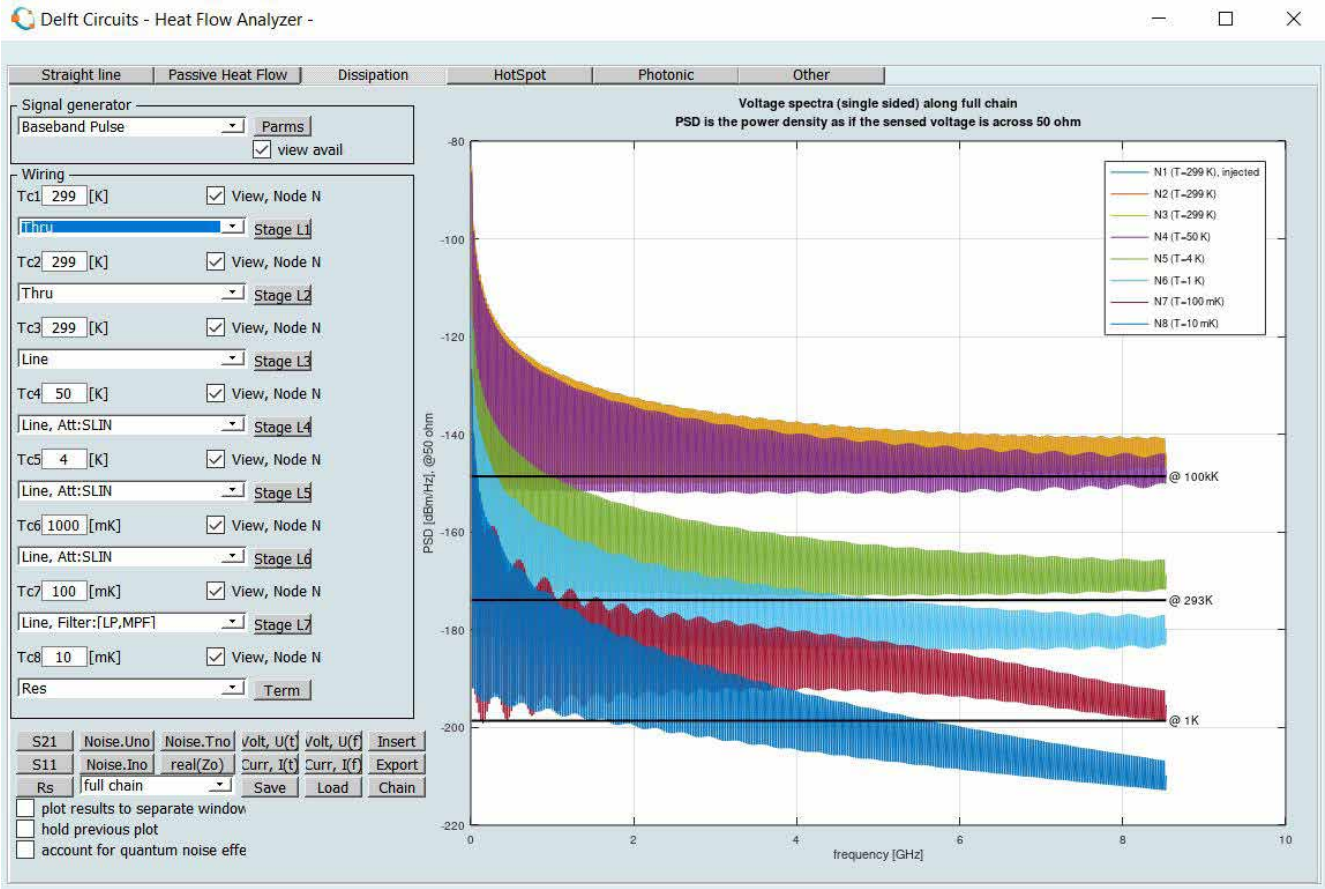
Transmission

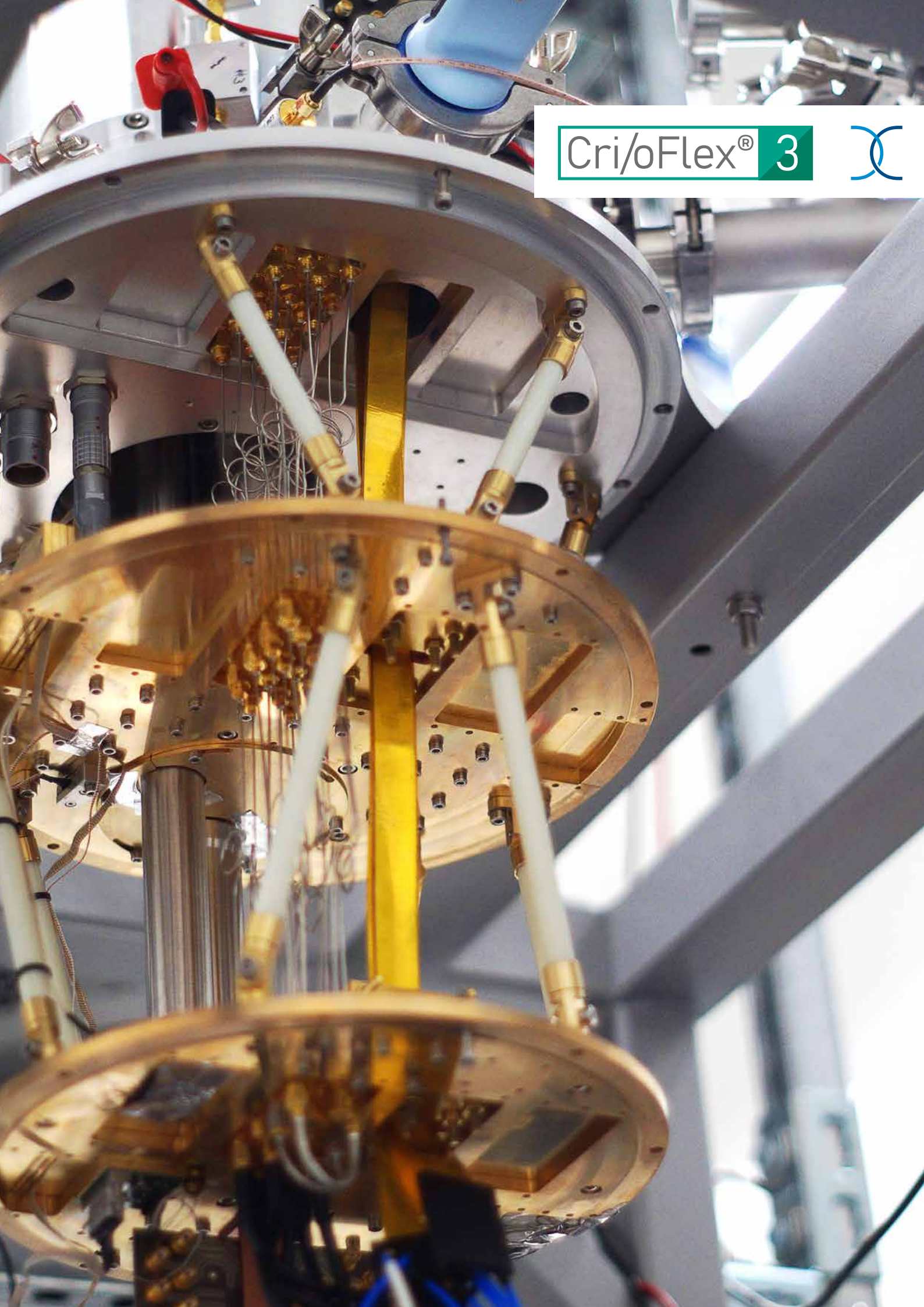
One aspect is estimating microwave transmission properties (S_{21}) of a Cri/oFlex® circuit for transporting control signals from and to cryogenic devices. This includes all cabling, attenuation, amplification, filtering and mismatch, in the presence of a temperature gradient from room temperature (RT) down to millikelvin temperatures.

The left figure shows simulated transmission through the first stage of an example i/o chain in a dilution refrigerator: a 20 cm Cri/oFlex® between 293 K and 35 K. The green curve predicts S_{21} when the Cri/oFlex® has a temperature gradient from the RT stage to the 35 K stage, the most realistic case. In contrast, the blue and orange curves predict the same, but for homogeneous temperatures of 293 K and 35 K, respectively. The tools allow for *S*-parameter prediction for new design parameters such as dielectric losses or geometric changes.

Noise

Another important aspect is the prediction of noise temperature at the end of a cryogenic chain. The heatflow and signal dissipation will raise the temperature in your chain at hot-spots, and thus the thermal noise at the end of your chain as well. Our tooling can predict how much that noise will rise, which is an essential design goal for optimizing the positioning and distribution of attenuators over your chain. The screenshot below shows the noise spectral density of the example chain in this article.




Cri/oFlex® 3

Case Study
Scaling up SNSPD read-out

Primary Field Lab

Project Outline

With Cri/oFlex® 3 development fully underway, we have started our partnerships with our Primary Field Labs. These are ambitious labs committed to finding better cryogenic i/o solutions, and have partnered up with us in its development. Our first Primary Field Lab for testing multi-channel i/o was a research group at Westfälische Wilhelms Universität Münster in Germany. Their primary goal was reading out a 64 SNSPD detector array, in a custom-made Entropy GmbH compact fridge as seen on the left page. As an initial stepping stone, a 16 line proof-of-concept was built first. Both of these milestones perfectly aligned with our internal Cri/oFlex® 3 development timeline, making this the perfect test case.

> "The flex lines were found to be robust against moderate tension and torsion, which allows for easy and fast installation without prior knowledge."
>
> - Matthias Häußler, PhD Candidate

On the right, a diagram is shown of the measurement setup, including a multichannel Cri/oFlex® 3. To connect the SNSPD array, two sets of unfiltered multichannel Cri/oFlex® 3 cables were installed, coupling the detectors at 3 K directly to room-temperature over a 55 cm gap. Thermalization was achieved through custom-built Delft Circuits thermal clamps, which thermalizes multiple Cri/oFlex® 3 cables in between them (Red in Figure 1). The vacuum barrier was crossed using a Delft Circuits vacuum feedthrough, compatible with standard KF-40 flanges.

Regarding ease of use and installation, we obtained the following feedback:

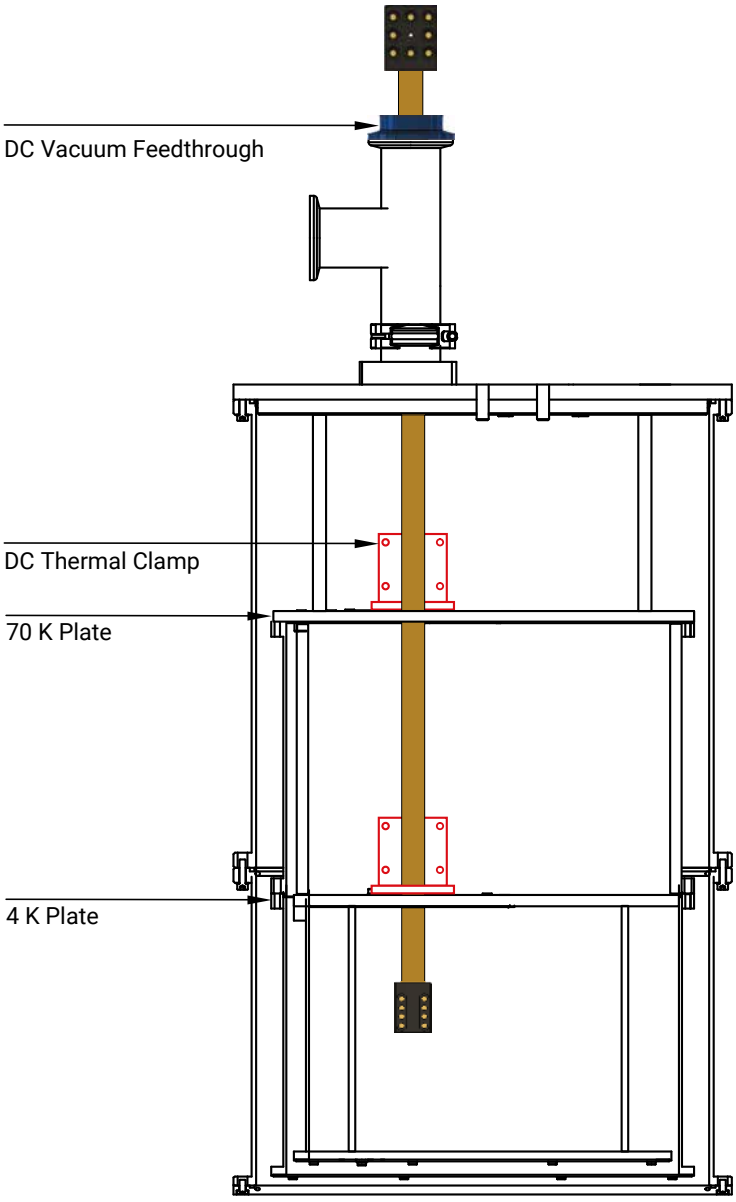


Figure 1: Schematic overview of the fridge and the positioning of the Cri/oFlex® 3 inside.

> "The installation of the flexible strip lines including the thermal clamping is fast, easy and straight forward. Tests on the vacuum tightness of the custom made feedthroughs and the heat load on the sample stage yielded positive results with a heat load of less than 2 mW/line at 3K."
>
> - Matthias Häußler, PhD Candidate


Cri/oFlex® 2X

Case Study

Cri/oFlex® for transmon control and read-out

ImpaQt

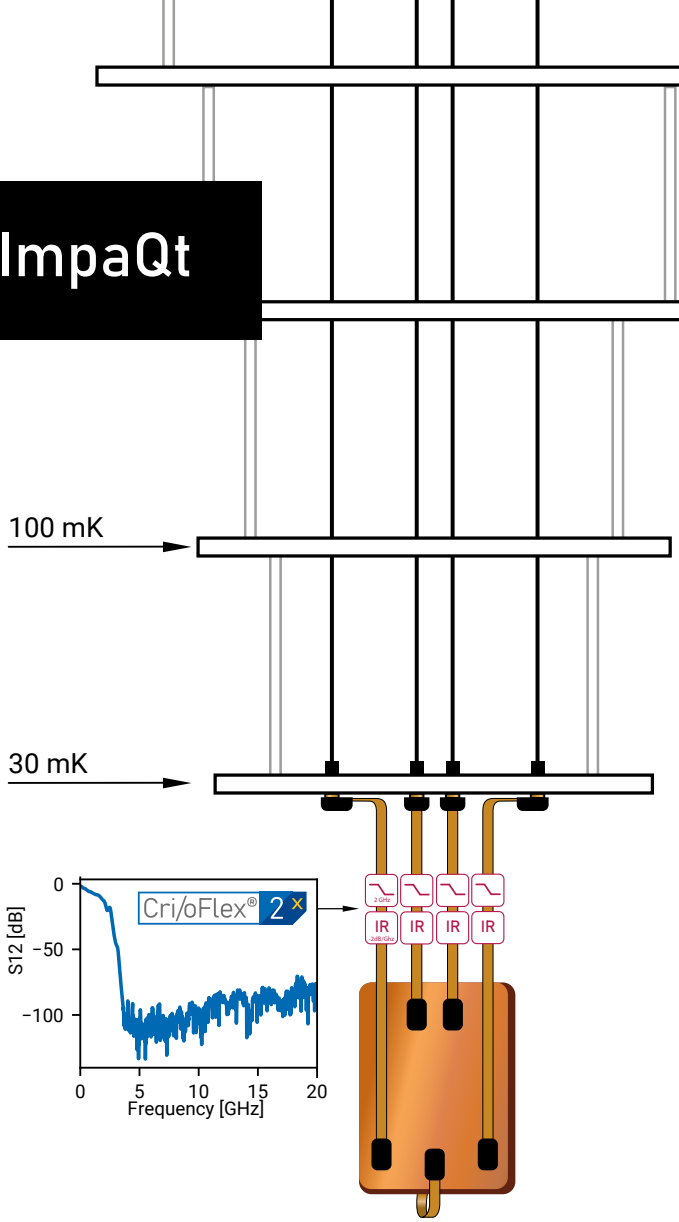
Project outline

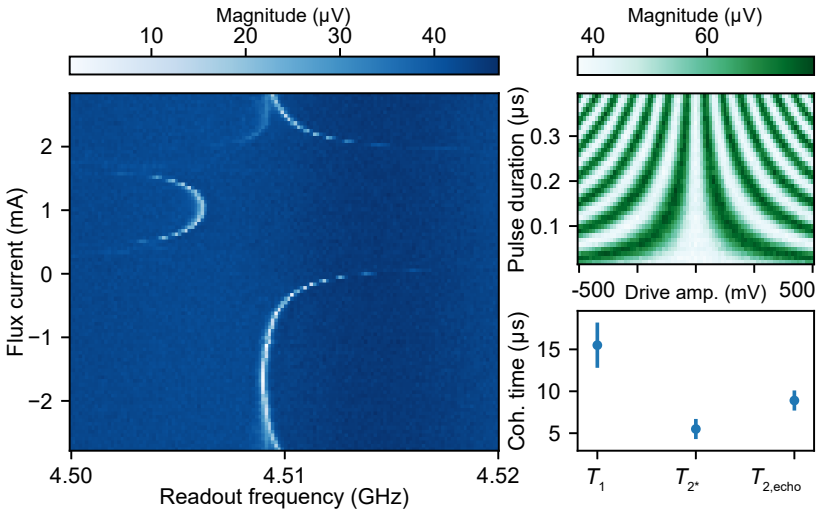
Within the ImpaQT consortium, several companies agreed to collaborate to build a demonstration platform for their individual quantum hardware solutions. Quantware fabricated a transmon-based quantum processor, Delft Circuits provided the cryogenic i/o for control and readout, QBlox delivered the quantum control electronics and Orange QS acted as systems integrator and supplied their control software. In only 4 months a multi-qubit system was successfully built, characterized and measured with qubit lifetimes of up to 15.5 µs.

Setup

For the project, Cri/oFlex® 2X cables were used to interface with the QPU on the cold finger. Based on our single-channel Cri/oFlex® 2, these cables have additional integrated on-Flex low-pass and infrared filtering to protect qubits from unwanted high-frequency noise. The high flexibility allows good thermal clamping and easy installation in the often crowded space of a mixing chamber.

The photography on the left page shows several installed CF2X cables, also shown schematically in the top-right of this page. For the low-pass filtering two different cut-off frequencies were used, 8 GHz for RF drive and read-in lines and 2 GHz for flux lines. A typical transmission of the 2 GHz-types measured at 77 K is included as well.

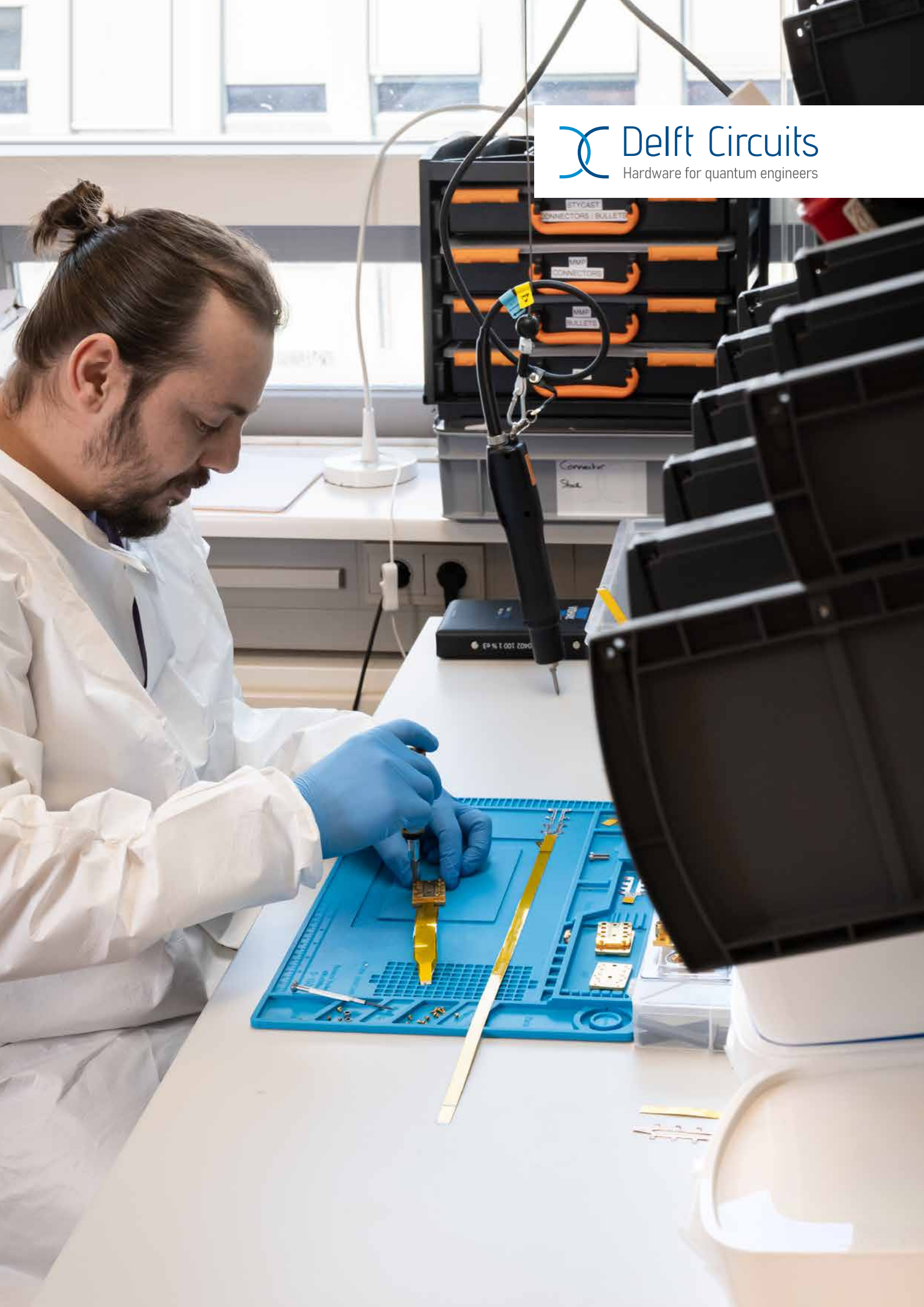




> "Cri/oFlex® cables are flat and very flexible, making it easy to clamp, thermalise and route many cables in tight spaces"
>
> James Kroll, Quantum device engineer at TNO

Results

With the Cri/oFlex® 2X cables in place, we performed a spectroscopy measurement where we change the qubit frequency with a flux drive line while measuring the resonance frequency of the read-out resonator. The results are plotted in the figure shown on the left. As the flux current is changed (vertical axis of the left subfigure), the qubit frequency crosses the resonance frequency of the readout resonator as expected. An optimal flux current is chosen, and a two-dimensional Rabi scan was performed, shown in the top-right subfigure. The qubit lifetimes were determined with $T_1 \approx 15.5$ µs, $T_{2^*} \approx 5.5$ µs and $T_{2,\mathrm{echo}} \approx 8.9$ µs. The standard deviations of the lifetimes are plotted in the bottom-right subfigure. These results show that Cri/oFlex® 2X is well suited for measuring transmon qubits and can drastically reduce installation time due to their compact size, flexibility and integrated filters.


Delft Circuits
Hardware for quantum engineers

Company profile

Delft Circuits is dedicated to supply the best hardware for the quantum engineer and industry. So far we have realised hundreds of i/o modules, for almost a hundred customers. Whether in a leading national laboratory, a Blue-chip corporation, or an ambitious professor, clients find their way to our solutions. As an independent, dedicated quantum hardware supplier, together with our customers, we make quantum technologies a reality.

Quantum technologies offer revolutionary new capabilities, the industry is booming, but is still in its infancy. With quantum computing, a landscape of new possibilities will be added to the thriving eco-system of high-performance computing, machine learning and artificial intelligence. Quantum-communication and -internet bring new capabilities in (information) security and distributed (quantum) computing. Finally, quantum sensing will bring a whole new dimension to a host of industries and sciences.
The past two decades we witnessed an explosion in academic research and results. Now this development is transitioning into the first steps of the quantum industry, of which we are proudly part. With our team, of 40 now, we are devoted to supply the quantum engineers in industry, academia and national labs, the best available tools, technology and services, such that they can focus on their real task.

Our lab space located at the Delft Quantum Campus

Customer visit to discuss new product development plans and learn about their measurement setup.

Our team

At Delft Circuits we combine a strong background in entrepeneurship and a highly-skilled multi-disciplinary team of engineers and scientists. Our backgrounds vary from design, electrical, microwave, and mechanical engineering, to process technology and various branches of physics, to business development and economics. This together with over many decades of accumulated experience in quantum research and cryogenic circuit technologies in the fields of superconducting-, spin-qubit and topological-quantum computing, cleanroom fabrication and microwave engineering, enables us to create products for the most challenging quantum applications.

Our company culture focusses on family values, engineering excellence and creative freedom, creating an environment where everyone can flourish in their own way.

Interested in joining our team? Contact us at careers@delft-circuits.com, or drop by at our lab in Delft!

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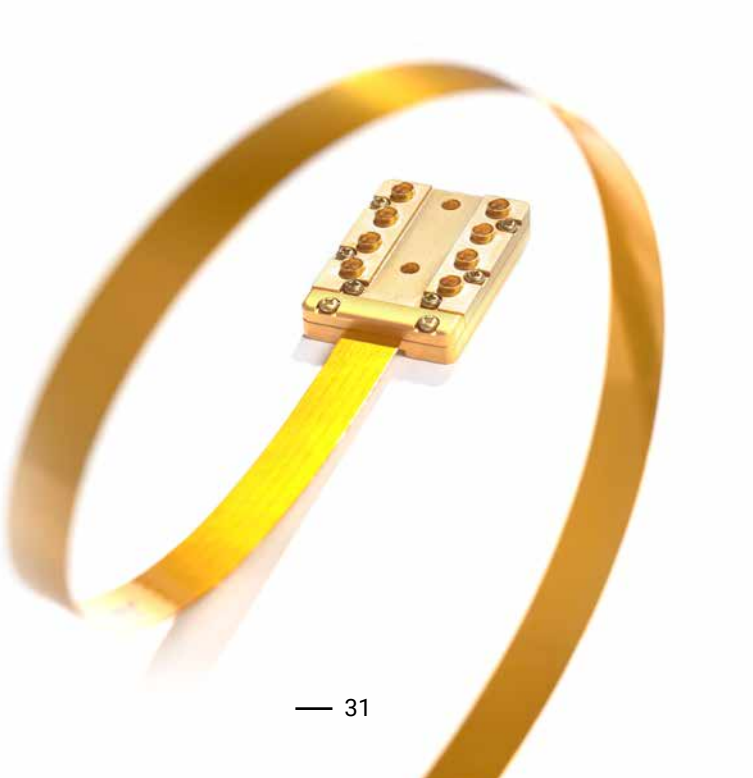

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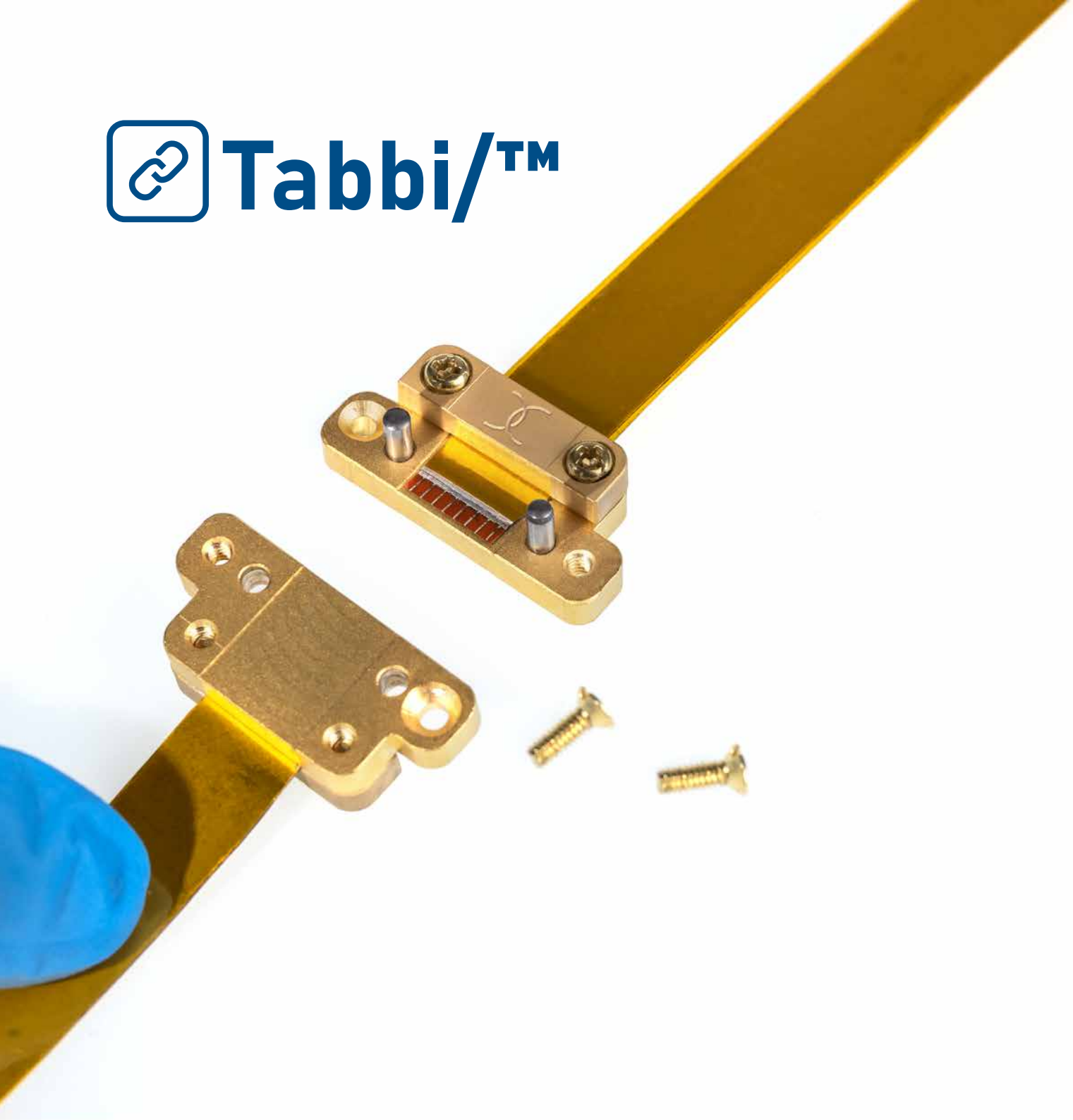

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