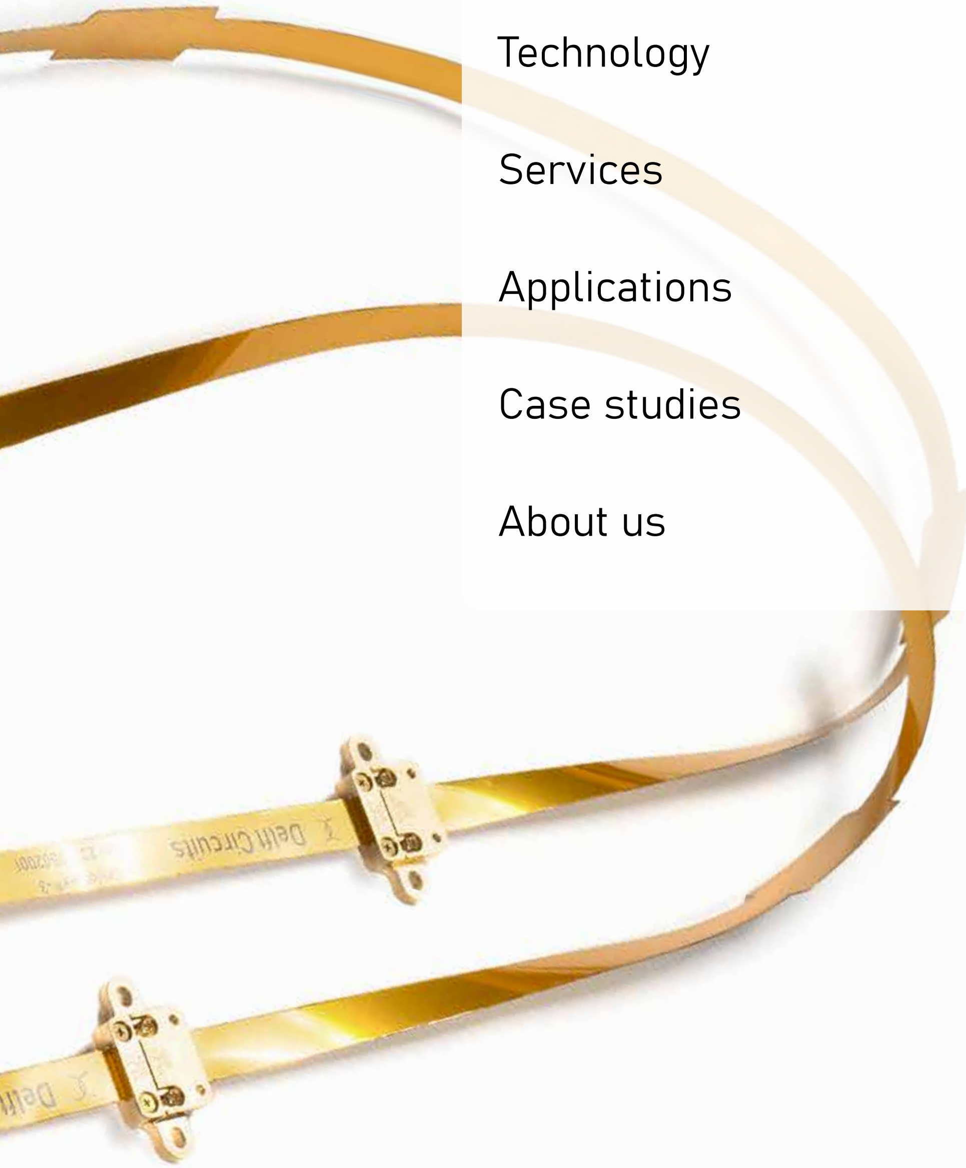
Delft Circuits

Hardware for quantum engineers

Cri/oFlex® io Flexible Cryogenic i/o


Delft Circuits



Last updated:
22/02/2024

Technology platform

Cri/oFlex® io

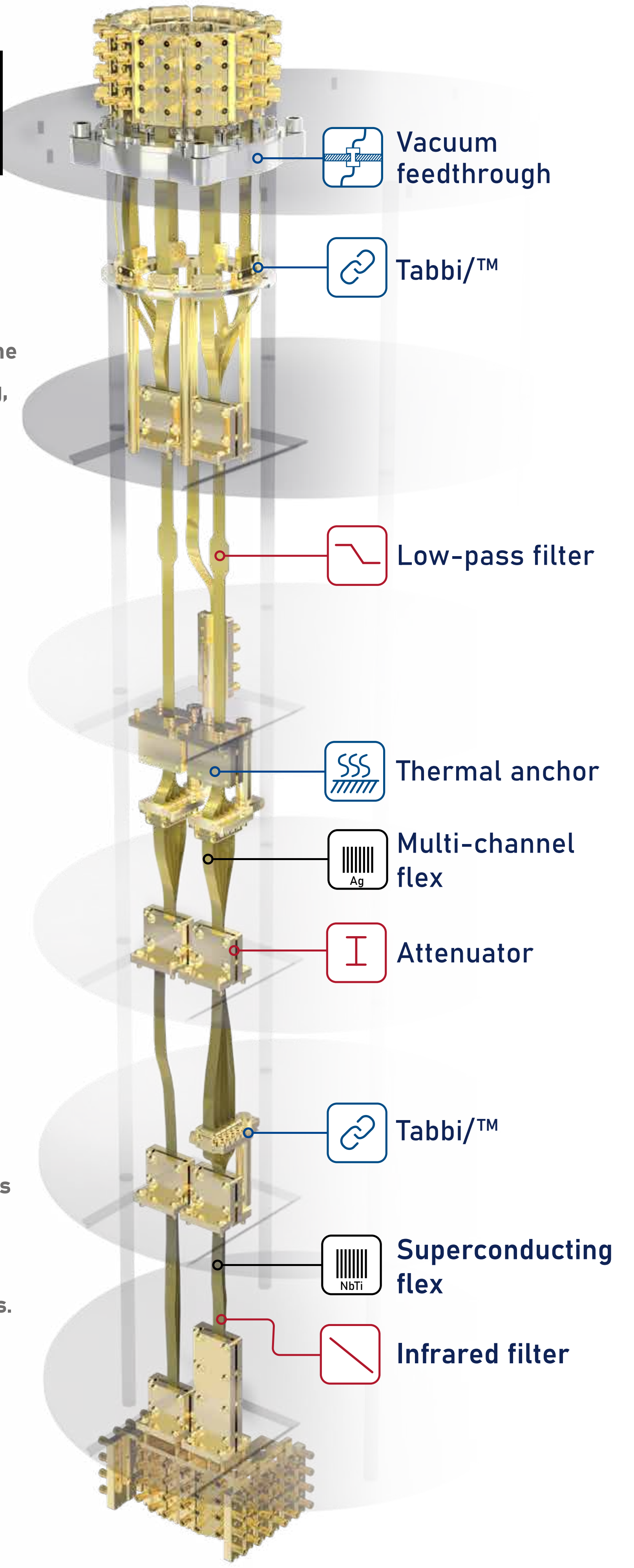
Input/output chains play an essential role in the performance of cryogenic quantum computing, communication and sensing. Especially in larger systems, cabling or component failure, passive heatload and limited space can be a challenge.

Cri/oFlex® is designed specifically for cryogenic (quantum) systems and offers a superconducting- and silver based platform. Integrated on-flex microwave filtering further reduces its footprint and thermal load.

Delft Circuits is your one-stop shop for cryogenic I/O assemblies. Our Cri/oFlex® products offer standard designs for specific applications. For example our microwave drive- and flux bias lines are optimized for superconducting quantum computers.

Additionally we can offer to design, manufacture and install complete I/O solutions tailored to your experiment. These include all input and read-out components required to connect your experiment with your electronics.

This way, we tackle every cryogenic I/O challenge!



Cri/oFlex® highlights

The state of the art in cryogenic cabling

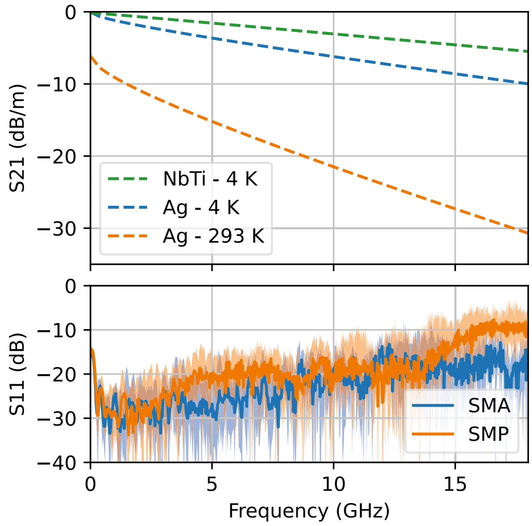
Key innovations

Facilitating thousands of lines in a cryostat requires a rethink of cabling. Our three key innovations are (superconducting) high density flex, integrated microwave components and scalable & adaptable fittings.

Flex: Superconducting & Silver

Get access to our unique flexible NbTi- and Ag based stripline technology. NbTi highlights:

- 1.5 dB/m of losses at 6 GHz
- 8 Kelvin critical temperature
- 150 mA critical current
- less then 10 mOhm contact resistance



On-flex components

Get rid of clunky and expensive microwave components and integrate them into your flex:

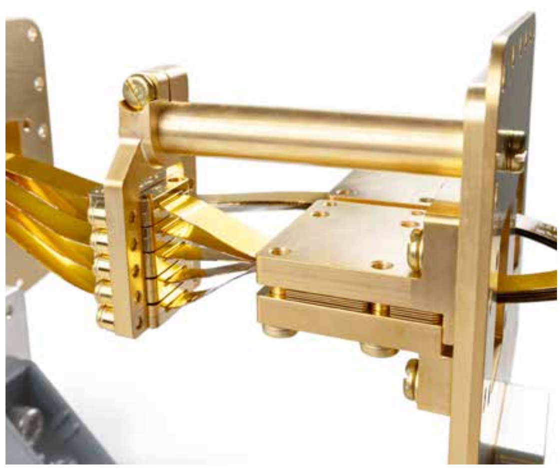
- IR (infrared) filter
- LPF (low pass filters)
- Attenuators of 10 dB, 20 dB

The integration of these components in the flex allows for improved thermalisation.

Scalability & adaptability

Maximise the wiring capabilities of your current or new cyostat:

- 32 channels through a KF40 port
- KF40, KF25, ISO 100
- Side and top loader ports
- Remove mechanical interruptions on every stage
- Adaptable to fit around current wiring



Microwave driveline

Cri/oFlex® Product sheet

Used for

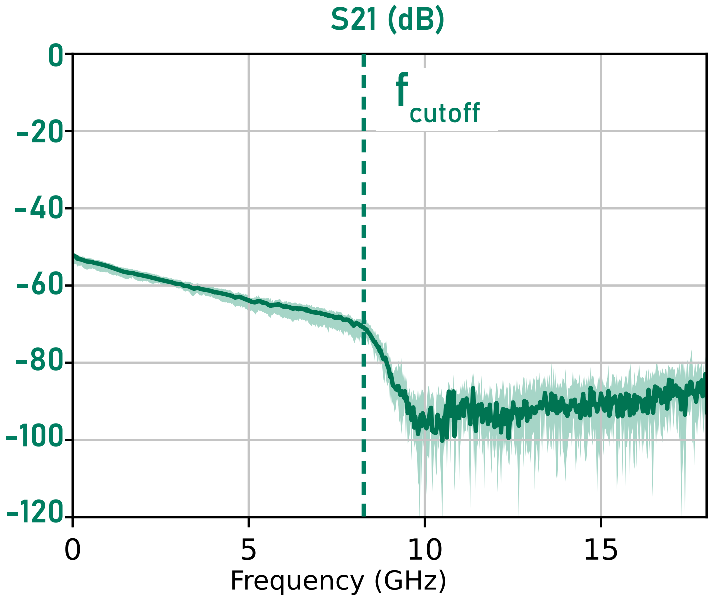
- Excitation between qubit states
- Measuring qubit state

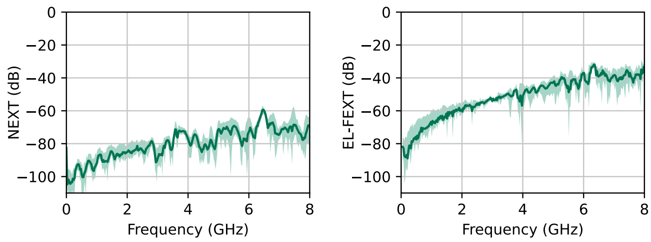
Optimized for

- Signal power and integrity
- Noise temprature

Key features

- 8 transmon qubit drive lines
- 8 GHz low-pass filter
- 50 dB distributed attenuation
- Integrated infrared filter
- Provided with vacuum feedthrough



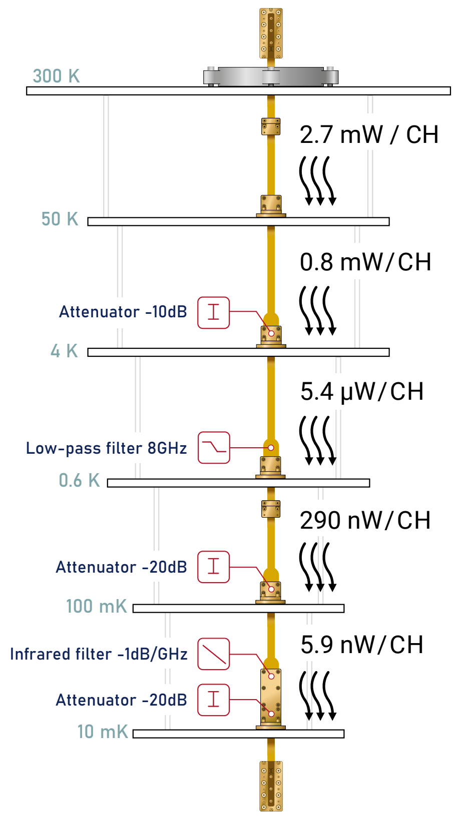


General specifications

Storage temperature	0 K to 320 K
Operating temperature	0 K to 400 K (gradient)
Applications	Qubit drive for super-conducting qubits or similar
Number of channels	8
Transmission type	Stripline
Connector type	SMA female / SMP
Primary flex materials	Polyimide, Silver (Ag)
Minimum bending radius	5 mm
Required length for 180° longitudinal rotation	10 mm
Vacuum feedthrough connection	KF25/40, ISO 100 side and top loader ports
Vacuum feedthrough leak rate	< 10-9 mbar L/s

Cable overview

Cable layout & passive heatload per channel



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Last updated: 22/02/2024

Flux bias line

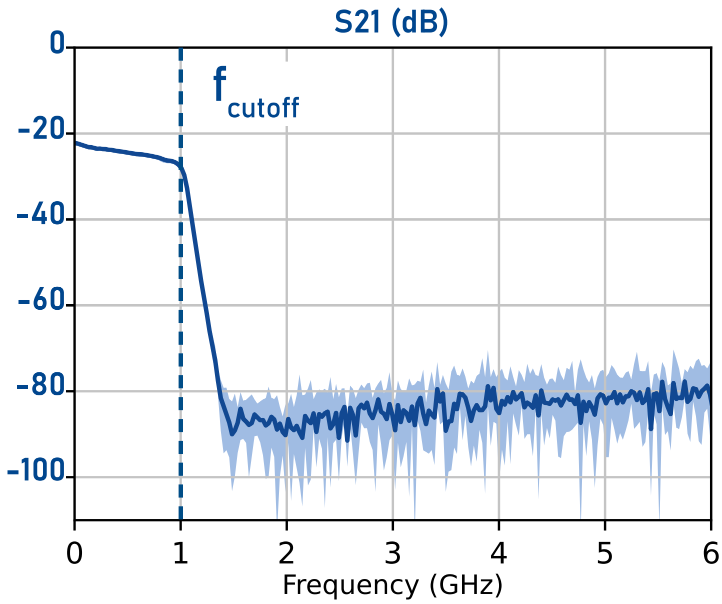
Cri/oFlex® | Product sheet

Used to

- Tune the energy gap between computational states

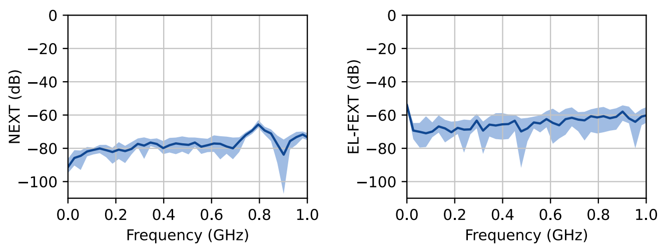
Optimized for

- Low frequency bias signals
- Minimising active & passive heating



Key features

- 8 transmon qubit flux lines
- 1 GHz low-pass filter
- 20 dB attenuation
- NbTi Superconducting lines
- Integrated infrared filter
- Provided with vacuum feedthrough

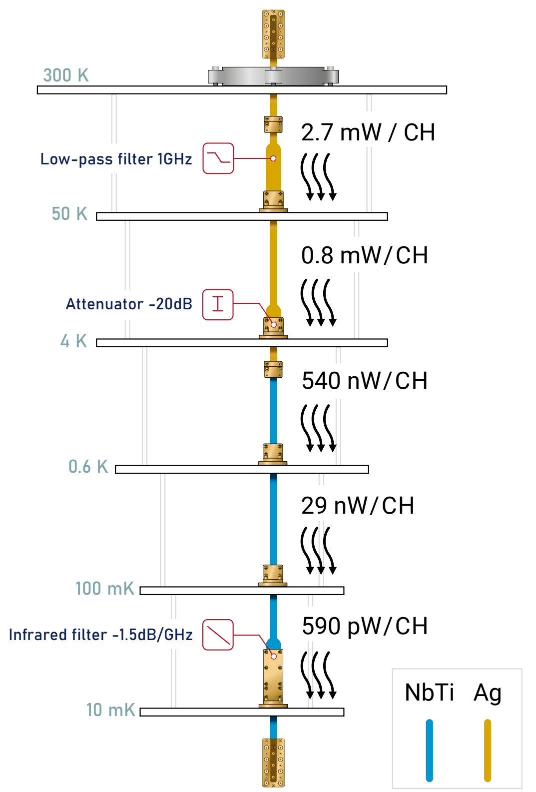


General specifications

Storage temperature	0 K to 320 K
Operating temperature	0 K to 400 K (gradient)
Applications	Qubit flux for super-conducting qubits or similar
Number of channels	8
Transmission type	Stripline
Connector type	SMA female / SMP
Primary flex materials	Polyimide, NbTi, Silver (Ag)
Minimum bending radius	5 mm
Required length for 180° longitudinal rotation	10 mm
Vacuum feedthrough connection	KF25/40, ISO 100 side and top loader ports
Vacuum feedthrough leak rate	< 10-9 mbar L/s

Cable overview

Cable layout & passive heatload per channel



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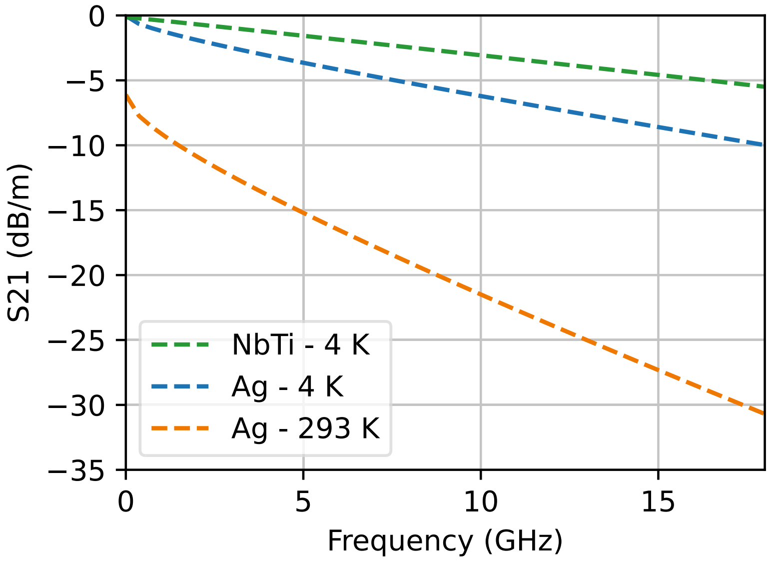
Signal line

Cri/oFlex® Product sheet



Indication of loss based on measured data

Tackle your cryogenic cabling challenge

Bringing many channels to your cold stage, signal lines provide a simple and elegant solution for a wide range of applications.

Key features

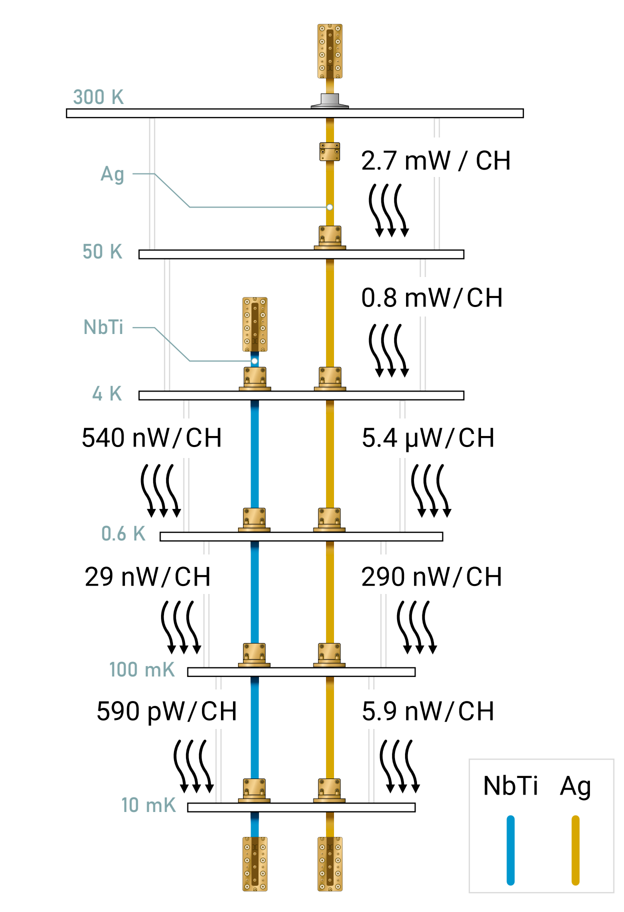
- High-density microwave channels
- Resilient against thermal cycling
- Optional filtering & signal conditioning
- Integrated vacuum feedthrough
- Low thermal load

General Properties	
Connector	
Connector Type	SMA female / SMP
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 type	Stripline
Minimum 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	KF25/40, ISO 100 side and top loader ports

Electrical Properties	
Impedance	Designed for 50 Ω
Operating frequency	DC to 10 GHz
Maximum crosstalk (channel-to-channel), L=200 mm	< -40 dB

Cable overview

Cable layout & passive heatload per channel



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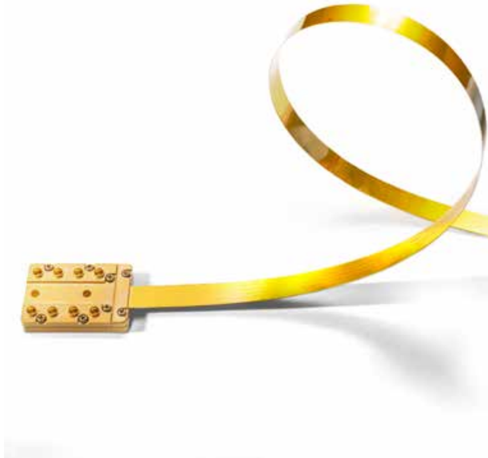
Signal line

Cri/oFlex® | Product sheet

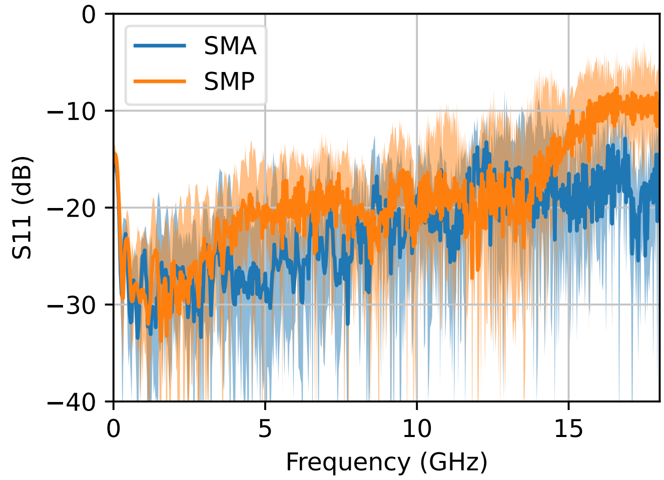


Measurements

All measurements shown on this page are based on a flex cable containing eight channels without components. The mean is shown with a thick line and the spread of all channels is shown with the transparent area.

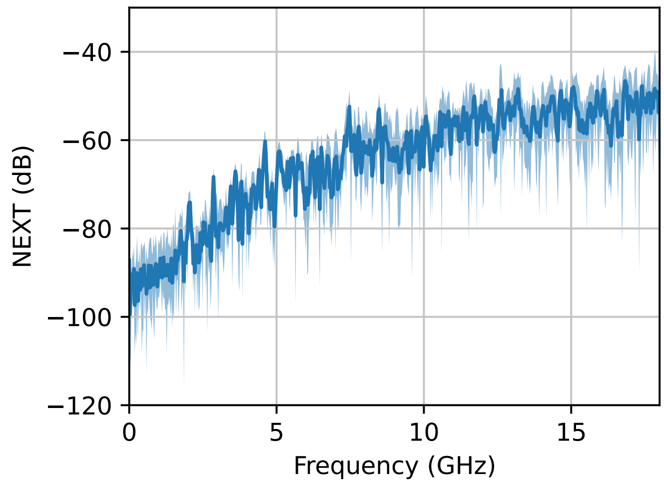
S11 – Reflection

Typical reflections for two types of connectors (SMA & SMP) are shown. Reflections are generally similar for both the Ag- and NbTi platform and are not significantly affected by temperature.



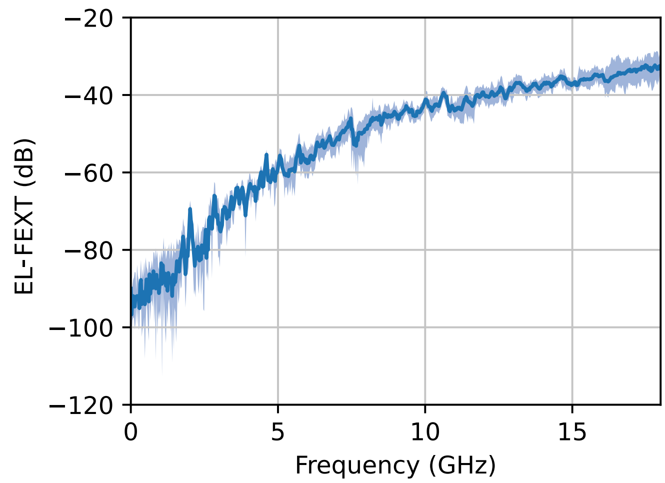
S31 – Near end crosstalk (NEXT)

NEXT is crosstalk between ports on the same side of the cable. It is therefore connectorblock dependent. Here we show results for an SMA connectorblock. SMP connectorblocks yield similar results. The NEXT always remains below -40dB up to 18 GHz. We see similar results for both the Ag- & NbTi platform.



S41 – Equal level far end crosstalk (EL-FEXT)

EL-FEXT is crosstalk between ports on the opposite side of the cable corrected for cable loss. These measurements are from a Ag- based cable at room temperature. We see comparable results for both the Ag- & NbTi platform. The length of this cable is 80 cm.



Microwave components

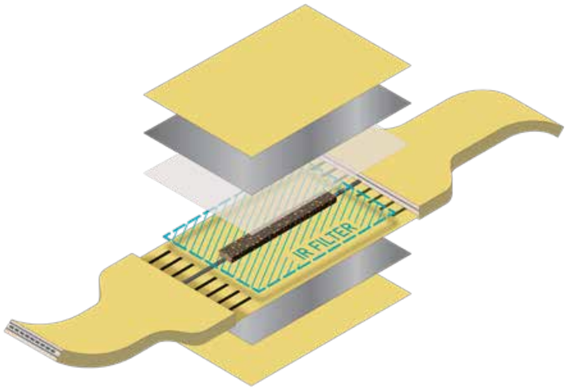
Integrated in multi-channel flex

Integrated filtering

A key feature of our Cri/oFlex® technology is the integration of cryogenic filtering components in the flex itself. This reduces the number of interconnects, simplifying installation and removing points of failure. Our current library of filtering components includes: low-pass filters, infrared (IR) filters and attenuators.

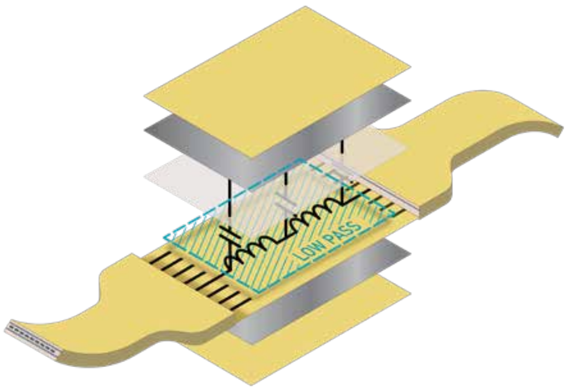
Infrared

Our IR filters are based on metal powder dissipating signals up to the THz range. The IR filters have a filtering range between 0.5-1.5 dB/Ghz. Infrared filters are available on both the Ag- and NbTi platform. These filters improve performance by blocking high frequency radiation to the quantum device.



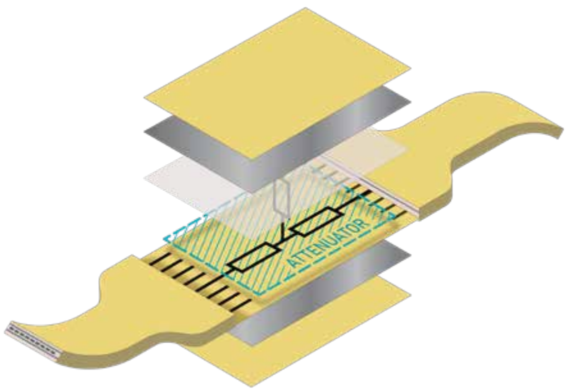
Low-pass

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. Low-pass filters are available on the Ag platform. By integrating these filters, noise and undesired frequencies can be surpressed at the quantum device.



Attenuator

Our attenuators are based on impedance matched resistance networks. The attenuation can be specified in 5 dB increments. Attenuators are currently available on Ag-based Cri/oFlex®. The thermal clamps provided with the attenuators ensure improved thermalization of the integrated resistors and limit thermal (Johnson) noise.



Interface

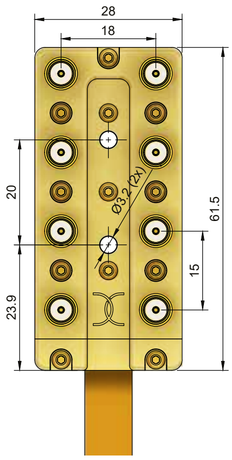
The i/o chain features three points of interfacing

Connectors

The i/o chain features three points of interfacing, outside the fridge, between flexes and at the quantum device. Our connector design is focused around firstly, low reflections (S11 < -15 dB up to 10 GHz) and low crosstalk (NEXT < -40 dB). Secondly, good thermalization and lastly, small footprint. To reduce the footprint, we are currently developing high-density connector interfaces.

SMA blocks

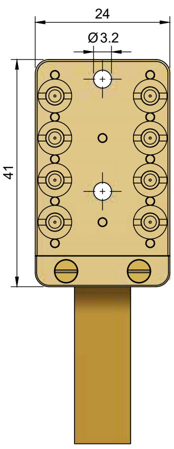
SMA connectors are available in 8 channel blocks. SMA connectors have long been the industry standard because of their sturdy nature and good microwave performance up to 18 GHz. The connector blocks are relatively large to allow tightening the connectors with a torque wrench.



SMP blocks

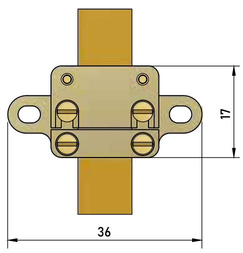
SMP connectors are available in 8 channel blocks.

These connectors are easy to install due to their click-in mechanism. The footprint of these connector blocks is ± 40% smaller than those of the SMA blocks, because of the smaller footprint of the connectors and because screw-in access is not required.

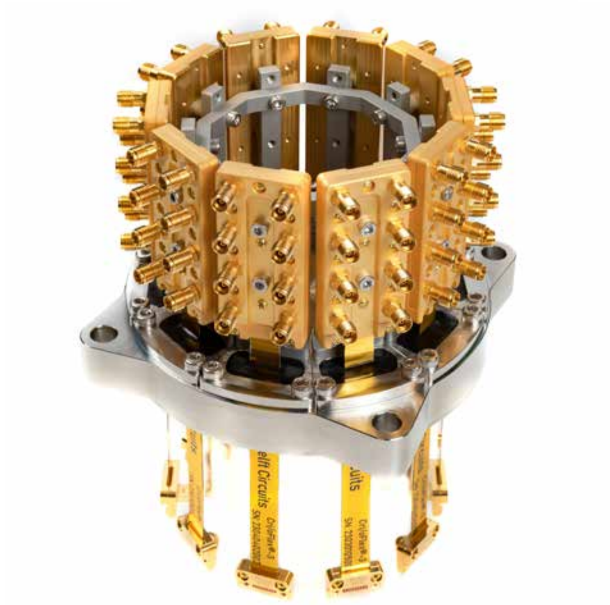


Tabbi/ ™

To remove 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®. This ultra-high density microwave interconnect allows modular configuration of any Cri/oFlex® i/o chain.



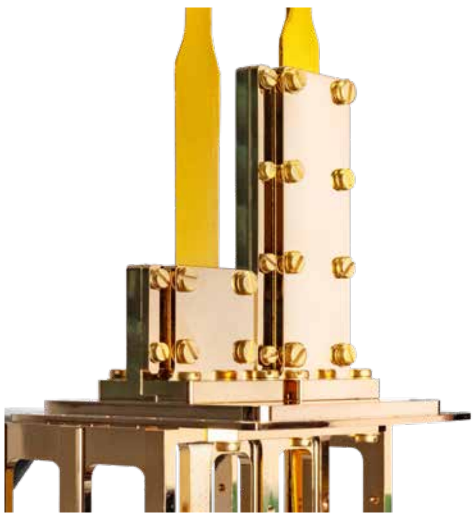
Fittings Vacuum feedthrough & RT



Vacuum feedthrough & RT node

We provide vacuum feedthroughs for the following standard ports (in brackets the max number of channels CH) ISO-100 (160 CH), KF-40 (32 CH), KF-25 (16CH). The hermetic seal has a leak rate below 1.2 x 10^{-9} mbar L/s, and an outgassing rate below 6 x 10^{-8} mbar L/s. Furthermore, each port has a dedicated mounting system to securely mount our SMA and SMP breakouts at room temperature.

Fittings Thermal anchors



Thermal anchors

At each stage, the flex needs to be thermalized to remove passive heating from a hotter stage and active heating from the components. The planar nature of Cri/oFlex® allows for thermalization by clamping of each flex. Multiple flexes with thermal inserts in between can be stacked within a single thermal clamp. The shape of our clamps is designed to fit each fridge and match the on-flex components that need to be thermalized. Tabbi/™ posts thermalize and mount the Tabbi/™s at the right place.

Fittings mK node

mK node

As each quantum device requires different routing, our current cold node solution consists of a connector bank (SMA or SMP) thermally anchored to the cold stage. From this connector bank, individual cables are routed to the quantum device. Delft Circuits is working on chip holder integration with key providers. Also, we can deliver customized solutions based on flex to PCB technology.

Fittings a complete I/O assembly

I/O

Many fridges allow for the installation of wiring outside the fridge by means of loaders or probes which can be mounted once the wiring is installed. We have extensive experience wiring and quality testing such loaders with Cri/oFlex® as well as all other required components to build a complete i/o assembly.

Readout

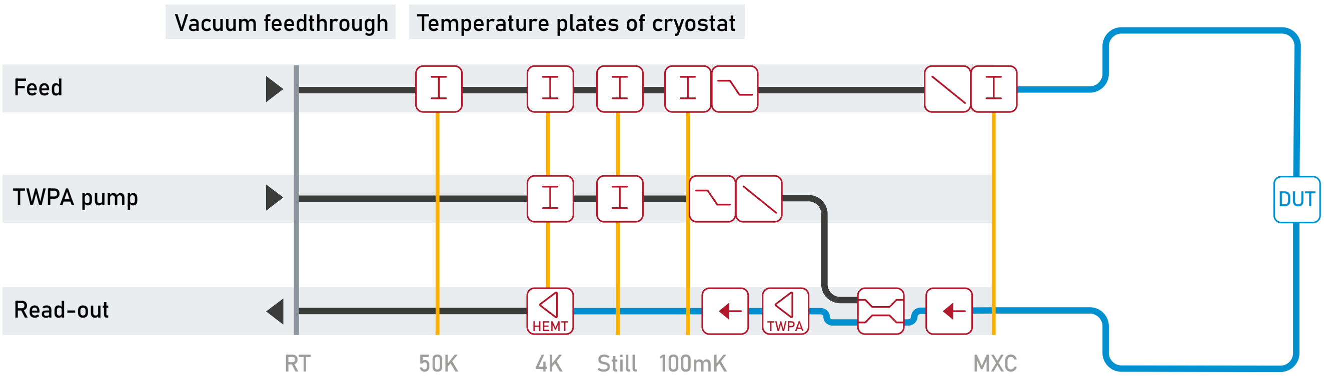
READ-OUT

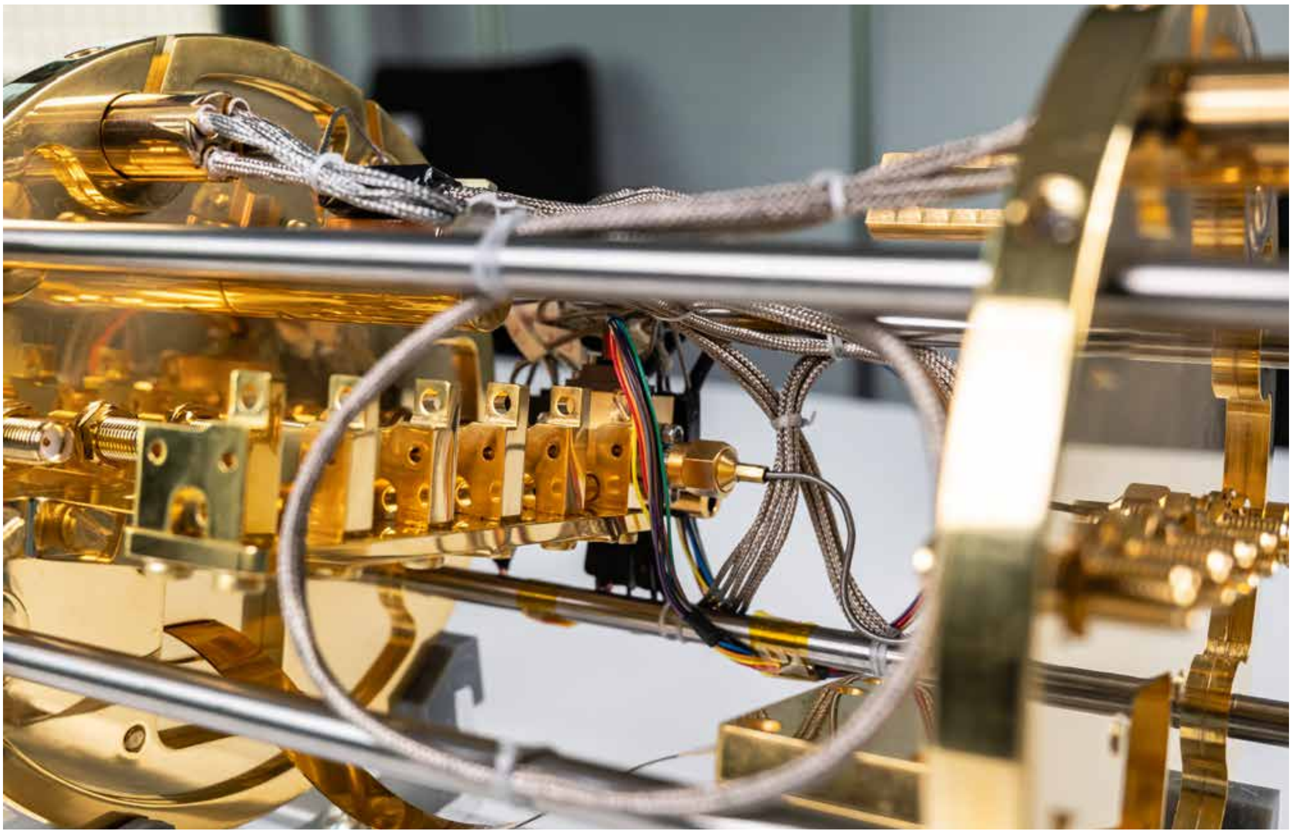
Bringing signals from the quantum device to control electronics puts high requirements on signal integrity and often requires amplification.
Delft Circuits provides a complete solution, integrating Cri/oFlex® with third party components.

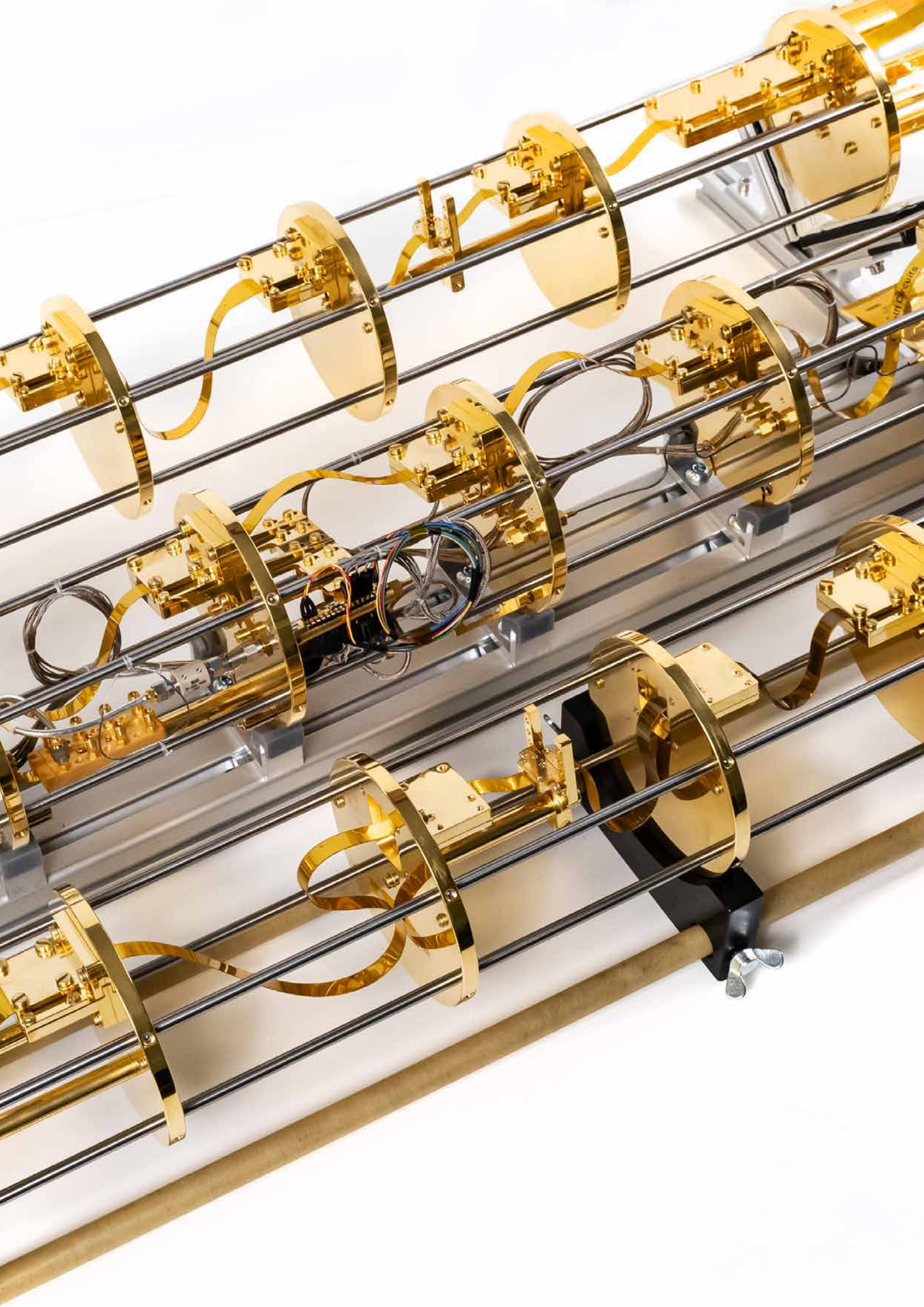
Delft Circuits’ read-out chains typically consist of

- Ag-based 4K-RT Cri/oFlex®
- DC-supply HEMT
- 4K HEMT amplifier
- NbTi coax or flex
- Isolator(s)

optional: TWPA (and Cri/oFlex® pump line)







Systems engineering | System requirements

The first step to engineering the optimal system is understanding the i/o requirements for the quantum system. Typically, the following aspects are important:

- Purpose of the line: e.g. Microwave drive-, Flux bias- or signal line. And more specifically, frequency range, dynamic range, noise temperature and stopbands
- Number of channels/qubits
- Interfacing solution (SMA, SMP, HD connectors)
- Readout line requirements: Noise temperature requirements and gain
- Fridge- & experiment layout: e.g. Vacuum feedthrough ports, space availability (taking fridge and experiment space requirements into account) and cooling power

Example Requirements

Complete i/o for 5 qubit experiment in standard fridge.

Type	Nr.
Qubits:	5
drive lines	5
flux lines	5
feed in lines	1
feed out lines	1
direct current lines	3 (Vg, Vd, GND for LNA power supply)

Drive line requirements: -75 dB with optimal attenuation distribution through the stages, 8GHz LPF, 1 dB/GHz IRF.

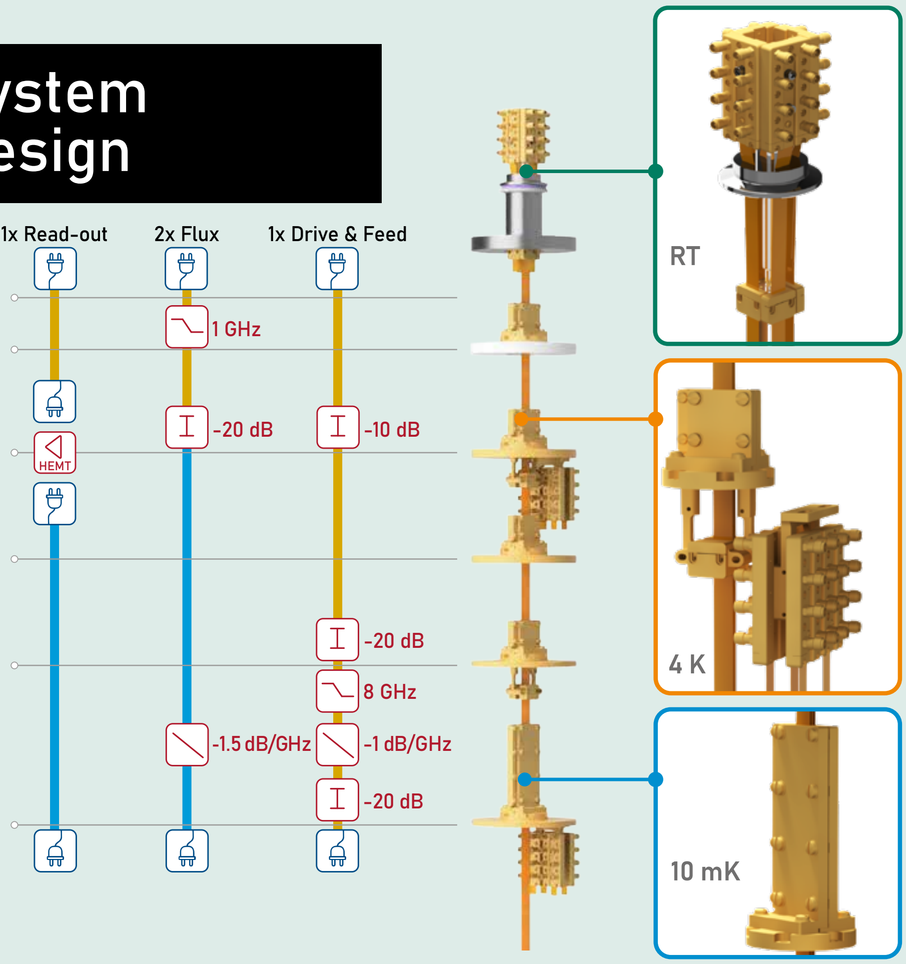
Flux line requirements: 25 dB of loss (@4K), 1.5 dB/GHz IRF

Pump line: Pump tone power at TWPA input: -60 dBm@ 10 GHz, Pump tone power at 300K: -10dBm@ 10GHz

Output line requirements: +55 dB of total gain, LNA, TWPA

Systems engineering | System Design

The optimal i/o system can be designed based on the electrical requirements and temperature- and mechanical profile of the fridge.
The combination of a CAD program with Cri/oSuite® (our inhouse software tool for cryogenic electrical- & thermal i/o design) allows us to optimize the i/o design and positioning of the various integrated components.
Typically, we optimize for minimum noise temperature at the location of the qubits.



Systems engineering

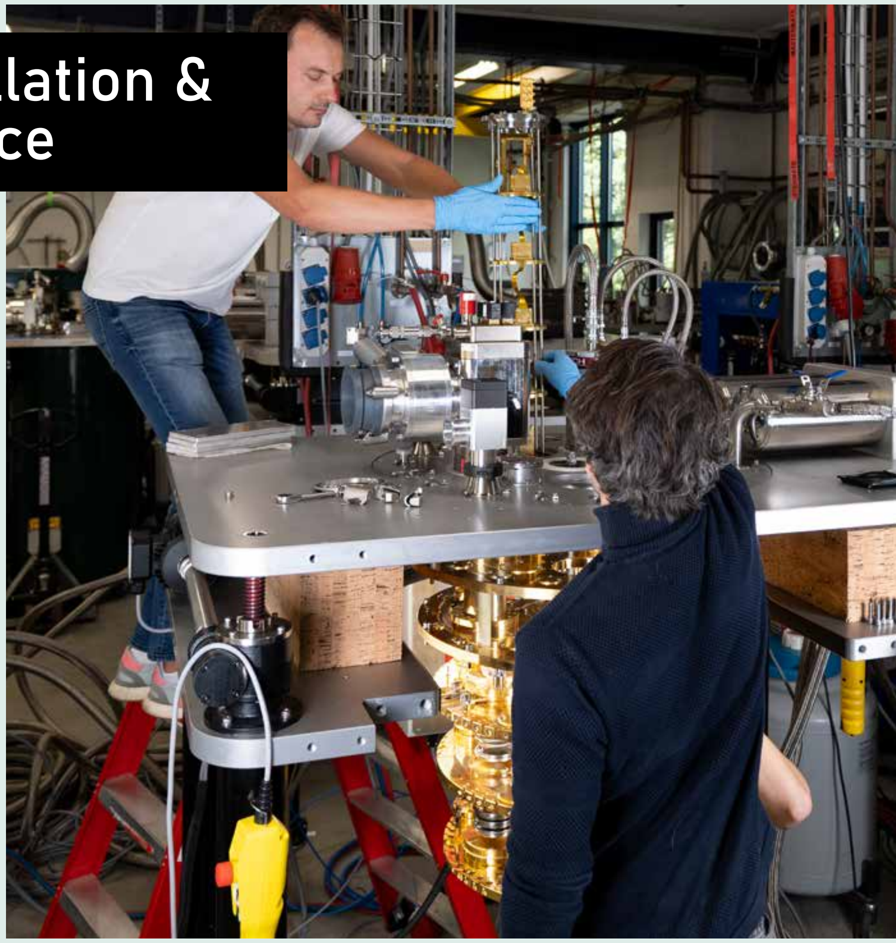
Manufacturing, Assembly & Quality control

Delft Circuits manufactures the flex in its inhouse manufacturing cleanroom. Accordingly, all flexes pass quality control both at room temperature as well as at cryogenic temperatures. Quality control focuses on microwave properties and is available upon request.
Once all flexes are ready, they are assembled in a loader / probe together with all fittings and 3rd party (readout) components. A final system check is carried out and the complete system is made ready for shipping.

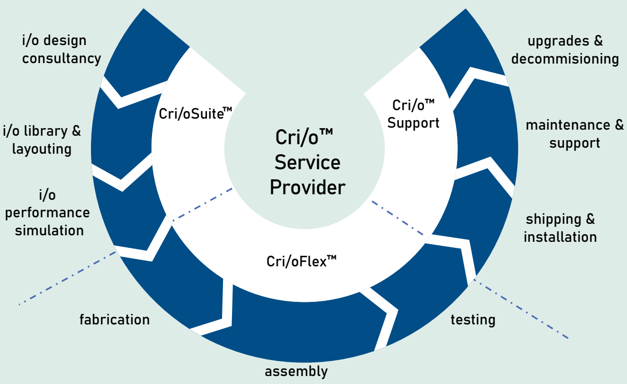
- Inhouse fabricated and cryogenically tested
- Quality control report available upon request.
- Pre assembled top and sideloaders possible.

Systems engineering

Installation & Service



Depending on the complexity of the system, Delft Circuits can install the i/o system and (help) carry-out on-site quality checks. Our maintenance service offers quick remote or on-site support with I/O upgrading, replacements or troubleshooting.



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.

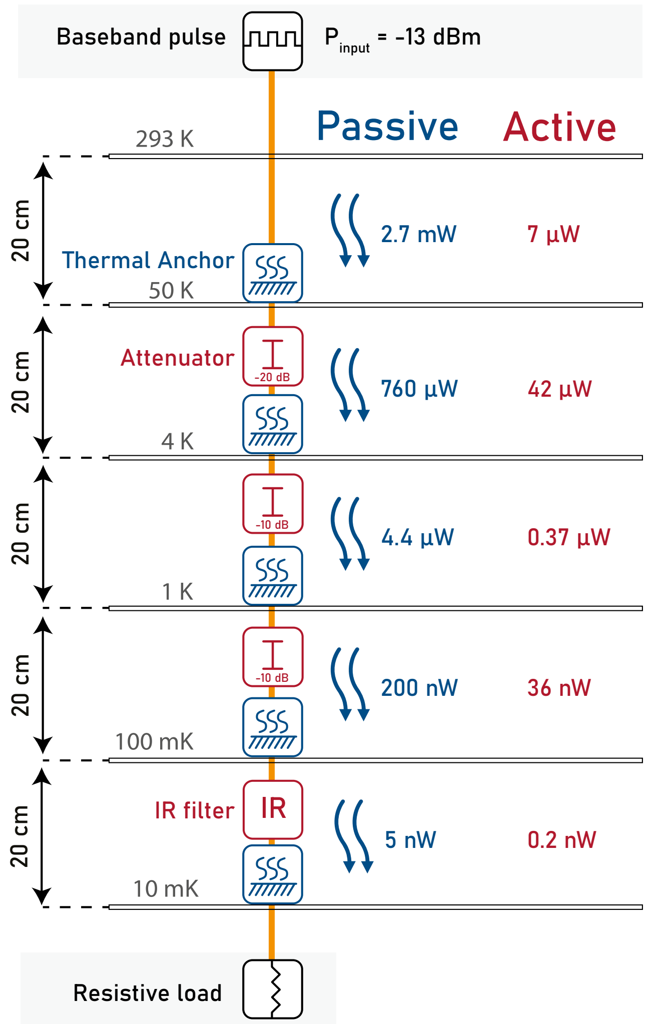
Next to design and analysis, it enables the user to process Vector Network Analyser (VNA) measurements, and to shift the reference plane of your measurements to arbitrary locations via de-embedding and/or calibration.

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 at 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 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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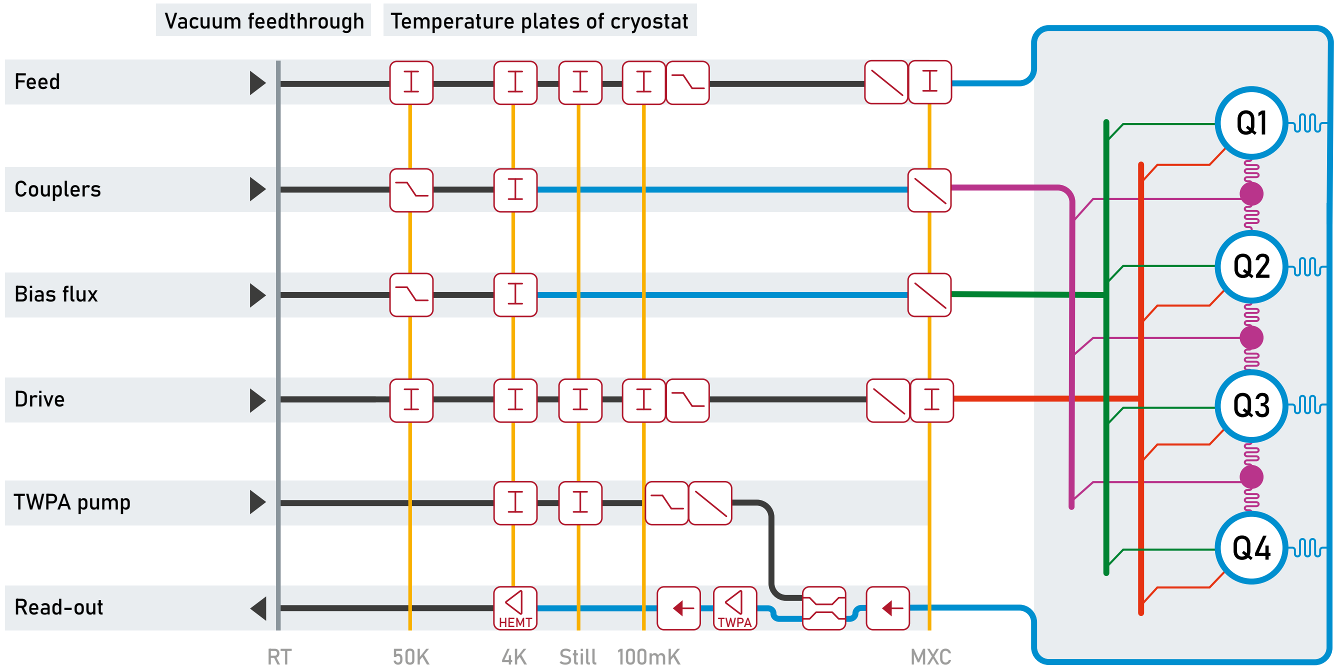
Applications Superconducting qubits



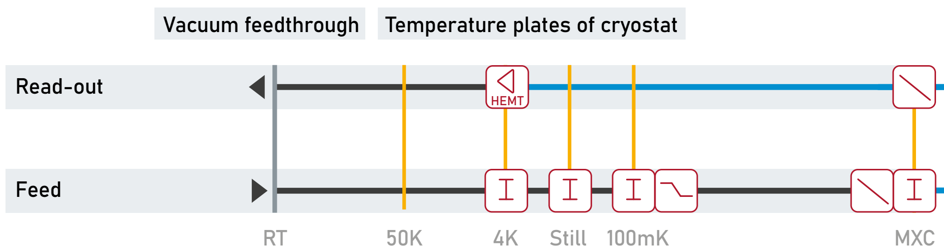
Wiring superconducting qubits poses two main challenges. First, due to an increase in qubit count, the sheer number of channels goes up, requiring many cables with a small form factor.
Secondly, the qubits require different types of signals and are very sensitive.

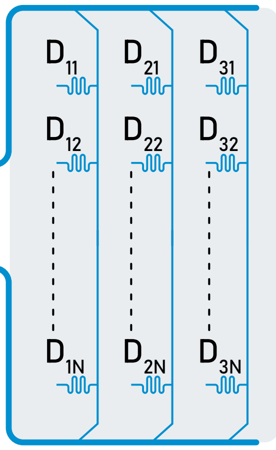
This poses strict requirements on the filtering and requires superconducting sections.
We have successfully provided complete i/o systems for superconducting qubits to various customers. Based on this experience, we have drafted a generalized wiring scheme, which is shown here.

Legend

- Directional coupler
- Parametric LNA
- Isolator
- Low-pass filter
- Attenuator
- Cryo LNA
- IR filter
- Bias-T

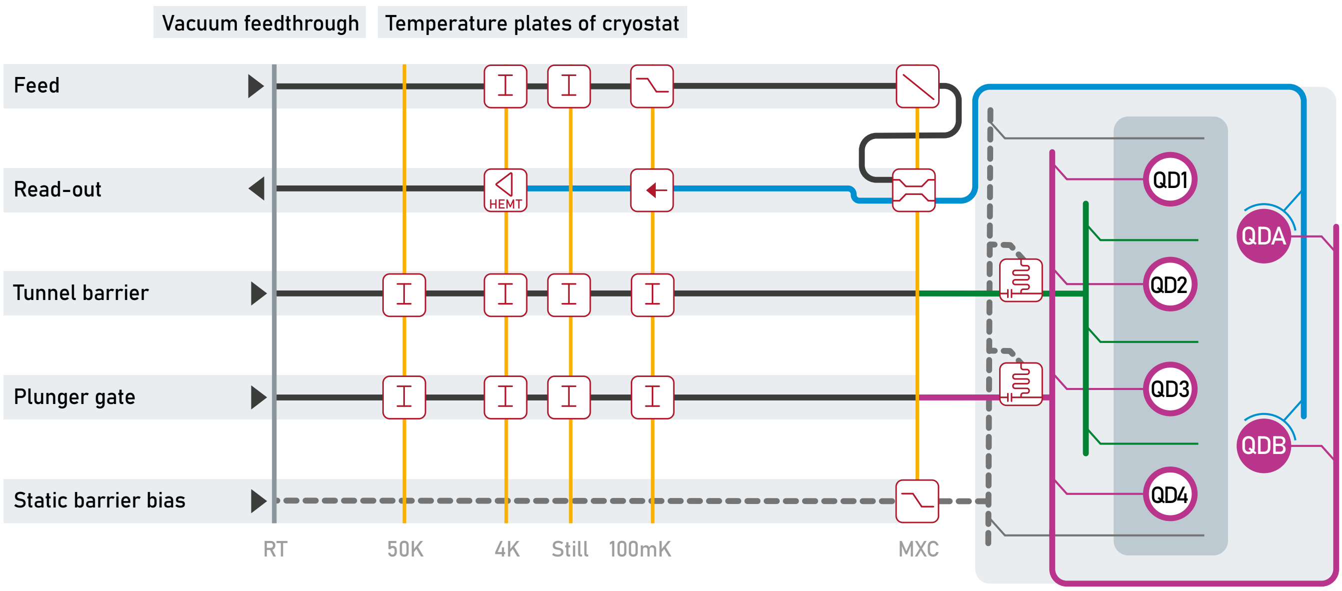
Applications MKID detectors





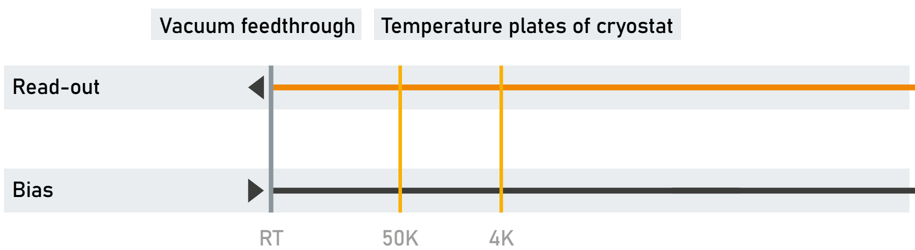
Delft Circuits' adaptable multichannel cables emerge as the optimal solution for detector arrays in astrophysics, whether deployed on the ground or in-flight. Designed with flexibility and low weight in mind, our cables enable seamless scaling due to their low heatload and a minimal number of connectors even for signals up to X-band and higher. This is ideal for MKID detector arrays and for TES detectors with novel microwave multiplexing readout.

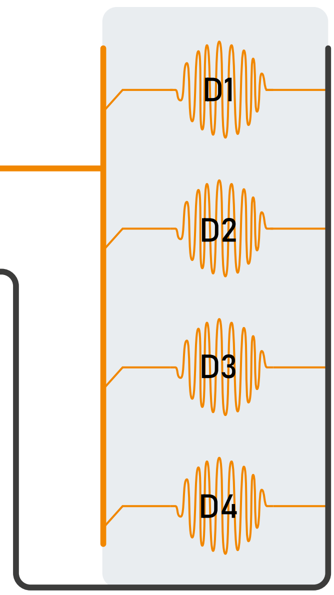
Applications Solid state spin qubits



Solid-state spin quantum processors face a number of wiring challenges. Firstly, processor housings (inside magnets) have limited space, demanding small form factor interconnects for large amounts of wiring. Secondly, the quantum dot-based processors are sensitive to electrostatic noise. Our rugged flexes prevent vibration induced electric noises, overcoming this problem. Delft Circuits excels in meeting the I/O requirements for semiconductor spin quantum circuits. Our multichannel cables with integrated attenuators and filters offer bus-like I/O with configurable channel to channel phase delays with picosecond precision.
The wiring diagram of the complete solution we deliver is shown here.

Applications SNSPD Readout & photonics





SNSPD detectors readout have a number of key requirements. The channels should have small form factor, low thermal load and be price effective.
Cri/oFlex® offers an optimal solution for this set of requirements. Our products are engineered for small form factor and low heatload per channel.

Also, our monolithic flex removes the connectors from each thermal stage, ensuring signal transmission with minimal distortion, even for pulses lasting less than a nanosecond.
This guarantees a robust and reliable I/O solution tailored for the most challenging photonic applications.

Case Study

The I/O system based on Cri/oFlex® CF3 platform

Quantware

Project outline

Within the Delft quantum ecosystem, Quantware and Delft Circuits have carried out multiple successful development projects together. This project was the logical continuation of the two companies' partnership and focused on providing a complete I/O solution ready for installation into the cryostat.

Additionally, Delft Circuits was requested to deliver a full-service package: RF performance (S-parameters and noise temperature) and thermal budget calculation and optimization, mechanical design for peripherals (multichannel vacuum break-out, custom thermal clamps, stage inserts, thermal posts), integration, assembly, and installation services.

Setup

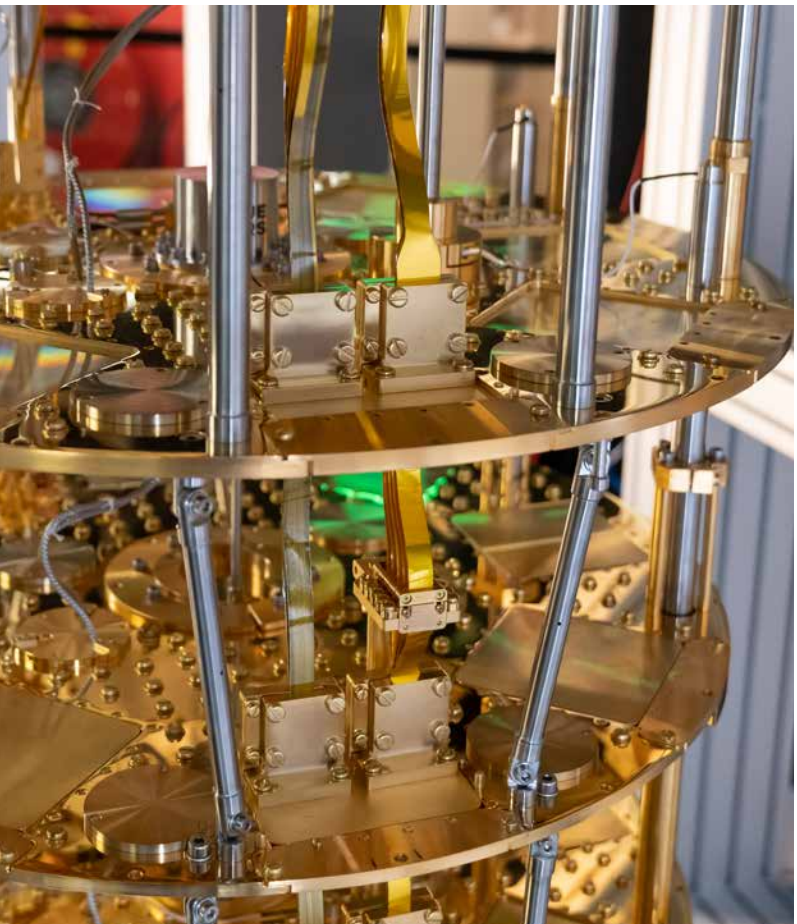
Quantware needed a setup with 40 MW Drive/Feed-in channels, 32 Flux bias channels, and 8 output channels (bare lines, 300K to 4K). In order to accommodate this amount of channels the standard Cri/oFlex® multichannel platform from Delft Circuits was employed. The position and parameters of all integrated components were optimized within our typical design kit to meet the transmon qubit requirements. All components (attenuators, low-pass filters, IR filters) were integrated into the flex substrate. MW Drive/Feed-in and output channels were produced by using our Cri/oFlex® Ag based platform. Flux bias channels were produced by using our Cri/oFlex® superconducting NbTi platform. All mechanical components were designed in-house and partially produced in-house partially manufactured by our industrial partners according to our specifications.

The I/O system was designed and produced to be compatible with the BlueFors XLD side loader system.

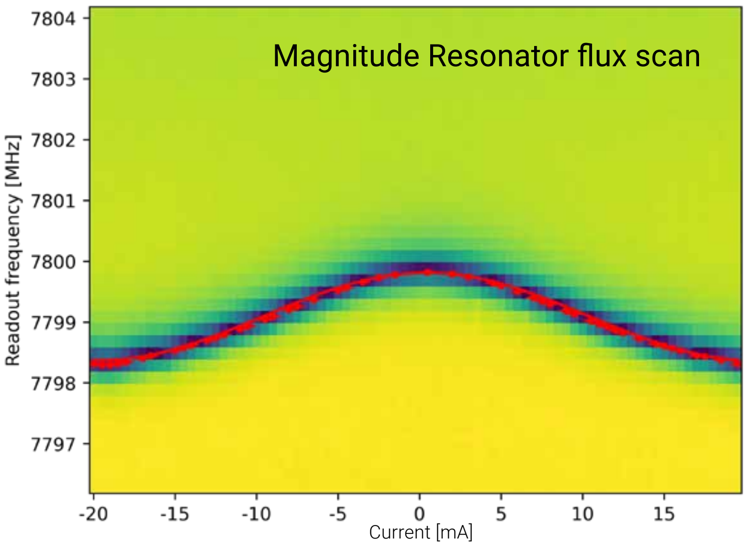
The picture below shows the full assembly of the side loader and the top part with a multichannel vacuum feedthrough. On the right side, the installation process is shown

Results

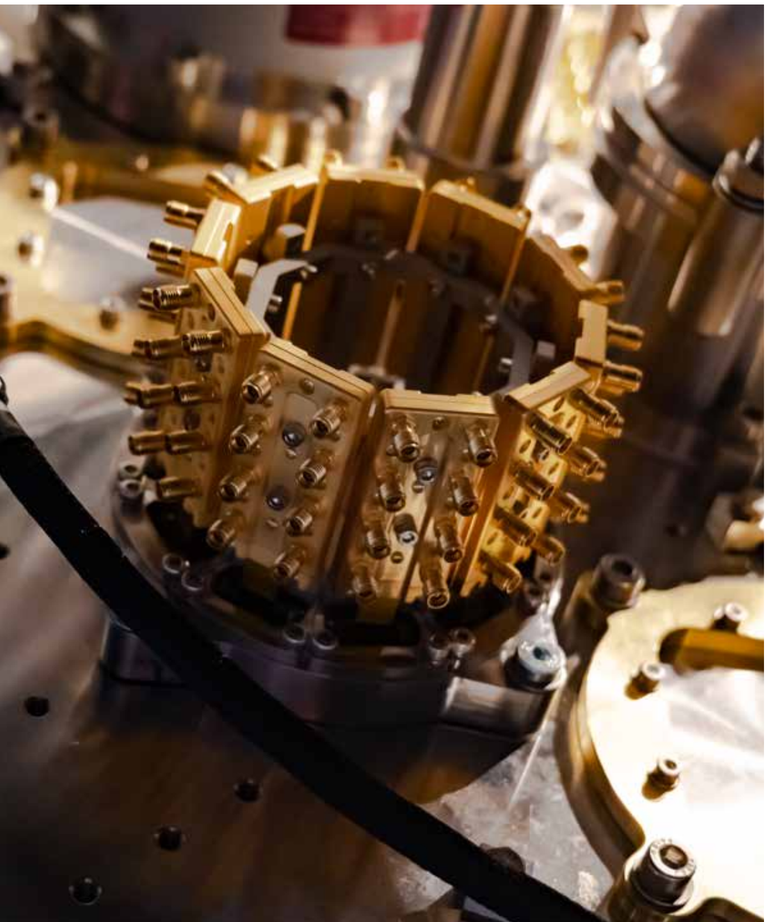
After installation we performed a standard DC/RF test to verify all the channels. Quantware used one of the QPU chips from the standard portfolio for the first real qubit experiment. This QPU was fully characterized before using a reference setup with wiring from another vendor. A typical spectroscopy measurement

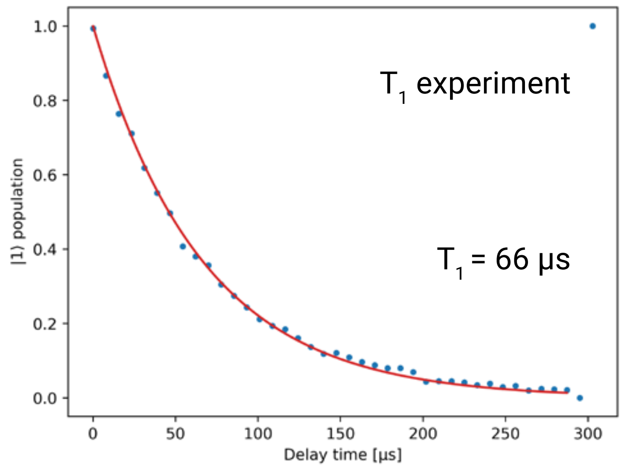


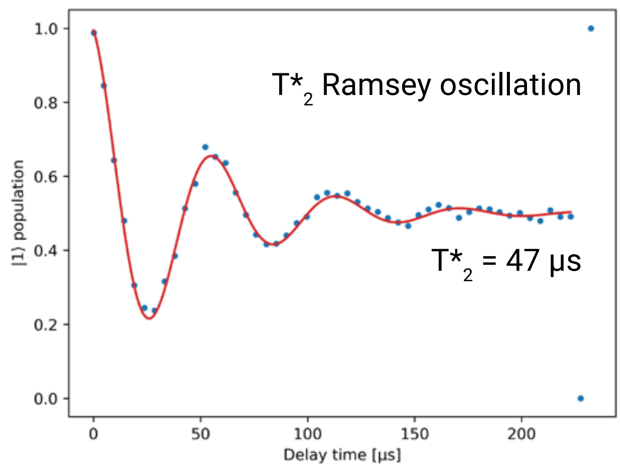
where the qubit frequency is swept while measuring the resonance frequency of the read-out resonator has been done. The result of this measurement is plotted in the graph below.

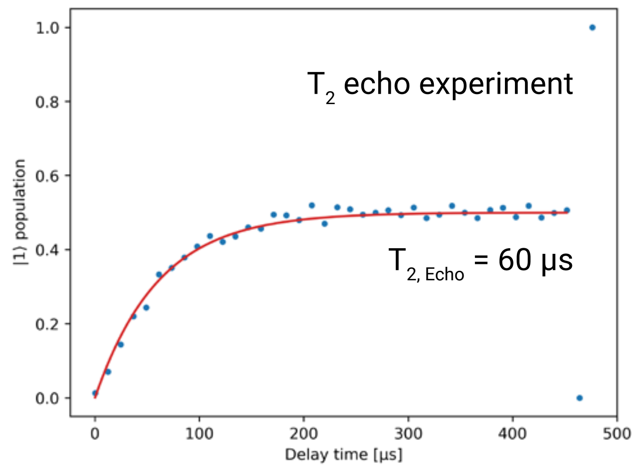


By adjusting the flux current it was possible to reach the expected sweet-spots for all qubits. When the optimal flux was chosen a Rabi scan was successfully performed.
The data acquired during qubit experiments is shown in the figures on the right side. The qubit lifetimes were determined to be T_1= 66 μs, T^*_2 = 47 μs and $T_{2,echo}$ = 60 μs.









Data plots credit: Arno Bargerbos, Senior Measurement Engineer at Quantware

These results show that the multichannel Cri/oFlex® platform does not limit the coherence of the transmon qubits below a value of 60 μs and can be used as an I/O platform with high scalability potential.

Compact size, low thermal load, integrated components, complete set of peripherals, and a user-friendly installation process make our I/O system the logical choice for mid-scale (below 1k qubit) systems with the potential to go beyond the 1k qubit figure.

Case Study

The first quantum computer in Spain

Qilimanjaro

Delft Circuits has built a long-term partnership with Qilimanjaro Quantum Tech company based in Barcelona, Spain to build the first quantum computer in Spain. The goal of the project is to install and validate quantum computing hardware and software at the Barcelona Supercomputing Center – Centro Nacional de Supercomputacion (BSC – CNS) as a part of the Quantum Spain initiative. This is a multi-year contract where Delft Circuits plays the role of a crucial supplier and service provider of the turnkey wiring solution.

The delivery consists of all microwave input lines for superconducting qubit control based on Cri/oFlex® technology, as well as output lines with necessary amplification and filtering. The end goal is to deploy a 30-qubit system at the BSC site. This will be the first-of-its-kind European high-performance computing (HPC) centre with access to the latest technology in superconducting circuits.

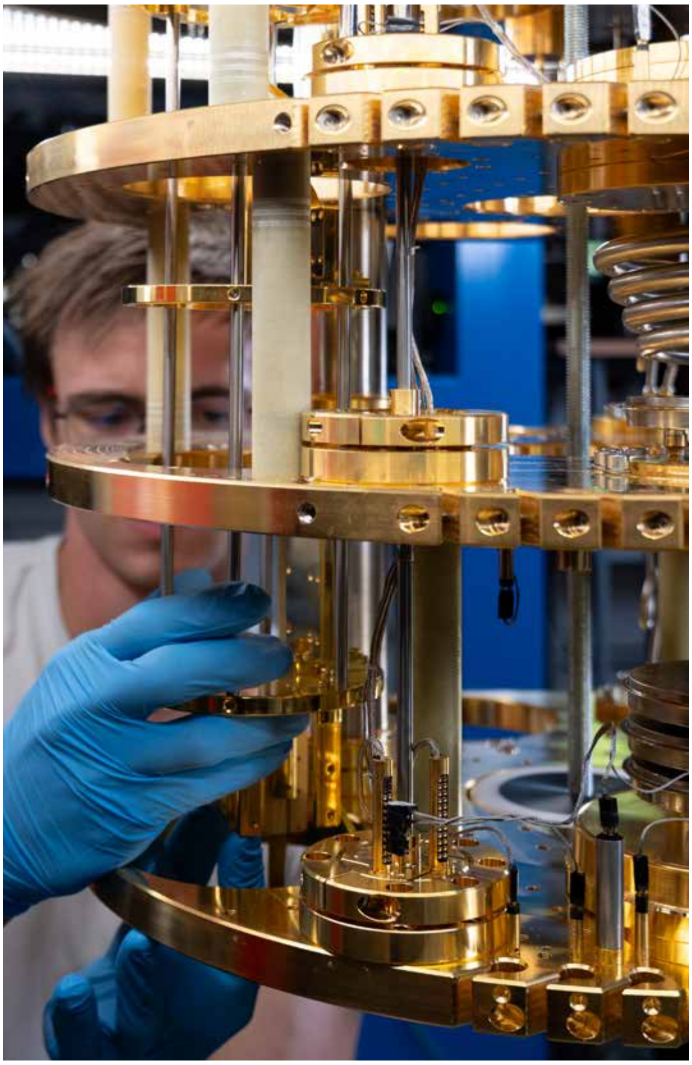
For the successful development of this quantum computer, the teams at Qilimanjaro responsible for hardware, control software, and quantum applications have been working in a fully integrated manner, and their success demonstrates the value of a full stack approach. The team of Delft Circuits engineers is facilitating our Spanish partners to achieve the goals. We provide fully integrated Cri/oFlex®-based microwave Drivelines, Flux Bias lines, Pump lines hardware and the design and installation service on site.

The success of the project is based on a deep interaction between vendors of cryogenic systems, qubit manufacture, and control electronics. The systems engineering team of Delft Circuits has developed a unique knowledge of system requirements and created products and services suitable for the end user. To achieve the ambitious goals of the project under strict deadlines, we work in close collaboration with the suppliers of critical components of the hardware units for quantum computers such as Leiden Cryogenics, Qblox, QuantWare and others.

The expertise built during this project is bringing valuable outcomes for accelerating the HPC-centric quantum computing applications.

“Delft Circuits is crucial in the ongoing construction of our 30-qubit system, demonstrating excellence in managing wiring requirements and designing seamlessly integrated mechanical components for the cryostat. The overall exceptional performance, including seamlessly integrated components and proactive problem-solving, is expected to significantly contribute to the success of the project. We are highly pleased with Delft Circuits' dedication and reliability, expressing eagerness for future collaborations due to their commitment to excellence and anticipated positive impact on our ongoing endeavour."

David Eslava Sabaté PhD
Quantum System Engineer Qilimanjaro Quantum Tech, S.L.



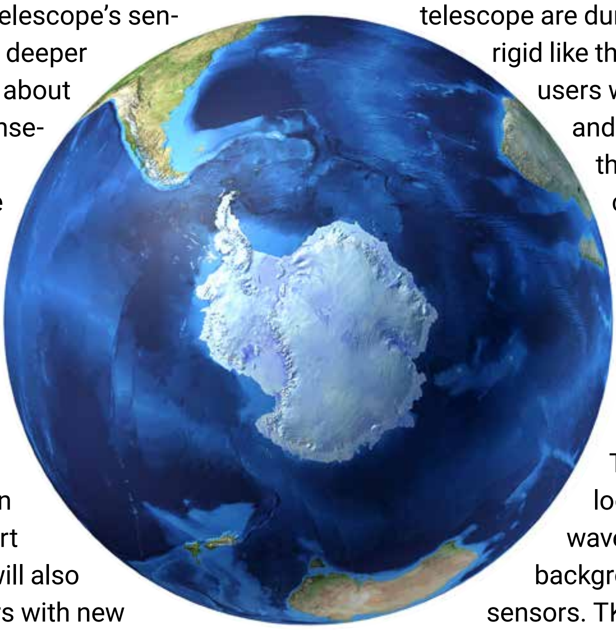
Case Study

BICEP Project in Antarctica for NASA

NASA

Delft Circuits Chosen by NASA JPL Scientists to Support BICEP Project in Antarctica

Delft Circuits proudly announces its inclusion in the BICEP project in Antarctica, supporting NASA's Jet Propulsion Laboratory (JPL) at CalTech and other project partners. The Background Imaging of Cosmic Extragalactic Polarization project (BICEP) has been ongoing for several years and is now seeking solutions for a hardware upgrade to its telescope's sensitivity as the project digs ever deeper into the cosmos to learn more about the origins of the universe. Consequently, a team at JPL is pioneering a new way to scale the number of detectors on the high optical frequency receivers of the telescope array.

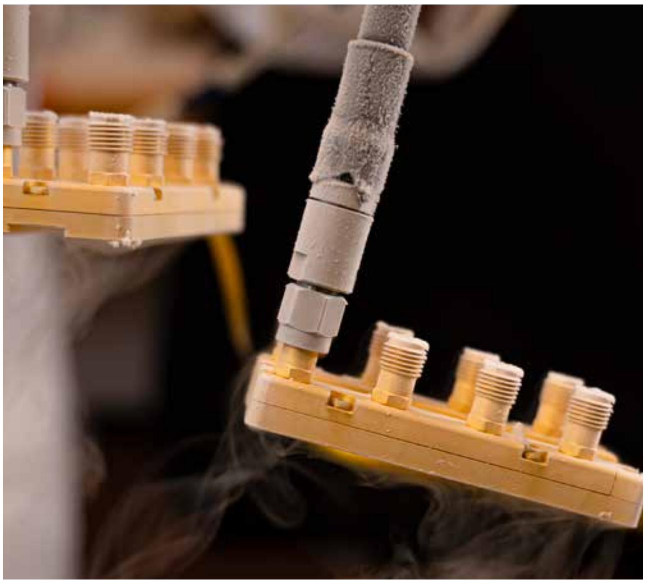


The team at the Jet Propulsion Lab has determined that advanced cables made by Delft Circuits will be installed in the telescope's cryostat, as part of its new camera. The team will also replace the telescope's sensors with new thermal kinetic inductance detectors (TKIDs), which are superconductive detectors leveraging the properties of quantum mechanics. The infrastructure requirements of TKIDs and the techniques used to measure them are extremely similar to what is required to set up and measure qubits in a quantum system. Once the new equipment is installed, the experiment will determine if the frequency multiplexing enabled by this new technology will allow for the necessary scaling of the telescope's detectors to greater sensitivities.

"I was very happy to find Delft Circuits, which was able to meet our stringent requirements for transmitting microwave frequencies, flexibility and cryogenic performance in a single cable. This makes my work considerably easier" said Lorenzo Minutolo of Caltech and NASA's Jet Propulsion Laboratory affiliate. "The cables perform well and remain flexible at any temperature. This is beneficial for us because they make it much simpler to assemble the hardware we need for this Antarctica upgrade. We can therefore devote more time and resources to other aspects of the experiment, which helps us reach our objectives faster and at a reduced expense."

The Cri/oFlex® multi-channel and RF cryogenic I/O cables which will be used inside the BICEP Array telescope are durable and flexible, rather than rigid like the alternative. This provides users with the opportunity to design and test multiple prototypes in their process while reusing the cables over and over for each different iteration. This had not been possible before, thus providing significant value for users both in terms of cost and setup time.

The BICEP Array telescope looks for traces of gravitational waves in the cosmic microwave background using transition edge sensors. TKIDs will replace those sensors, and their performance will be validated by comparing their results with existing maps produced using the old technology. The experiment will validate TKIDs as a viable technology for future missions.

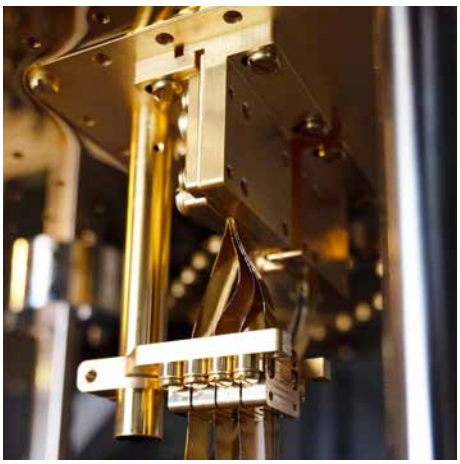


Our team

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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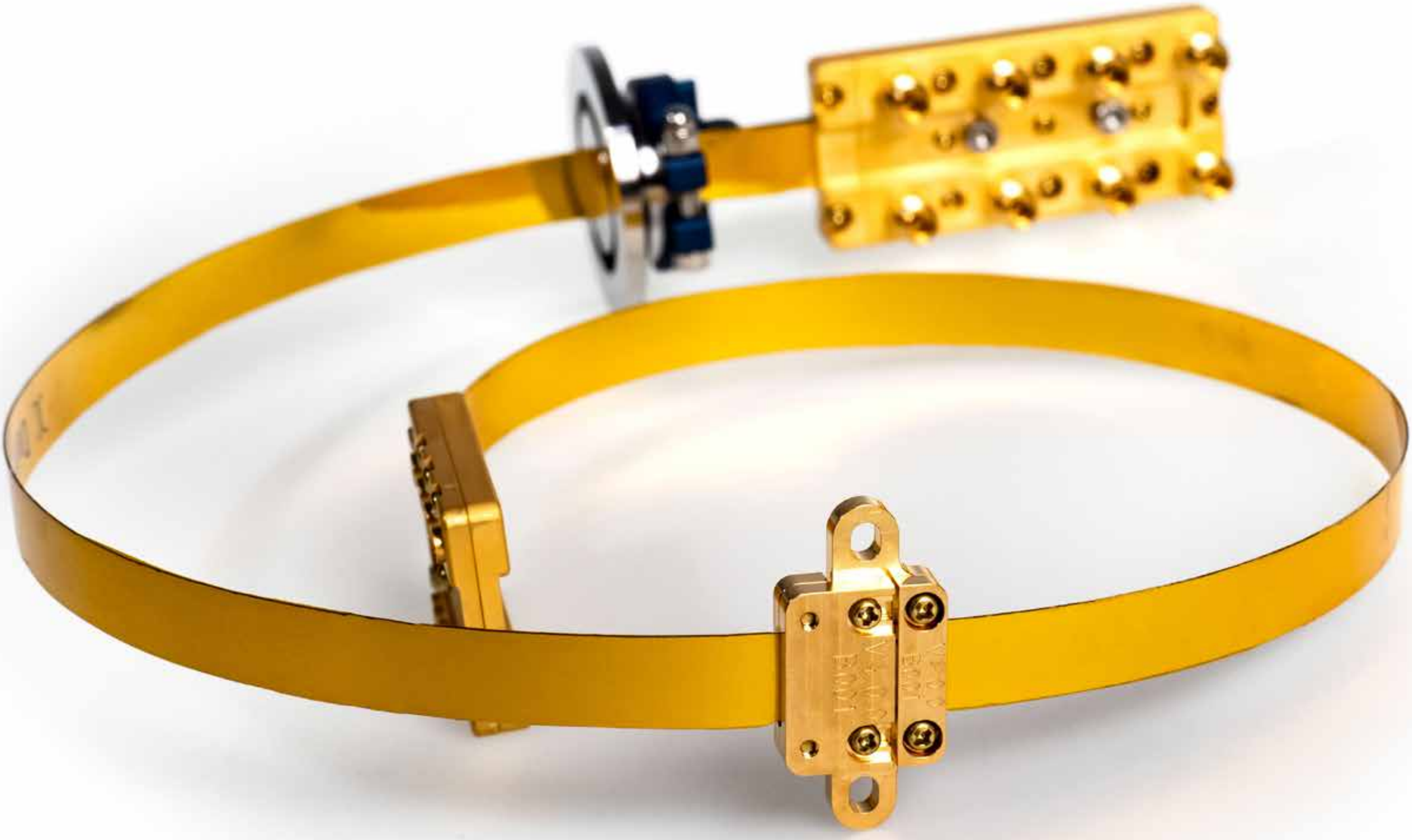

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