



SWTEST
2026 CONFERENCE

35th
ANNIVERSARY

Revolutionary Solutions for Cryogenic On-Wafer Test

CELADONTM
A Wholly Owned Subsidiary of **MPI** CORPORATION

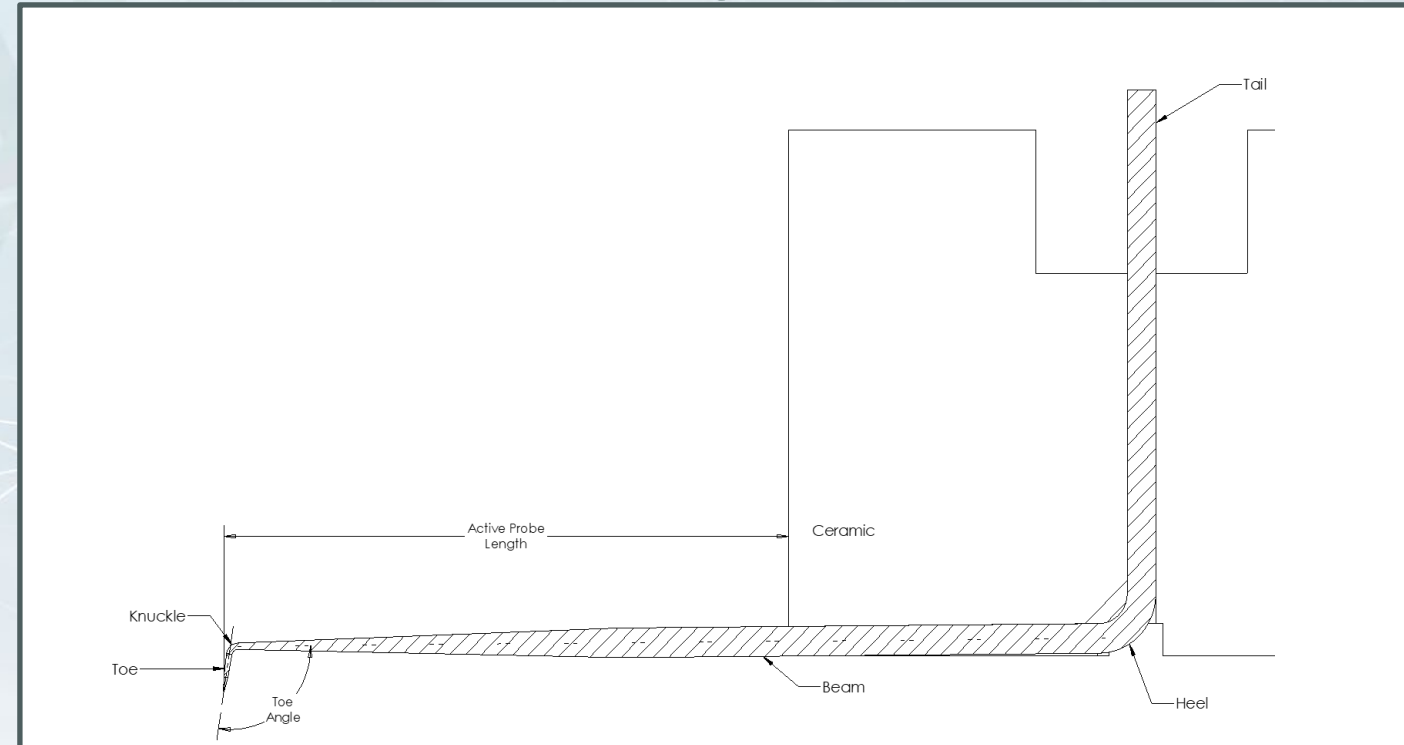
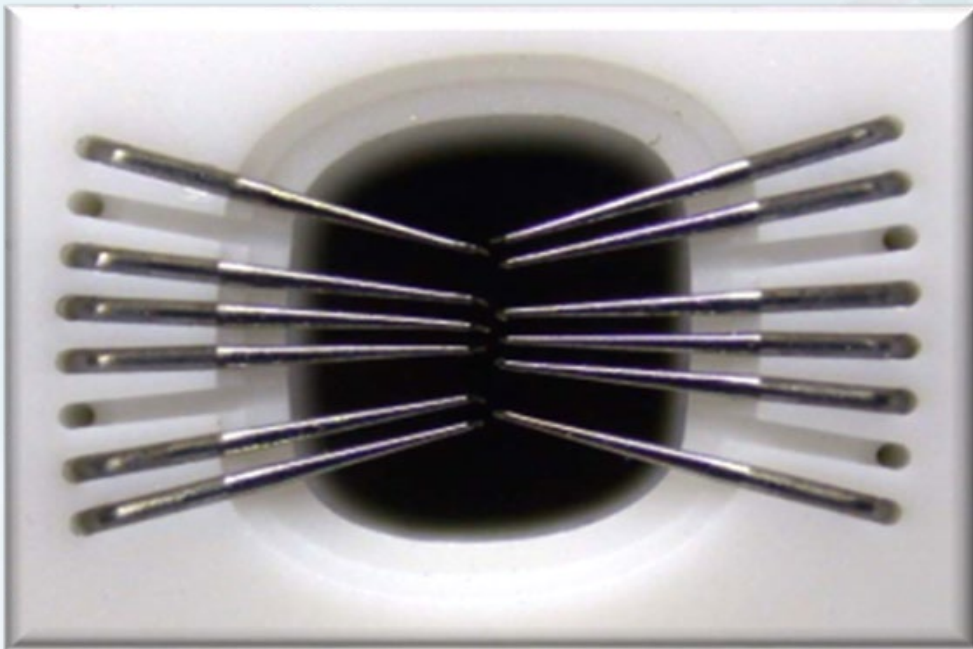
Garrett Tranquillo
Celadon Systems, Inc.

Who is Celadon

- **High performance probe card supplier based in Burnsville, MN**
 - Founded in 1997, and acquired by MPI Corporation in 2021
 - Core competencies: probe cards, cables, and mechanical interfaces
 - ISO Certified and CMMC Level 2 Compliant
- **What is Celadon known for?**
 - Long probe lifetime with accurate measurements
 - Extreme temperature capability [quantum cryo → 600C+] using out ceramic
 - Customizable solutions for advanced applications

Core Technology

- **Celadon uses a hybrid vertical probe technology embedded in a ceramic substrate.**
 - The ceramic used allows us to make probe cards for cryogenic applications. It is low outgassing [per ASTM E 595-07 standards], and has a CTE match to silicon allowing for a wide temperature operating range.



Industry Challenge

- **Growing demand for cryogenic testing**
 - Rapid growth in multiple areas
 - Quantum bit (qbit) development
 - Infrared focal plane arrays
 - Superconducting material characterization
 - Increasing need for on-wafer validation and characterization
 - Existing probing solutions can create barriers for many labs and development teams



Pain Points with Existing Solutions

- **Technical Challenges**

- Shrinking test pads
- Wire bonding [cost and lead-time]
- Complex pad geometries
- Thermal stability
- Large device planarity

- **Operational Challenges**

- High capital equipment cost
- Significant infrastructure requirements
- Large system footprint

What is the Merlin™

- **A Flexible Cryostat-Based Alternative**

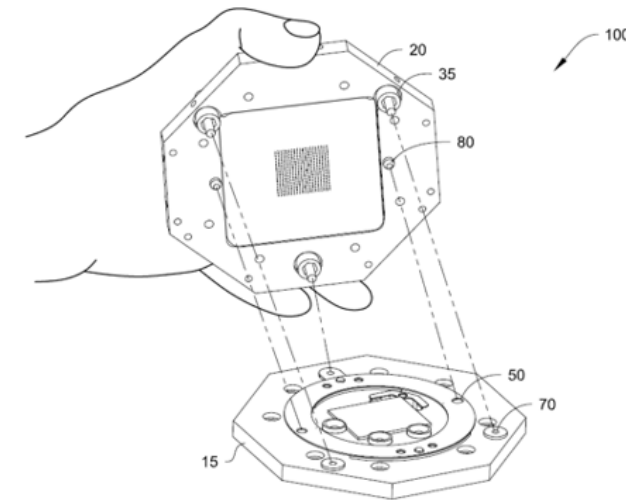
- Merlin™ eliminates the need for a full cryogenic wafer prober for many applications
- Optimized for
 - Low to medium throughput environments
 - R&D Labs
- While Merlin™
 - Lower cost of entry
 - Simplified infrastructure requirements
 - High customization capability



History

- **Development was driven by customer need**
 - Had to test a 4 Kelvin superconducting device but did not have a cryogenic wafer prober
 - Had to test hundreds of signals in a Montana S200 cryostat [therefore no moving chuck]

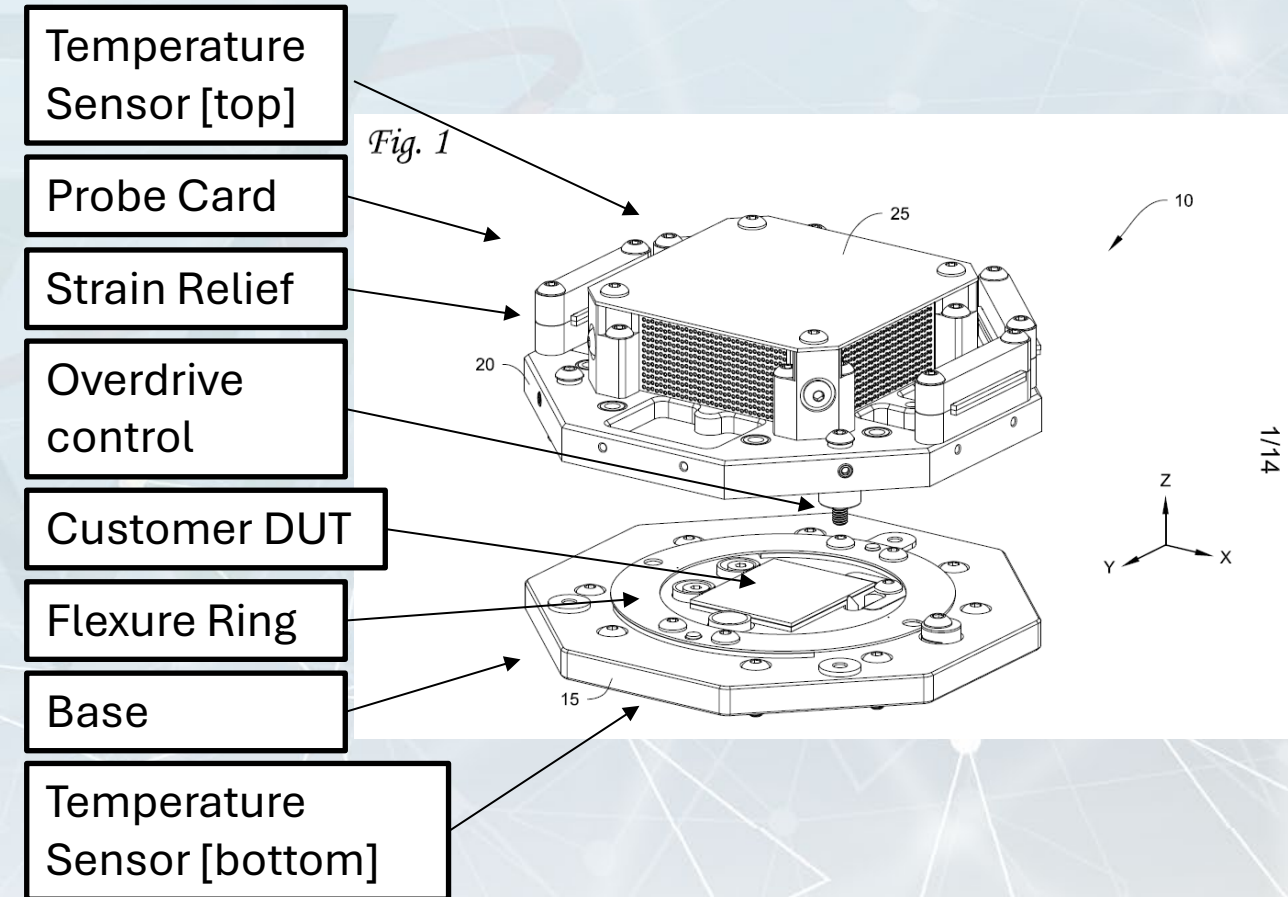
Fig. 9A



Original Solution

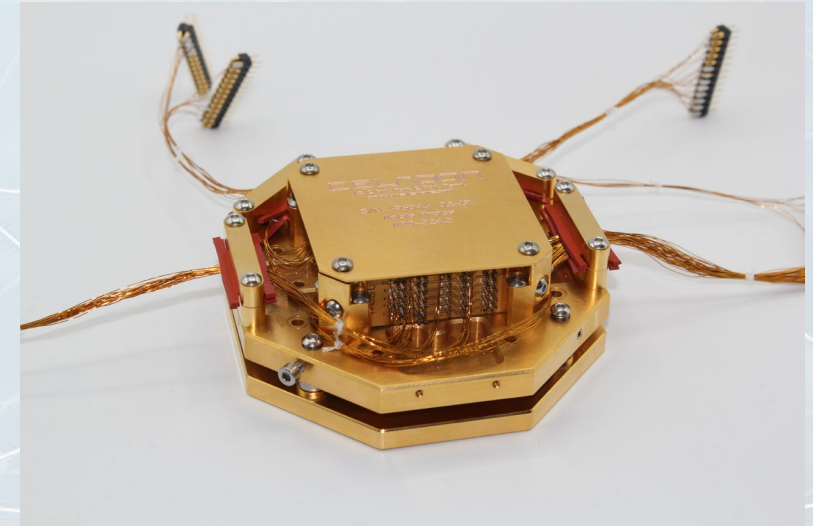
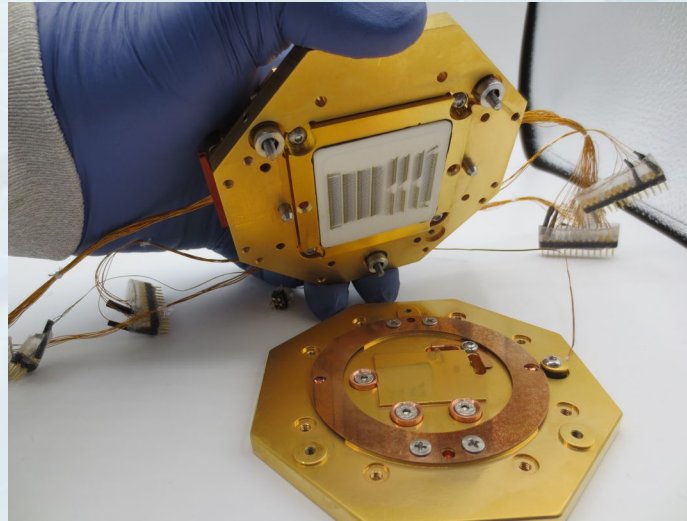
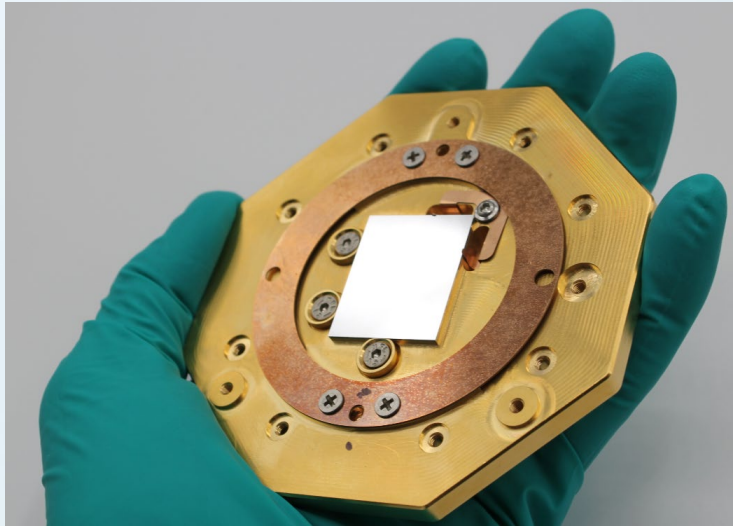
- **Aligning:**

- It was determined that through the precise machining, kinematic mounting system, customer kerf error during wafer cutting, that the aligning was not required for this application.



Completed Assembly

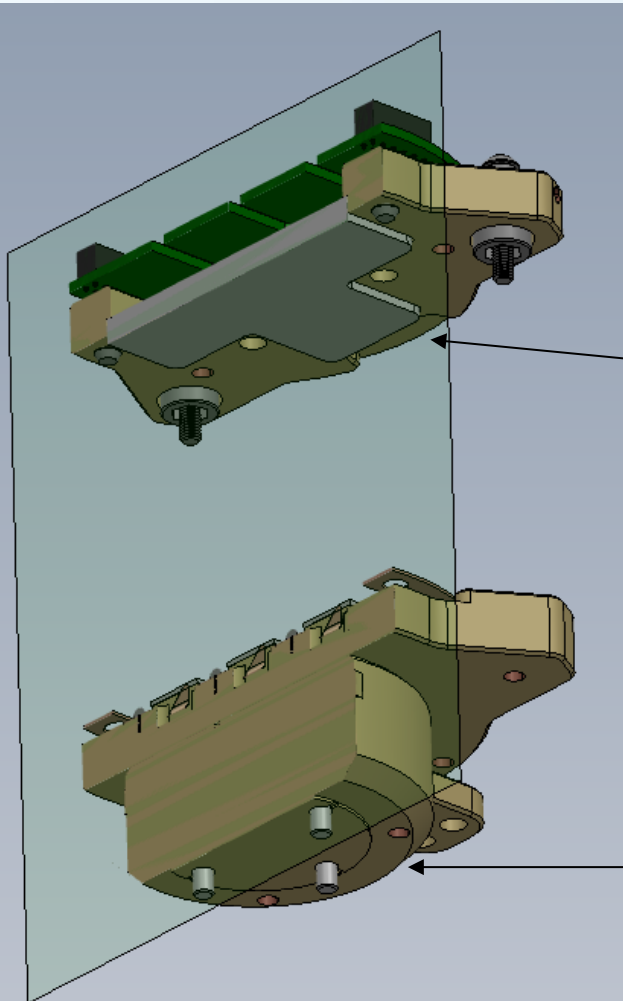
- System was successfully deployed and added thermal mass of probe system had minimal impact on cooling time.



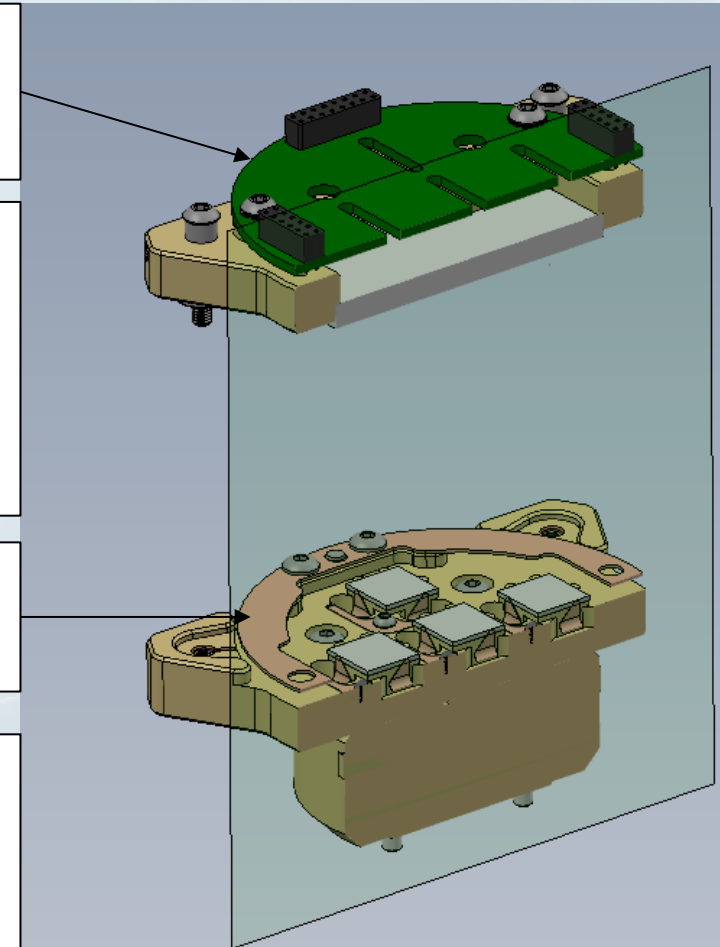
What happened next?

- **New customer requirement needing to test 5 die at the same time in a Montana S100 cryostat.**
 - 4 Kelvin application
 - 800µm square pads [no aligning features needed]
 - 100mm opening inside radiation shield [half the size of project 1]
 - Test 5 die simultaneously for increased throughput
- **How to remake the Merlin™ for this application?**

Merlin™ – what can be customized?

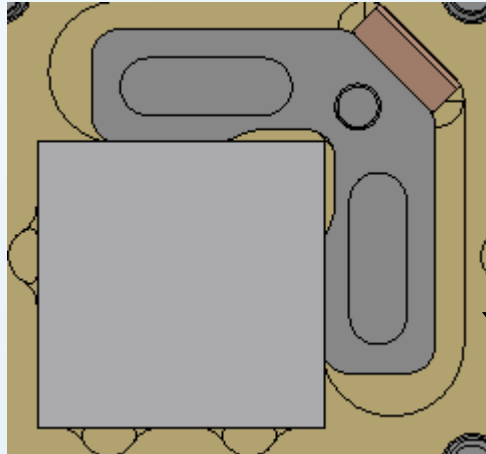


- **PROBE TERMINATION:** Each new MobileProbe will need a new PCB, with probes terminating to via to reduce the need for wired harnesses etc.
- **CERAMIC SIZE:** Determined by # of probes and die shape
- **CERAMIC MOUNTING:** This will be determined by customer **Pad Size [400µm+ does not need aligning features]**
- **FLEXURE PLATE:** The geometry of this will be determined by the overall size of the system.
- **BASE PLATE:** The geometry of this component will be determined by the:
 - Cryostat
 - Customer Die



Merlin™ - what can't [or shouldn't] we change?

35th
ANNIVERSARY



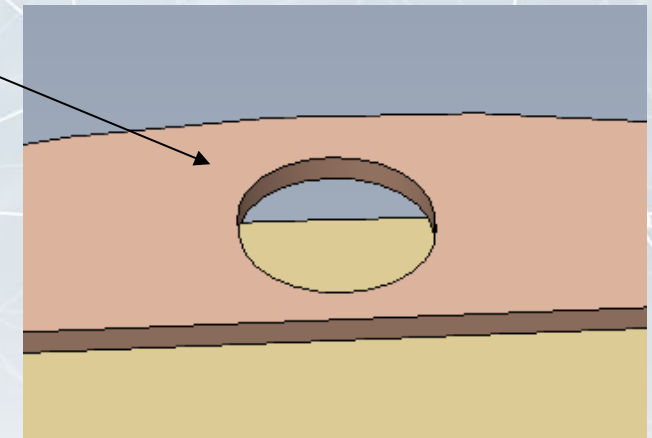
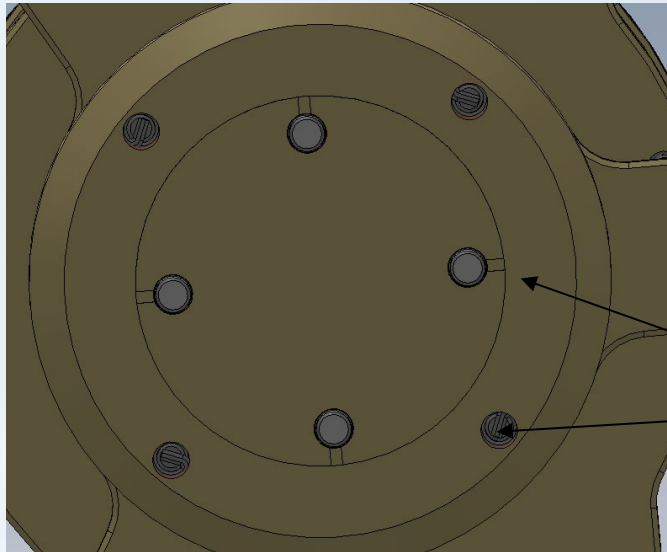
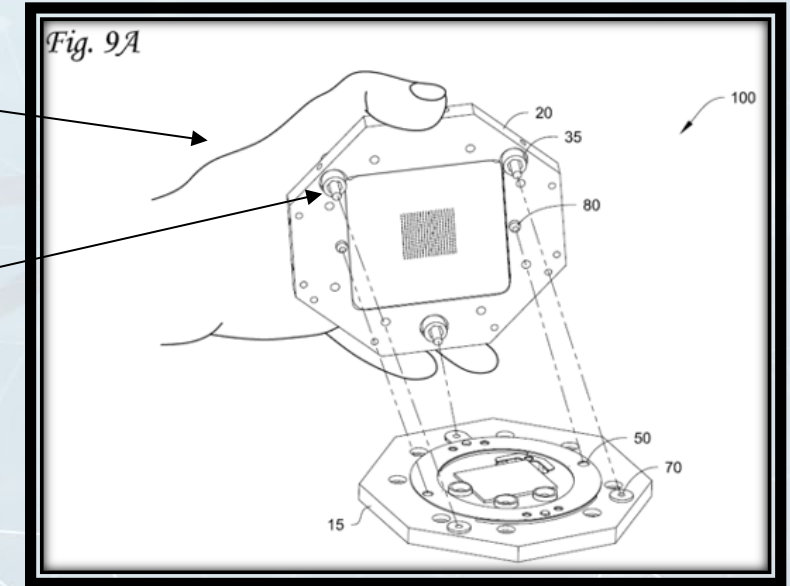
- Core technology, kinematic mounting

- Overdrive control stop

- Chip / DUT Mounting

- Tapered pin to flexure technology

- Venting features [required for vacuum]



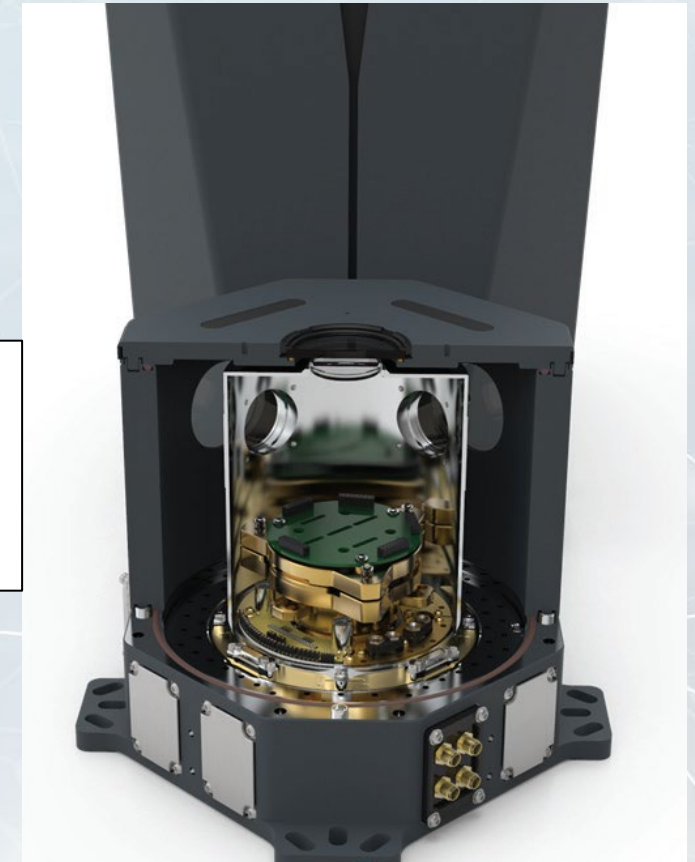
Partnership with Montana Instruments

35th
ANNIVERSARY

- During project 2, Celadon and Montana Instruments formed a close partnership to ensure we could be successful in this smaller footprint.

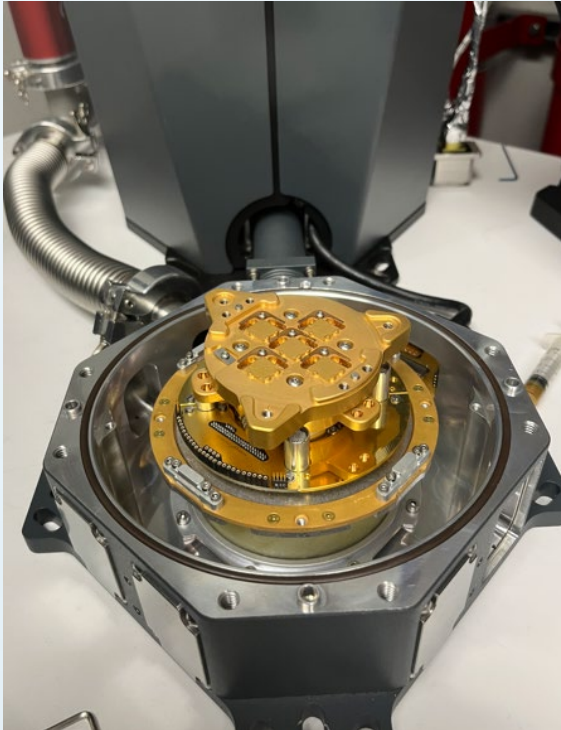


Pictured: Montana CryoAdvance 100 and Celadon Merlin™

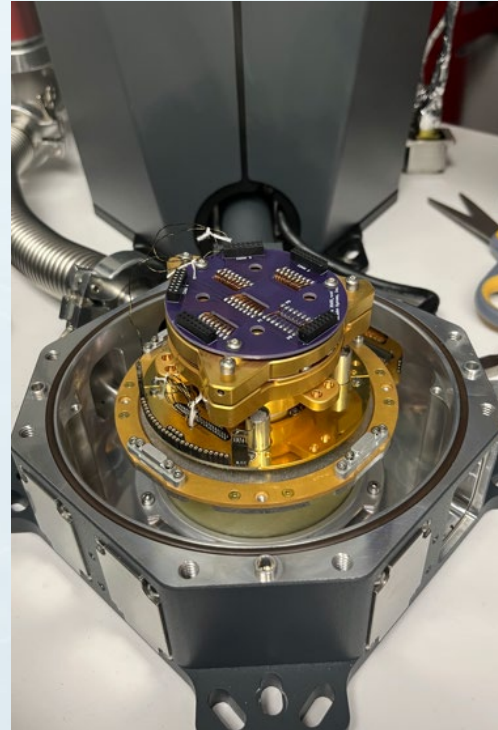


MONTANA INSTRUMENTS®
COLD SCIENCE MADE **SIMPLE**

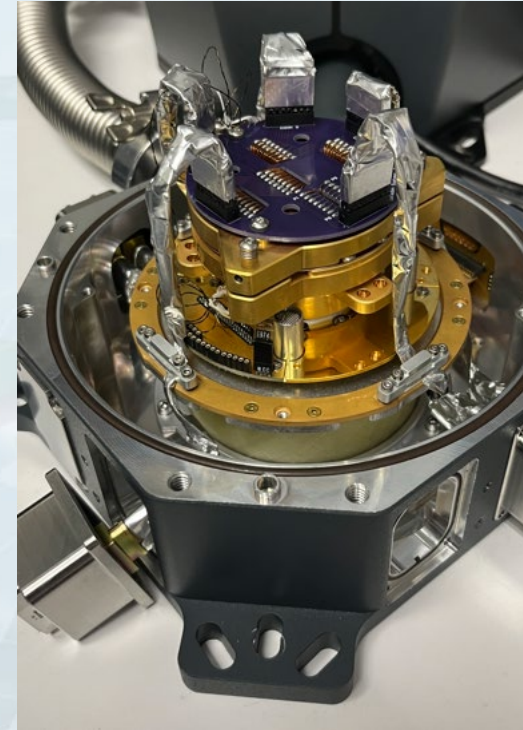
Installation and Setup



Merlin™ base plate
installed on 4K stage of
CryoAdvance 100



DUT Installed and
Probe Card
Assembled



Cables installed and
mounted to thermal
connection points



Fully Installed and
under vacuum

Next Generation Merlin™

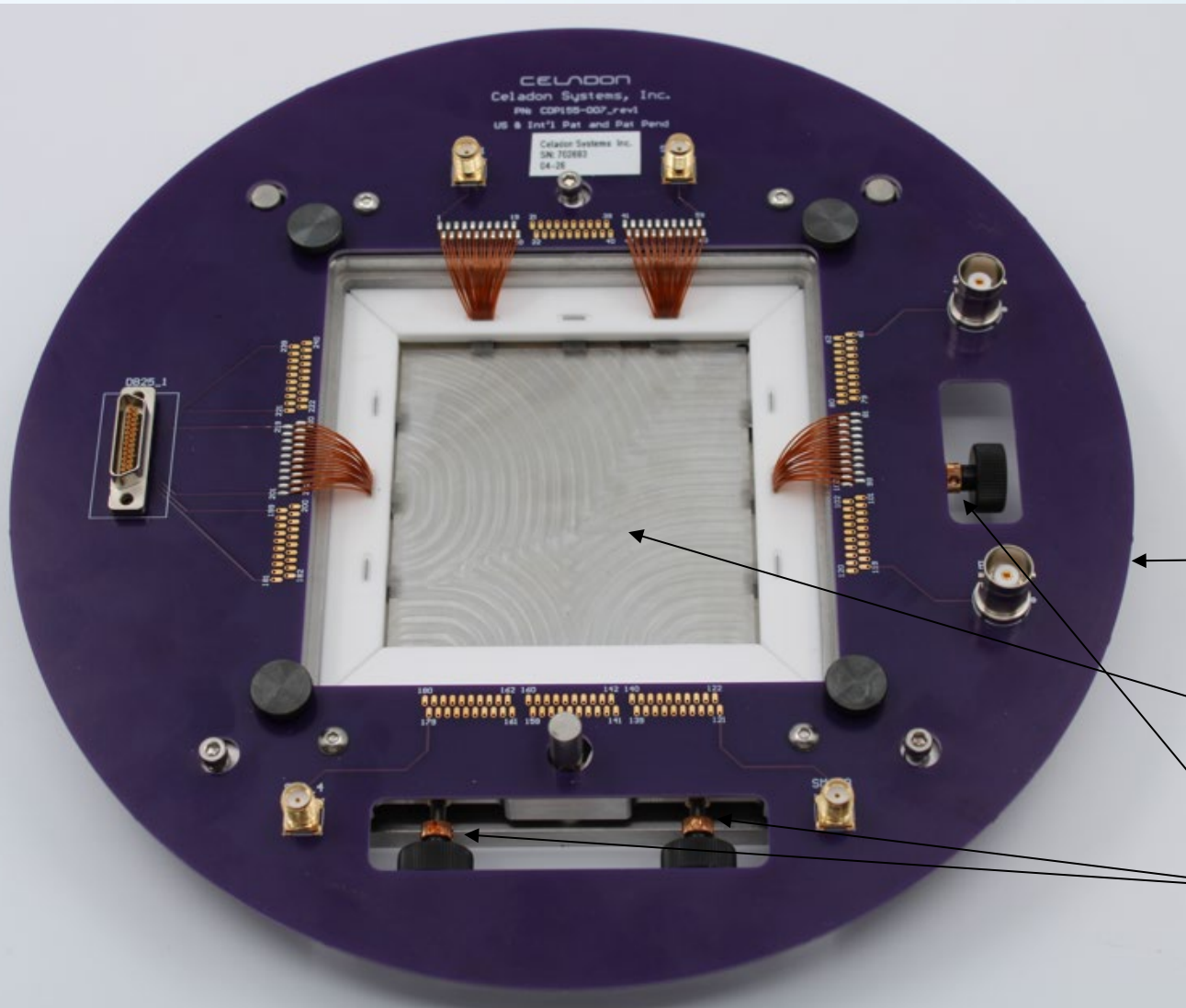
- **Multiple customers testing infrared Focal Plane Arrays were interested in the MobileProbe for 77 Kelvin testing**
 - Why?
 - Pads getting smaller
 - Die getting larger
 - Optical requirements
 - Utilization of dilution refrigerators and cryostats
 - High repair cost of existing probe cards
- **How can we fix this with Merlin™?**

FPA Optimized Merlin™

- **What changed?**

- **Size:** the actual FPA die could be as large as the previous projects. Needed to get bigger
- **Ceramic “Quadrant Style”:** Historically when building cards we utilized a single ceramic. Damaged probes? We had to replace the whole ceramic and probe assembly.
- **Optical Access:** Both for FPA testing [it’s a functional test] and pad alignment we needed to open the center of the assembly.
- **Probe Tip Alignment:** We needed to be able to align the probe head assembly to hit smaller pads [anything under 400µm].

FPA Merlin™ Prototype [Top]



Requirements:

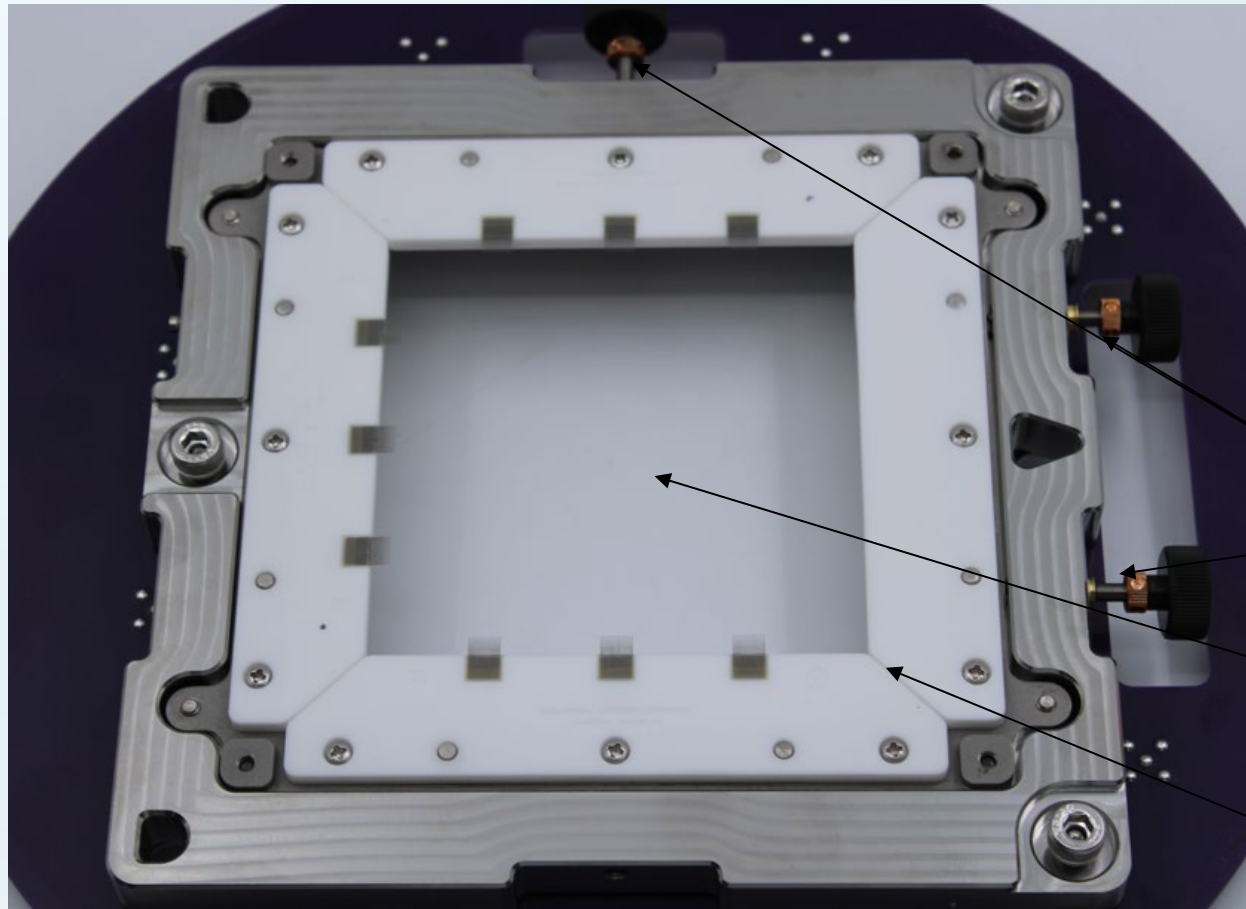
- Top-Down Alignment
- Accommodate die up to 70x70mm
- Accommodate up to 1,250 probes [min pitch 50µm / layout dependent]
- Functional Temperature: 77K
- Minimum Pad Size: 75µm

≈9inØ PCB allows for active component placement

Top-Down Optical Access

Precision Alignment Access Points

FPA Merlin™ Prototype [Top – Tester Side]



Requirements:

- Quadrant solution for repairability
- Ability to move probe head for fine alignment
- $\pm 500\mu\text{m}$ movement in X and Y

Fine pitch alignment
control

Top-Down Optical
Access

Utilizes 4 ceramics so we
can repair “sub
assemblies”

Why Merlin™

- **Merlin™**

- Lower capital cost
- Reduced facility requirements
- Modular, highly customizable
- Ideal for Lab / R&D use
- Compact cryostat-based approach
- Shorter lead time [12-18 weeks]

- **Traditional Cryogenic Wafer Prober**

- High capital cost
- Extensive infrastructure
- Less flexible to R and D customization
- Optimized for production throughput
- Full wafer prober platform
- Longer lead time

Future Work

- **Verify compatibility with new Montana RapidCycle 100 EC**
 - 100mmØ sample area 75mW
 - <4.2 K
 - **<1 Hour Cooldown!**
 - Need to complete vibration testing to ensure the new cooling system doesn't affect the probe to wafer interaction
- **Add the aligning features to a smaller footprint**
 - We aim to have the alignment capability in a 100mm footprint
 - Verify precision of alignment and determine if we can accommodate smaller pad sizes.
- **Mixed Signal**
 - We aim to integrate mixed signal capability including
 - DC
 - RF
 - Optical



Key Takeaways

- **Celadon is known for customizable solutions.**
 - The Merlin™ emphasizes Celadon's ability to take advanced requirements and demonstrate innovative solutions to unique problems.
 - The Merlin™ is a highly adaptable cryogenic probing platform designed to test on-wafer inside a cryostat, providing a highly customizable test vehicle with a lower cost of entry than full wafer probing solutions.