Testing of Chips Used for Artificial Intelligence

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Agenda

Artificial Intelligence Evolution and Market Space

- Why AI Today
- AI Market Size

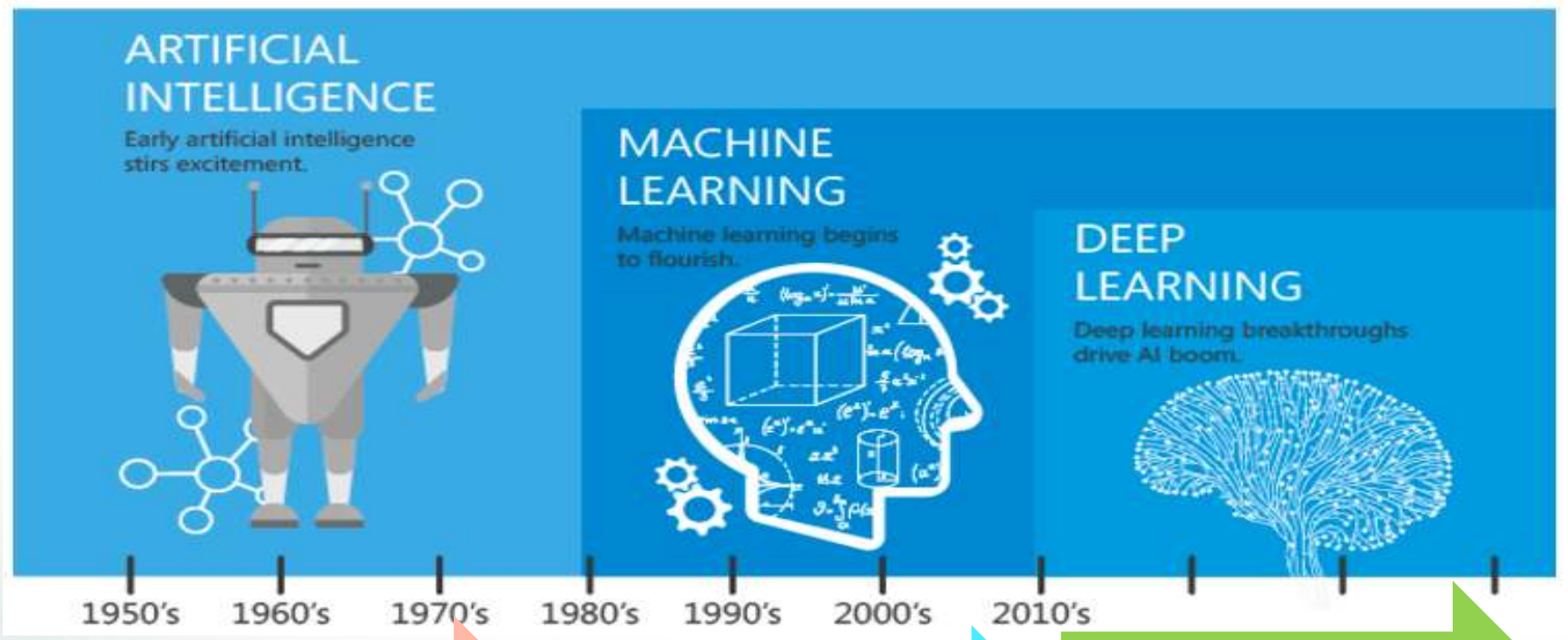
AI IC Testing Requirements

Probe Card Solution to Meet AI IC Testing Requirement

- Probe Solution: MF130 Flat tip Probe
- Space Transformer Solution: Custom MLO and V93K DD PCB

Conclusion, Future Development Direction

Artificial Intelligence Evolution



AI By Simple Mathematical Modeling

Building Complex Modeling

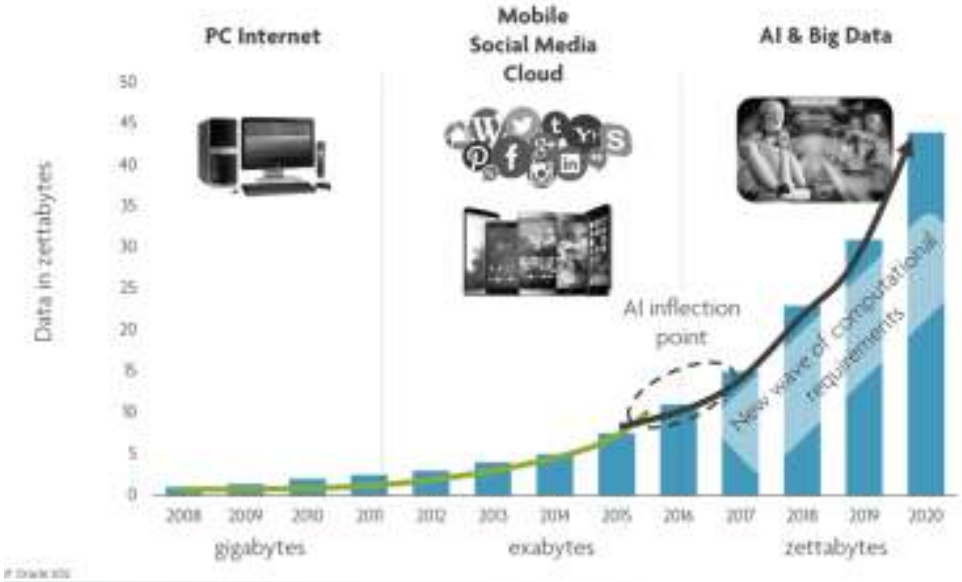
Building and Improve Complex Modeling by data

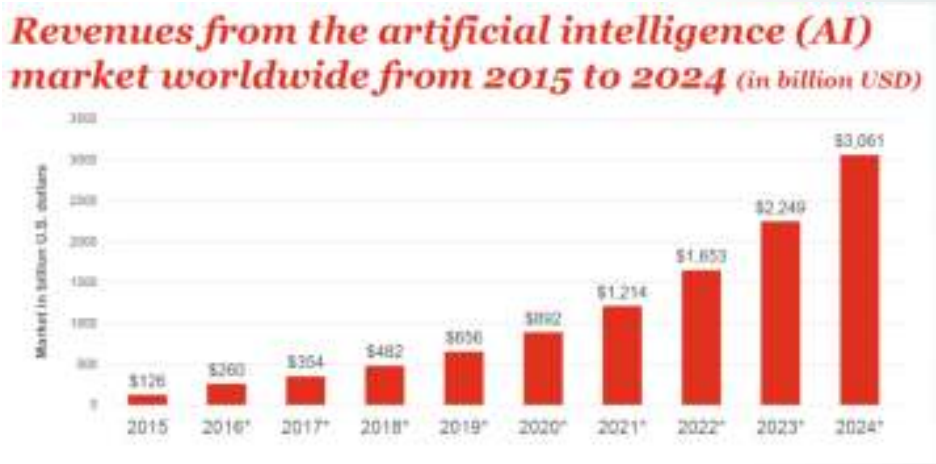
Technologies Enable Alpha-Go Won Go Game

- Go Game 围棋 바둑 囲碁
  - This game was invent in China 2500 year ago
  - Much more complex game compare to Chess
    - Larger board: 19x19 grid total 10171 potentiate moves
    - Lower bound on # of legal board position est. to be $2x10^{170}$
  - 2015 Alpha Go won 4:1 against to Prof. 9-Dan Player
  - 2017 Alpha GO won 3:0 against to world 1st Player

- What Enabled Alpha-Go to Win
  - Big Data Pool:
    - Provided data of more than 30M moves by player
    - Instantly training 494 matches with computer
  - Huge Computing Power:
    - 1920 CPUs and 280 GPUs

AI closely coupled with data-centers – that is where the data resides





Source:Price Waterhouse Semicon West 2018

Source:IMEC Semicon West 2018

Intelligence Processing Unit

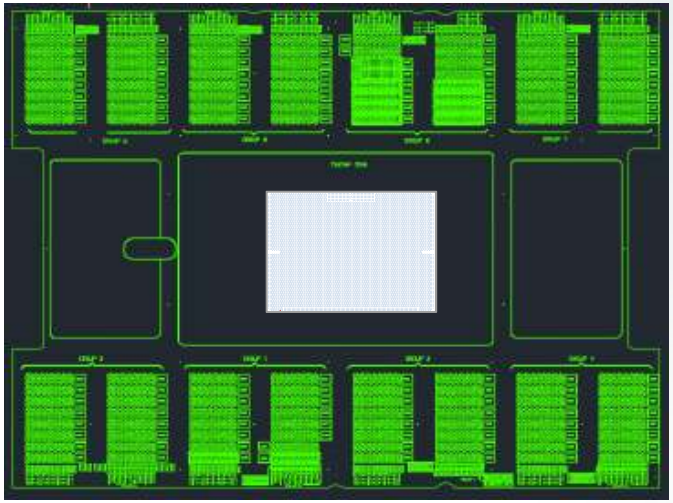
Design Details

- 9056 probes capable upgrade to 13112 PH

  166um pitch CuP with solder cap
- 93K DD Tester Platform
- Dual Temp test -25C to 125C

Testing Challenge

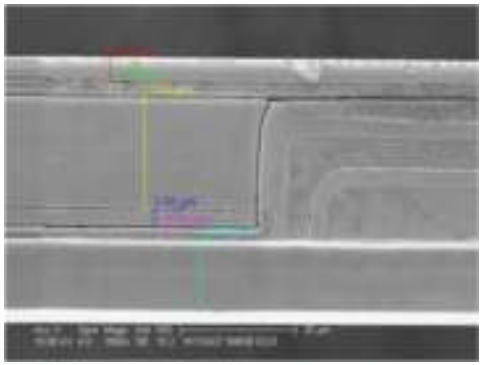
- Protect PC from Bad Die: 1.5A Current Protection
- Dual temp probing performance



MEMS Fabricated Vertical Probe:
High Current, Low Force

Offer Unique Capability Meet AI IC Testing Requirements:

- Highest current protection capability <130um: **1.5A**/probe CCC, **1.2A**/probe MAC
- Low probe force on large pitch probe, **<3g** at production OT/ probe
- **Low CRES**, "**No float**" architecture for contact stability and thermal agility over wide temperature range
- **HVM Capability**, Machine-assembled probe head for high throughput and superior quality, >30k pins per card



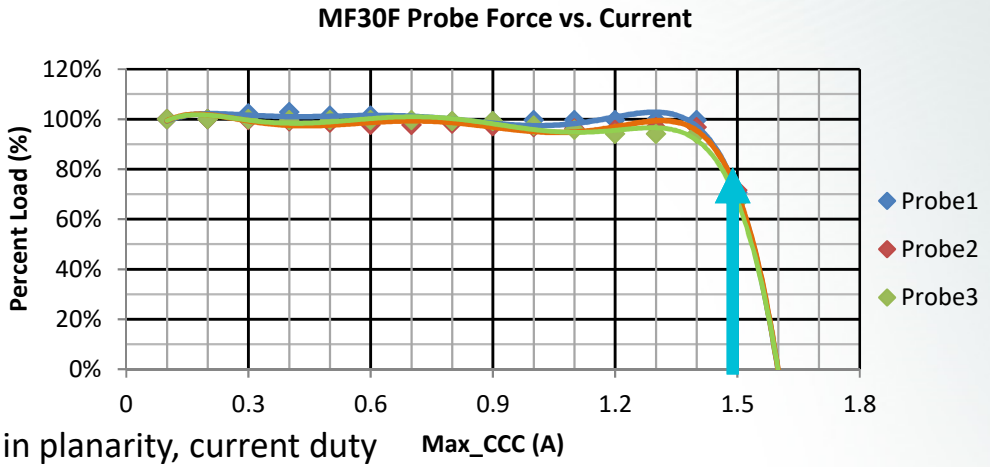
Composite MEMS Probe with different materials, at different locations, with micron-level precision

80um Pitch Grid-array
MEMS Probe Head
30k pins, X8

Current Protection Case Study: MF130

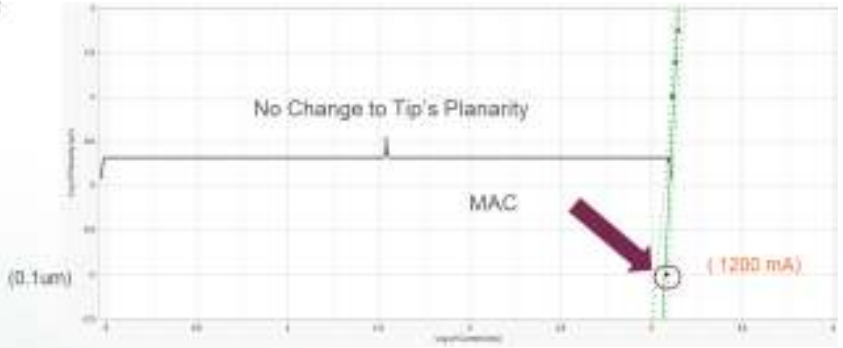
Current Carrying Capacity (CCC)

- ISMI CCC: **1.5A**
- ISMI CCC is the current where the spring force is reduced by 20%, current duty cycle 2min on and 2min off



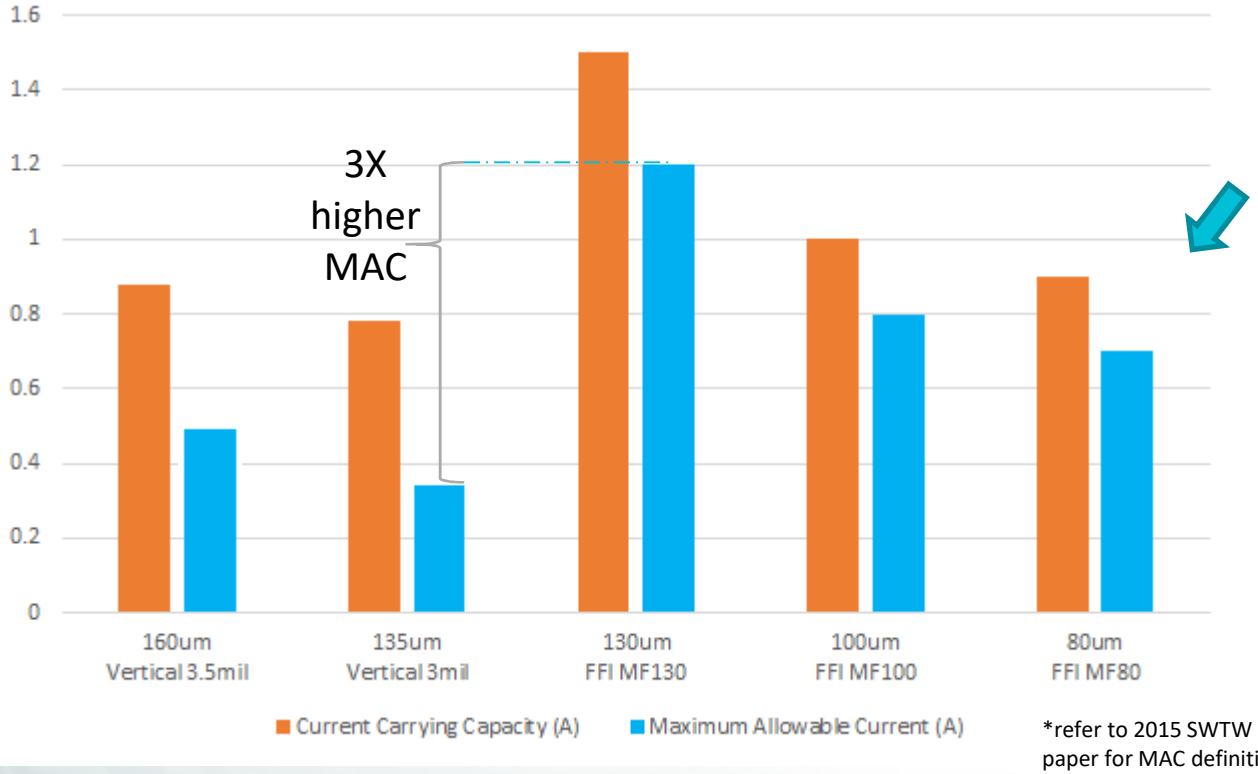
Maximum Allowable Current (MAC)

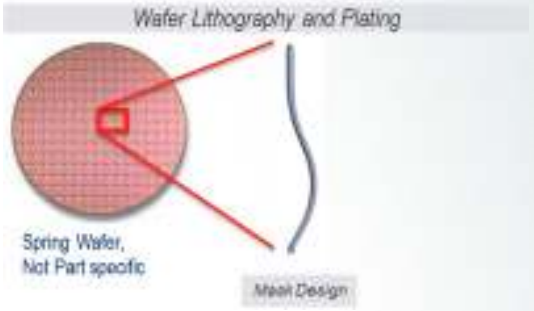
- MAC: **1.2A**
- Calculated current associated with a 0.1um change in planarity, current duty cycle 1min on and 1sec off



MEMS Probe Provides 3x Current Protection

Protect Probe Card from bad die



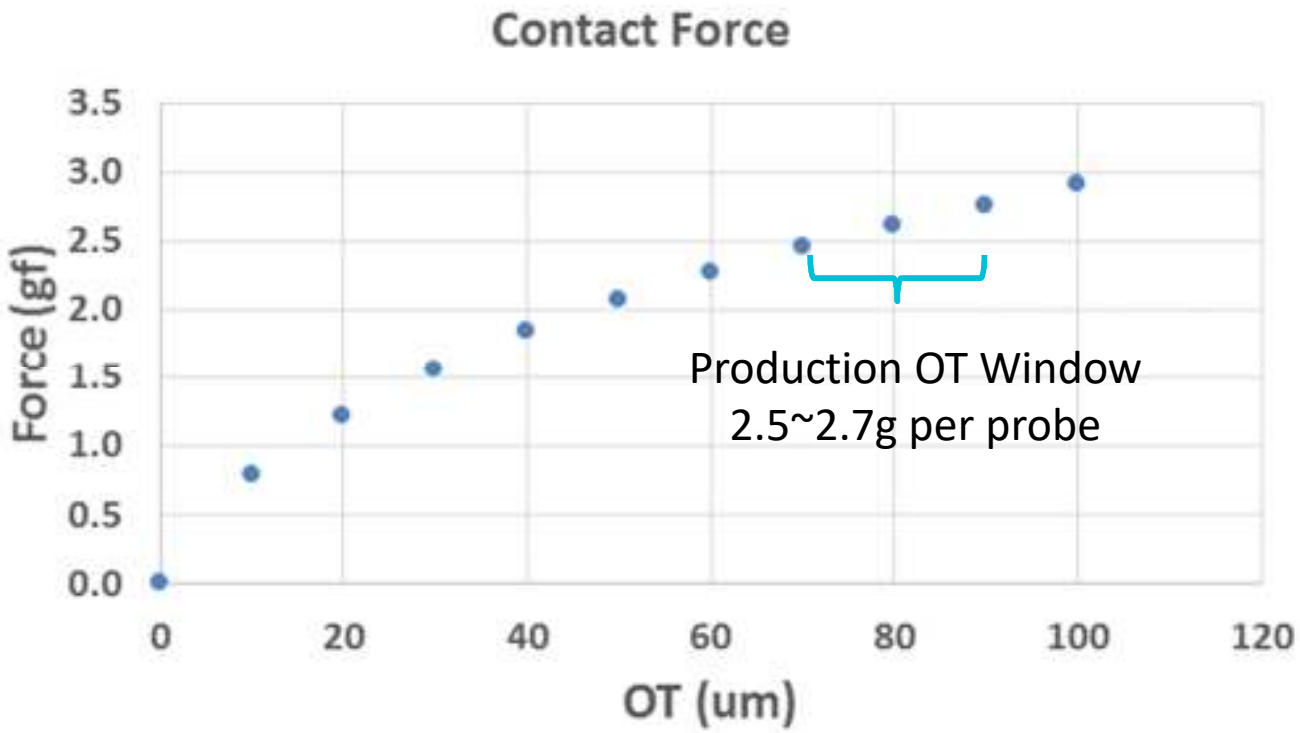


MEMS process enable composite probe body achieve higher MAC

*refer to 2015 SWTW paper for MAC definition

MF130F Low Contact Force MEMS Probe

Capability to Support High Pin Count Designs



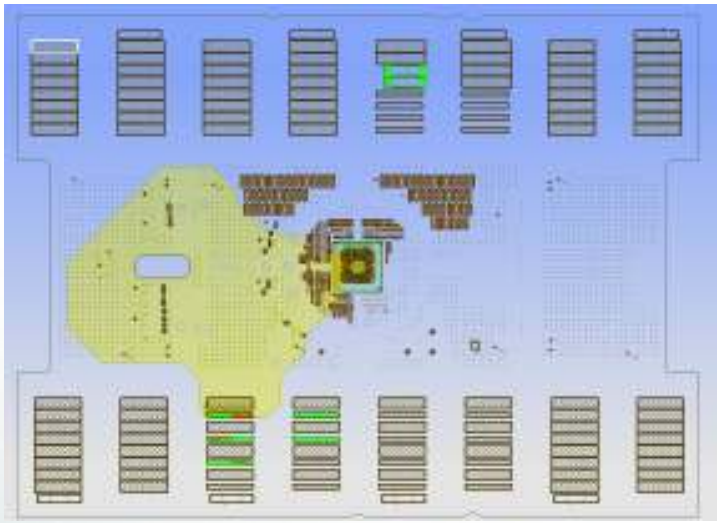
Imagine 30K Probe Count Total Force:

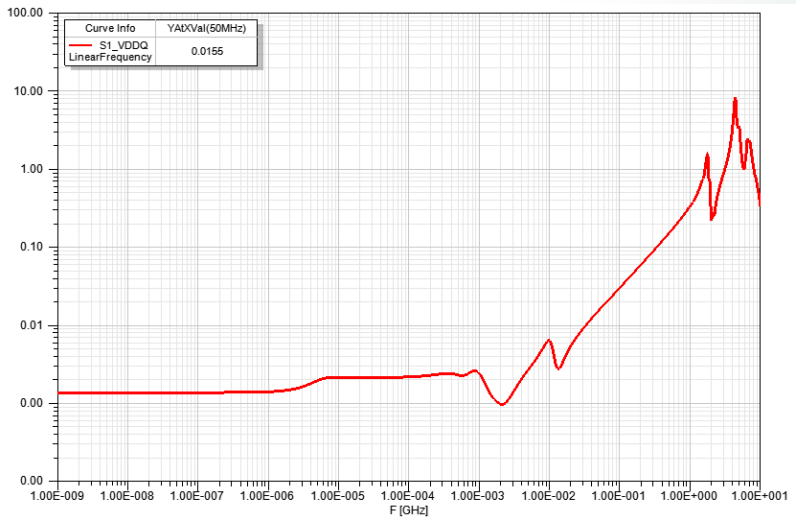
3mil Cobra ~10g ->300Kg

Reach prober limitation

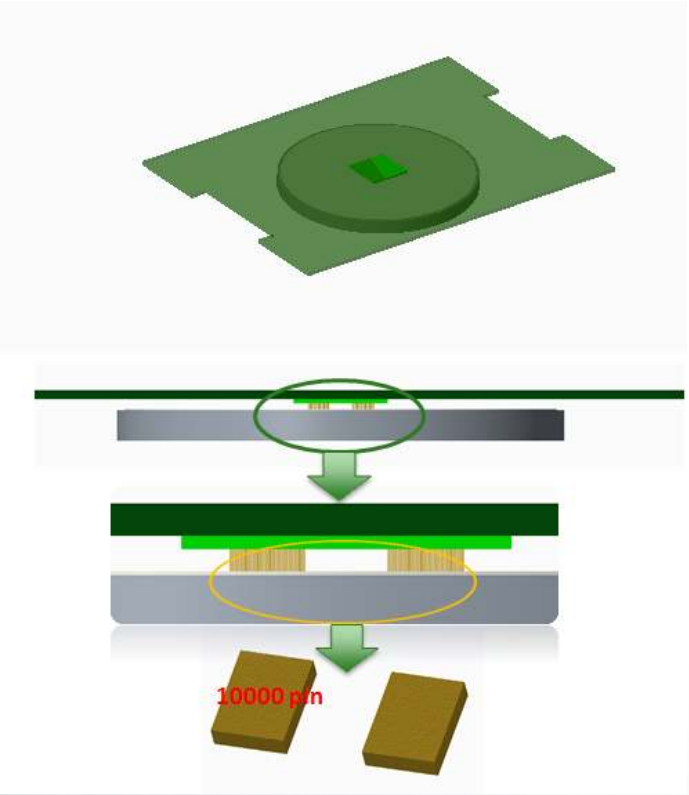
MF130 MEMS: ~3g -> 90Kg

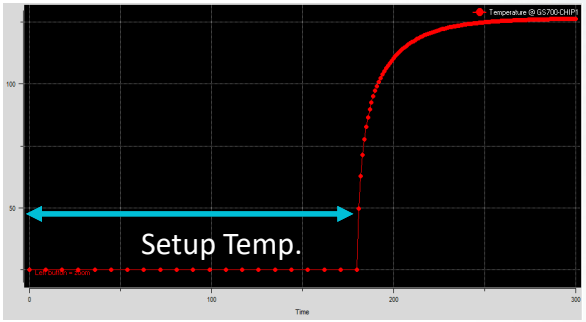
Space Transformer Solution: Custom MLO and V93K DD PCB - PI Analysis

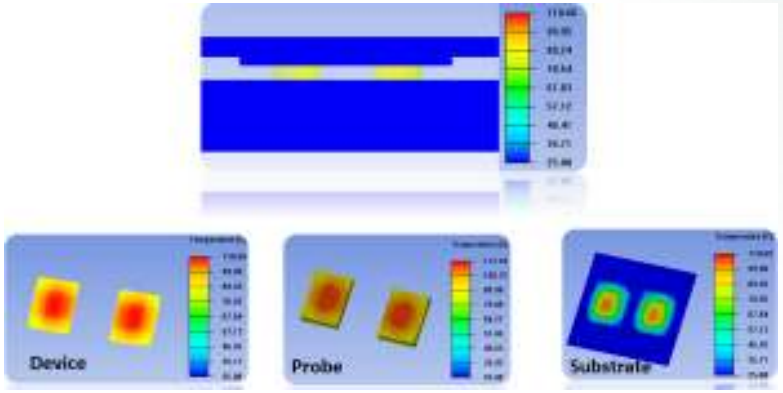




Space Transformer Solution: Custom MLO and V93K DD PCB - Thermal Analysis

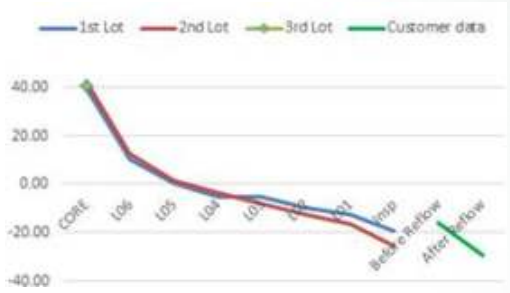




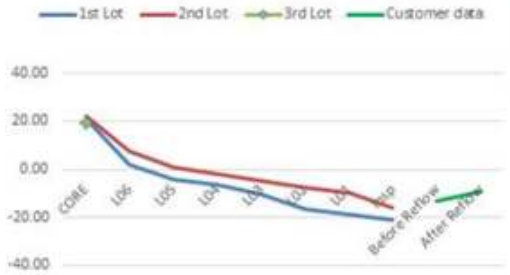


Space Transformer Solution: Custom MLO and V93K DD PCB
- pad shrunk analysis of Substrate pad shrunk

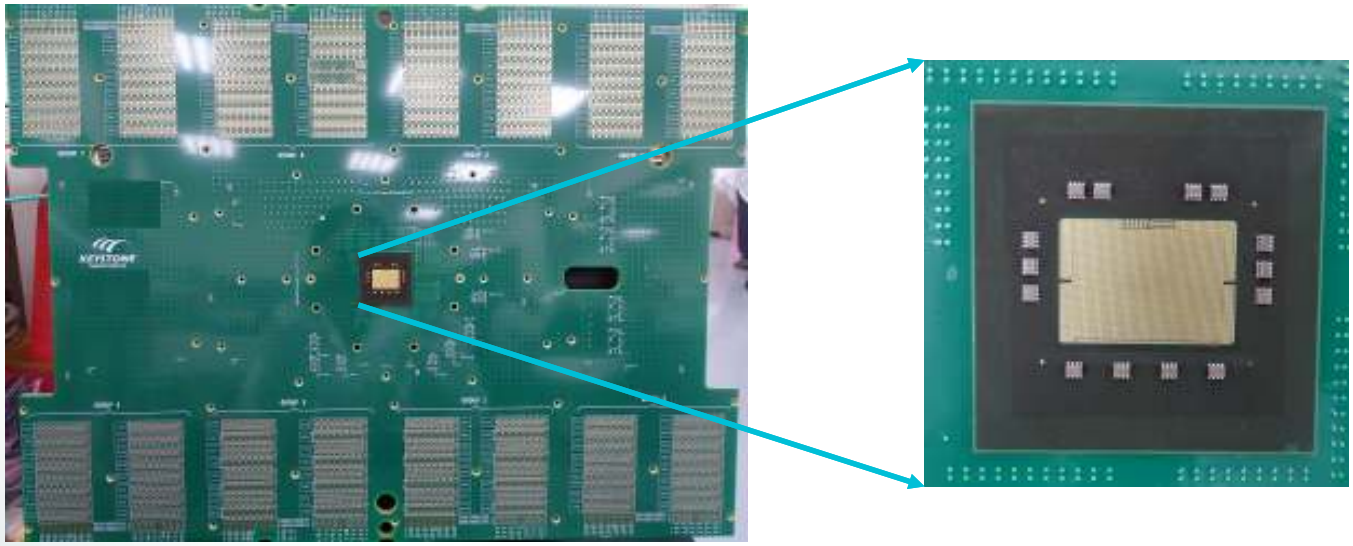
Pad shrunk at X - direction



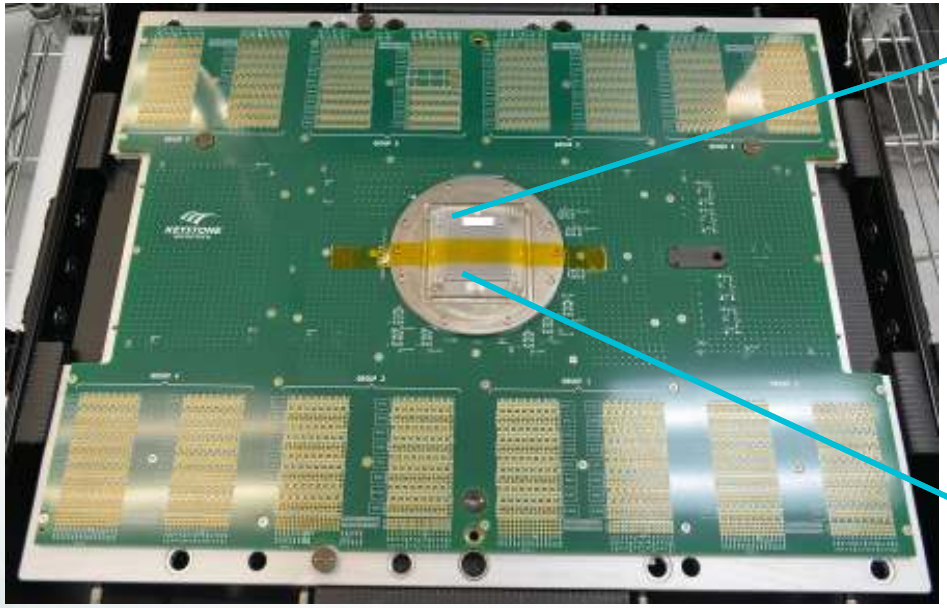
Pad shrunk at y - direction

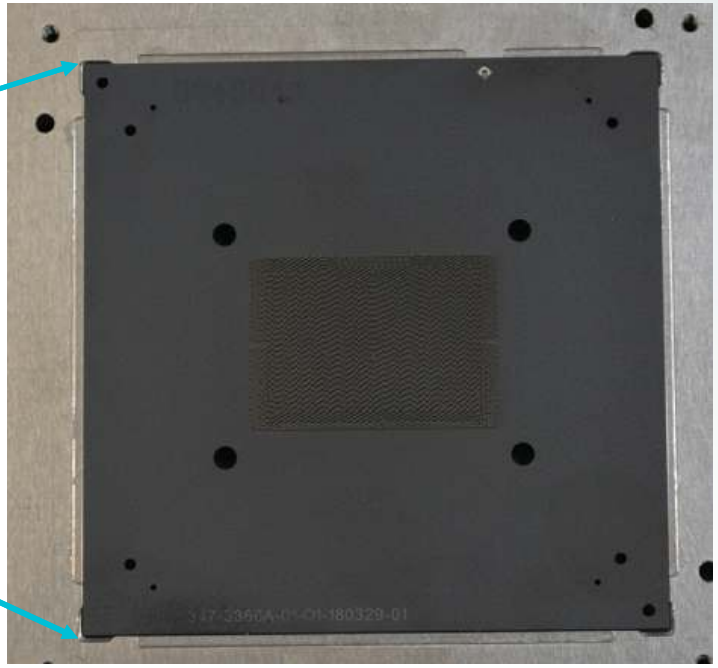


Good attach of PCB and MLO for probe contacting



- Flatness of substrate after Reflow : < 30um





Conclusion and Future Development Suggestion

Combine FFI MEMS Probe and KeyStone Advanced ST Design Provide Ideal Product to Meet Challenging AI Chip Testing Requirements:

- Highest current protection capability <130um: **1.5A**/probe CCC, **1.2A**/probe MAC
- Low probe force on large pitch probe, **<3g** at production OT/ probe
- Optimized MLO design to meet challenging Power Integrity spec
- Achieve within +/-15um planarity over 150°C temperature range, provide super contact stability.

Next Step/Future Development Direction

- FormFactor enhance MEMS probe current protection capability to 2A/probe
- Keystone and FFI work together finalize thermal model over whole probe card
  - Provide guideline to customer for power pin reduction
  - Analysis/characterize thermal to suggest power pin distribution

Thank You!

For questions, please contact:

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