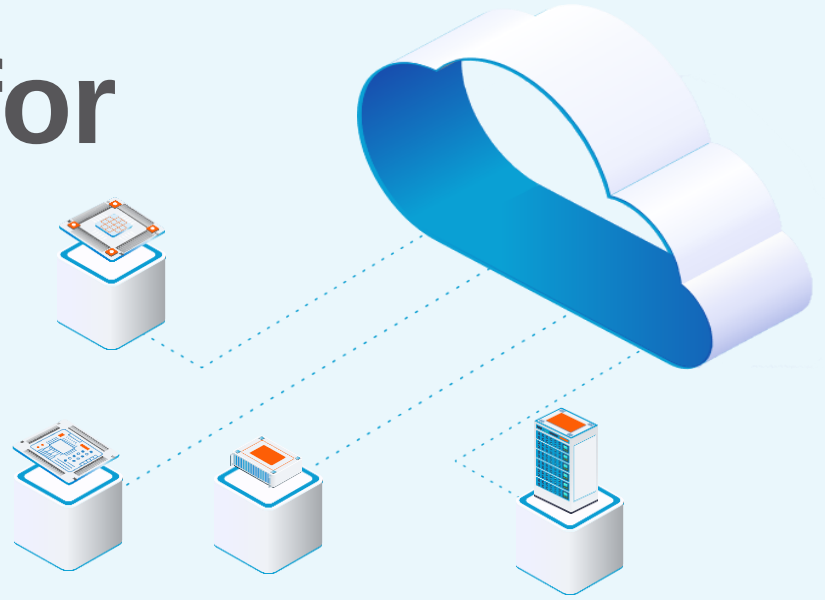
proteanTecs
Electronics visibility. From within

OPEN Compute Project®

Using In-Chip Monitoring and Deep Data Analytics for High Bandwidth Die-to-Die Reliability



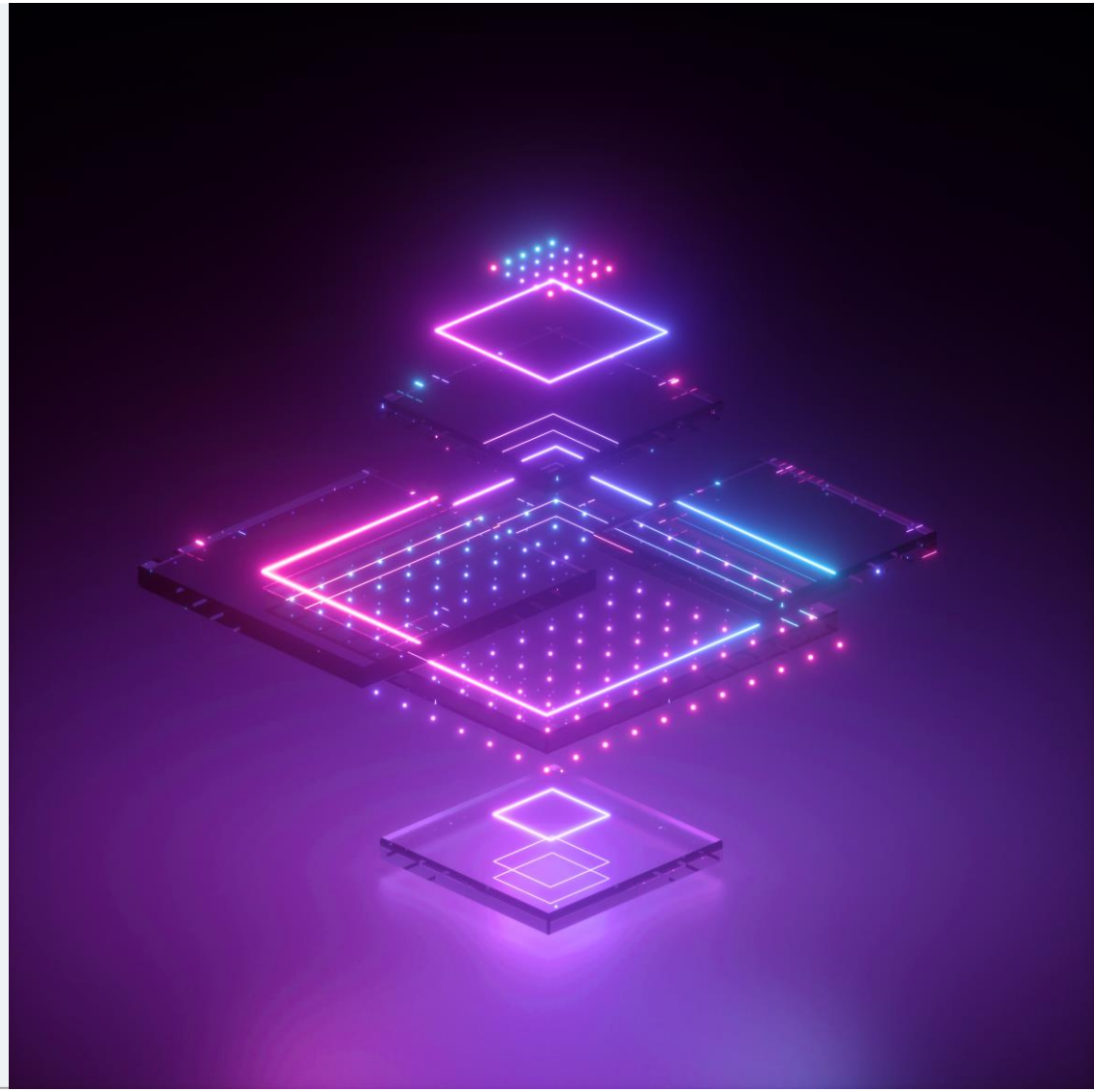
Alex Burlak, VP Test & Analytics

19 June 2022

HiPChips Chiplet Workshop @ ISCA 2022

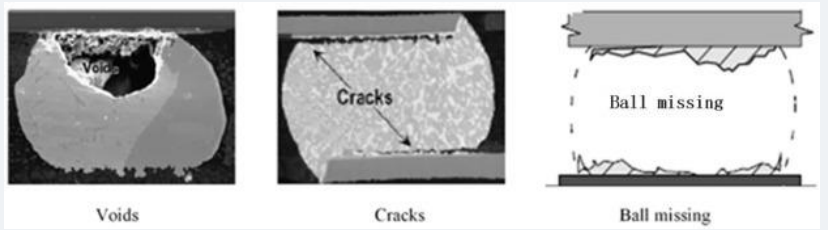
More Than Moore

- Allow overcoming reticle size limitations for large devices
- Improve yield: Yield goes down exponentially with size but with tiling, it is linear
- Allow hybrid devices: Each IC in a SiP can be manufactured at a different process:
  - CPU/GPU/NPU/TPU on latest CMOS technology
  - DRAM on DRAM process
  - Wireless/RF on Analog RF process
- Support “economies of scale” with Chiplet
  - Uses the same building block multiplied according to application instead of multiple designs



Heterogeneous Integration
Quality and Reliability Challenges

- Bump Reliability
  - Voids and cracks
- TSV Reliability
  - Partial fill
  - Copper plating cracking
- Lane Trace Reliability
  - Bridge shorts
- Driver and Receiver
  - Parametric variation
  - Aging (driver weakening, VREF shift, etc.)



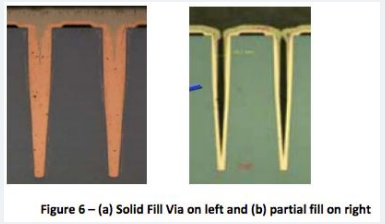


Figure 6 – (a) Solid Fill Via on left and (b) partial fill on right

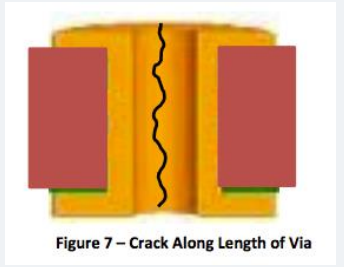
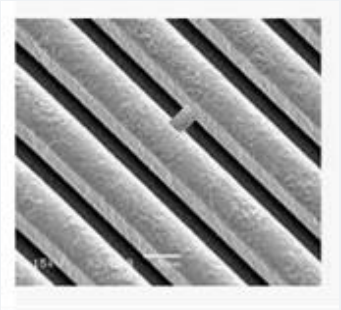


Figure 7 – Crack Along Length of Via

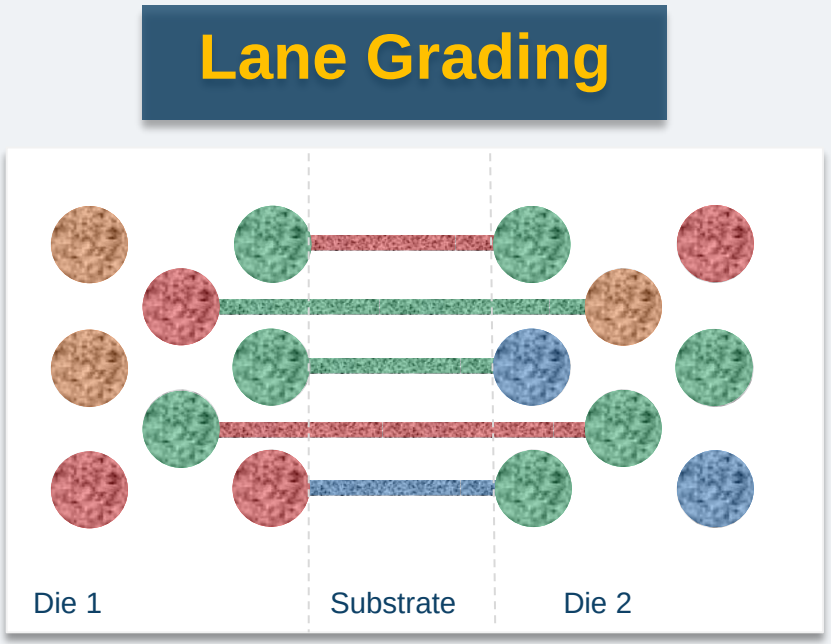


Thousands to millions of potential failure points, no visibility!

Images sources: https://doi.org/10.3390/app10041292
Predicting the Reliability of Zero-Level TSVs (dfrsolutions.com)

Per-Lane High Resolution Monitoring

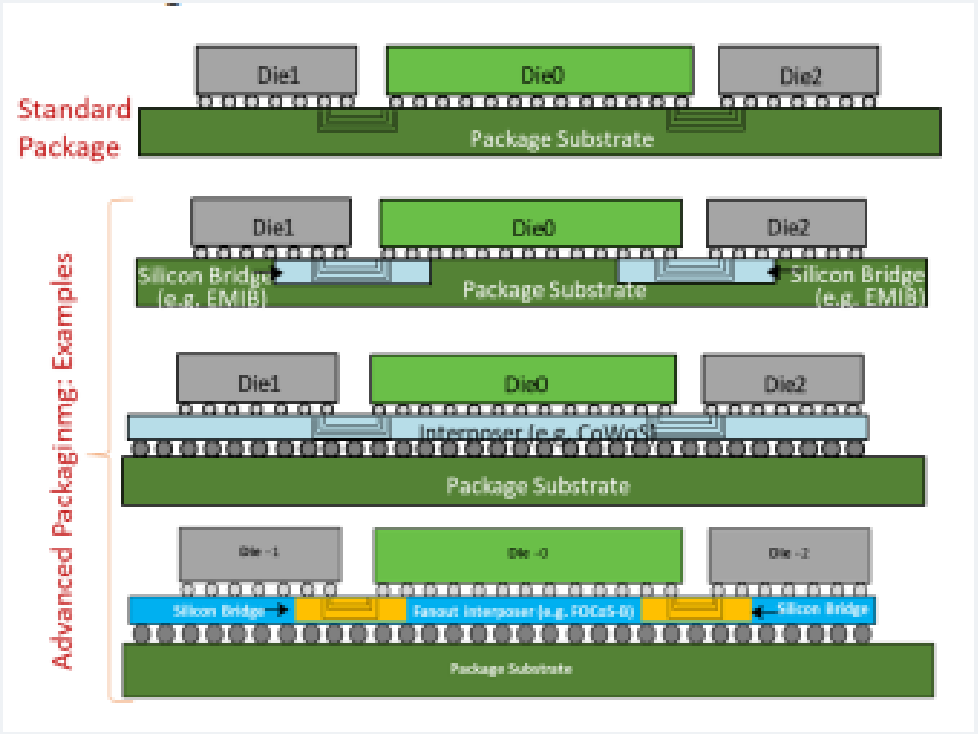
- Comprehensive parametric lane grading
- 100% lane coverage
- During test and in-mission
- Data analytics capabilities
- Patent protected



- **Go beyond just Pass/Fail testing**
- **Part of proteanTecs comprehensive chip performance and health monitoring solutions**

Visibility at Every Stage, from Production to the Field

- NPI and Characterization
  - Lane performance (eye width and jitter) under PVT range
  - Test coverage and test time optimization
  - Inter-lane skew and cross-talk characterization
- Mass Production (MP)
  - Outlier detection (assembled unit)
  - Spare lane activation (if available)
  - Yield monitoring and early alerting
- In-field Reliability
  - Lane degradation for Predictive Maintenance (spare lane, module swap)

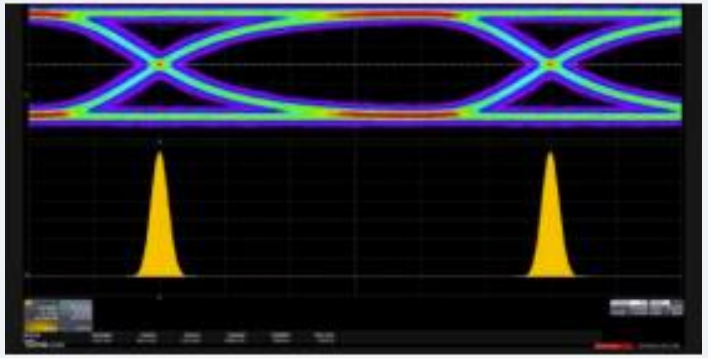


Enhanced Characterization

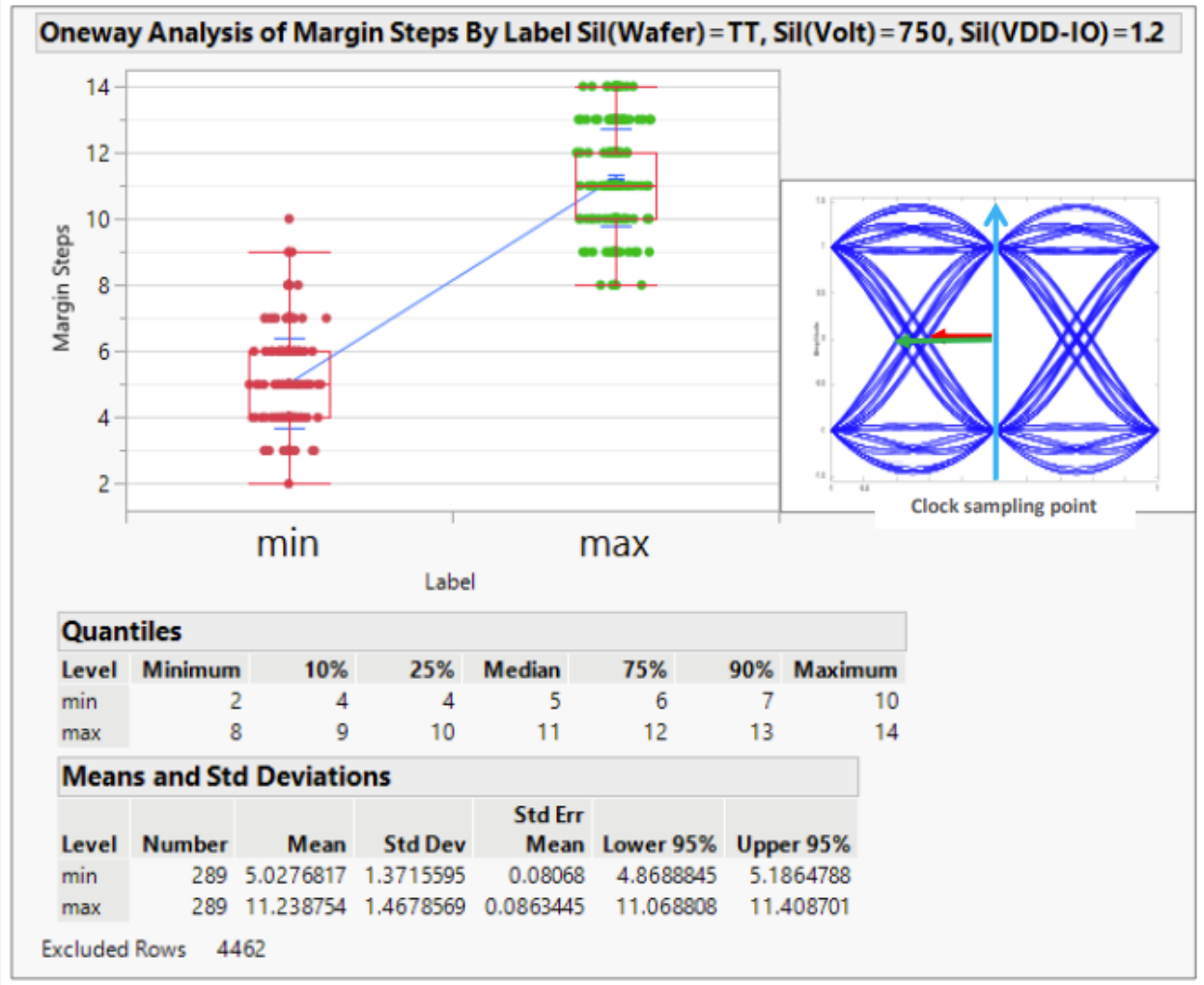
At Product Introduction

- Parametric Lane Grading
  - Maximum eye width measurement (green arrow)
  - Minimum eye width measurement (red arrow)
  - Eye width crossing jitter, max-min (orange arrow)

- Per PVT (Process Voltage Temp) data visualization
- 100% pin coverage



- **Full eye width and jitter characterization across PVT**



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
min	2	4	4	5	6	7	10
max	8	9	10	11	12	13	14

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
min	289	5.0276817	1.3715595	0.08068	4.8688845	5.1864788
max	289	11.238754	1.4678569	0.0863445	11.068808	11.408701

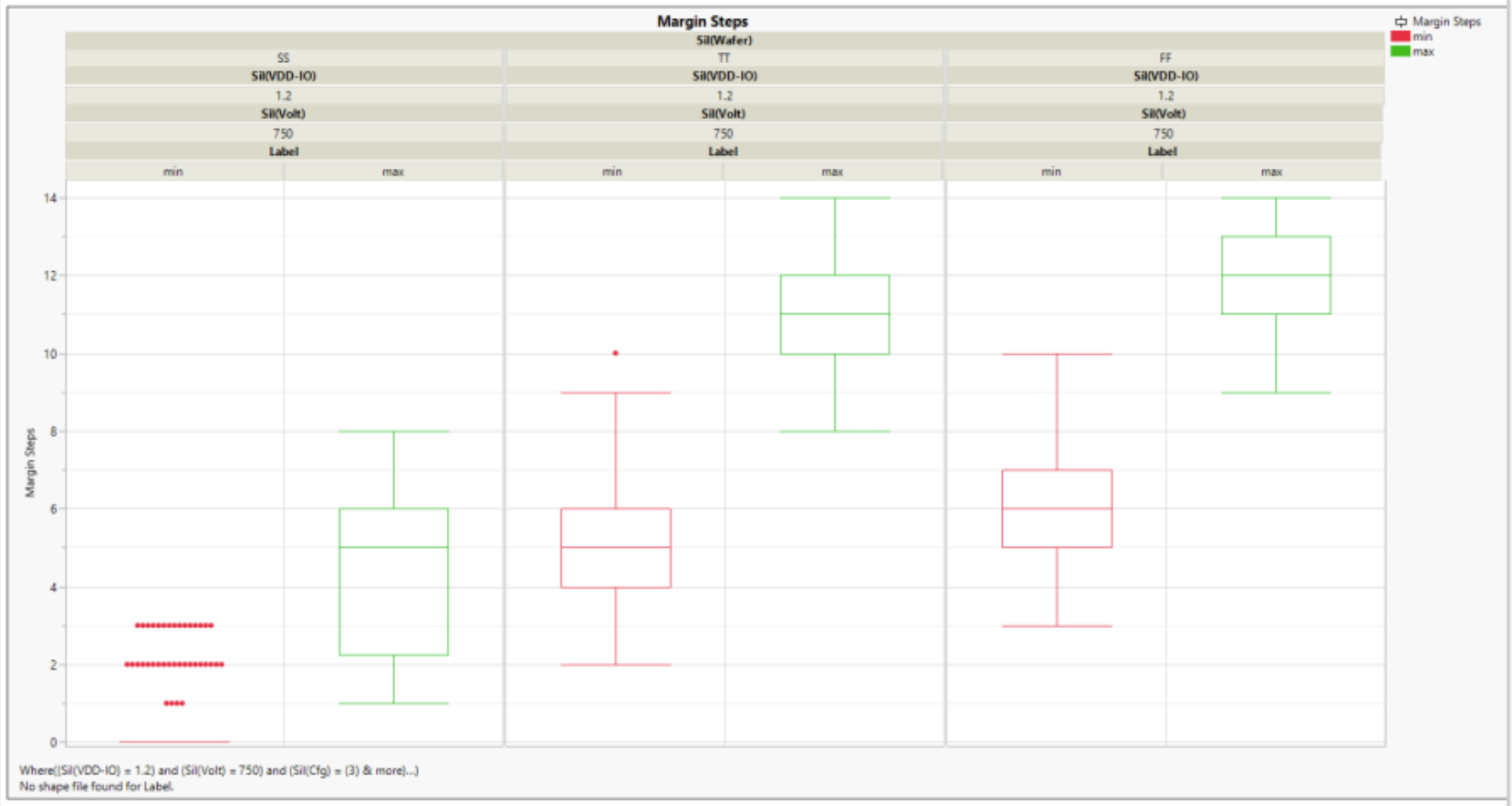
Excluded Rows 4462

Improved Characterization

At Product Introduction

- Samples from different process corners are analyzed
- By showing similar measurements for all samples, characterization is improved
- Enhanced with pin-point process related issues

Process corner effects on transceiver performance, per lane



Test Optimization with Enhanced Coverage

At Product Introduction

Test coverage is critical to assure all lanes are fully operational and meeting performance requirements

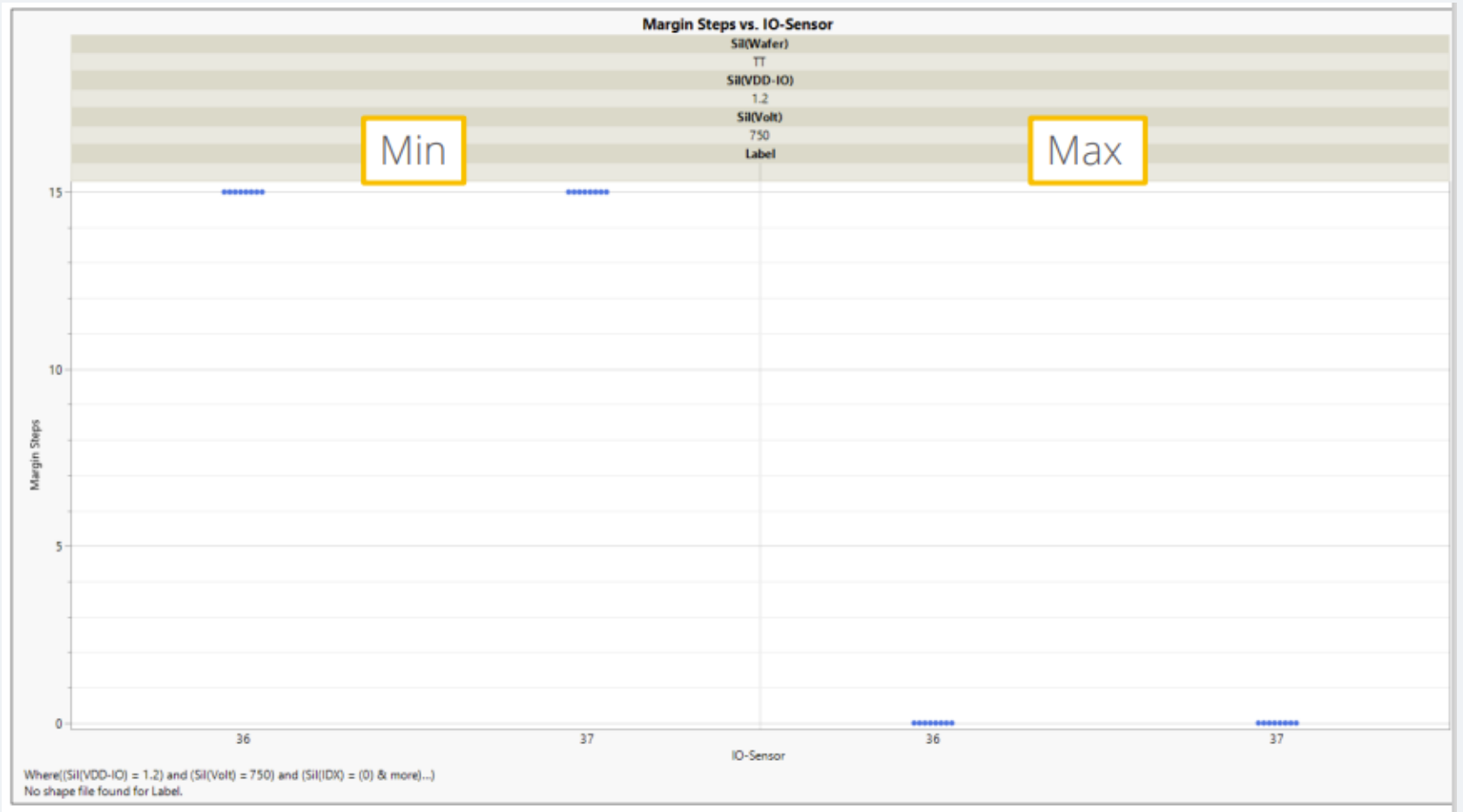


Figure shows:

Observation for specific pins that were not toggling (sufficiently) during test

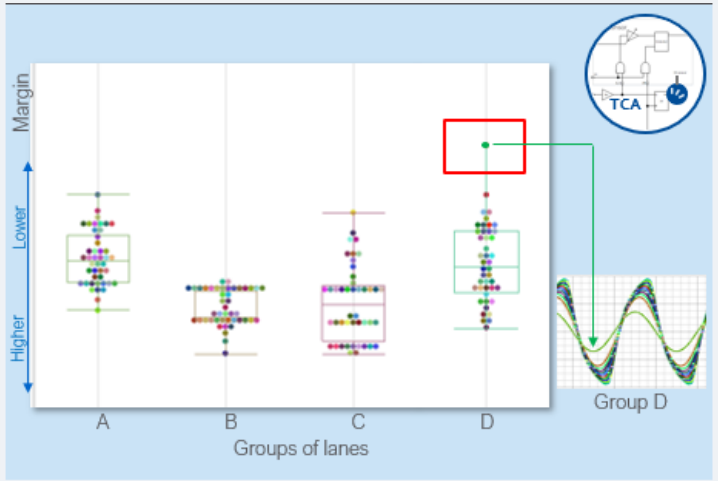
Results:

- Test coverage increased
- Test time optimized

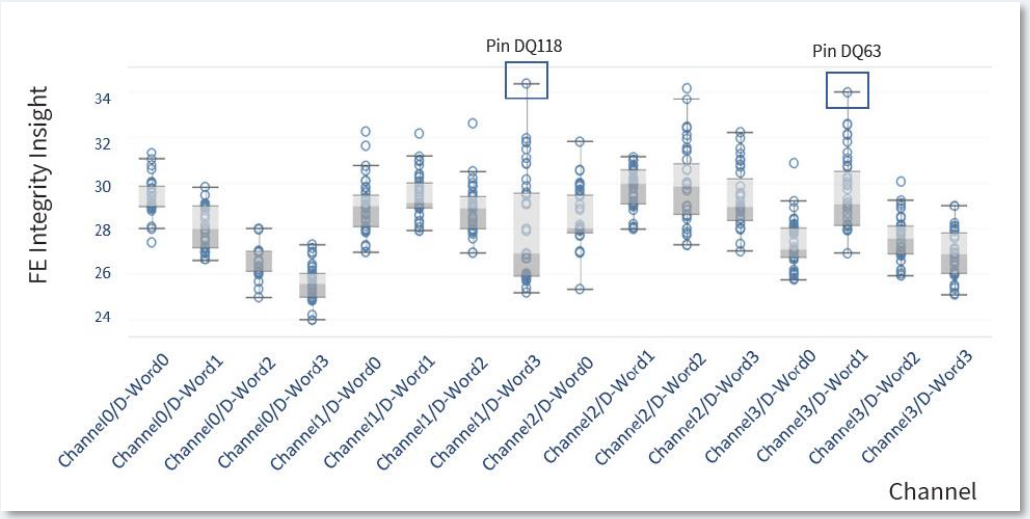
Personalized Outlier Detection

At Volume Production

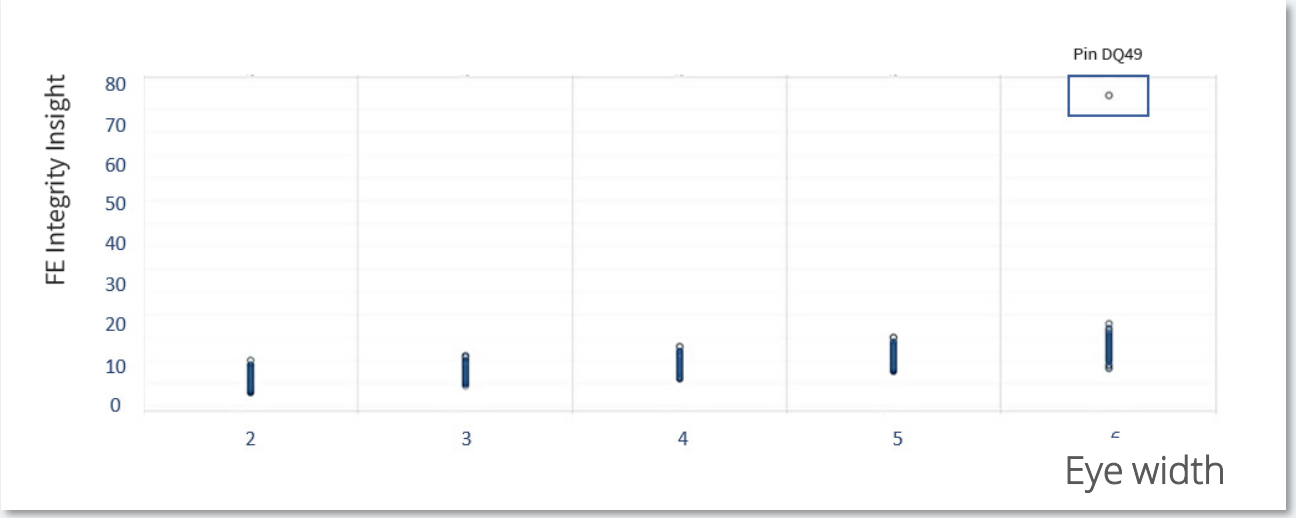
- Full population analysis
- In-line monitoring
- Real-time alert via Edge Client



Far-End Integrity Insight per Channel and Pins in Channel



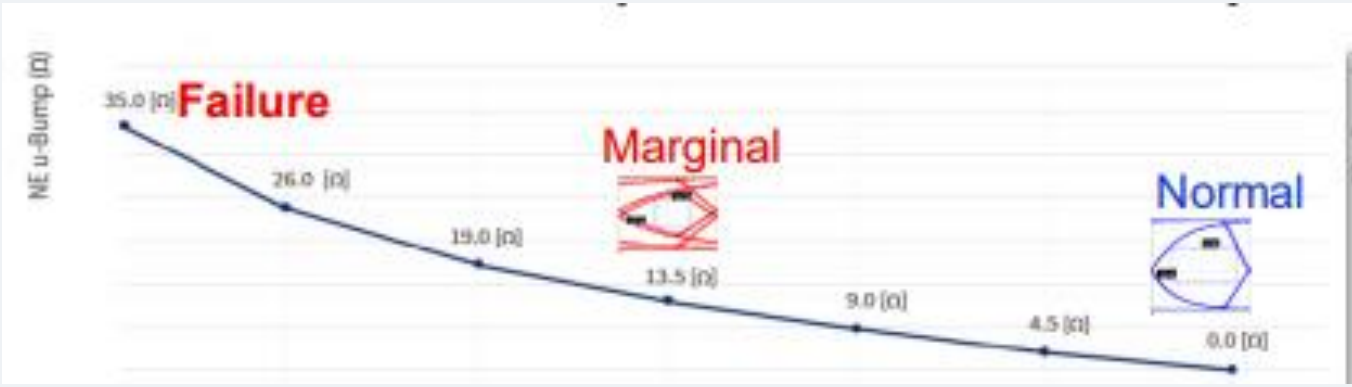
Rx Signal margin at Pin



Performance Degradation Monitoring

In-Field

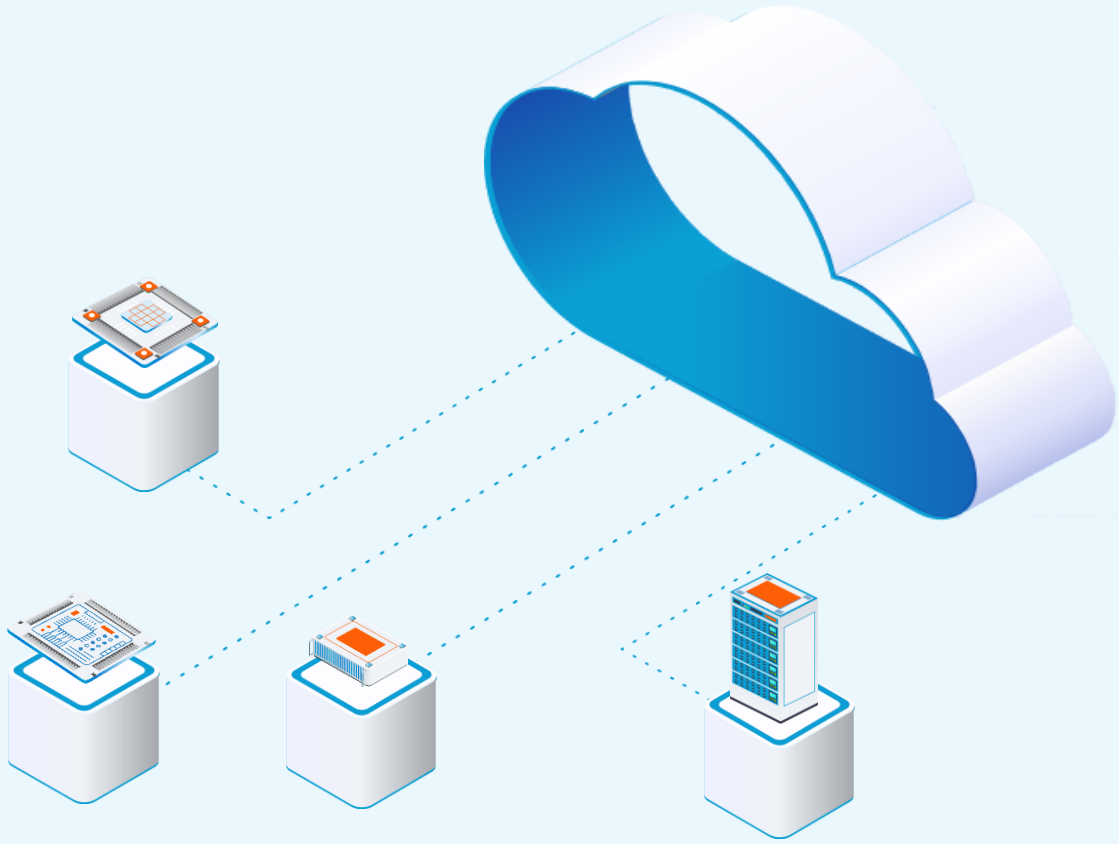
- Continuous Monitoring
- In-field and in-mission
- Issue alert to enable Predictive Maintenance



Thank you.

www.proteanTecs.com

alex.burlak@proteanTecs.com



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