# Characterisation of 2nd generation flex cables

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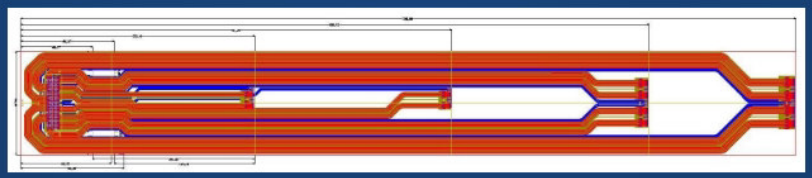
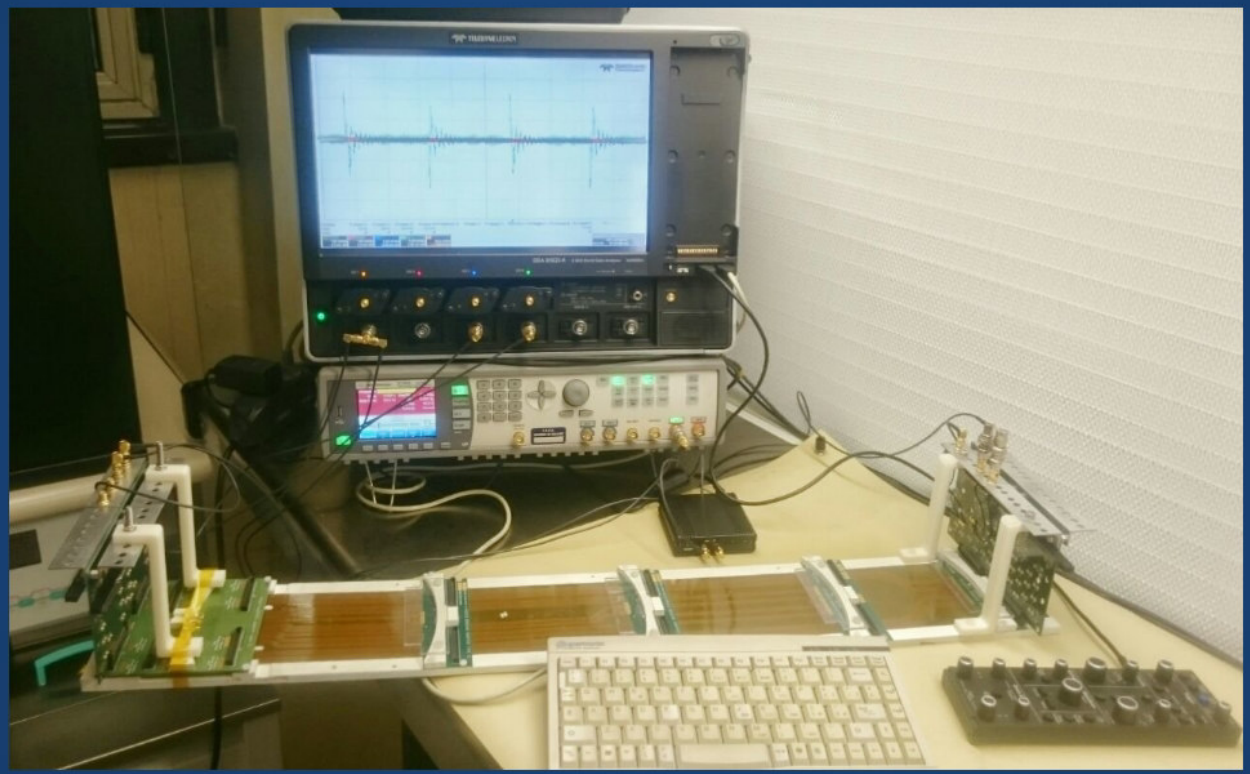
# Second generation flex cable changelog

Technology: Full-flex + stiffener design

- Stack-up: Two double cores
- Traces with/space adjusted in the inner layers to keep Zdiff ~ 100 Ohm
- Power traces width increased from 4 mm to 6-7 mm
- Digital and analog power traces maintained just in case
- Central symmetry maintained



# Test setup

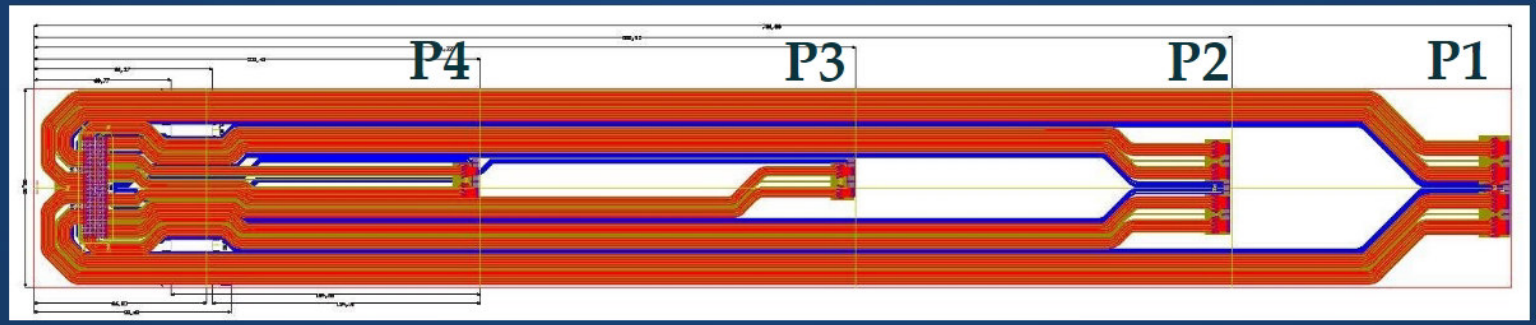


# Test setup

- Milli-Ohmeter for precise Resistance and DC measurement
- Sampling oscilloscope with dual channel TDR module for trace impedance characterization
- Digital signal analyzer for signal integrity measurement + low jitter PRBS generator
- Passive board provided by Maryland

Digital power lines resistance measurements (one way)

| *Flex position* | *Current [A]* | *Resistance [mOhm]* |
|---|---|---|
| P1 | 3 | 114±3 |
| P2 | 1 | 101±2 |
| P3 | 1 | 84±1 |
| P4 | 1 | 41±1 |



# Power lines resistance measurements (one way)

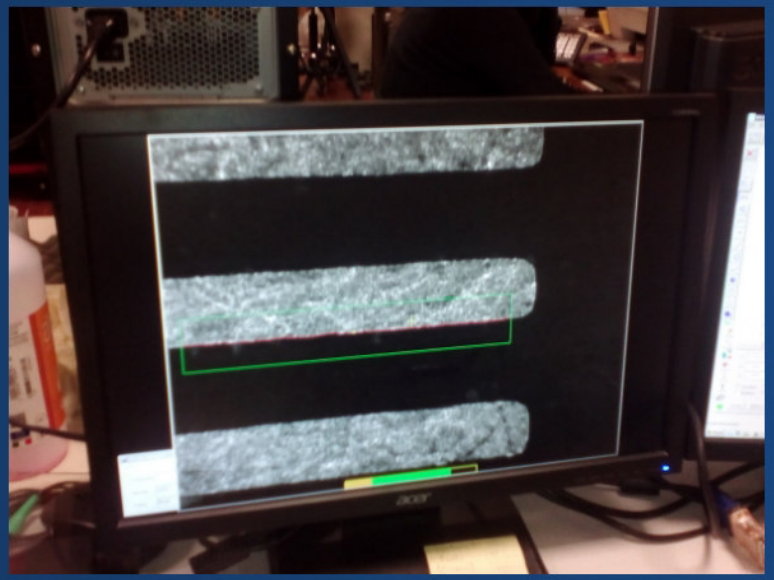
- A single via (0.6x0.3mm) can withstand at least up to 3A
- We have consistency between ***AnSys SiWave*** simulations and our measurements, achieving a maximum of 6% deviation 1.5% on average.

# Differential pairs resistance measurements

| Dataflex position | Resistance @10mA [Ohm] | Resistance @20mA [Ohm] | Layer |
|---|---|---|---|
| P1 | 5.211±0.09 | 5.224±0.10 | Top |
| P1 | 7.751±0.12 | 7.767±0.12 | Inner |

By climbing from 10 to 20mA we consistently get an increase of 20mOhm ca.

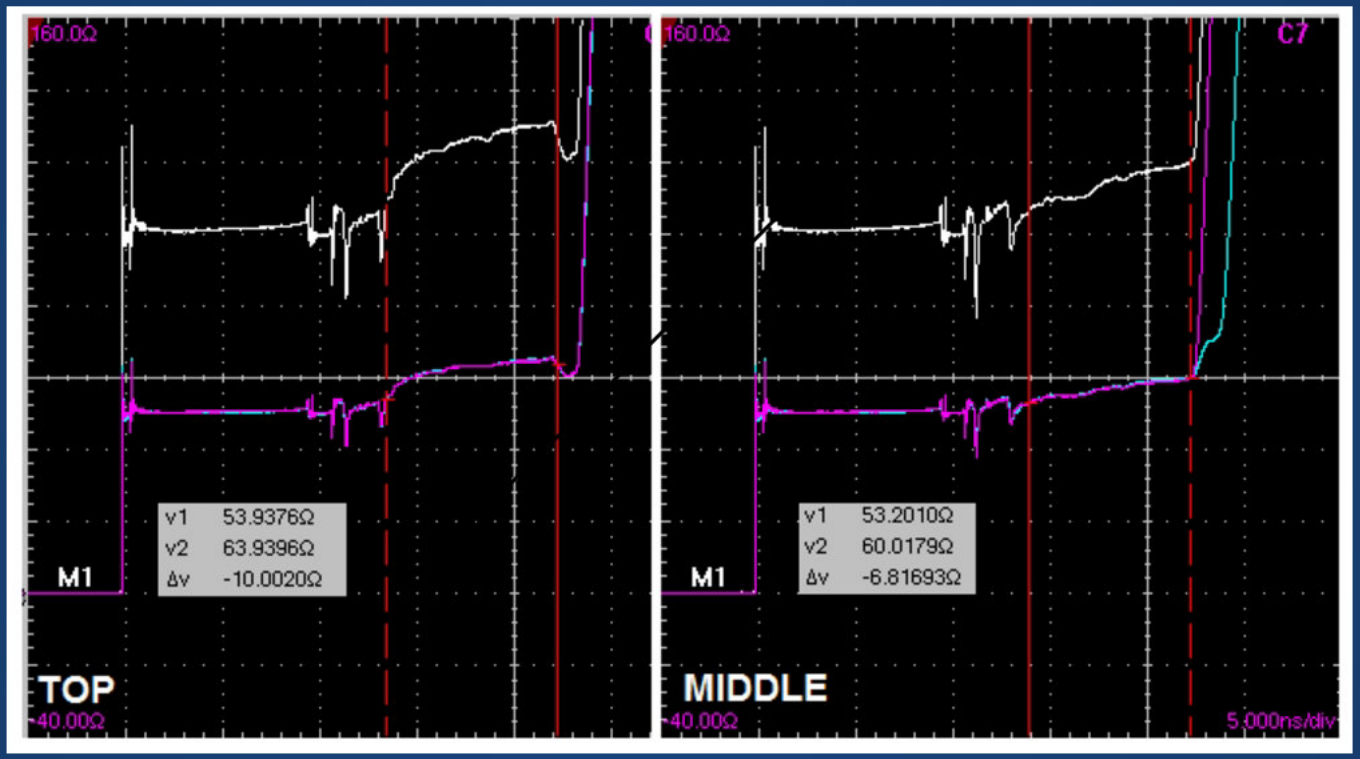
# Differential pairs resistance measurements



- CERN confirmed top-layer lines to be thicker than expected (30um, originally 22.5um)
- After an optical inspection we have also found them to be thinner (90um, designed to be 115um)
- Section area ratio is consistent with resistance measurements and symulations

To do: flex micro-sectioning to analyze traces geometry & multiple samples

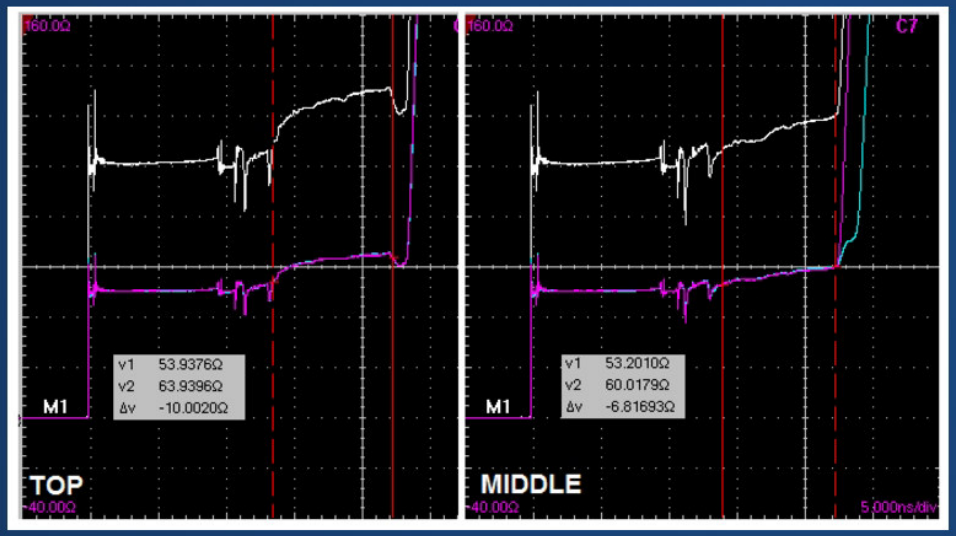
# Time Domain Reflectomery (TDR) Measurements




Impedance (Ohm)

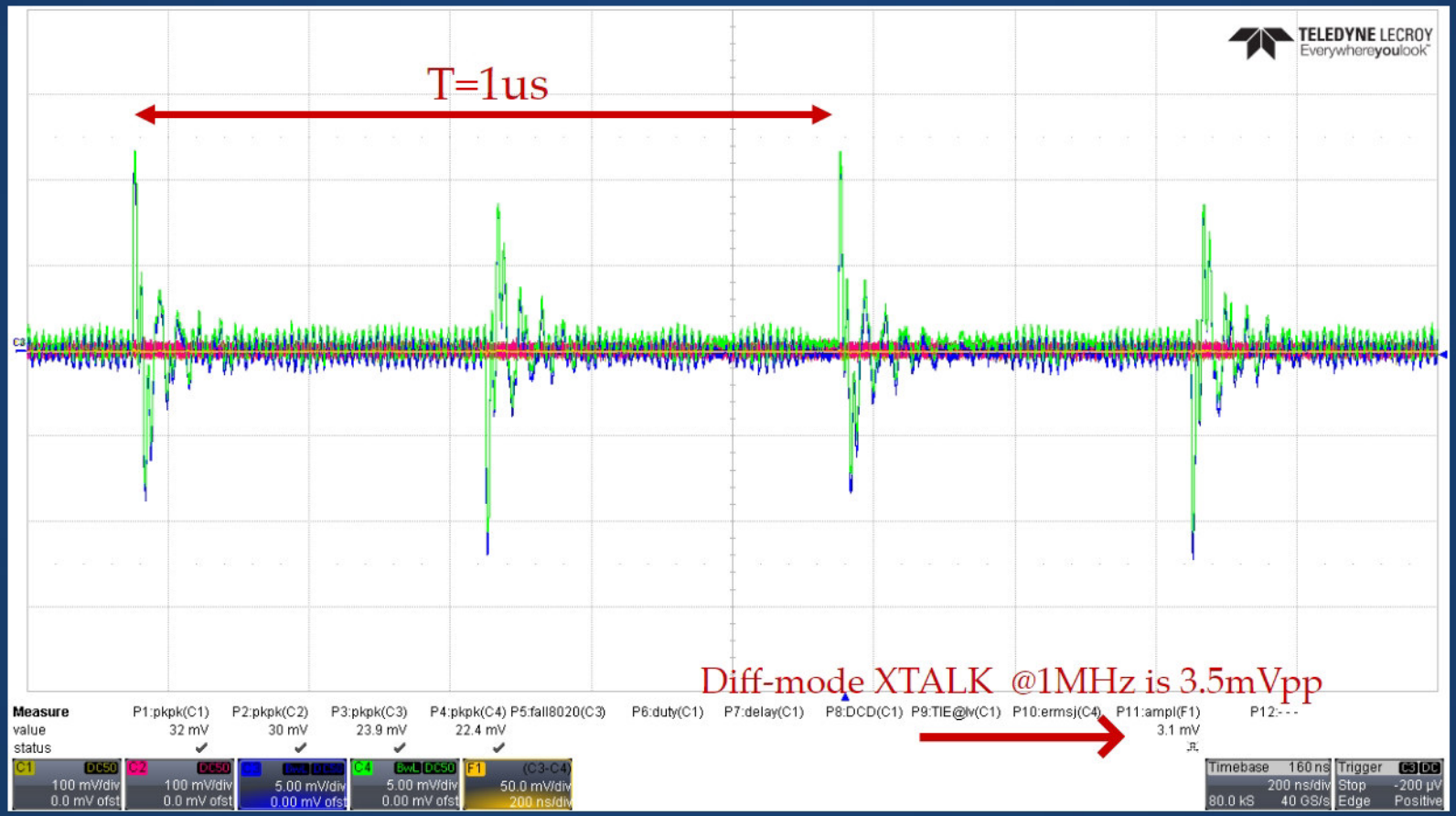
Time

# Time Domain Reflectomery (TDR) Measurements

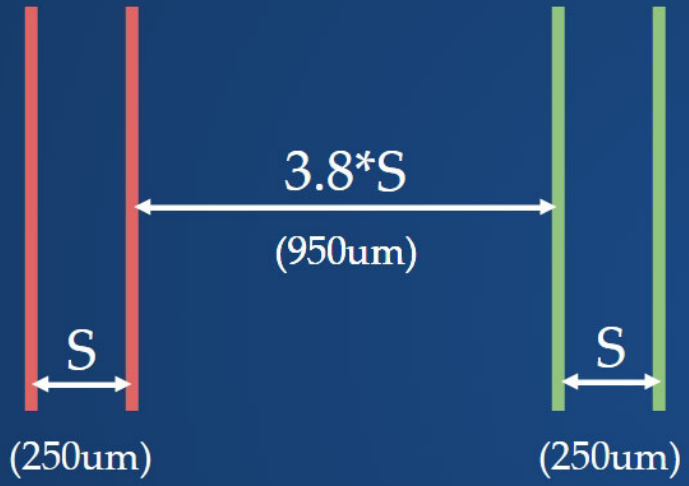


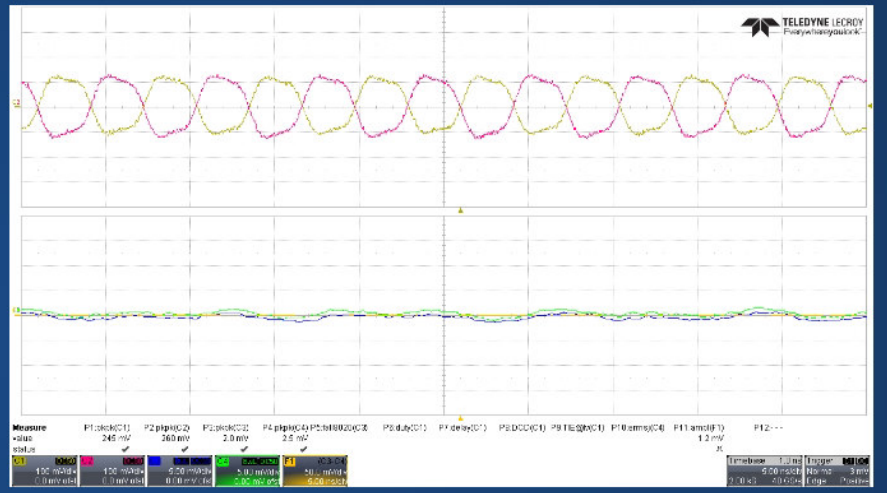

- P2, P3 and P4 behave like P1
- 6 Ohms slope in both layers
- Reflections are probably smoothing the graph
- We can't extract the "line model" yet
- Top-Middle differences are resembling what we're supposing the flex section to be

# Crosstalk measurements



# Crosstalk measurements



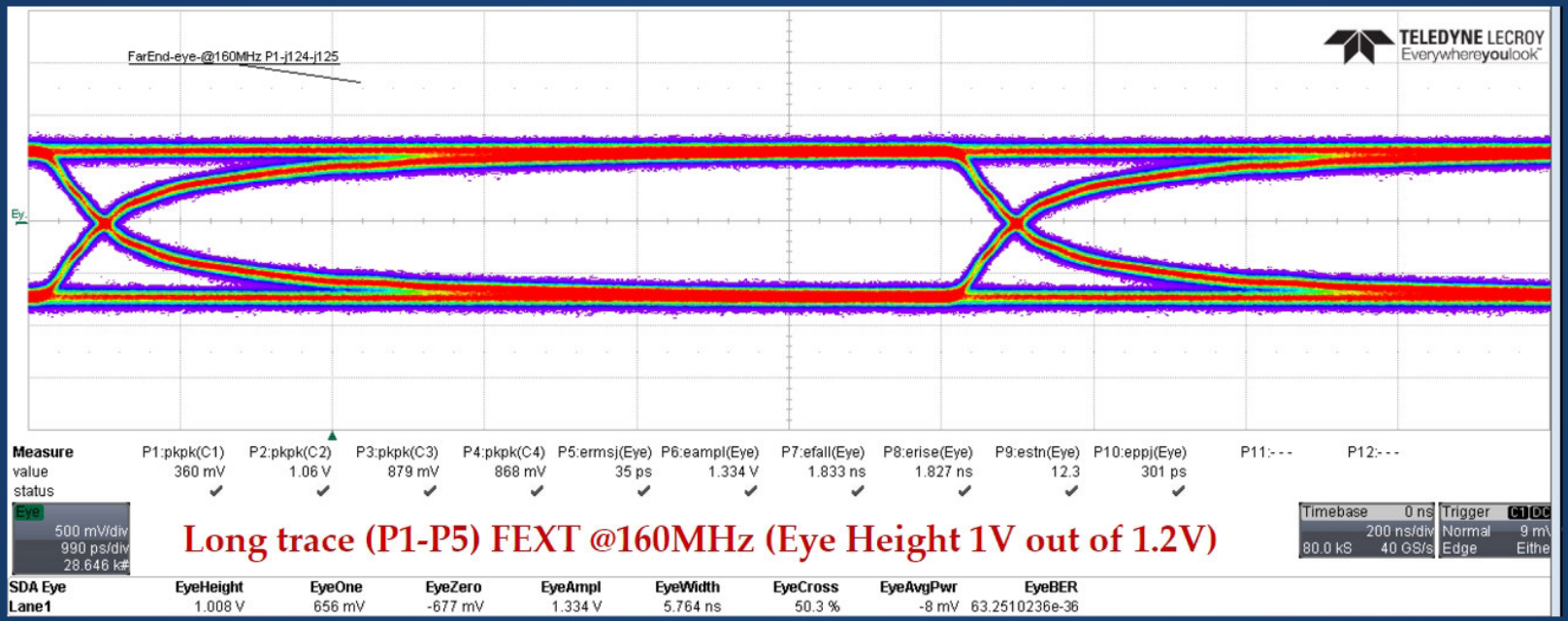



We have measured FEXT in every combination (top-middle, top-top, middle-middle)

@10MHz & @160MHz we consistently have about 1% Far End Cross-Talk

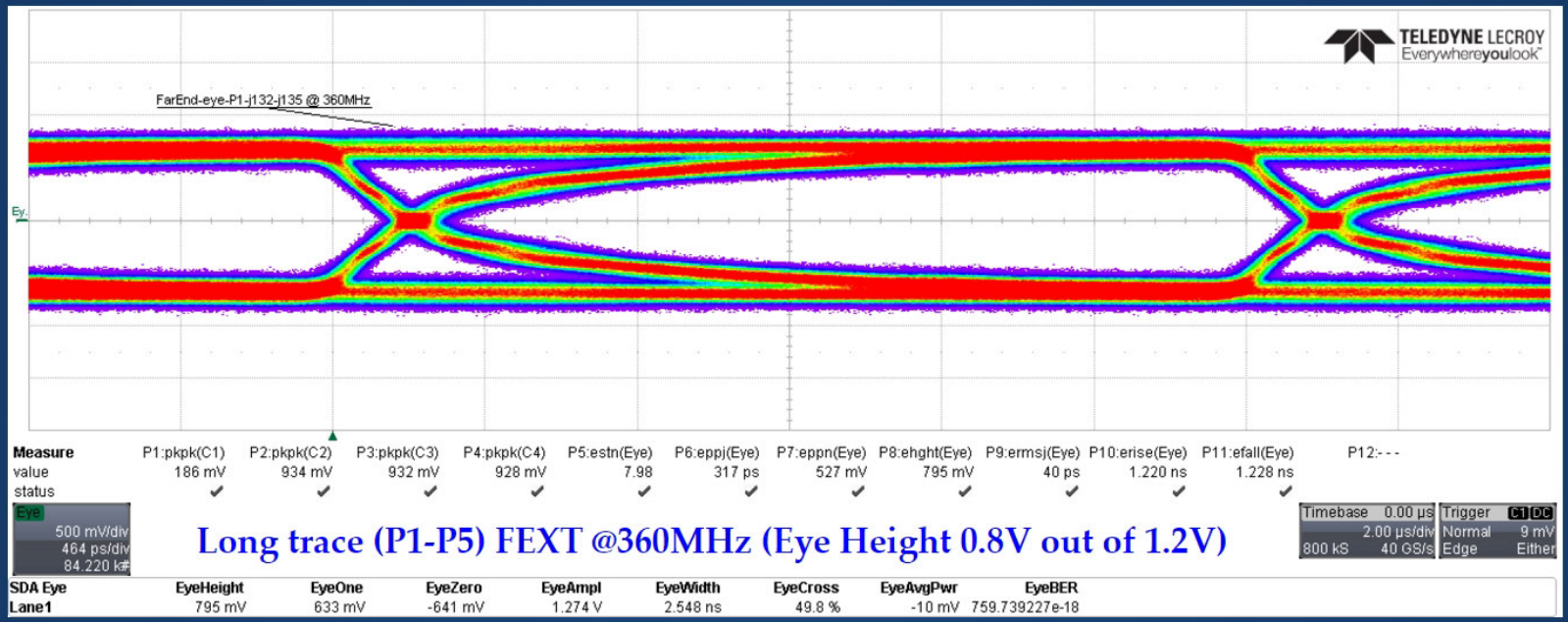
(In theory it should be around 0.8%)

# Far-end eye diagrams




Eye wide open @160MHz, S/N>10 and jitter(RMS) around 36ps (12ps due to the setup)

# Far-end eye diagrams




The Eye is still open @360MHz but then the S/N goes below 8, jitter(RMS)=40ps

# Summary

- Resistance expectations achieved, flexes are fully working with promising results
- We still have to consolidate the production line to achieve the best impedance matching
- HV distribution will be tested soon
- We can trust Ansys and Hyperlinx simulations for further development of flexes
- We have consistent measurements between different flexes (made with the same process)
- Via behaviour will be analyzed by routing a few via-chains in the future release
- Extensive testing setup is still in discussion