PIN Diode Qualification

Devices Tested

QA Procedure Outline

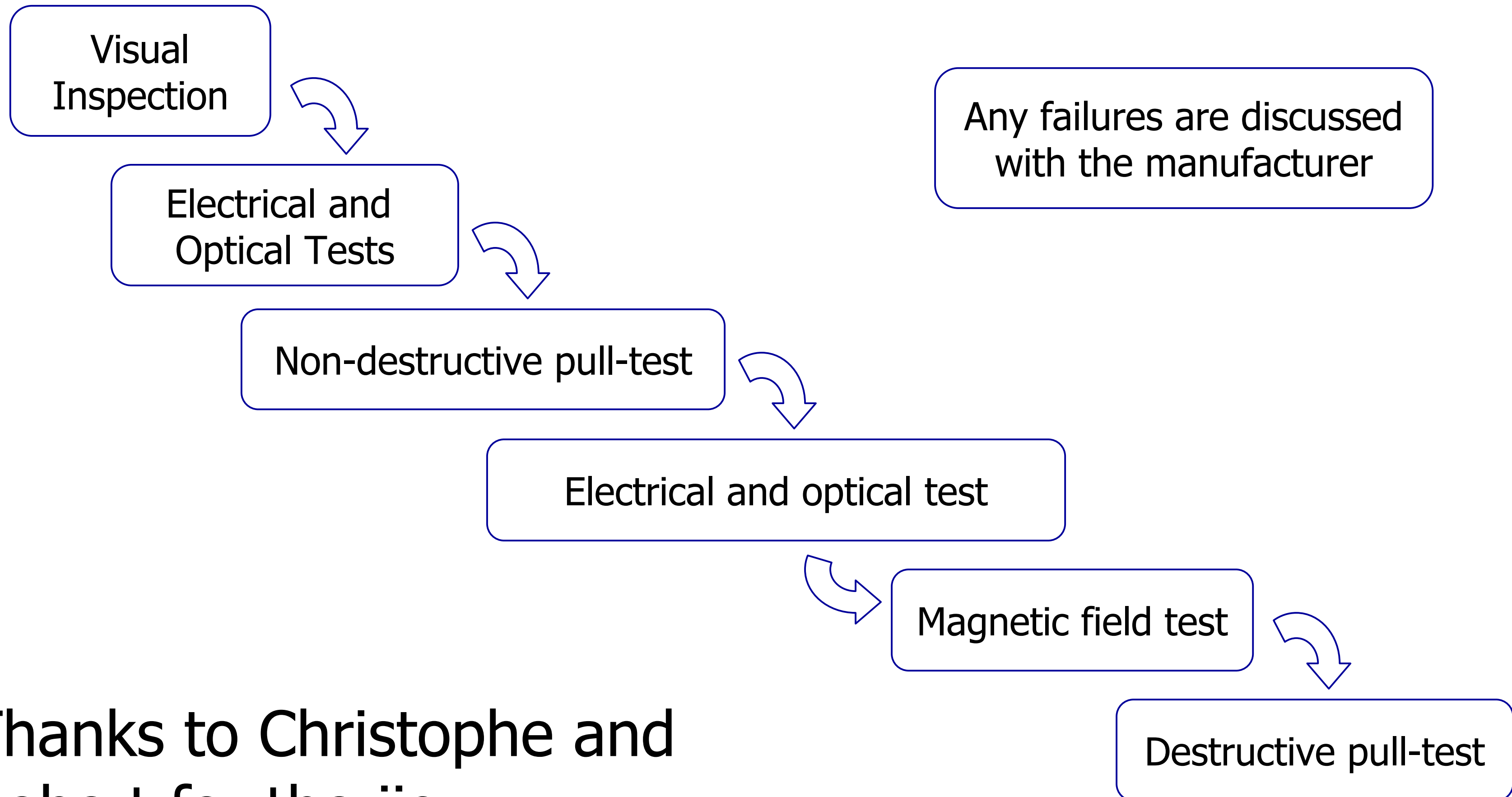
Results

giulia papotti

Introduction

- 190 diodes delivered from Fermionics
  - 90 diodes for AVT
  - 100 diodes for pre-production qualification
    - come from 3 different wafers:
      - Serial number 1-33, wafer W770J-D
      - Serial number 34-66, wafer W517I-M
      - Serial number 67-100, wafer W520I-R
- 50 re-qualification diodes from wafer W517I-M
      - Serial number 191-241, without 226

Qualification procedure



- Thanks to Christophe and Robert for the jig

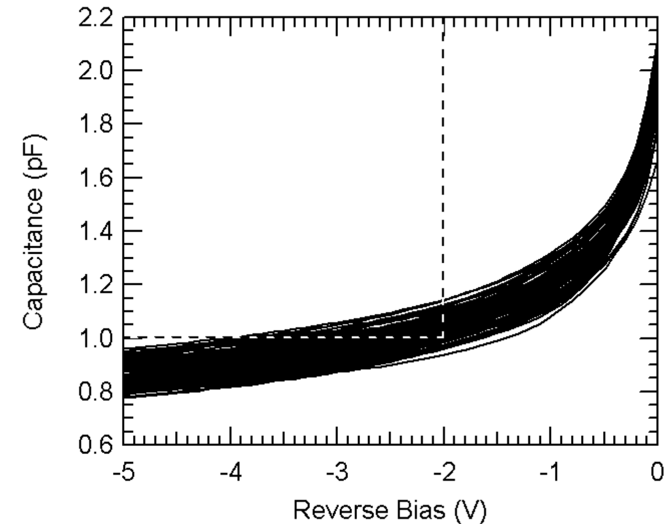
Visual Inspection

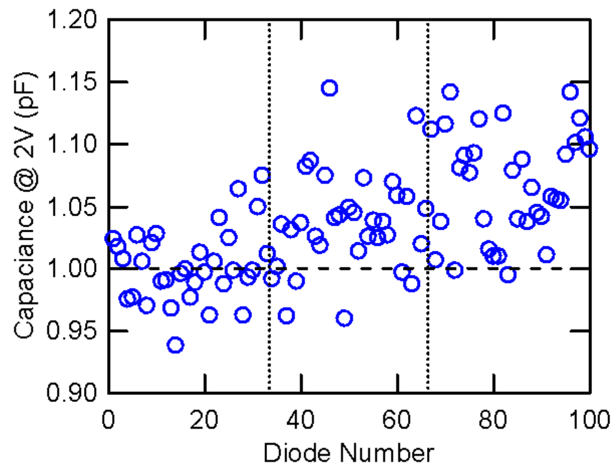
- Inspection of the pigtail:
  - Measured lengths
  - Found light scratches on the fibres
- Inspection of the dimensions of the package
- Scan codes properly attached

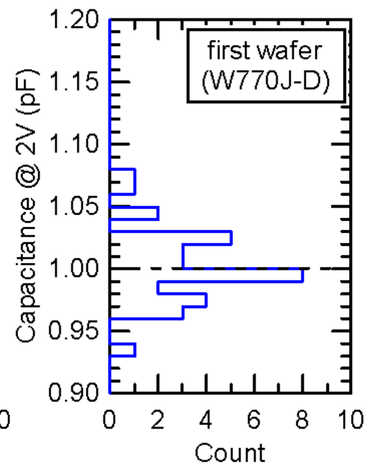
- Thanks to Etam and Margherita

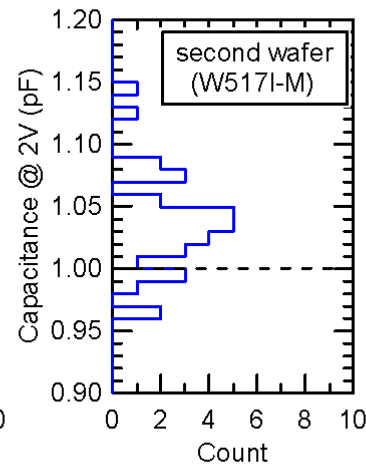
Capacitance

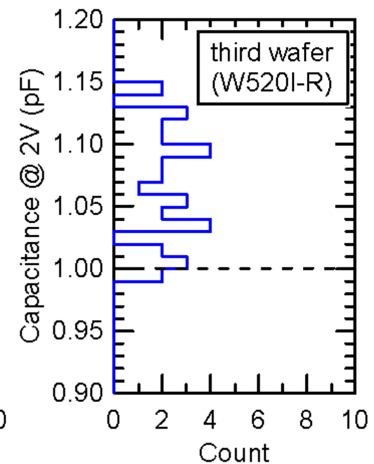
- Device + jig measured with a C-V meter
  - series resistance mode
  - reverse bias voltage range: [0V, –5V] in 0.1V steps
  - 74 out of spec
    - Change spec to typ?





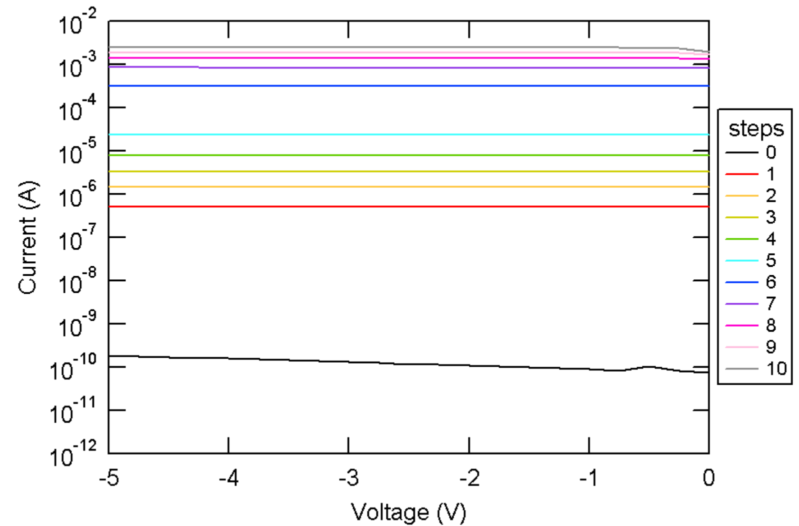


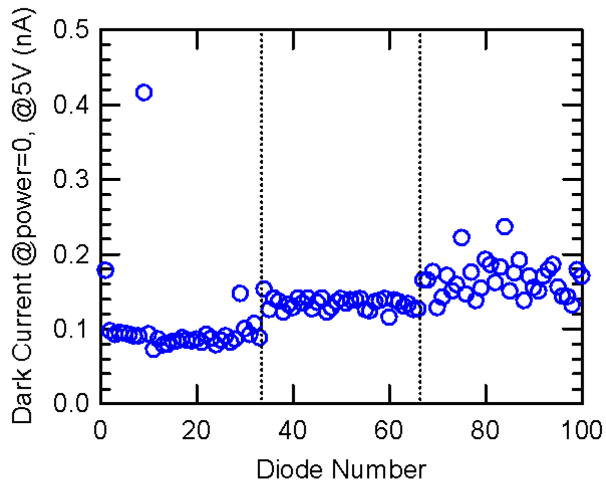


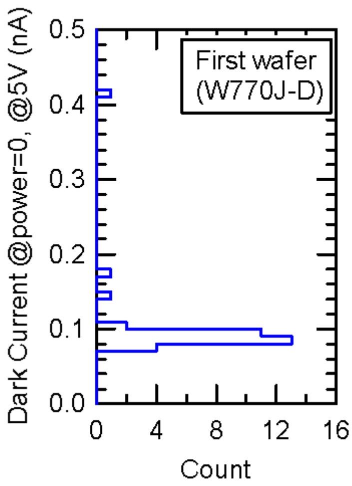


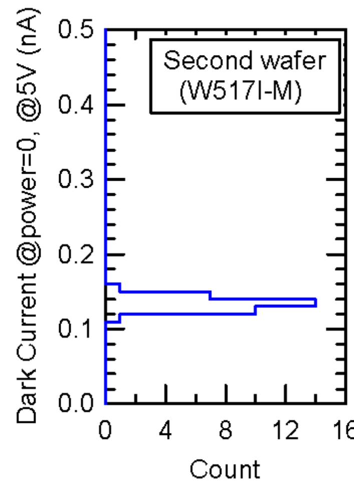
Dark Current & Responsivity - 1

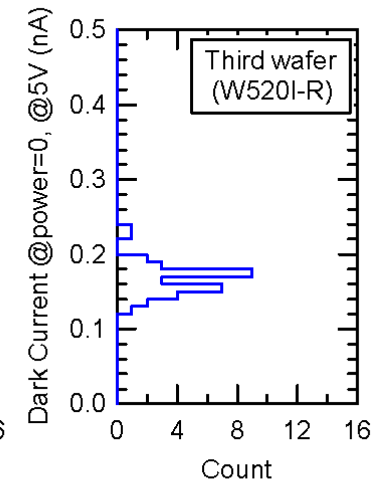
- I-V over a reverse bias voltage range of [0V, -5V] in 0.25V steps
  - 11 steps of power, [0mW, ~2mW]
    - first step: dark current
      - Spec 1nA



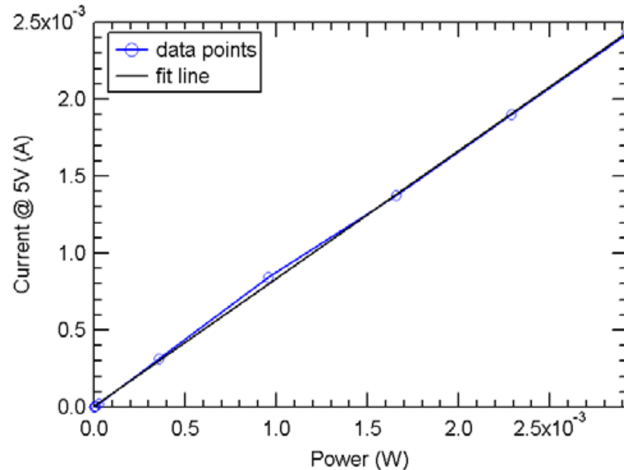




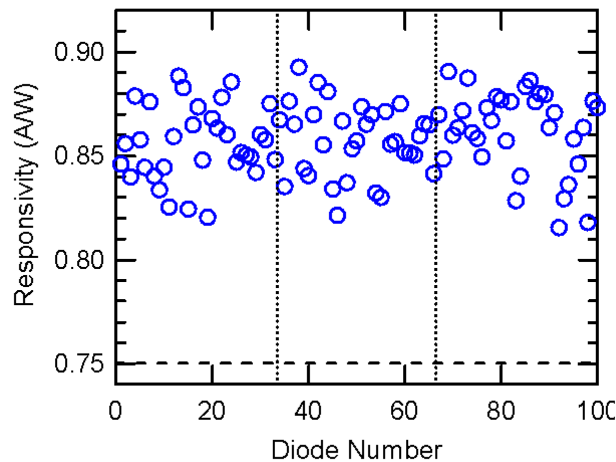


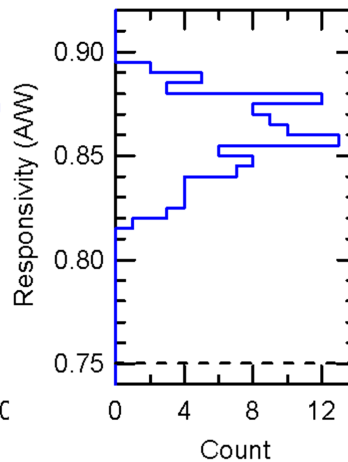


Dark Current & Responsivity - 2



- Responsivity: slope of the fit line to photocurrent versus injected optical power at –5 bias voltage

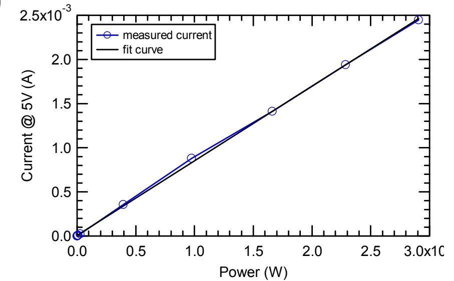


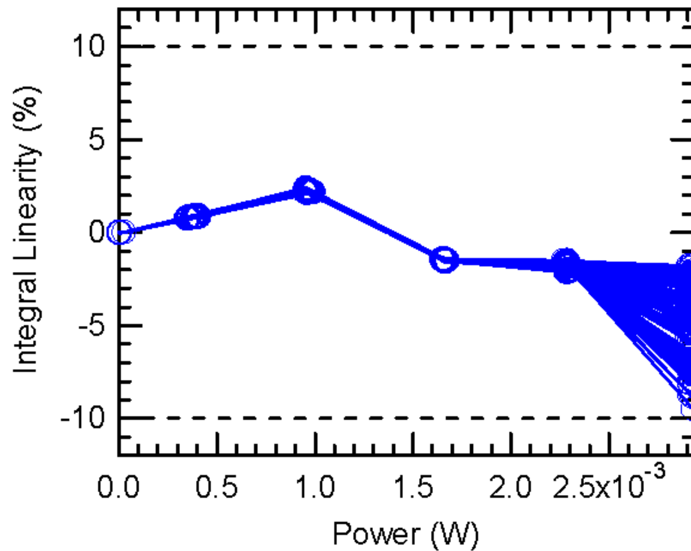


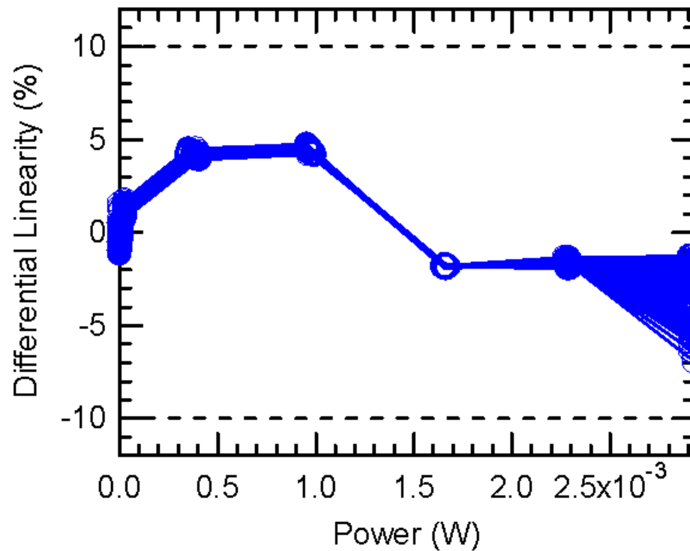
- Spec 0.75A/W
- No appreciable difference between wafers

Dark Current & Responsivity - 3

- Differential Linearity: $$\text{Diff.Lin}\,(\%) = \frac{\text{Curr@5} - \text{fitline}}{\text{Curr@5}} \cdot 100$$
- Integral Linearity: $$\text{Int.Lin}\,(\%) = \frac{\text{Curr@5} - \text{fitline}}{\text{resp} \cdot 2\text{mW}} \cdot 100$$
  - No spec to meet

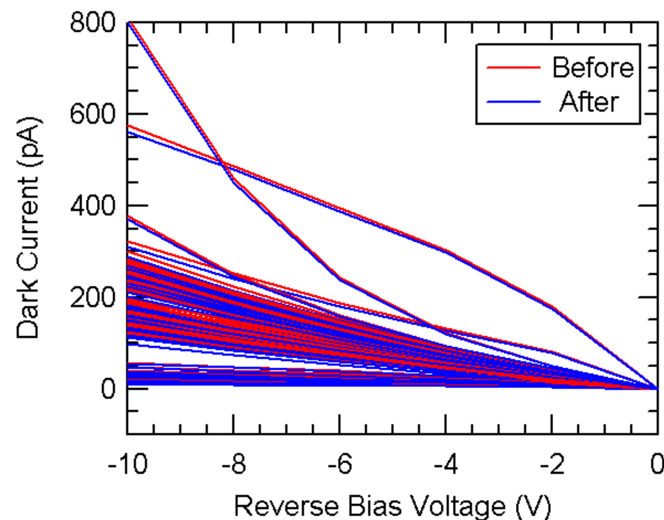


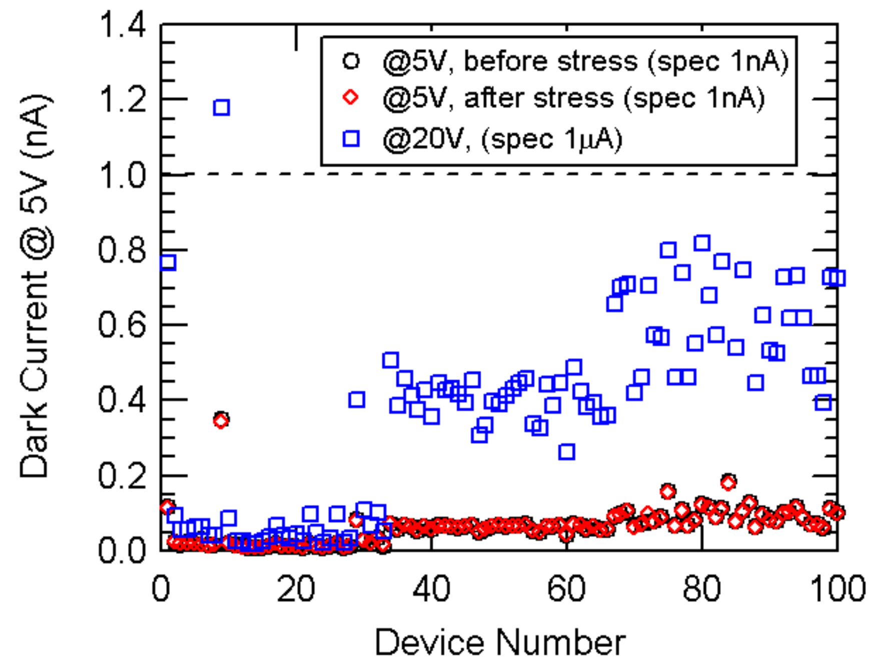




–20V Stress - Maximum Reverse Bias Voltage

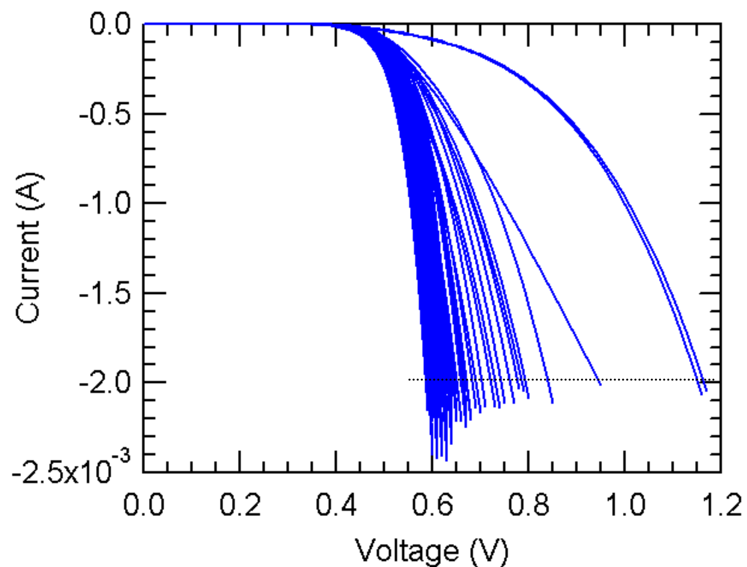
- Dark current in the range [0V, –10V] in 2V steps, before and after biasing the device at –20V for 5 seconds
  - No device has been damaged by the biasing at –20V
  - Specs verified

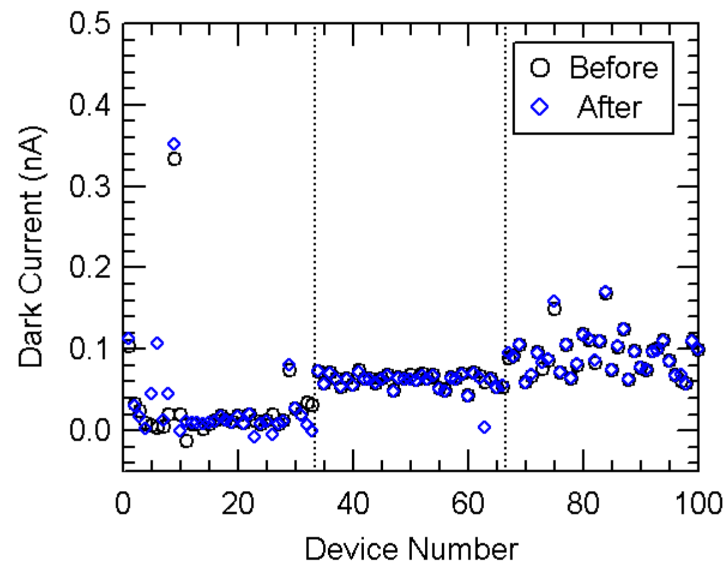




Maximum Forward Current

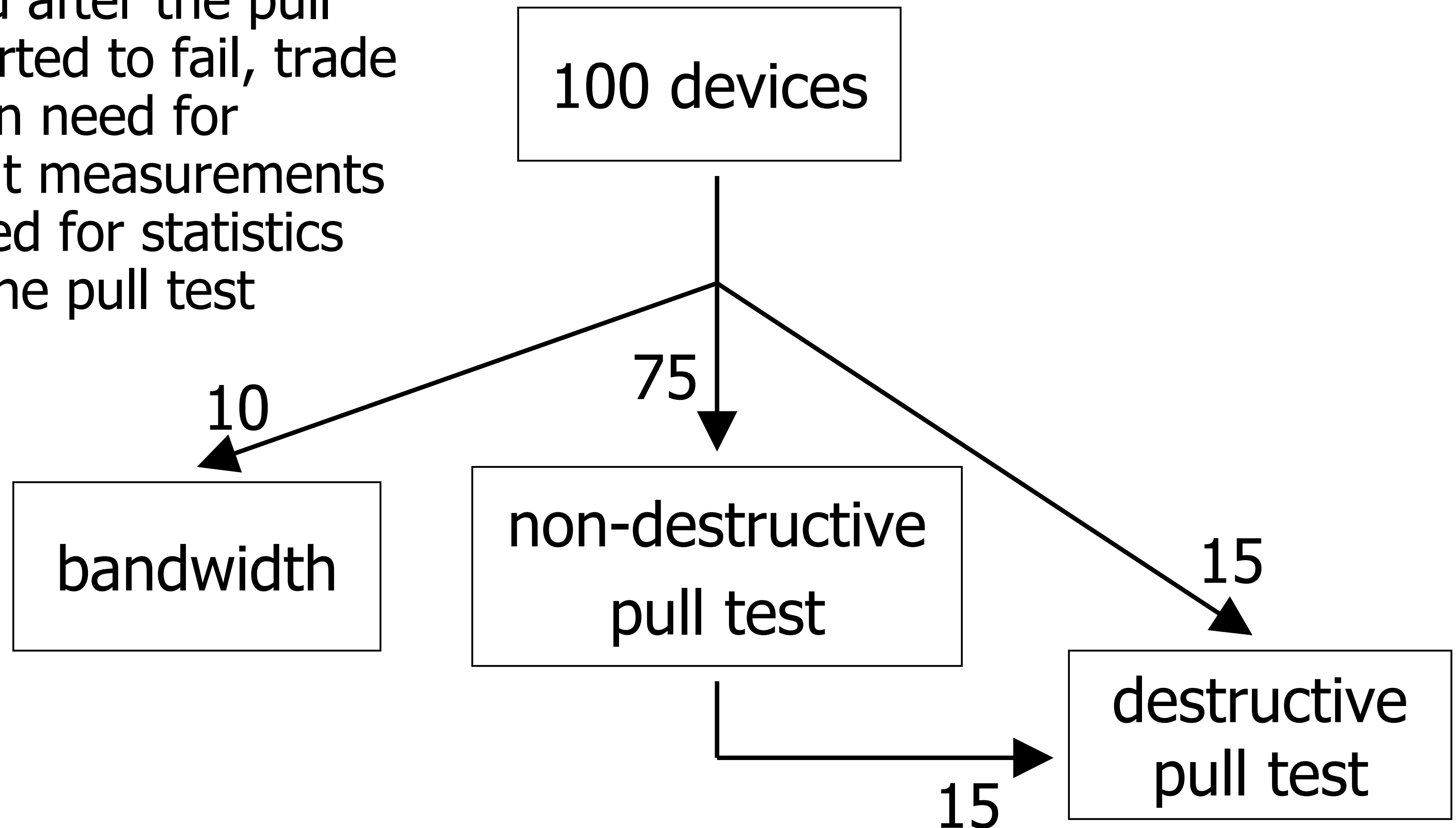
- Diode forward-biased with the voltage being increased from 0V in steps of 0.01V until the forward current exceeds 2mA
- Dark current at –5V measured before and after the sweep
  - Spec is 1nA





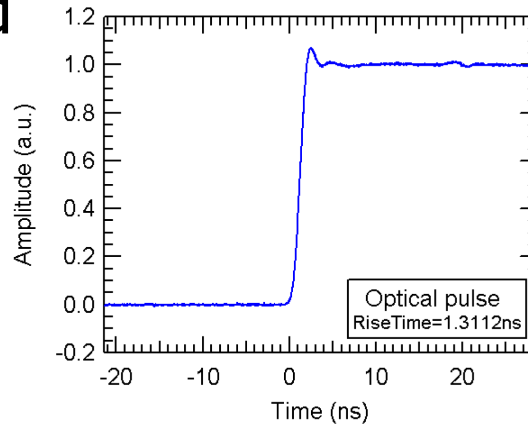
Subsequent Measurements

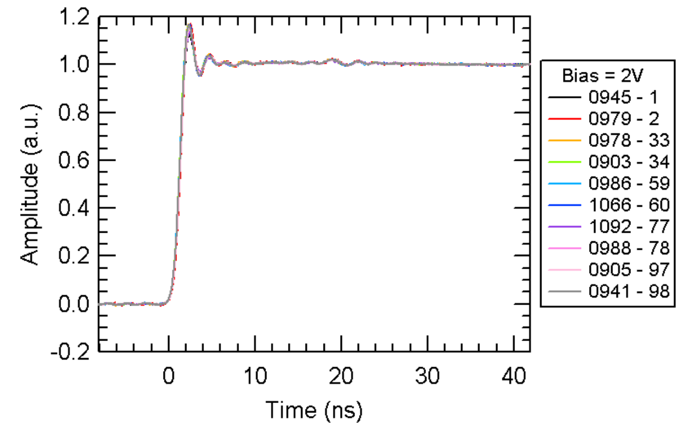
- 100 devices tested then according to different measurements
  - Decided after the pull test started to fail, trade between need for different measurements and need for statistics about the pull test

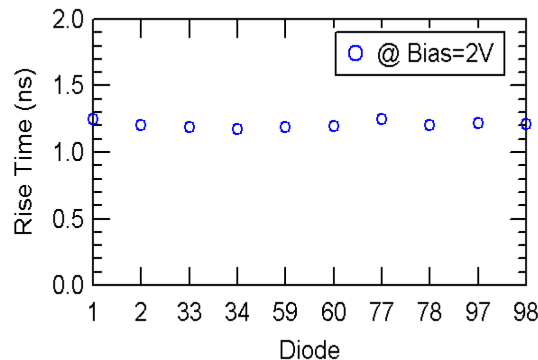


Bandwidth

- Diode connected to scope as optical head, with –2V bias, and fast pulse train applied

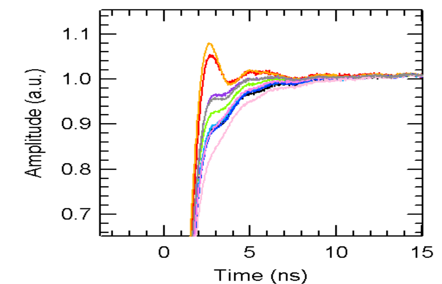






- Diode should not increase the rise time (10%-90%) of the pulse more than 3ns

Note: the behaviours are quite different when the bias is 0V: some diodes are slower



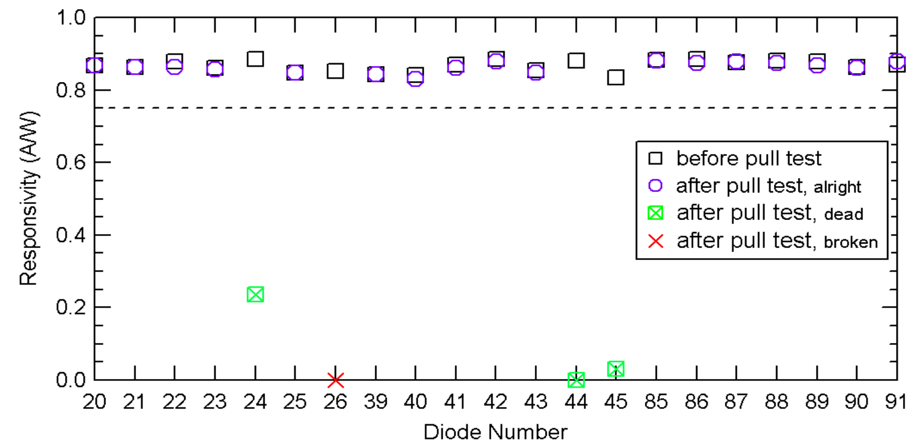
Non-Destructive Pull Test - 1

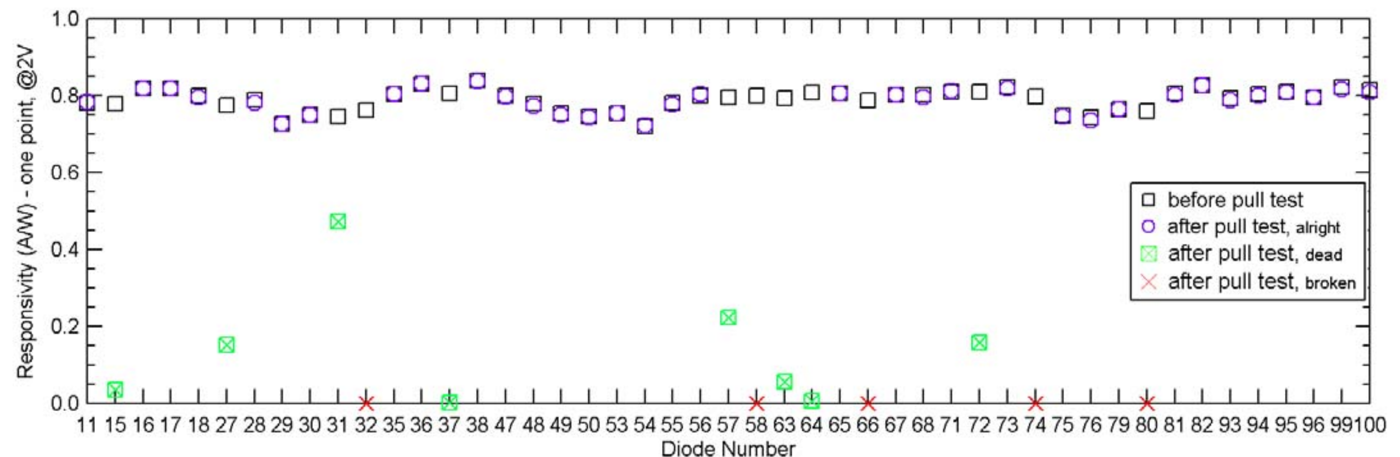
- Need to compare performance before and after pulling
- Early failures led to decide to test more devices
  - Three different test set-ups had to be used

  - 1st test: comparison of responsivity for 21 diodes
  - 2nd test: 2 lasers used, no comparison available
    - on 7 devices, which did not break
  - 3rd test: 1-point measurement for 47 devices

Non-Destructive Pull Test -2

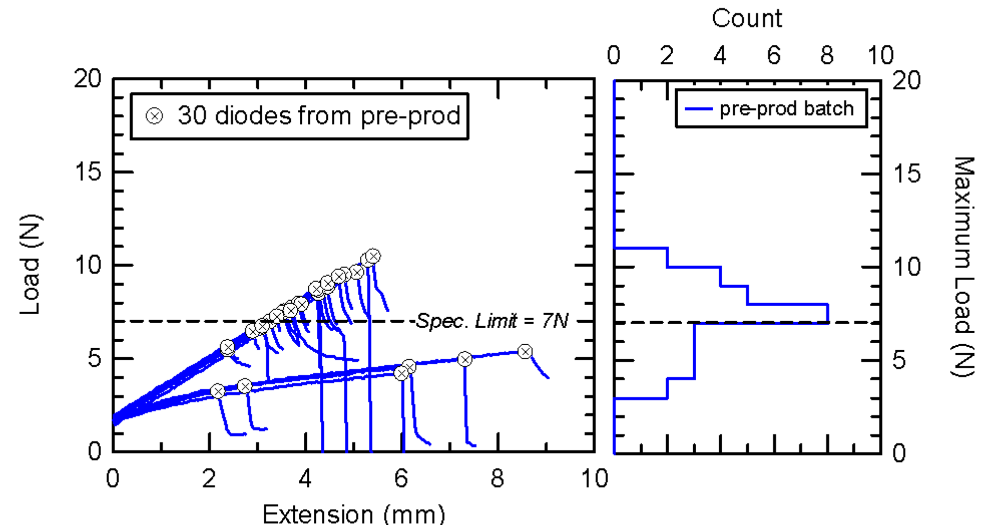
- Two different kinds of failure:
  - Diode detached from pigtail (*broken*)
  - Diode still attached but with low responsivity (*dead*)
- 17 failures in total (23%)
  - 11 dead
  - 6 broken

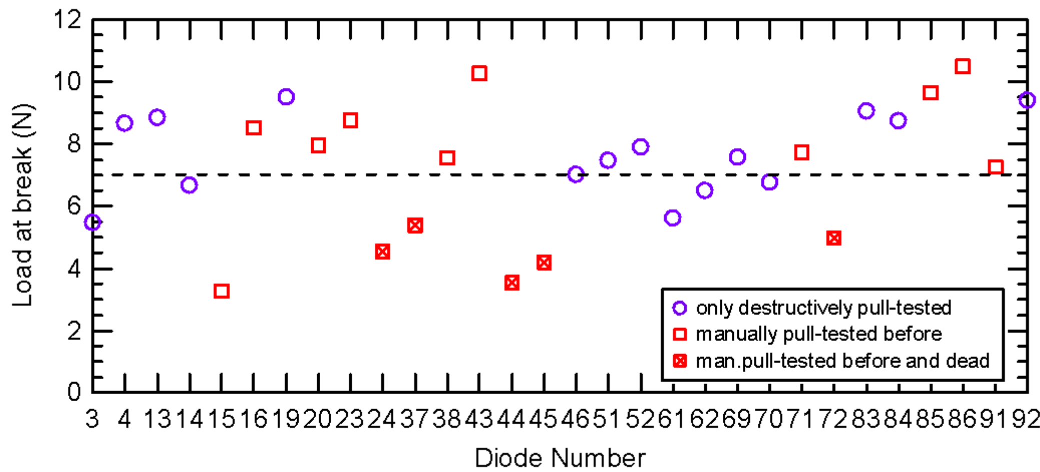


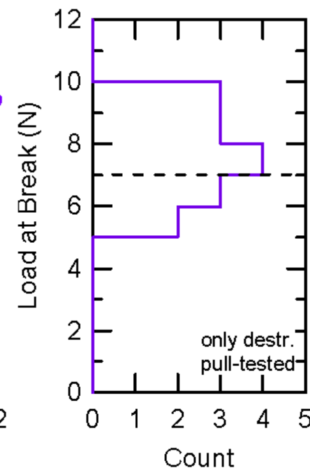


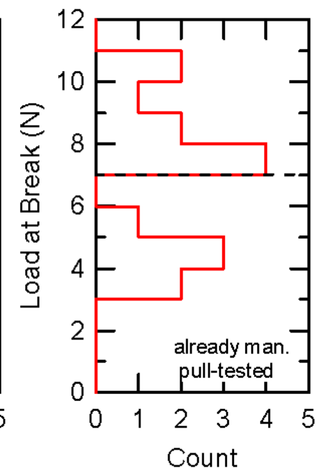
Destructive pull-test

- Pulled on MU-connector and diode ceramic
- 11 diodes out of spec
  - Dead (from manual pull-test) are clearly weaker









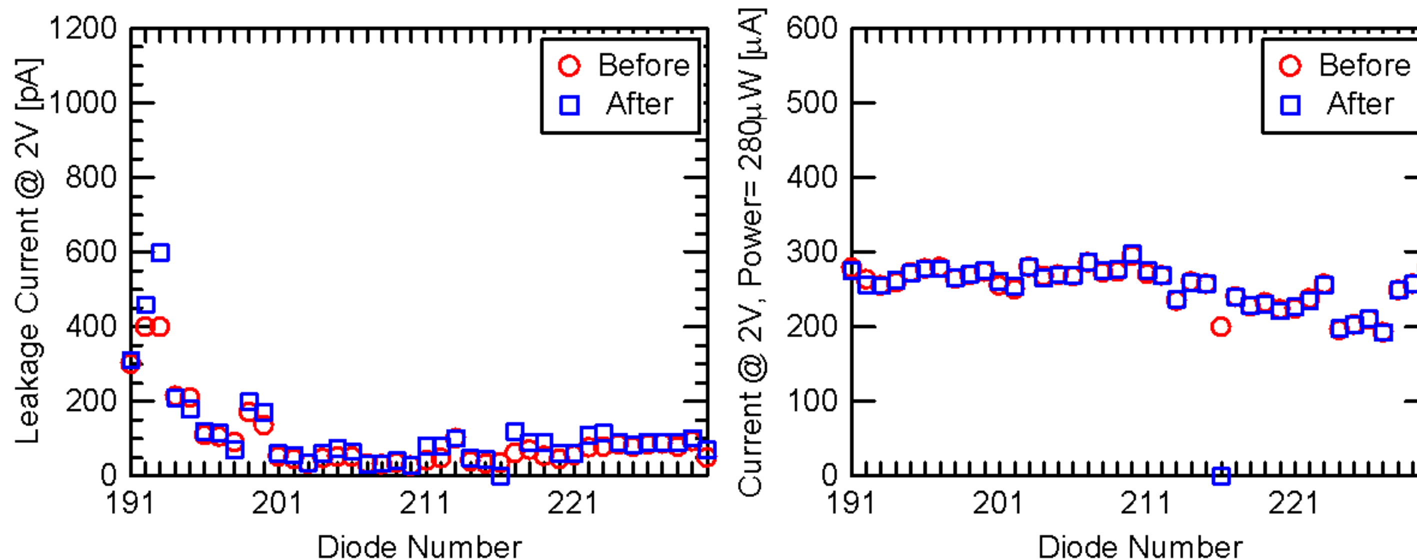
Re-qualification batch - 1

- 50 devices delivered after failure of pre-production
  - 40 non-destructively pull-tested
  - 30 (20 from 40 + 10 new ones) destr. pull-tested

- Visual inspection on 40 devices:
  - 2 cathodes 2.5mm long instead of 4mm
  - No bad scratches on fibre
  - Antistatic aluminum bends the pins

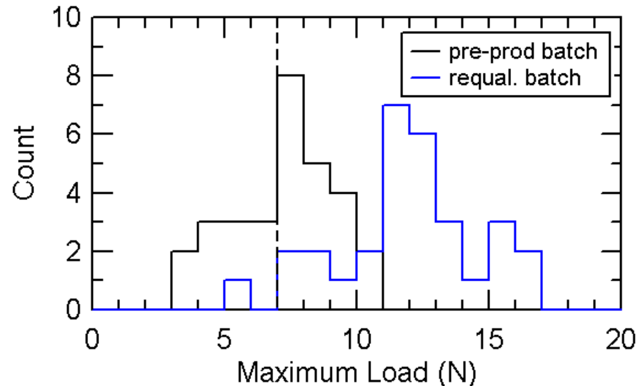
Re-qualification batch - 2

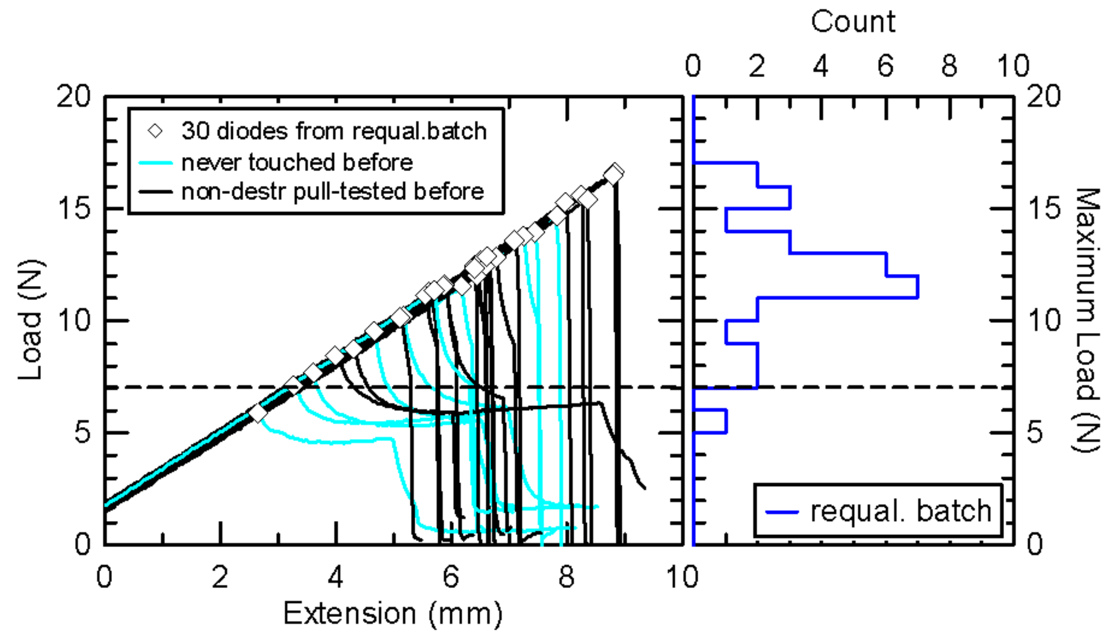
- Leakage current and photocurrent measured before and after the manual pull-test
  - Still not perfect, but very good improvement:
    - No *dead* ones, but 1 broke



Re-qualification batch - 3

- 30 diodes destroyed
  - No difference between new ones and pull-tested before ones
    - One broke on the MU side

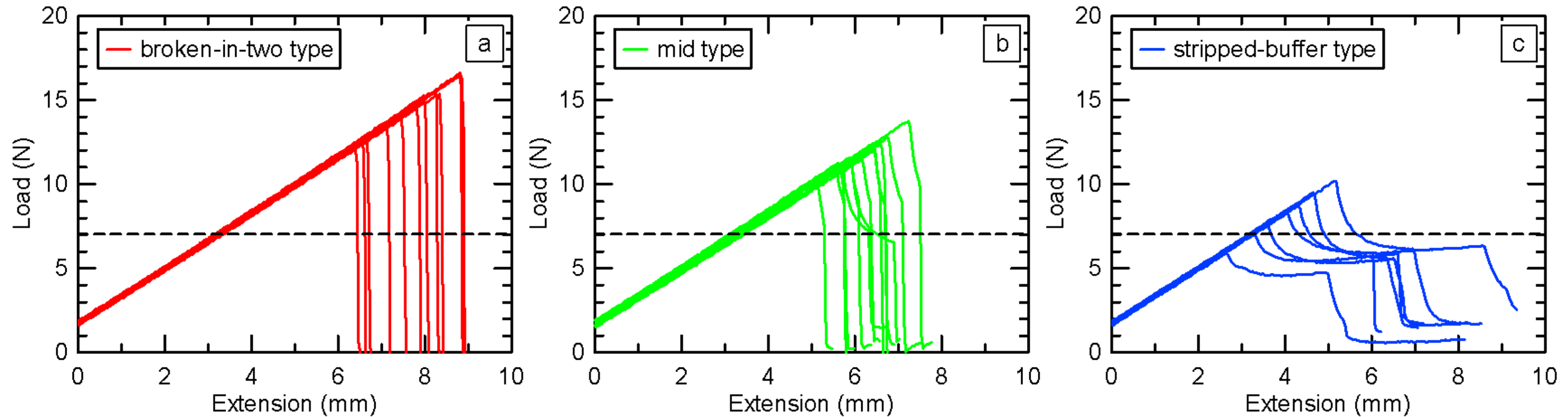


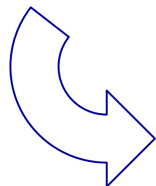


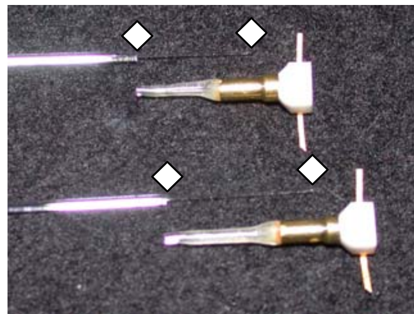
- Joint much stronger than before

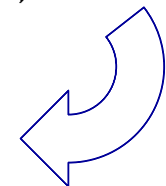
Re-qualification batch - 4

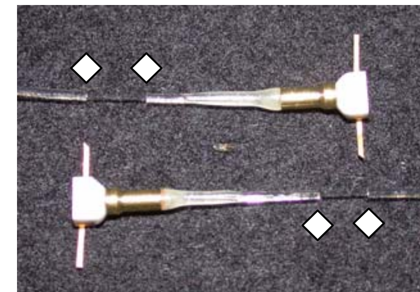
- Two different types of breakage observed











Summary

- As always, nothing is perfect at the first attempt
  - Some doubts about the visual inspection
  - Capacitance not perfectly targeted
  - Diode-pigtail joint first found too weak
    - More glue solved the problem almost completely

- Karl and Francois have the last word, but I think the diodes are **qualified**