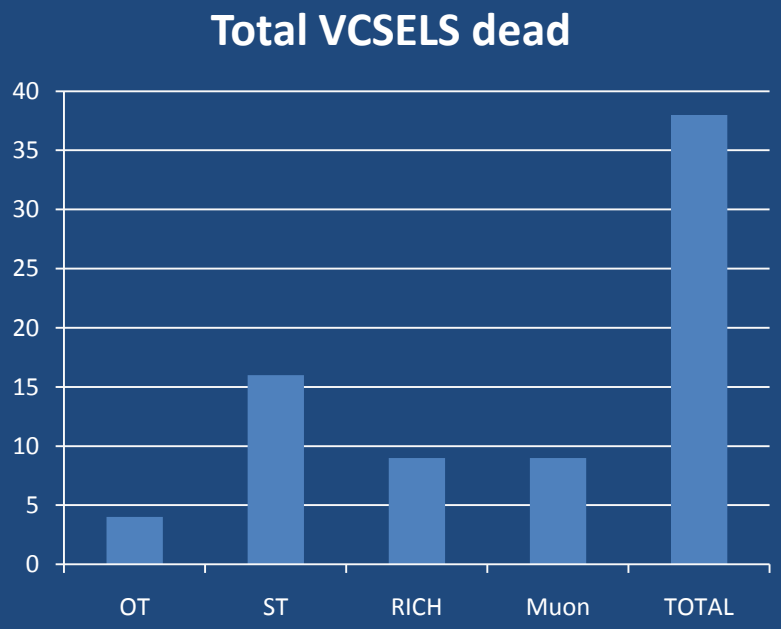
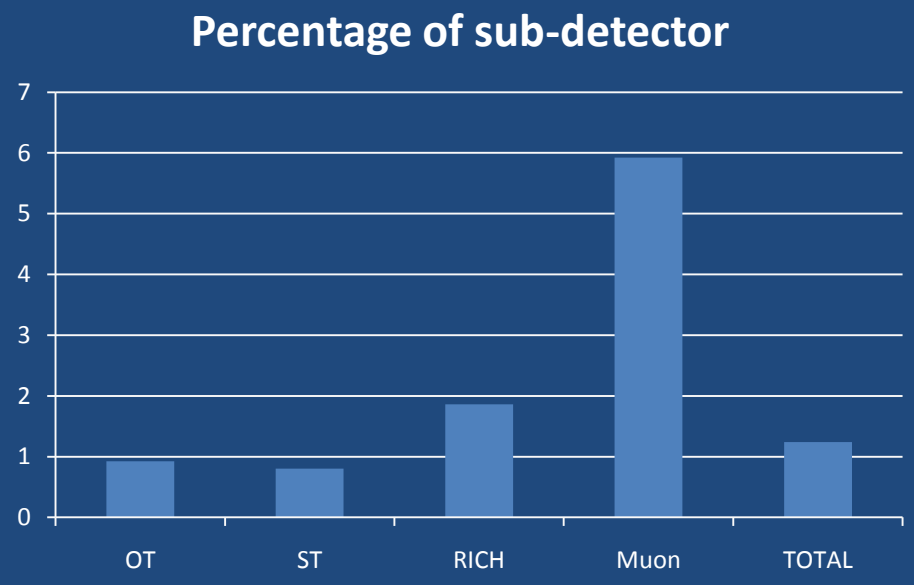
VCSELs in LHCb

LHCb has 3068 installed, all the same device, driven by GOL

2000 in Silicon Tracker
432 in Outer Tracker
484 in RICH
152 in Muons





VCSEL

Oxide-confined, 850nm, 6mW, 1mA threshold

Packaging (2 steps): TO-46
SMA

Burn-in after TO-46 packaging (48h at 100degC, 15mA)

Vendor promises:
good handling (ESD) procedures (but LHCb can't!)
good hermetic sealing
wafer position tracing (all from one wafer)

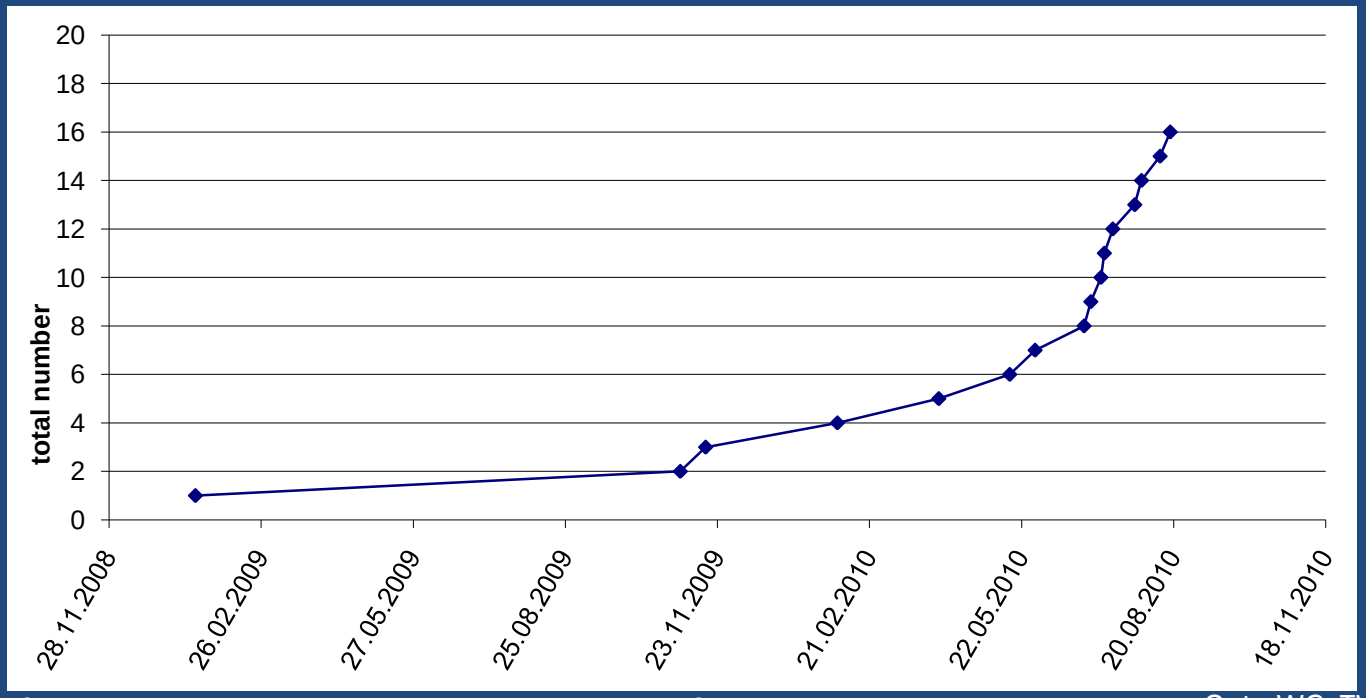
Bias currents 1.5 – 3 mA, modulation current = 10mA (fixed)
They are ALWAYS biased above threshold

Timeline

Before spring 2010:
RICH2 early deaths (2007-2008)
RICH1 (3): 2009(2), 2010(1)
All of Muon deaths

Since spring 2010:
All deaths in OT
Most in ST
RICH2 (2)

Rate is slow (or zero) except Silicon Tracker (biggest user)



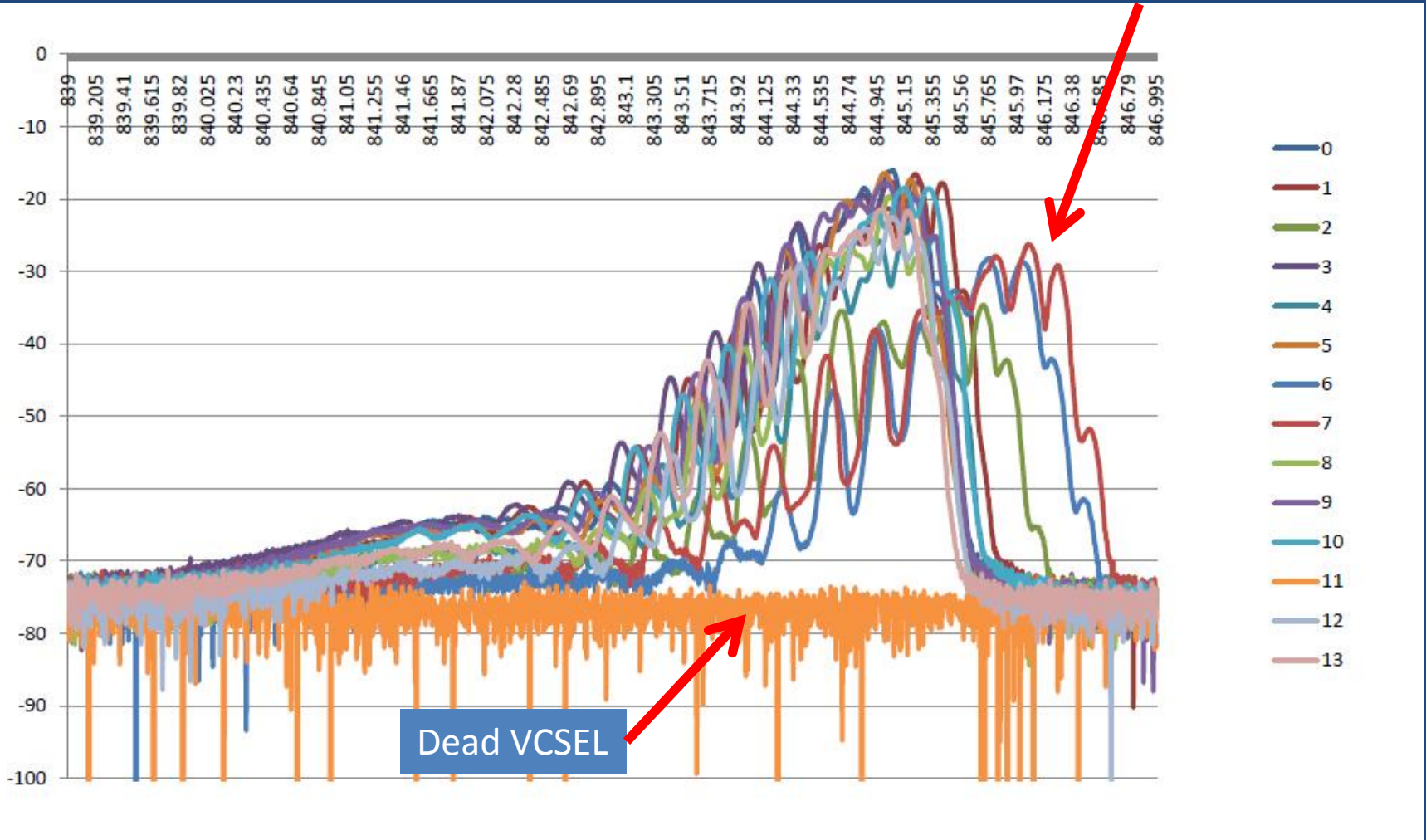
RICH tests

After consultation from Stefan Simion (ATLAS LAr), we measured optical spectrum of ~ 150 VCSELs in RICH

Look for correlation between spectrum shape and future death:
one subsequently died, but spectrum looked ‘normal’

We would like to measure all VCSELs when data-taking stops this year

OSA on RICH1, column D3



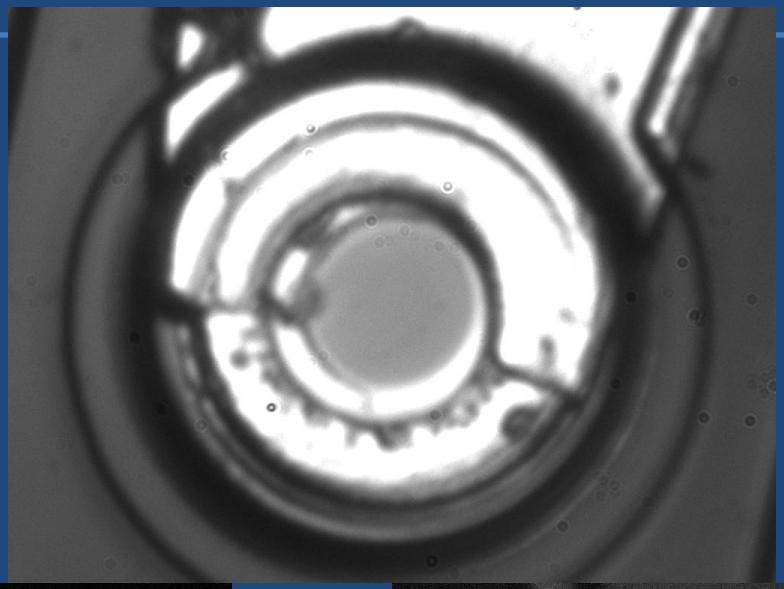
Failure analysis by vendor

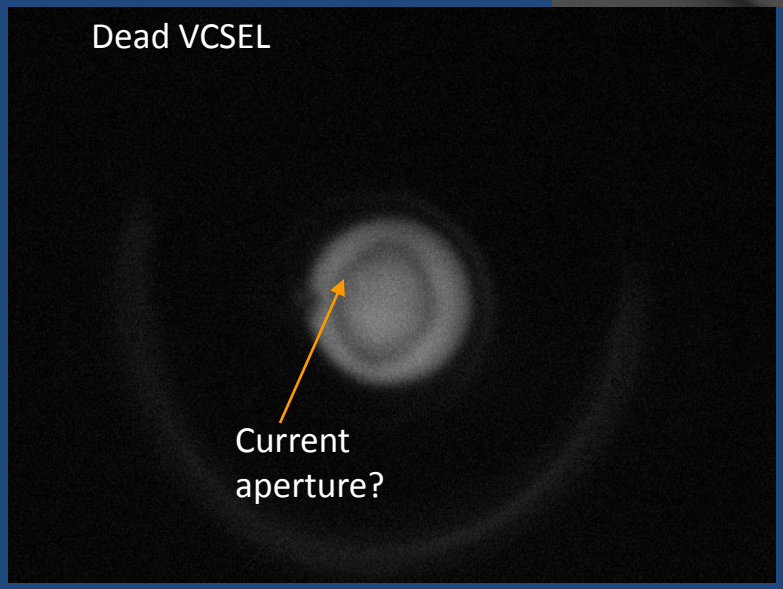
LIV curves: downward shift in diode-turn-on voltage

Only light output from spontaneous emission
-> electro-luminescence images

Preparing for imaging with electron microscope (DLDs)

Vendor admits failure rate is much higher than normal




Dead VCSEL
Current aperture?


New devices from same wafer with very small bias current

Plans

Discussing with vendor on:
Failure analysis
Bad wafer?
-> vendor will extend burn-in on samples from same wafer and another wafer
Purchase replacements (based on these results)
Consider alternative devices……

End of year:
OSA measurements, and replace suspicious devices

Our VCSELS are ‘accessible’