Optimization of the ATLAS Muon Detector Readout for high counting rates

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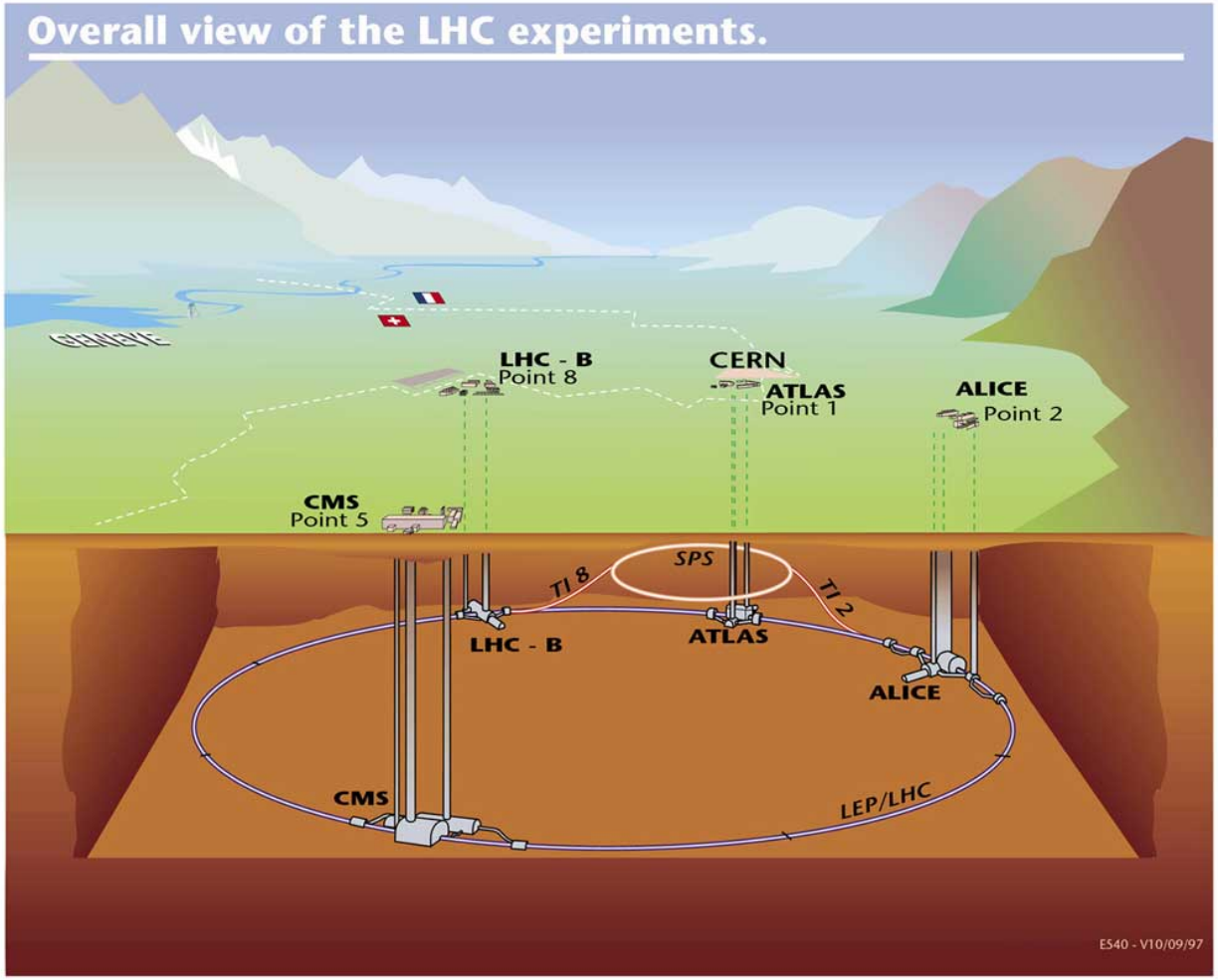
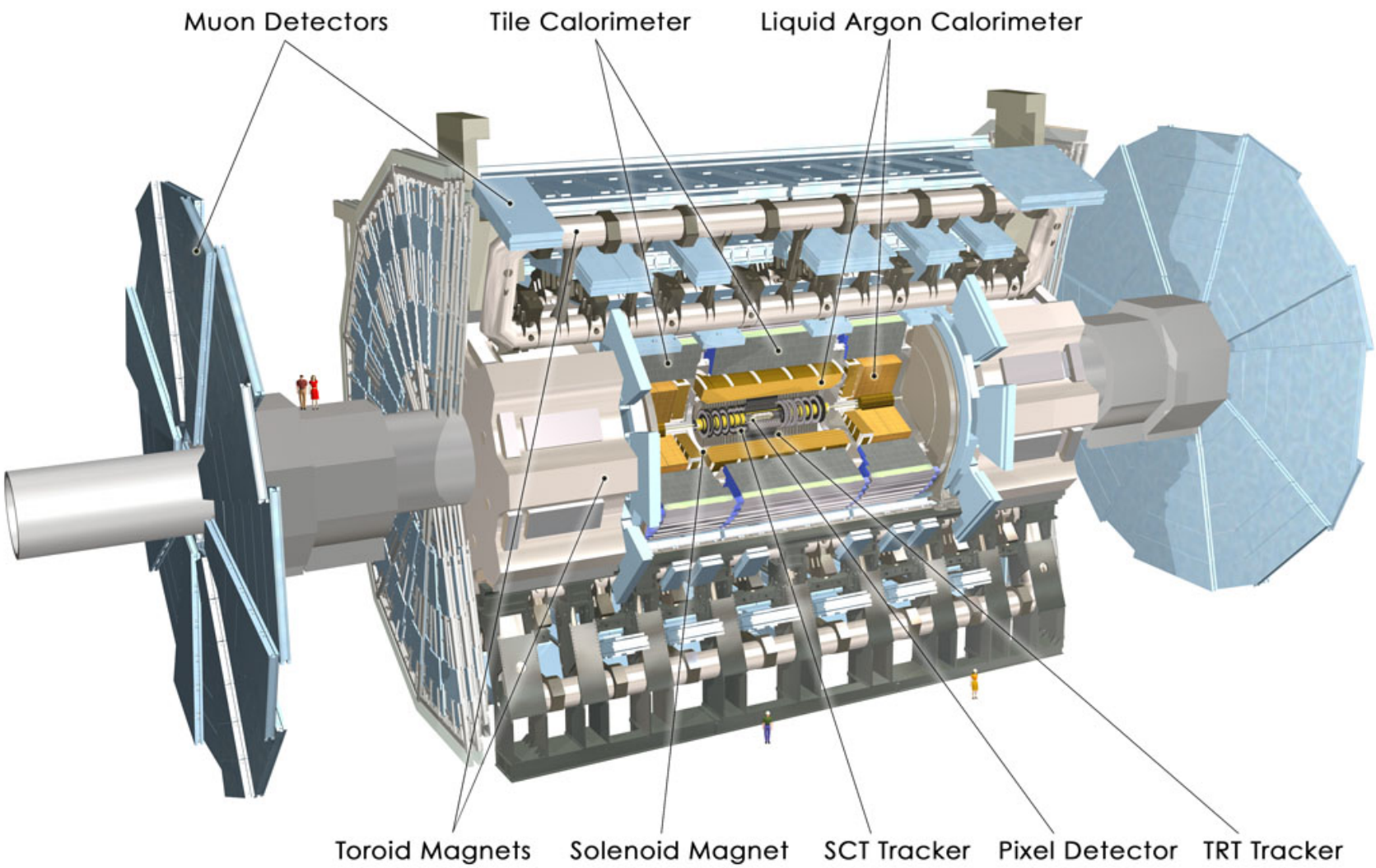
LHC

- Proton-Proton collision at 7 - 8 TeV (2012)
- Aim of energy increase: 13 TeV (2015)
- Design luminosity: 10^{34} $cm^{-2}s^{-1}$ (2015)
- Luminosity increase to $7*10^{34}$ $cm^{-2}s^{-1}$ (2023)

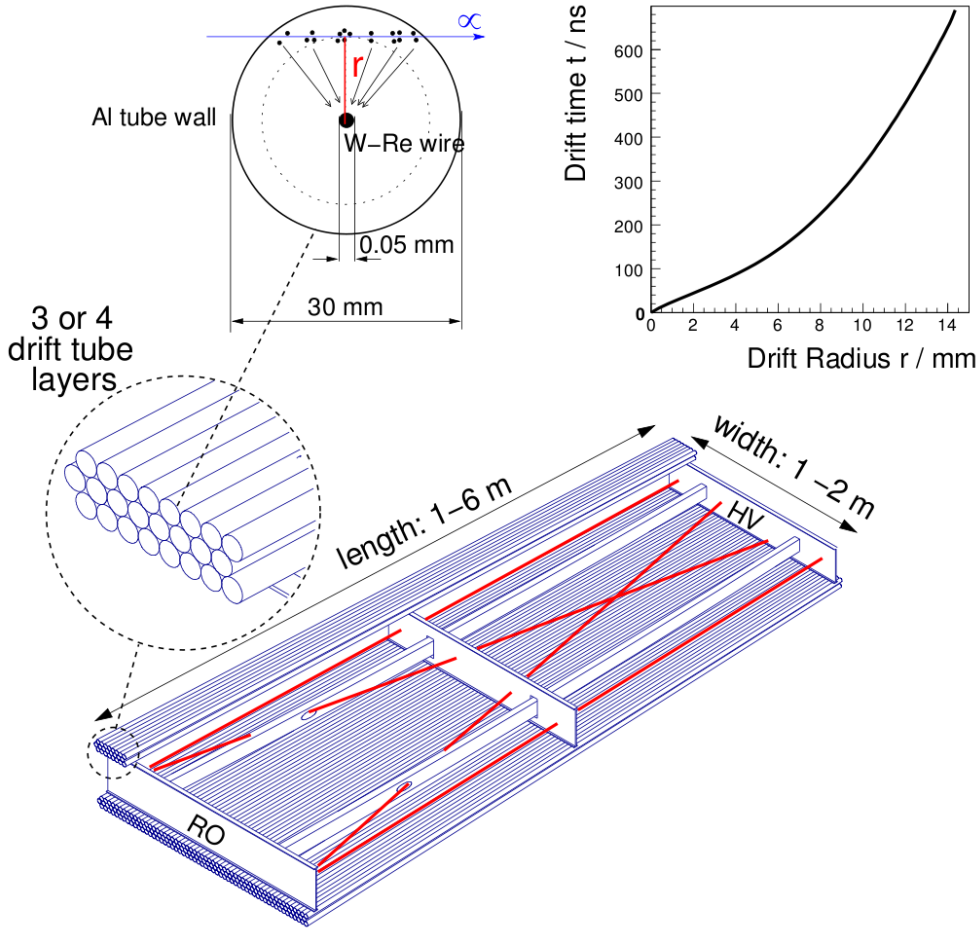


ATLAS


Muon Detectors
Tile Calorimeter
Liquid Argon Calorimeter
Toroid Magnets
Solenoid Magnet
SCT Tracker
Pixel Detector
TRT Tracker

ATLAS Monitored Drift Tube (MDT)-Chamber

- Tube diameter 30 mm (currently mounted)
- Gasmixture Ar/CO_2 (93/7)
- Pressure: 3 bar
- Voltage: 3080 V
- Max. drifttime: 700 ns
- Nonlinear r-t-relation
- Background rate capability: 300 kHz/tube (500 Hz/cm^2)

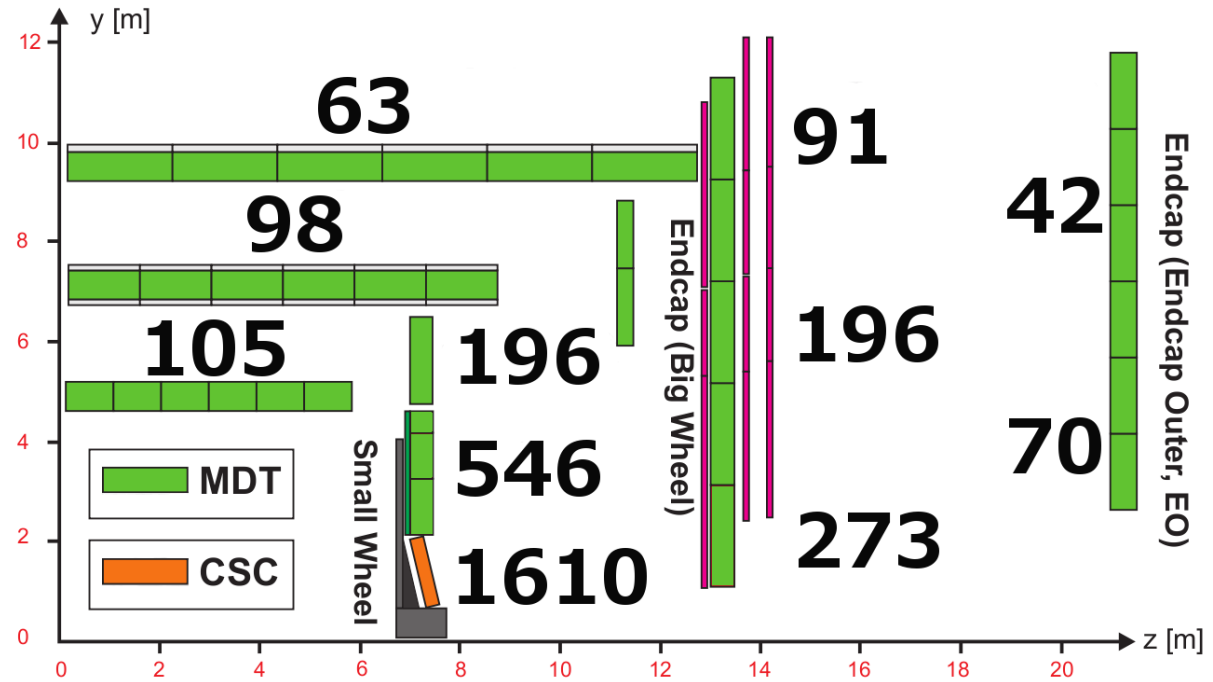


Upcoming Requirements

Background:

- Photons
- Neutrons

- Background $\propto$ luminosity



- Higher signal rates

$\Rightarrow$ In some regions the MDT-chambers will come to their limits

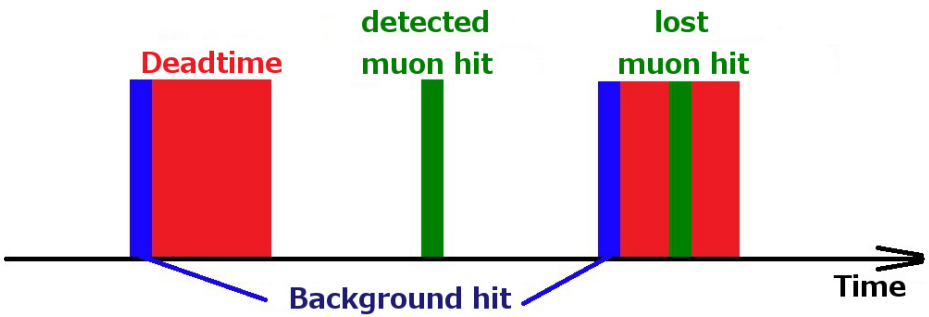
Improvement of the MDT-Chambers - sMDT

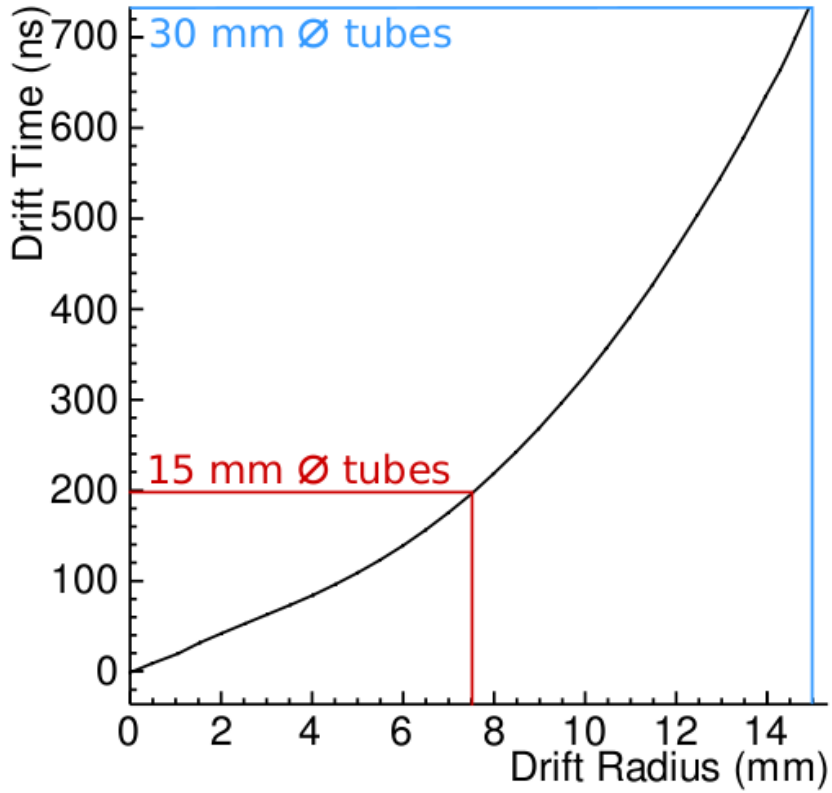
Reducing the diameter to 15 mm

- Shorter max. drifttime

⇒ Deadtime can be reduced

⇒ Fewer masking effects



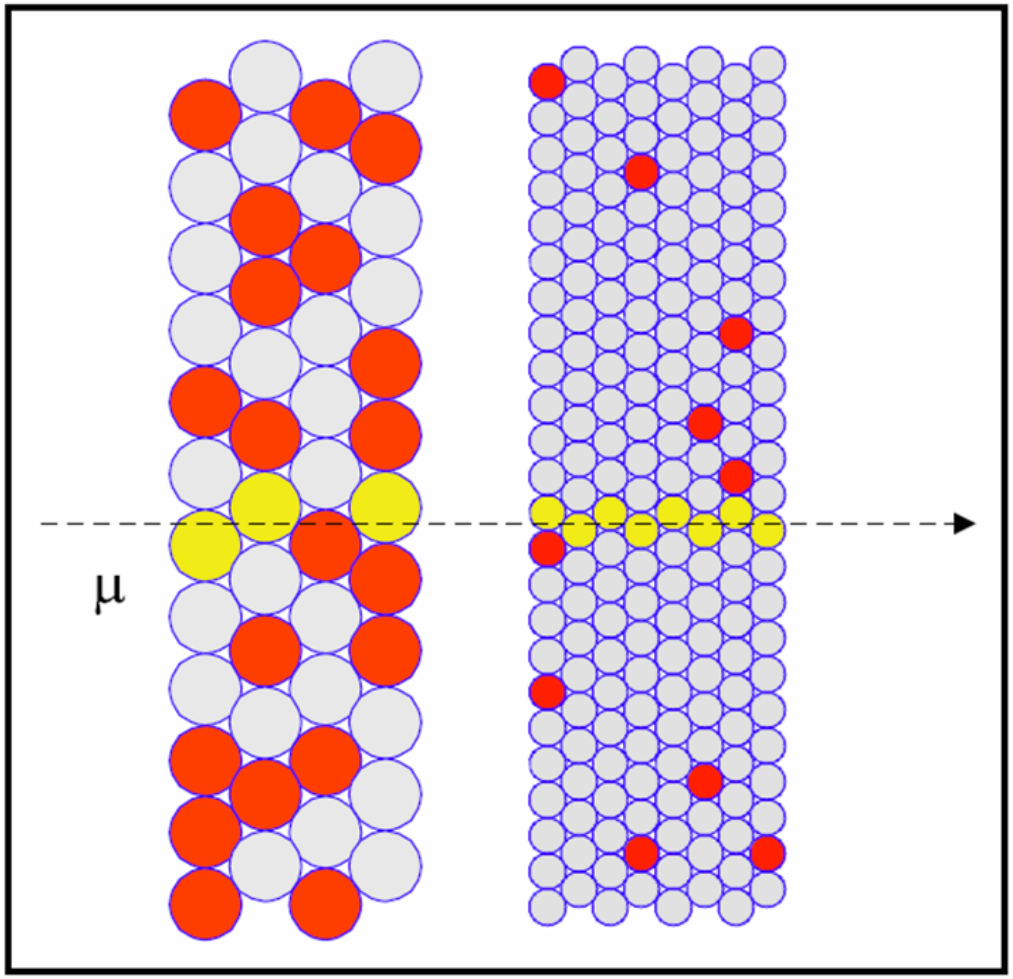


Improvement of the MDT-Chambers - sMDT

Reducing the diameter to 15 mm

- More tubes per chamber

$\Rightarrow$ Lower occupancy

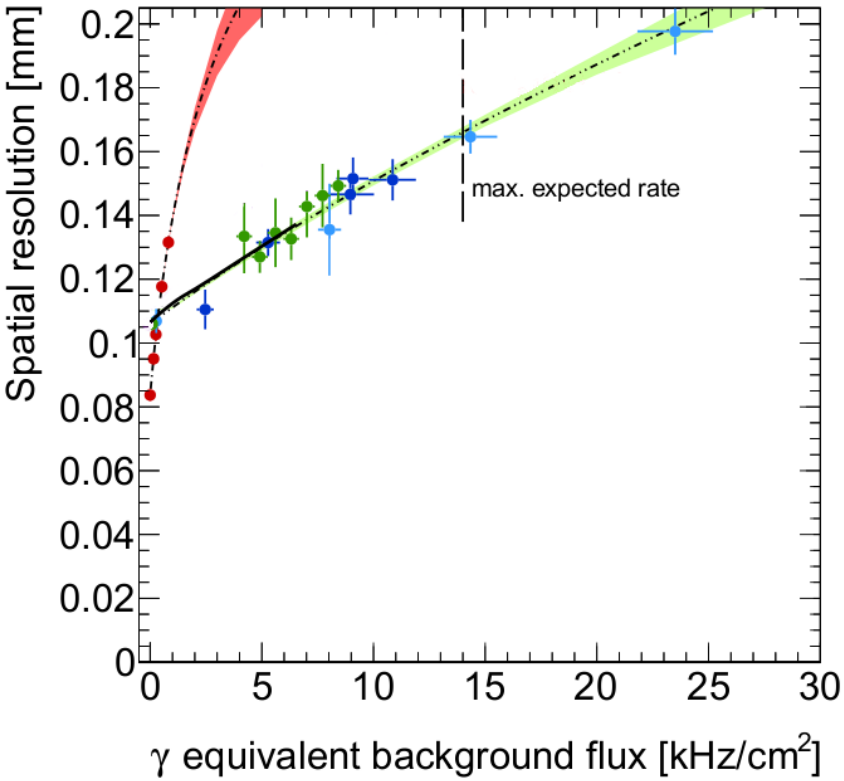


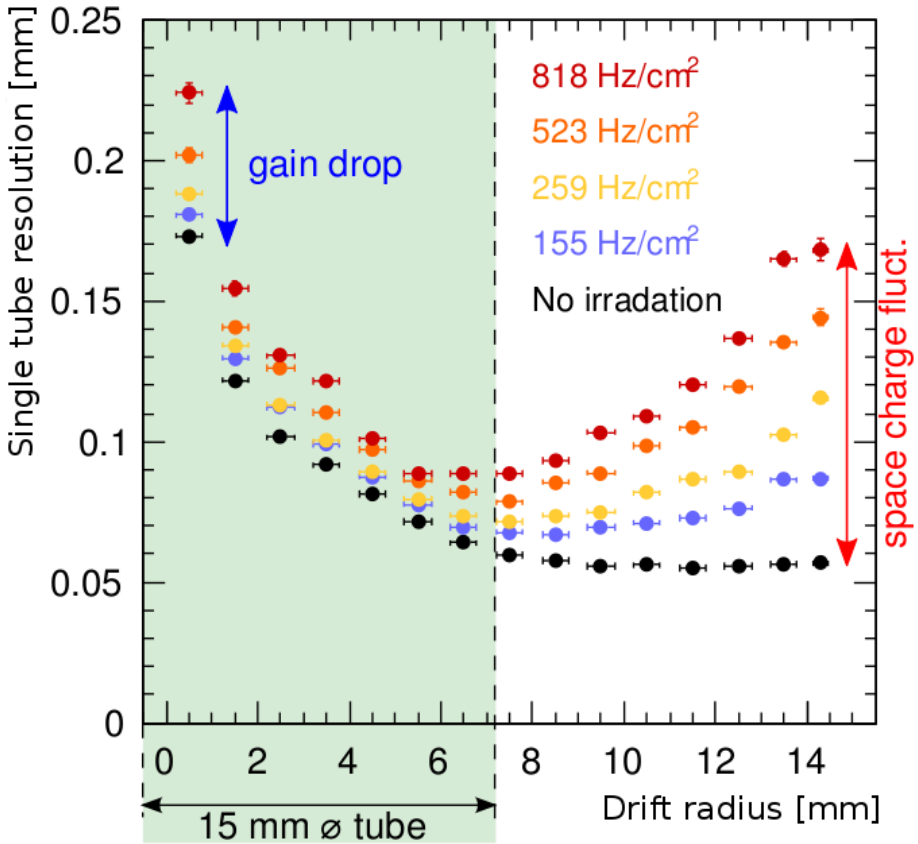
Improvement of the MDT-Chambers - sMDT

Reducing the diameter to 15 mm

- Less space charge fluctuations

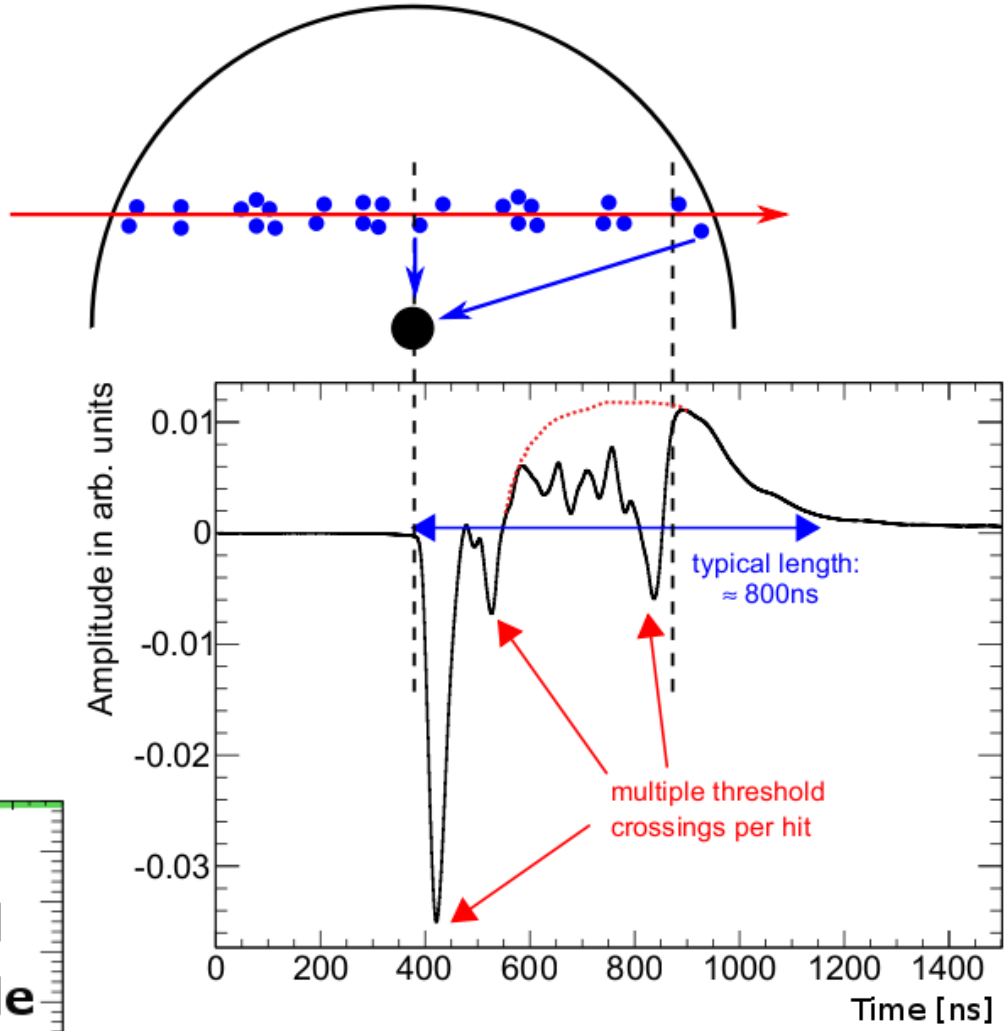
⇒ Better resolution

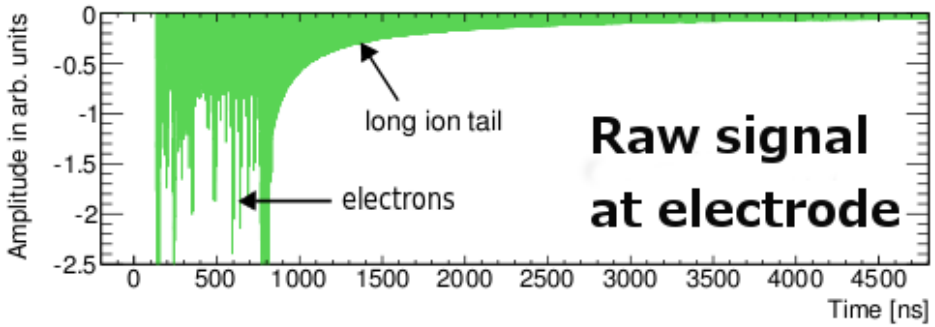




Improvement of the MDT-Chambers - sMDT

- e^--Ion-pairs
- Fast e^- signal is interesting
- Multiple threshold crossings for one Muon possible

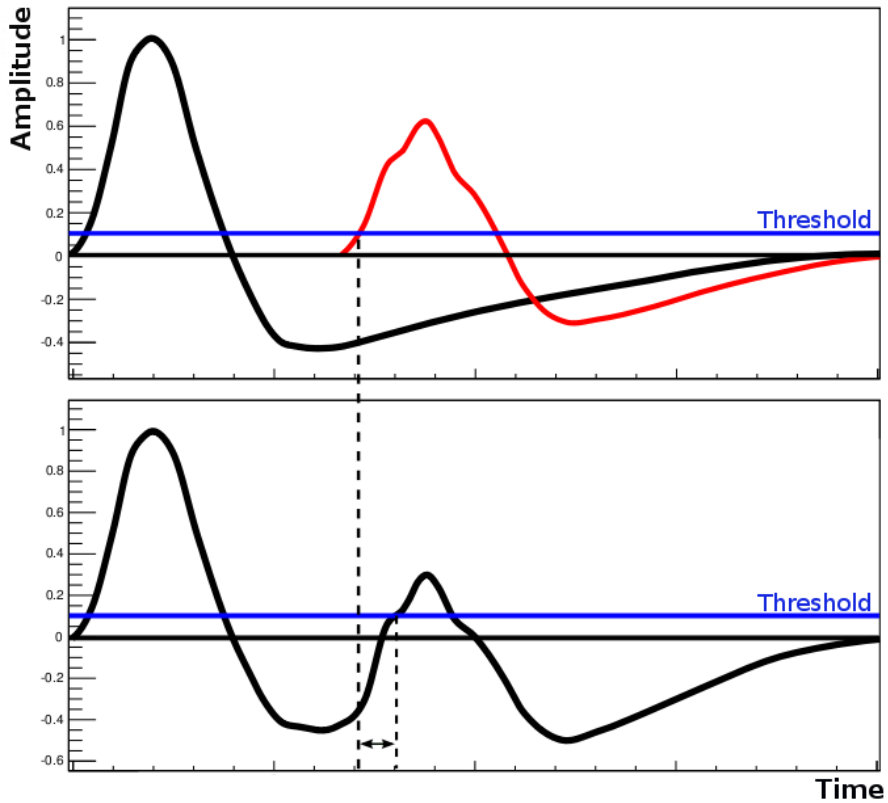




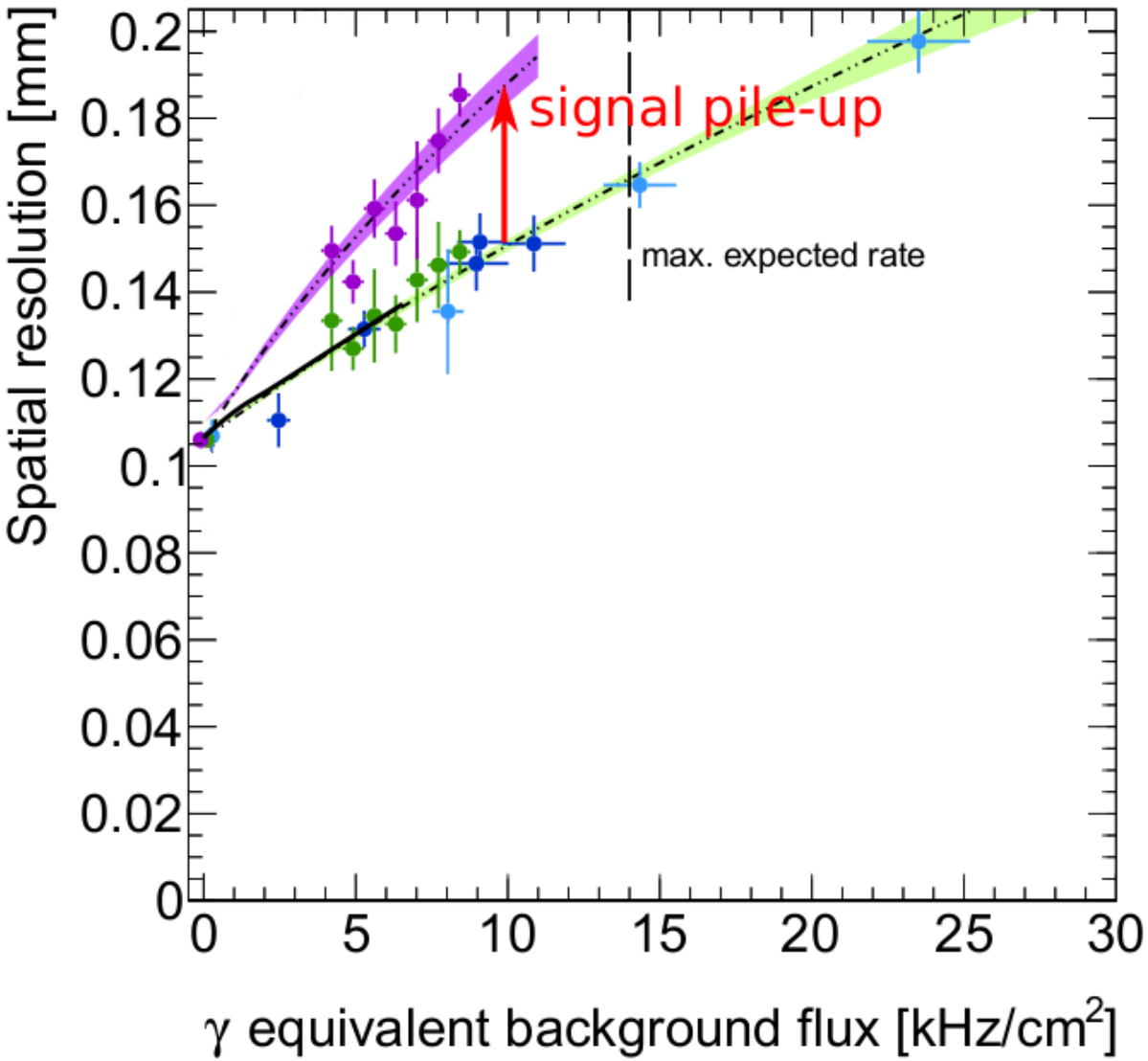
Signal Pile-Up

- Large undershot from bipolar shaping
- Shift of a second threshold crossing
- Even loss of second hit is possible
- Efficiency loss

$\Rightarrow$ Still more potential in the sMDT



Signal Pile-Up



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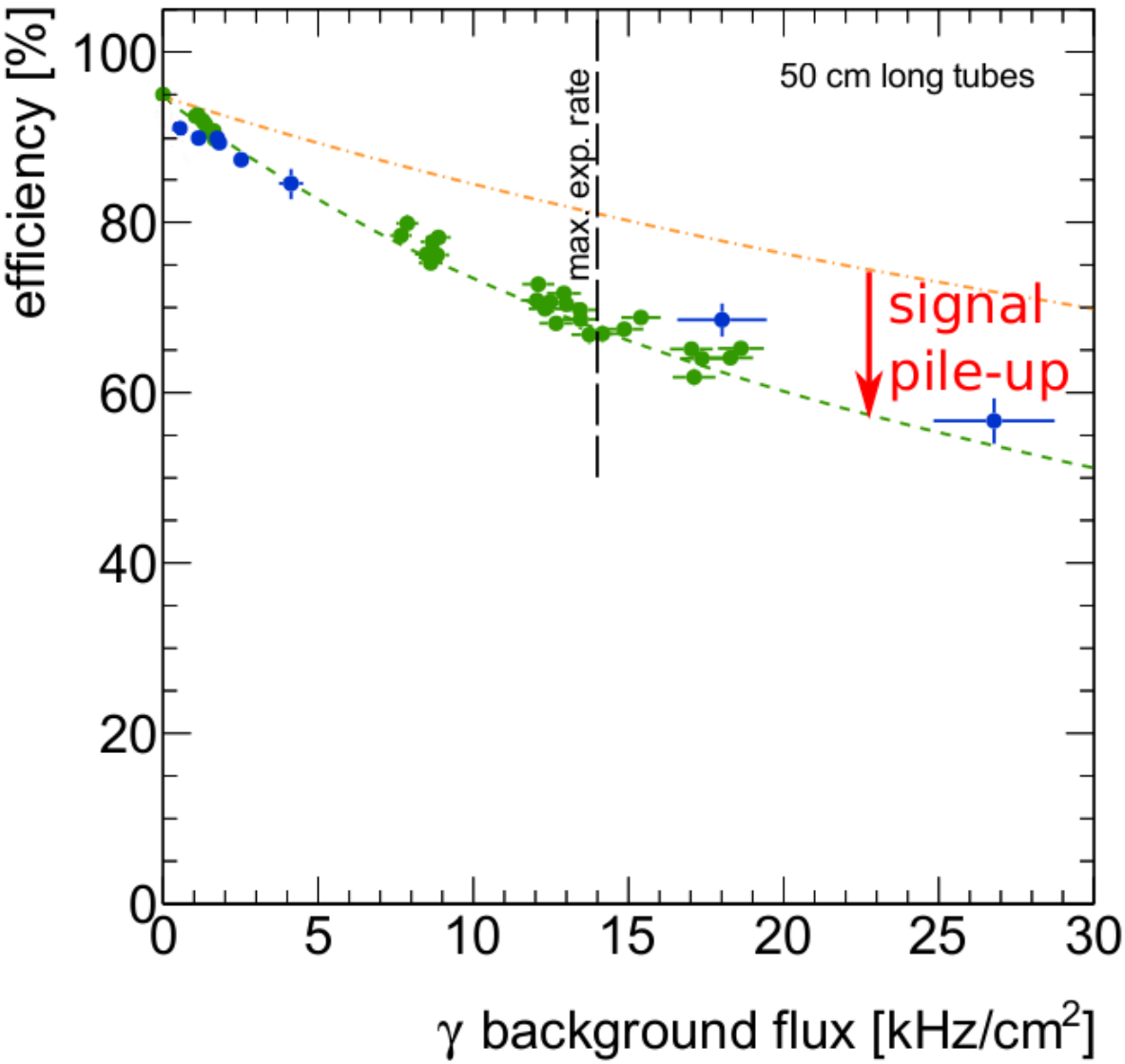


Base Line Restauration

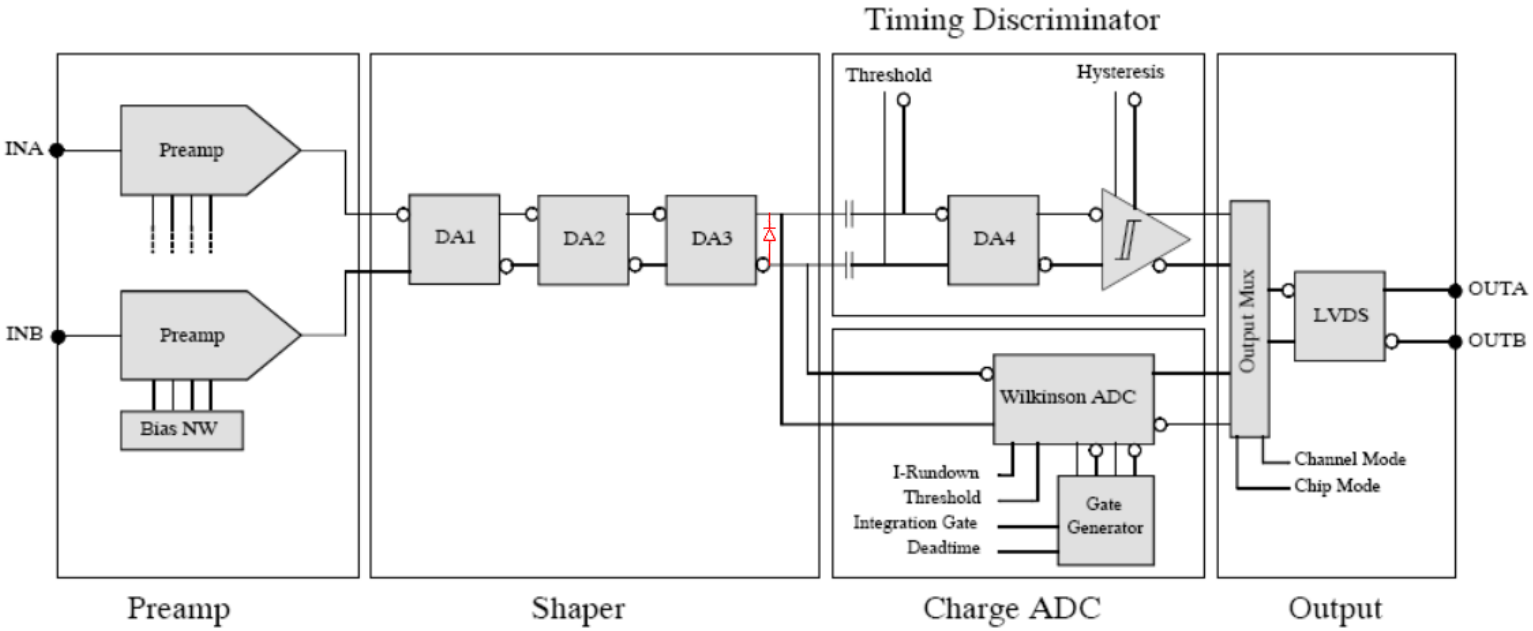
- The aim is to get rid of the long signal tail

$\Rightarrow$ Negative signal part is unwanted

- Simplified idea:
  Insertion of a diode

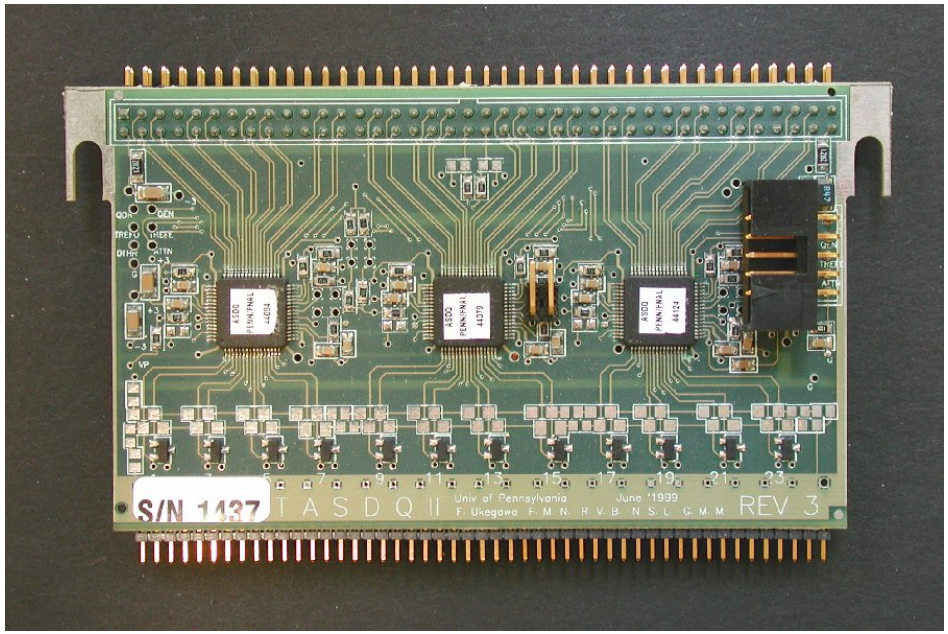
$\Rightarrow$ Negative part is 'cut' off

$\Rightarrow$ Lower deadtime



Testsetting

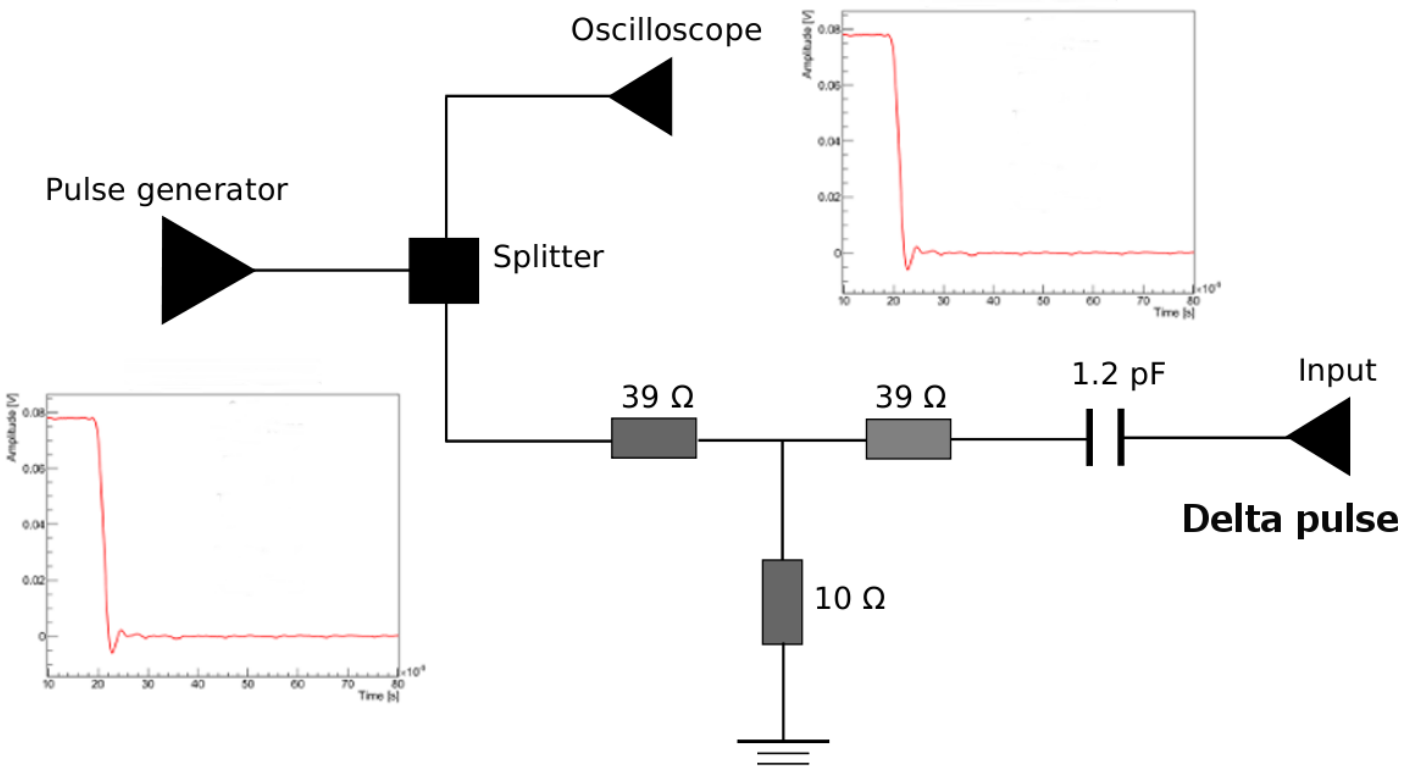
- Testboard with BLR electronics
- Delta pulse



First Test of Readout Electronics with BLR

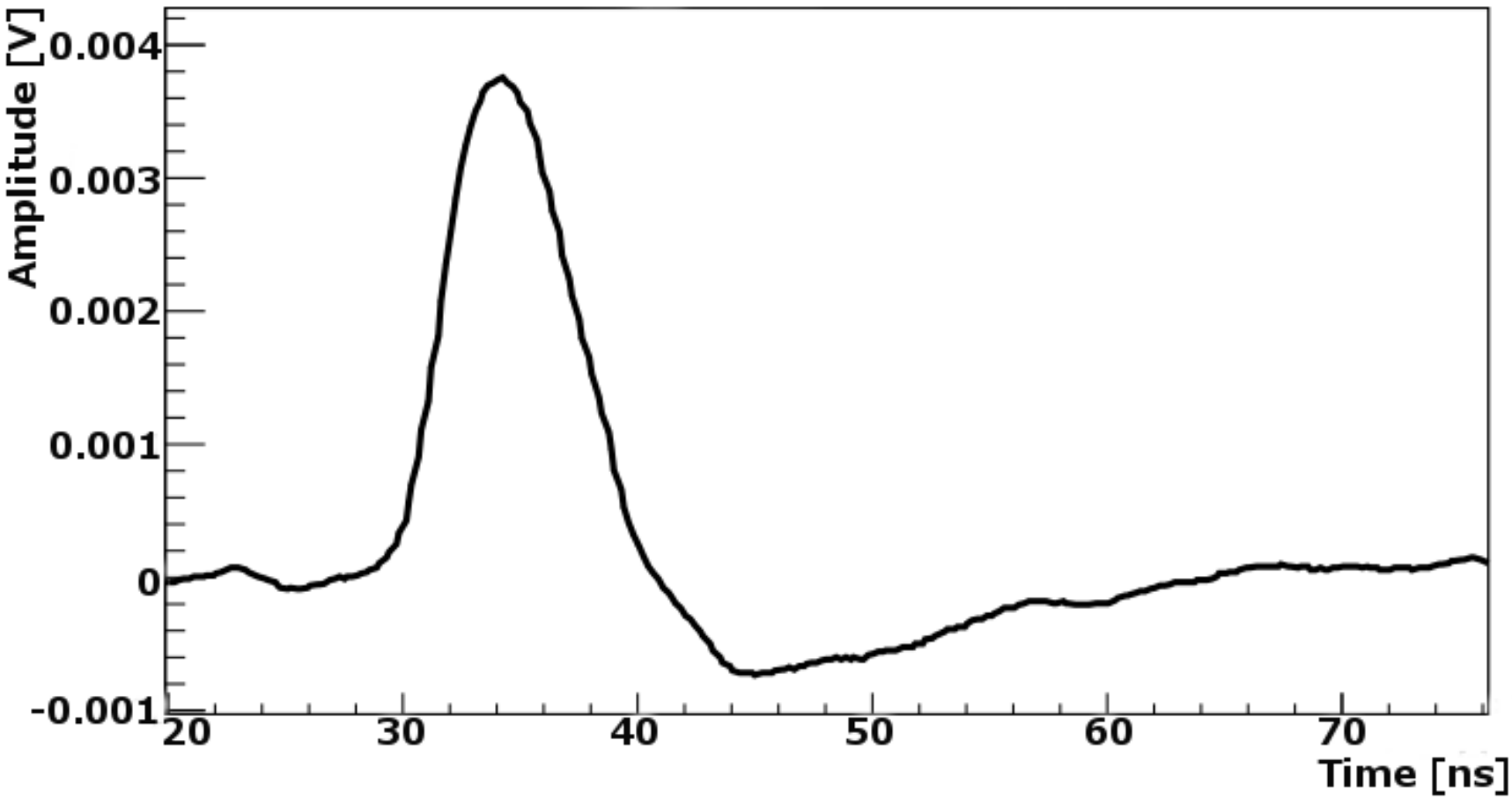
- Rectangular signal from pulse generator
- Feeding the input via capacitor

$\Rightarrow$ Delta pulse at the input of the electronic



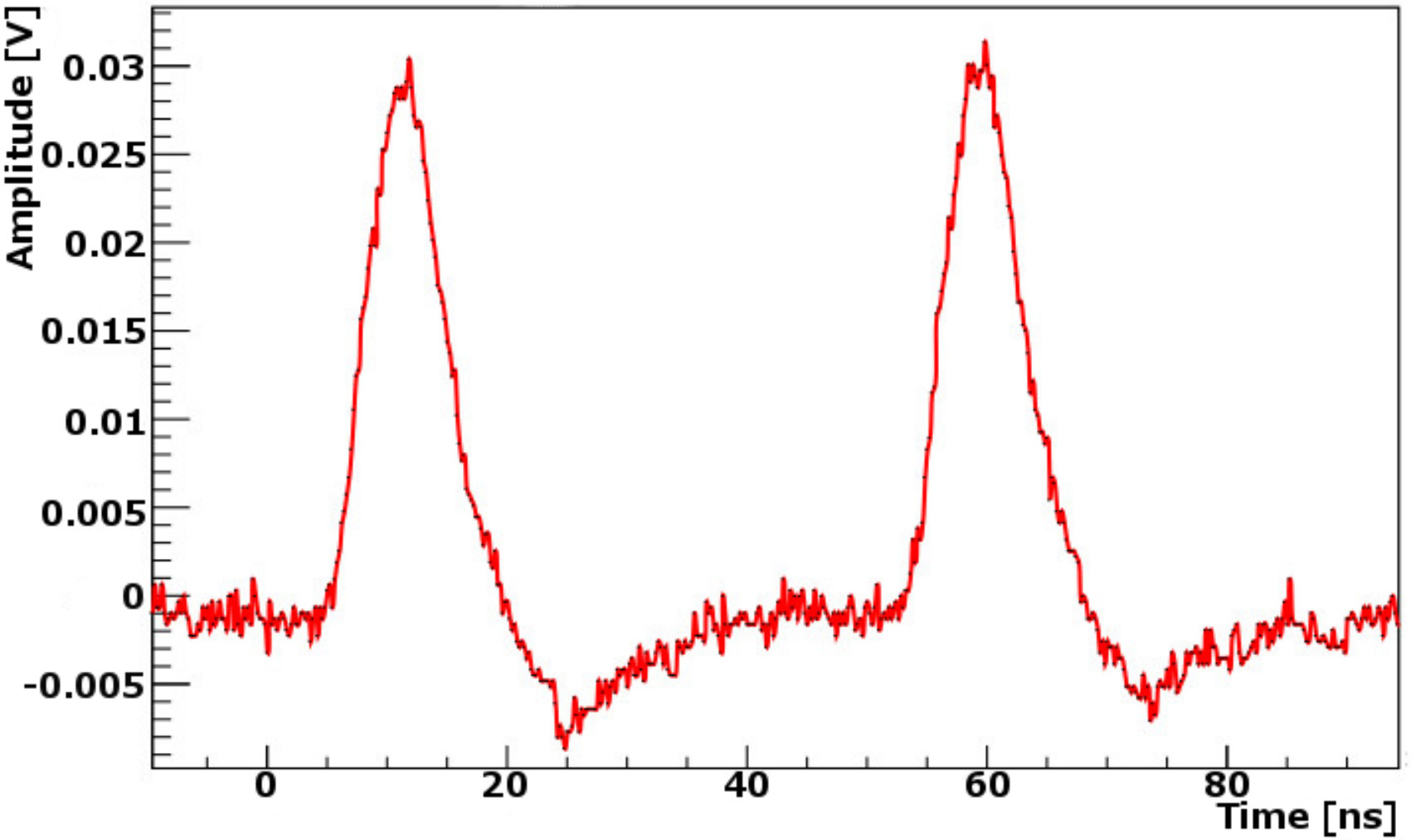
First Test of Readout Electronics with BLR

- Only a small undershot
- Fast base line restauration



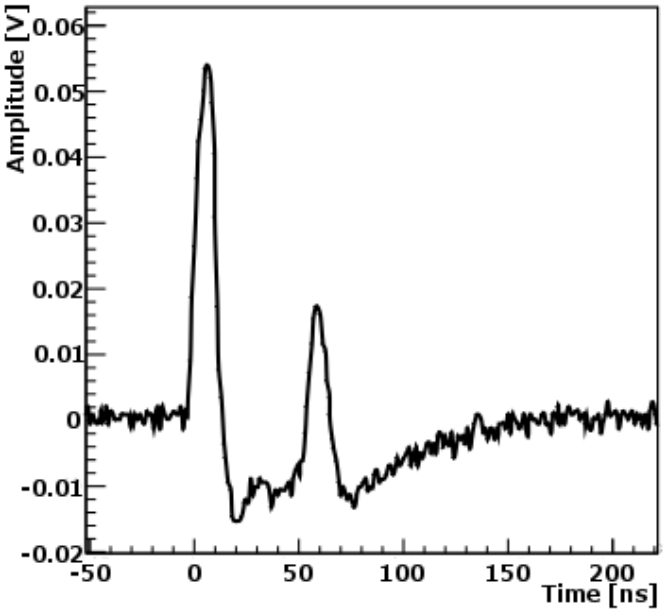
First Test of Readout Electronics with BLR

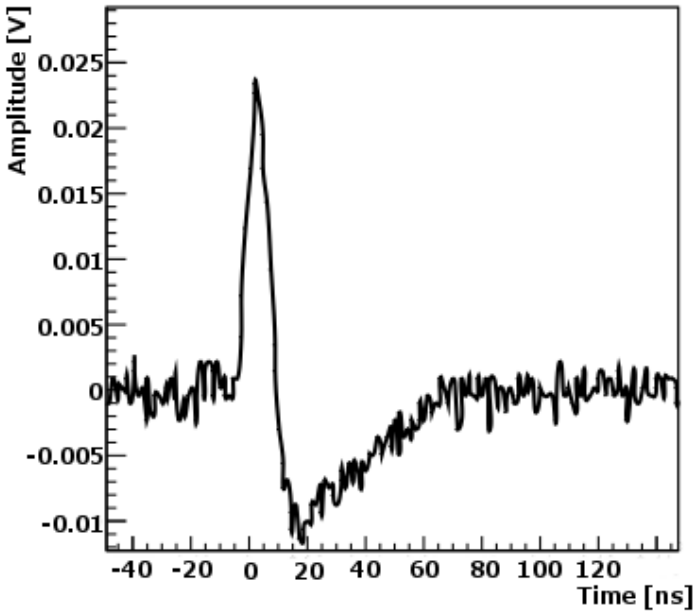
- No pile-up
- No loss of amplitude

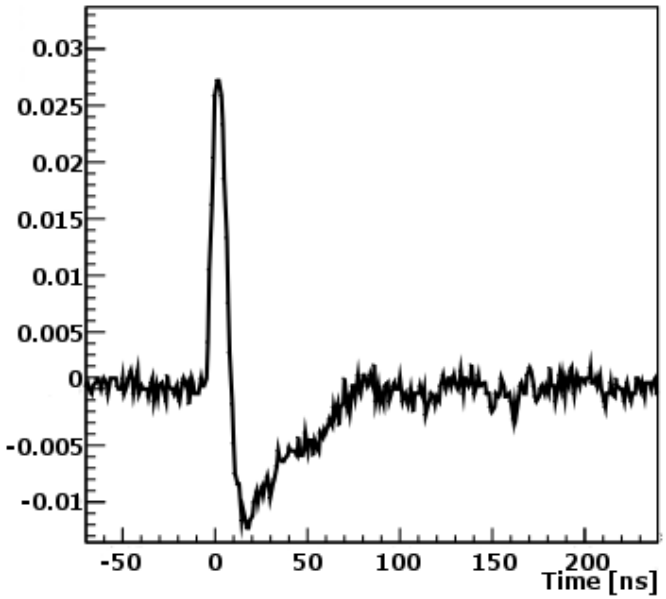


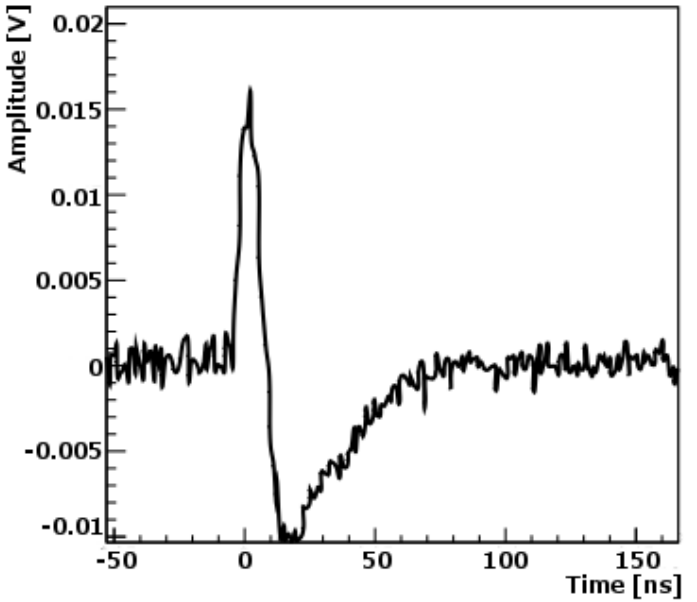
First Test of Readout Electronics with BLR

First Test of Readout Electronics with BLR









Conclusion and Summary

- Signal pile-up lowers efficiency
- Shaping has to be improved
- Chip with BLR
  - Shows expected characteristic
  - Lowers deadtime
  - Shortens the undershot
- Test measurements on a chambers
- Development of a new adjusted chip

Thank you for your attention