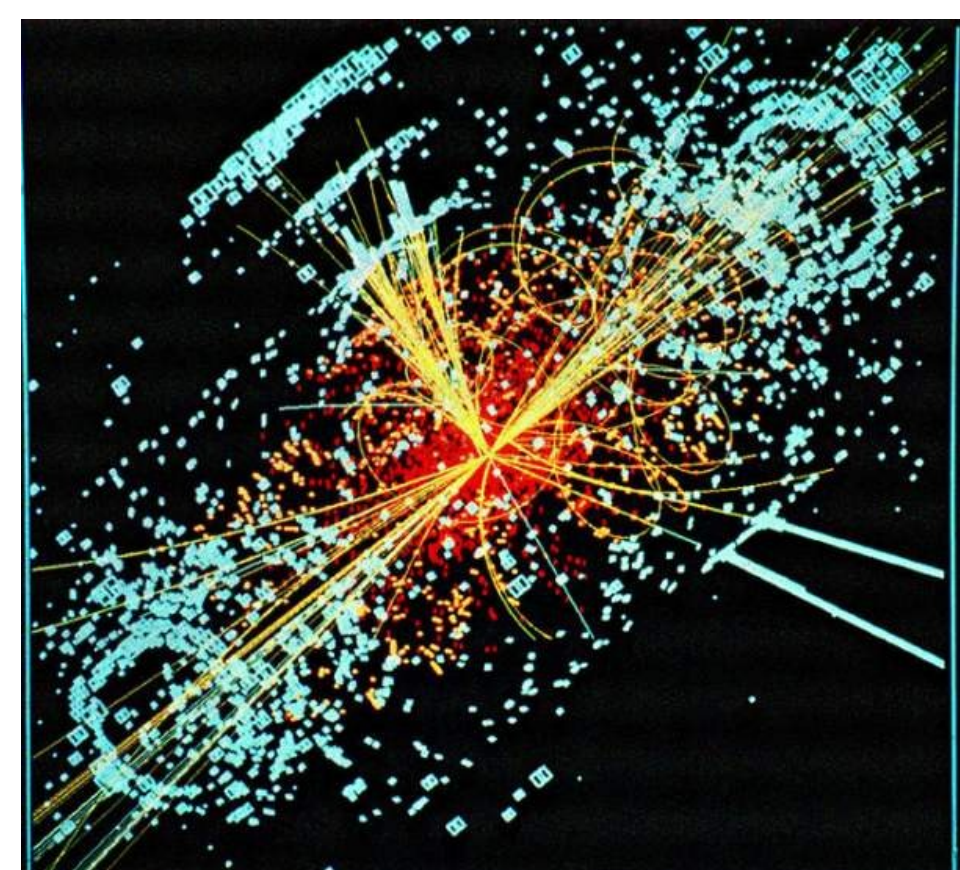
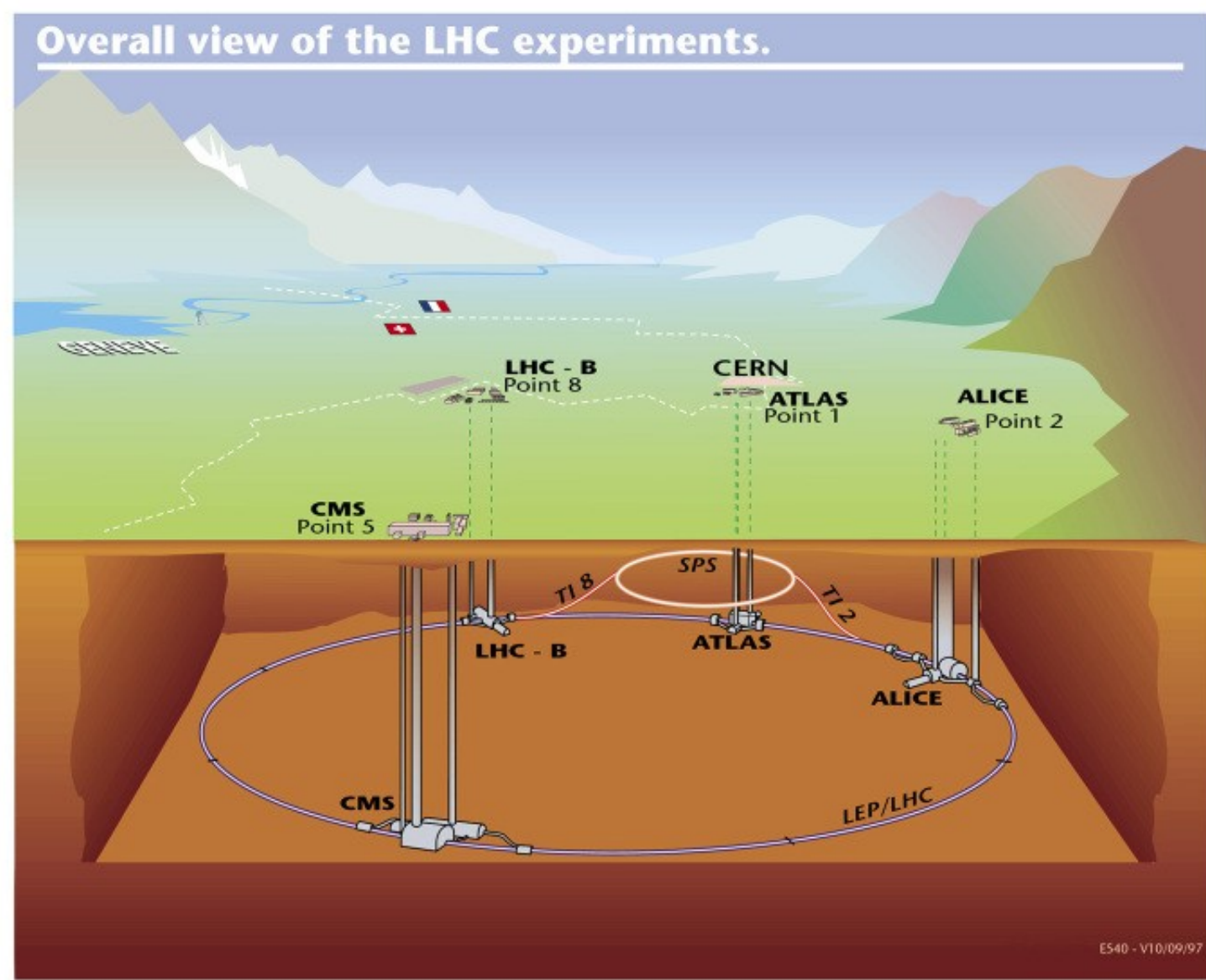


## 1. High Energy Physics at CERN

### LHC – The Large Hadron Collider

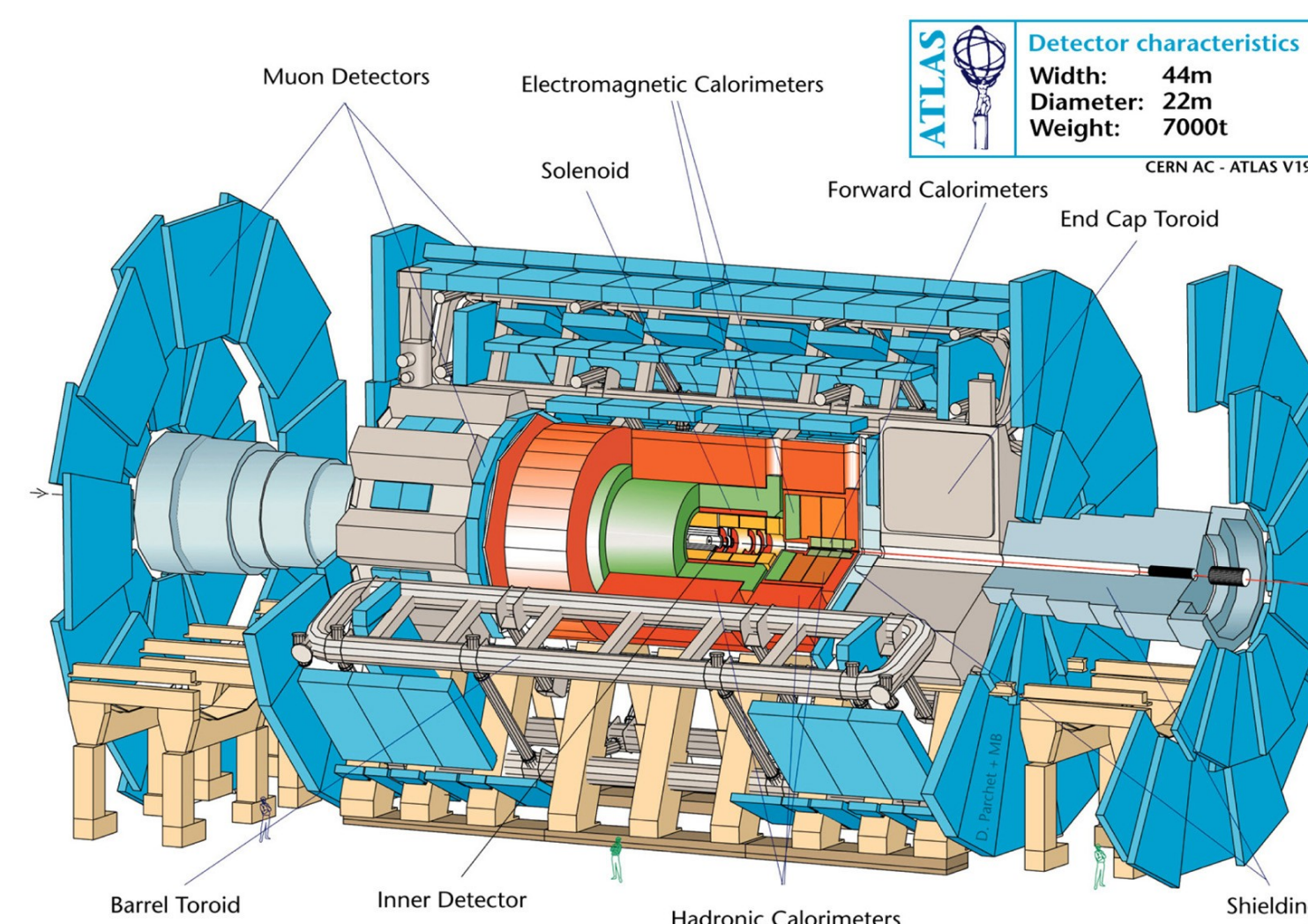
- 27 km circumference (100 m underground tunnel)
- Proton-proton collisions (up to 14 TeV at the center of mass)
- New physics discoveries
  - Supersymmetry
  - CP violation
  - Dark matter
  - Higgs Boson
  - Standard model and beyond
- Extremely high collision rate
  - Collisions every 25 ns
- Up to 25 interactions per collision



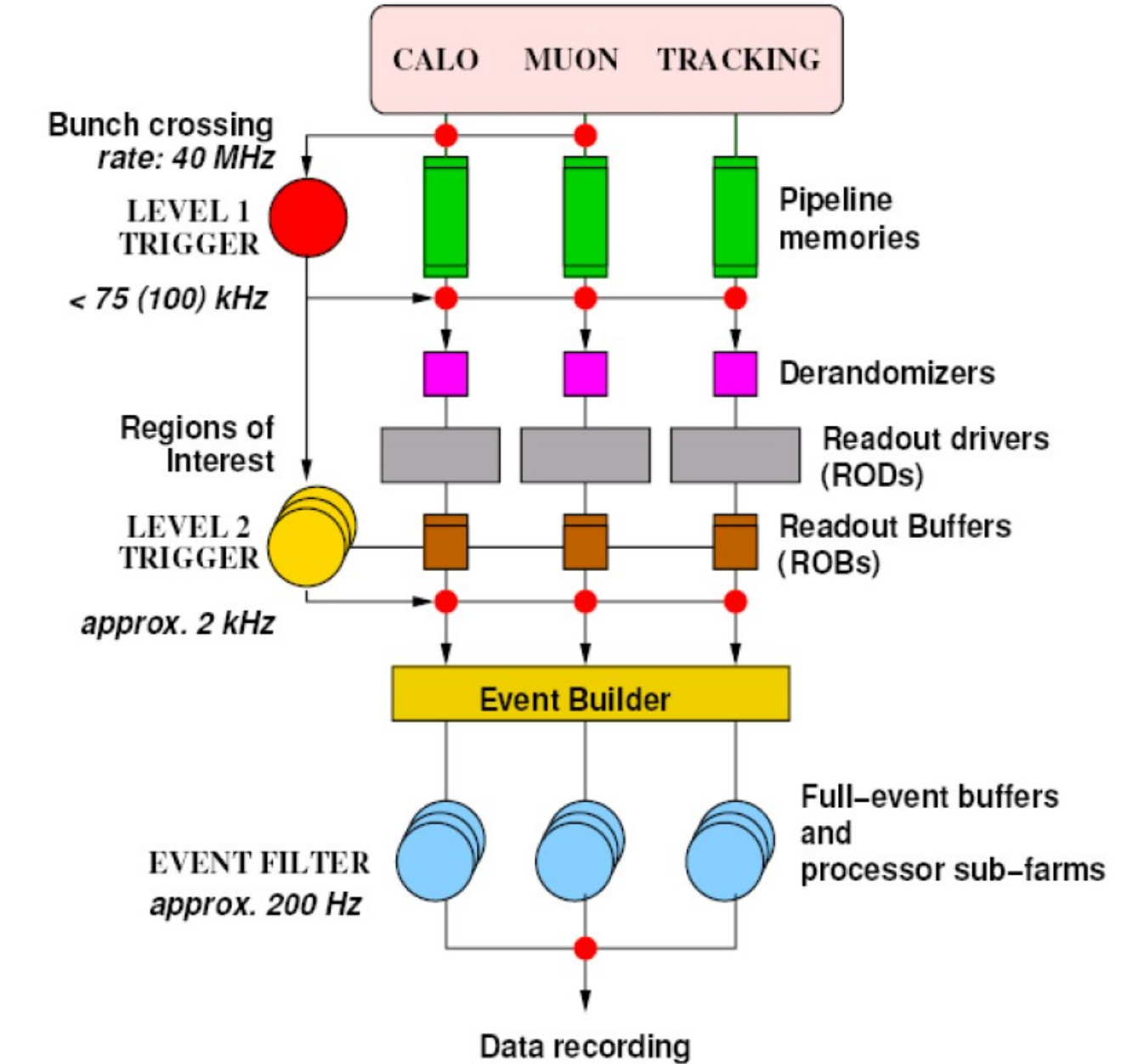
## 2. A Toroidal LHC Apparatus - ATLAS

### A general purpose detector

- Tracking
- Calorimetry
- Muon chambers
- Engineering challenge
  - Assembled in a cavern
  - Several integrated subsystems
  - Incredible high data flow – 60 TB/s!
  - Online Trigger is mandatory



### Trigger System



### An engineering playground

- Online filtering and monitoring
- HW and SW development
- Distributed control systems
- Data acquisition and quality
- Cutting-edge technology

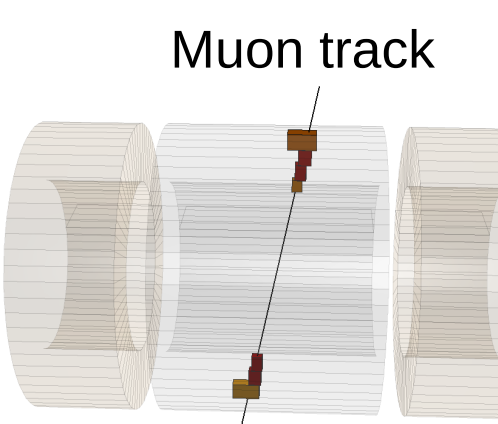
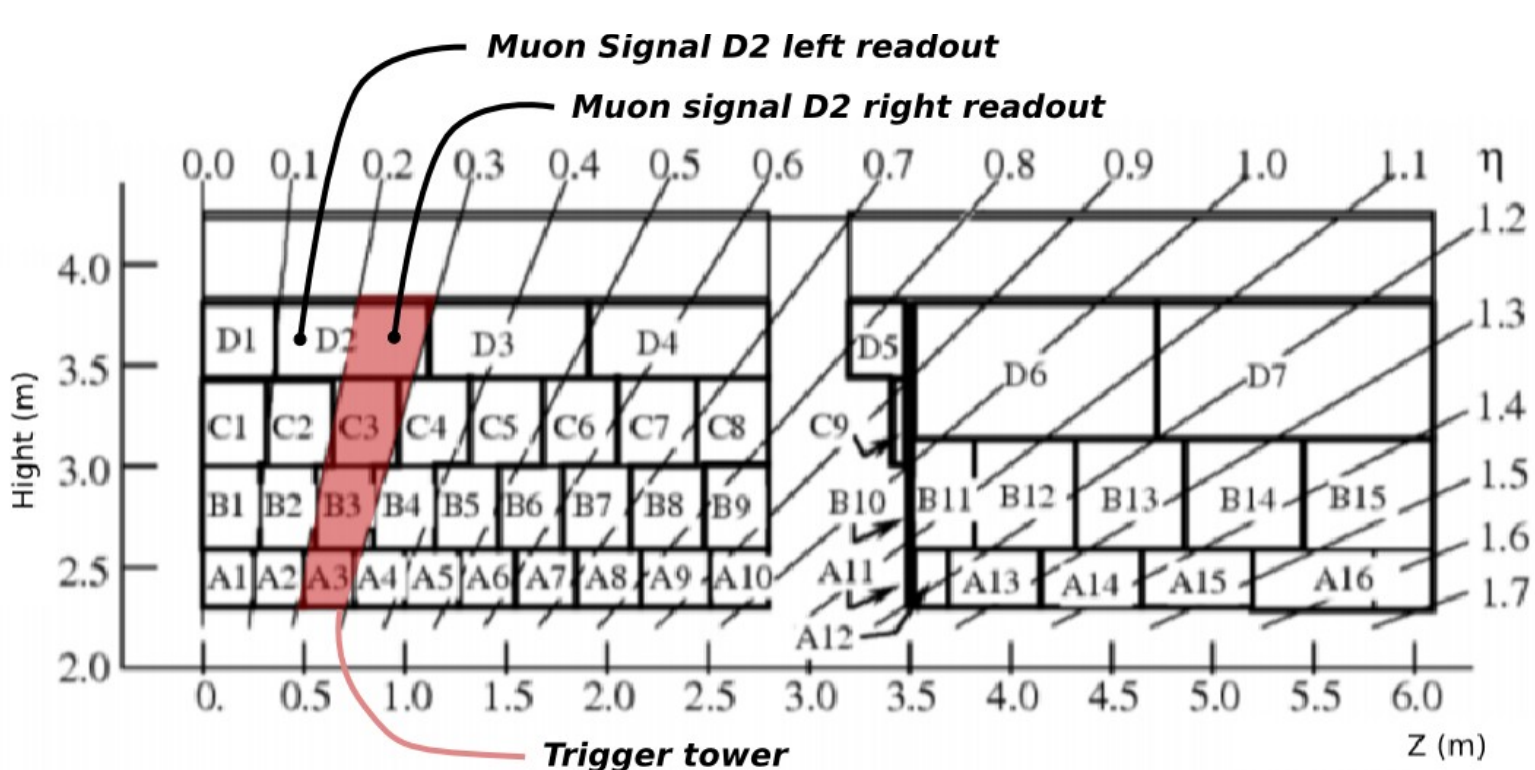
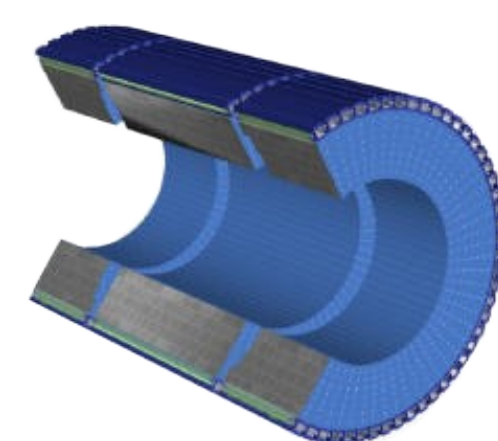
## 3. The Tile Calorimeter - TileCal

### ATLAS central barrel hadronic calorimeter

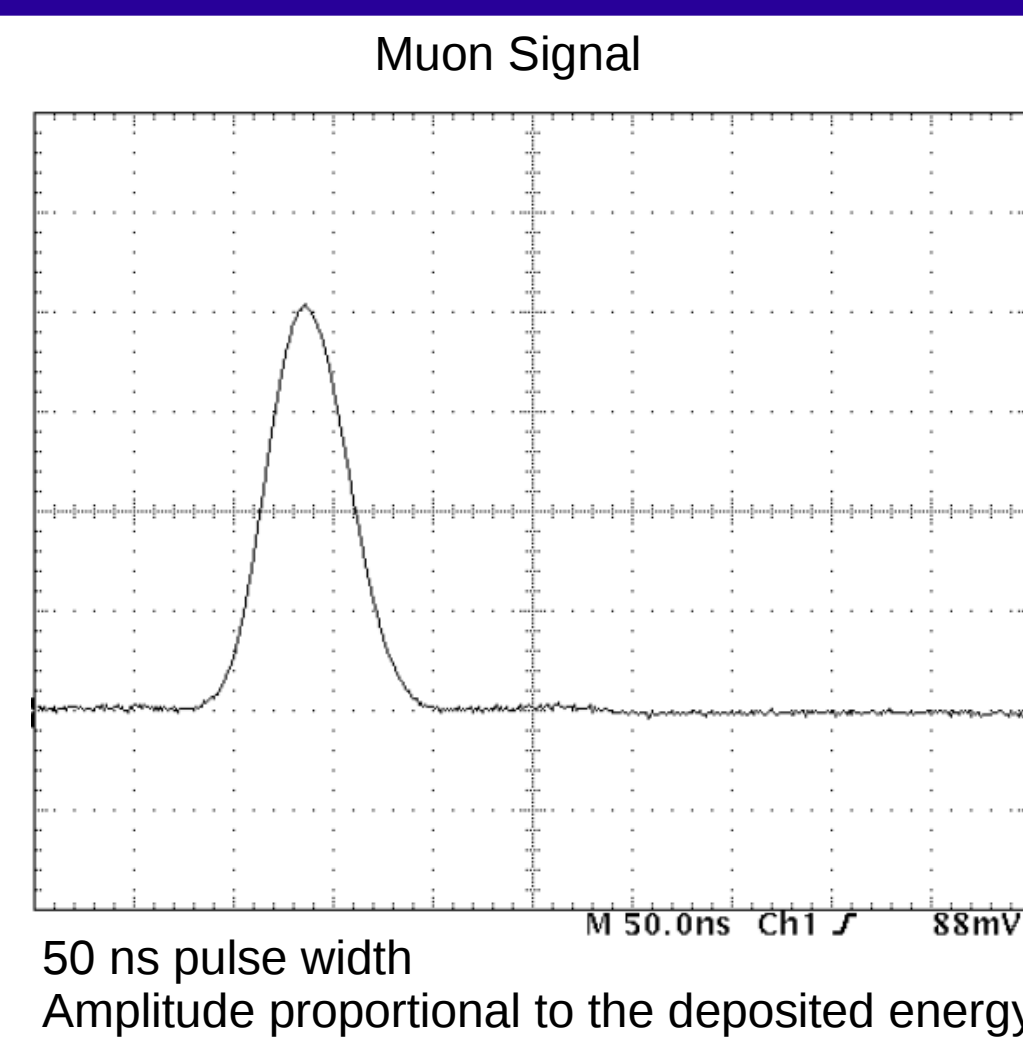
- 256 modules
- Scintillating tiles as active material
- Iron as structure and absorber
- 10,000 data channels
  - Double readout per cell (redundancy)

### Trigger interface

- Trigger tower region
- Muon signal – D cell readout
- Analogue signal



## 4. The muon signal

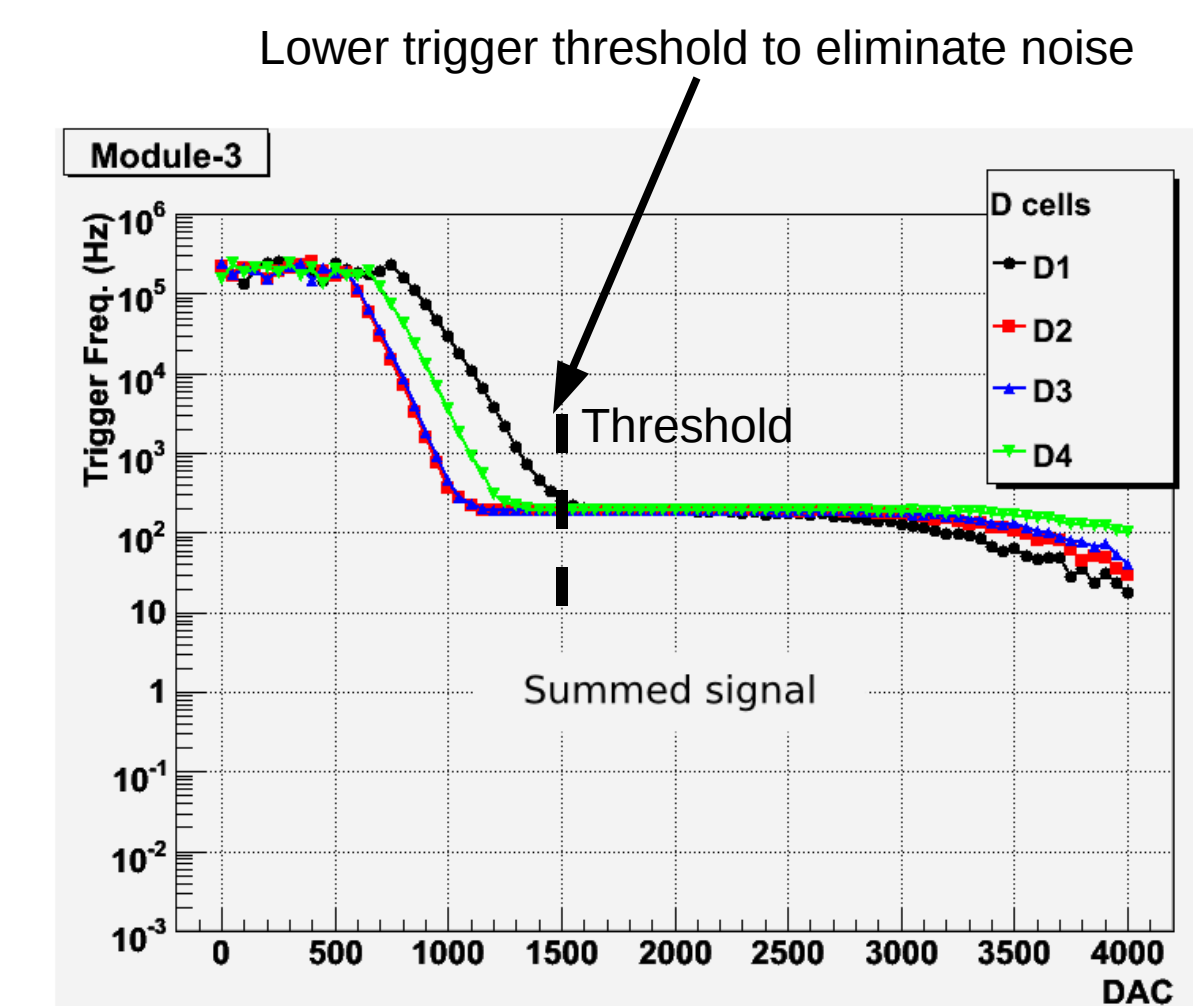
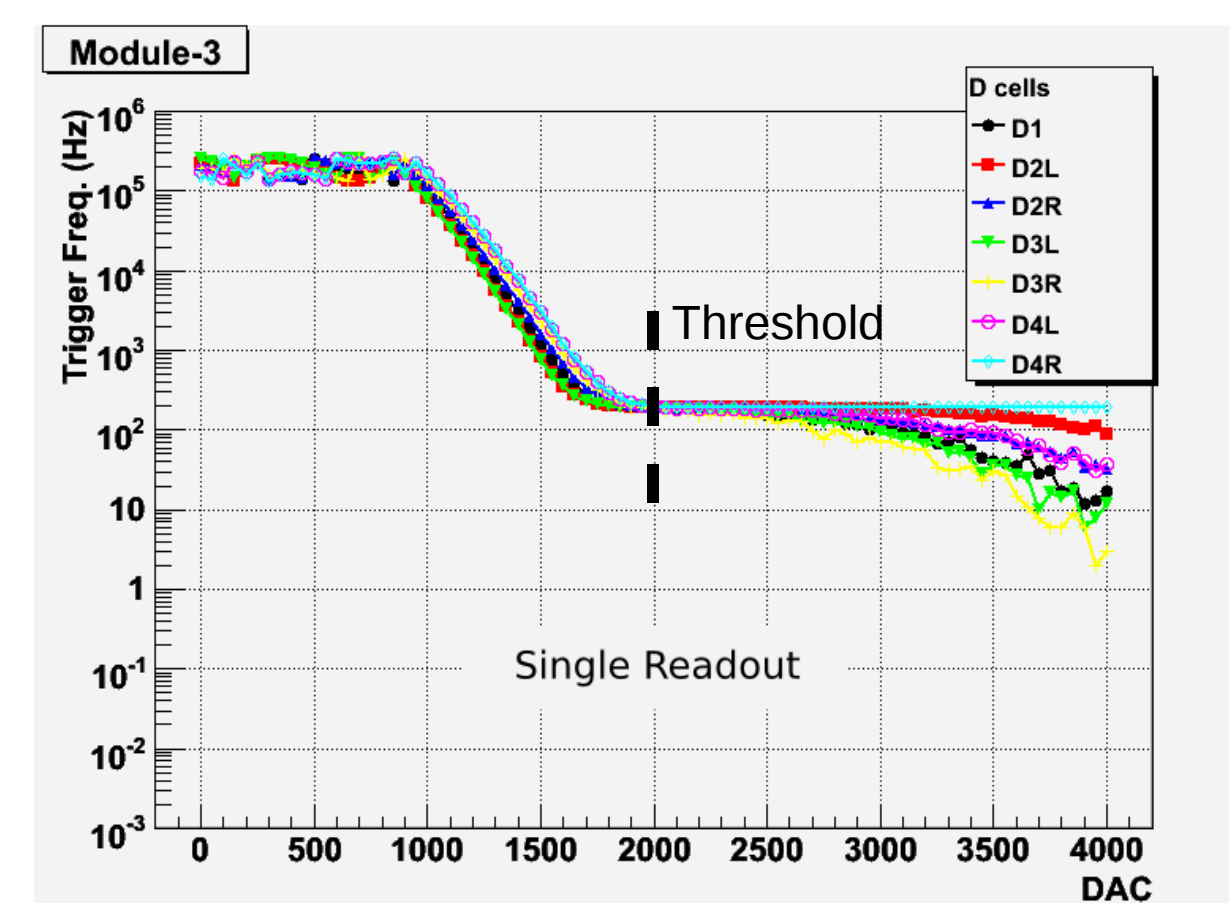
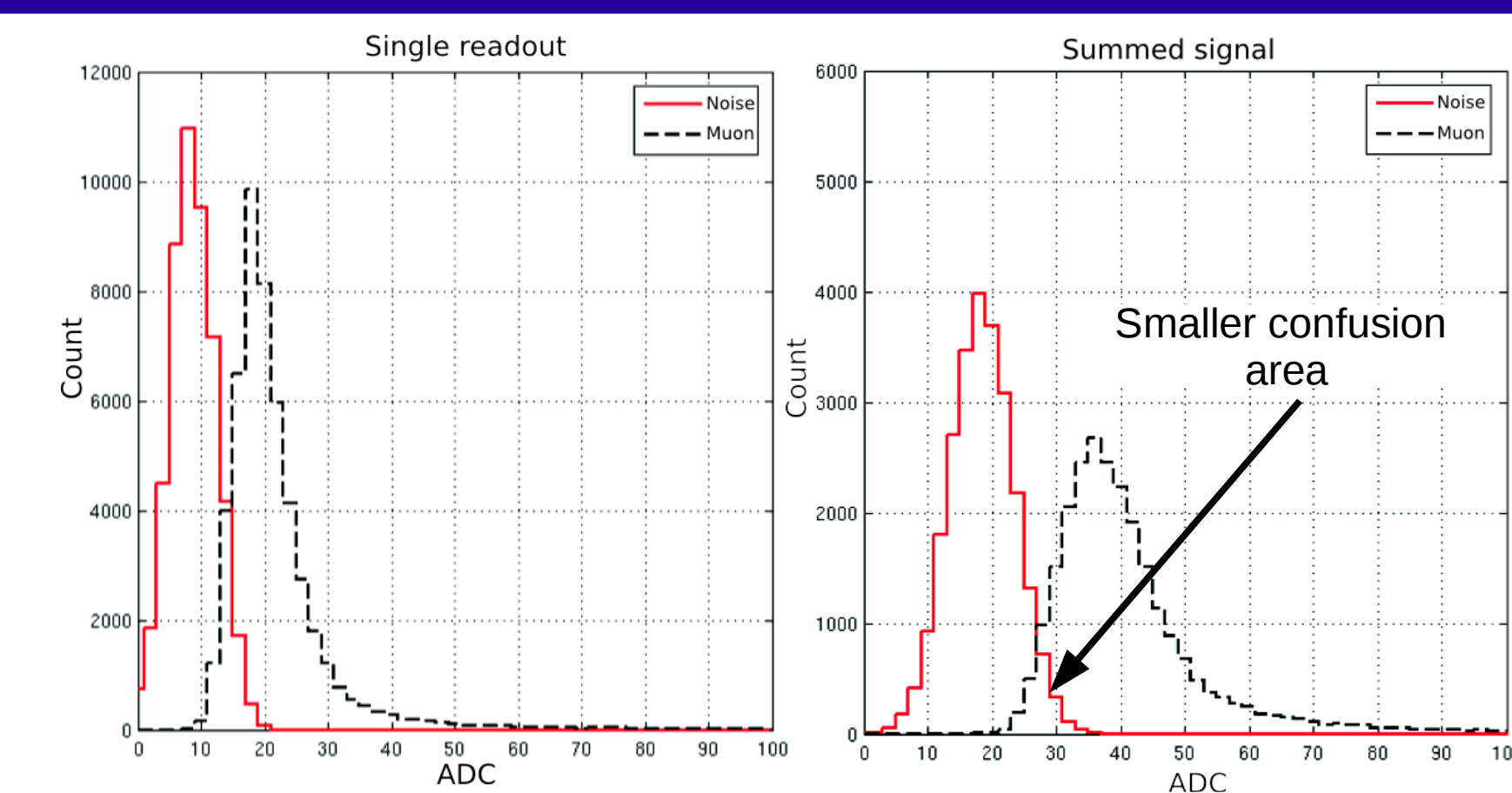


### Laser tests

- Injection of laser pulses
- Pulses at a constant rate
- Trigger cut variation
- Detection of muons with lower energy

### Summing muon signals

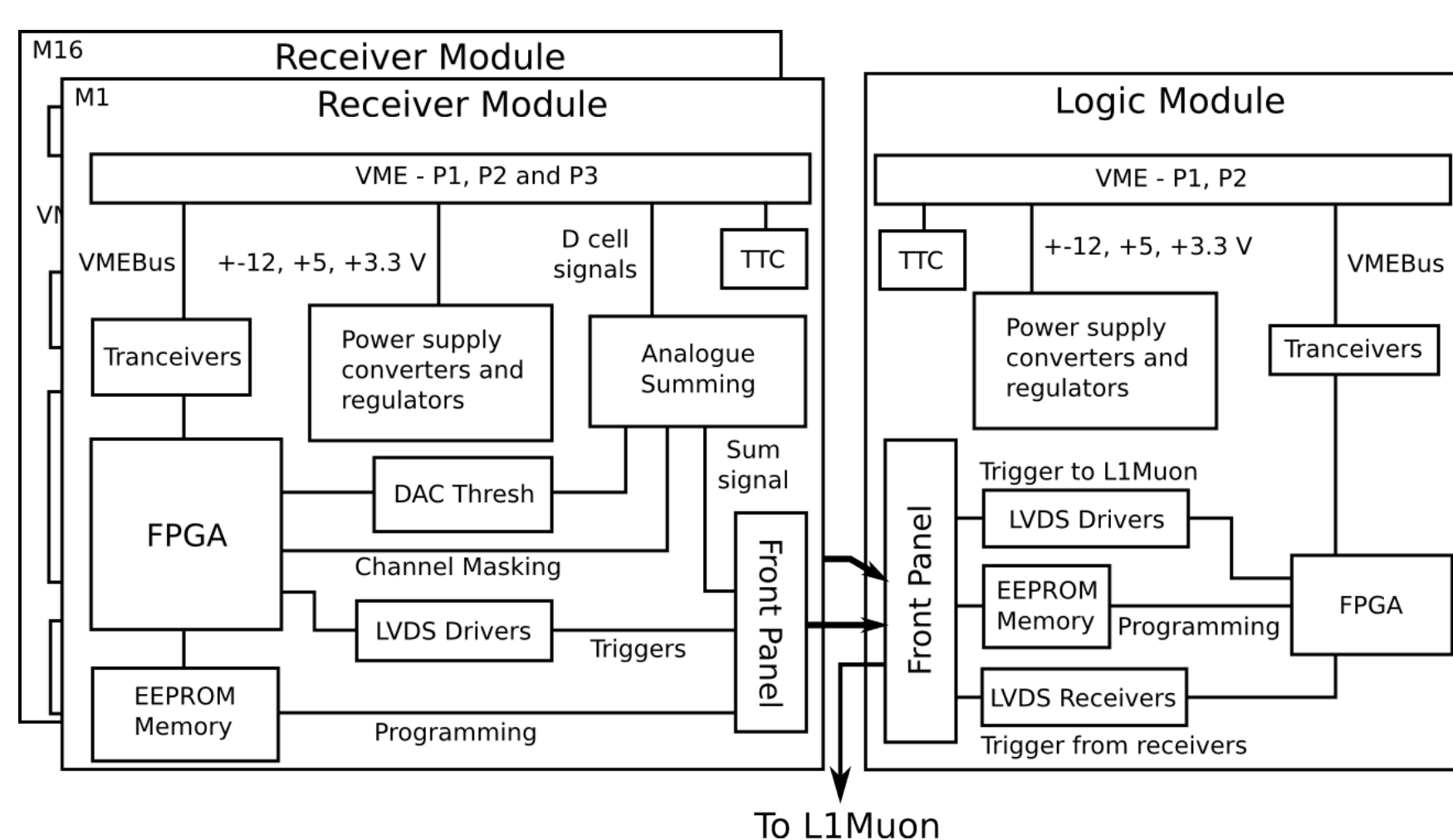
- Increases the signal-to-noise ratio
- More discriminant against noise



## 5. TileMuonReceiver

### Combined level-1 trigger with the Muon Chambers

- Up to 768 trigger signals
- Avoid veto: geometry alignment
- 2 independent partitions: A and C detector side



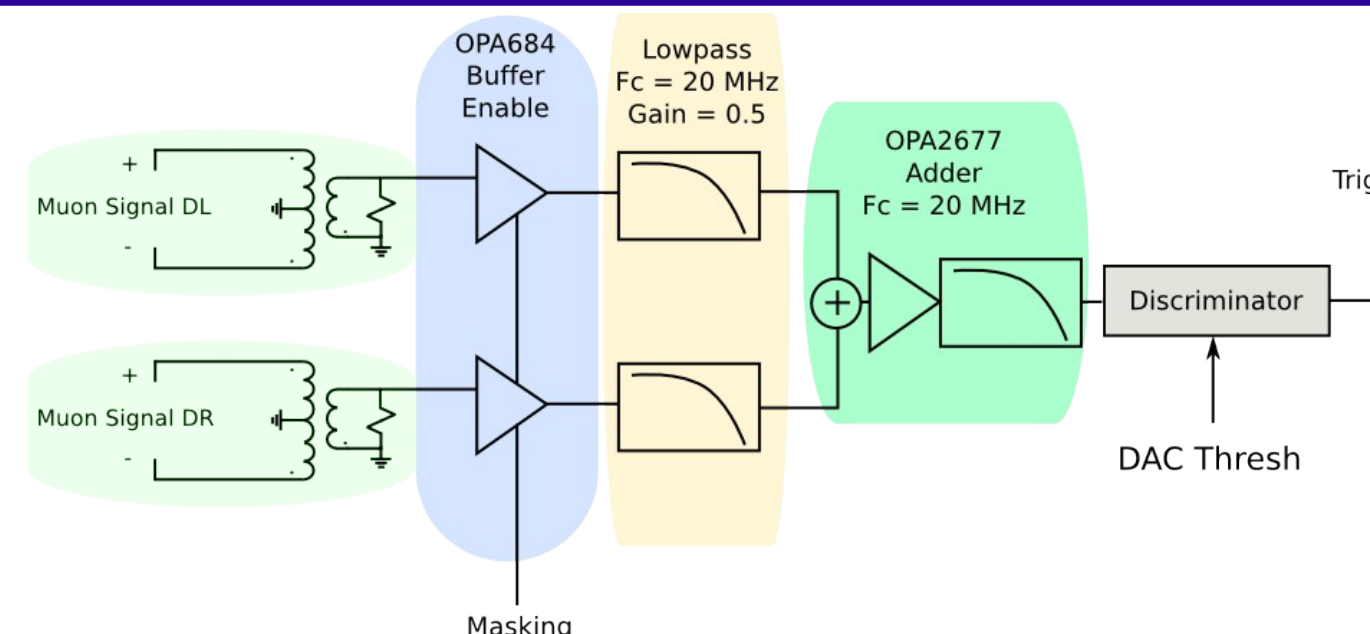
### Receiver Module

- Adds both muon signals from the same D cell
- Communicate over VME bus for calibration purposes
- Threshold discrimination
- Channel masking
- TTC circuit for LHC clock
- FPGA to control all features

### Logic Module

- Receives trigger information from receiver modules
- Trigger region alignment and bunch-cross ID
- Furnishes trigger information to level 1 ATLAS muon trigger

### Summing Circuit

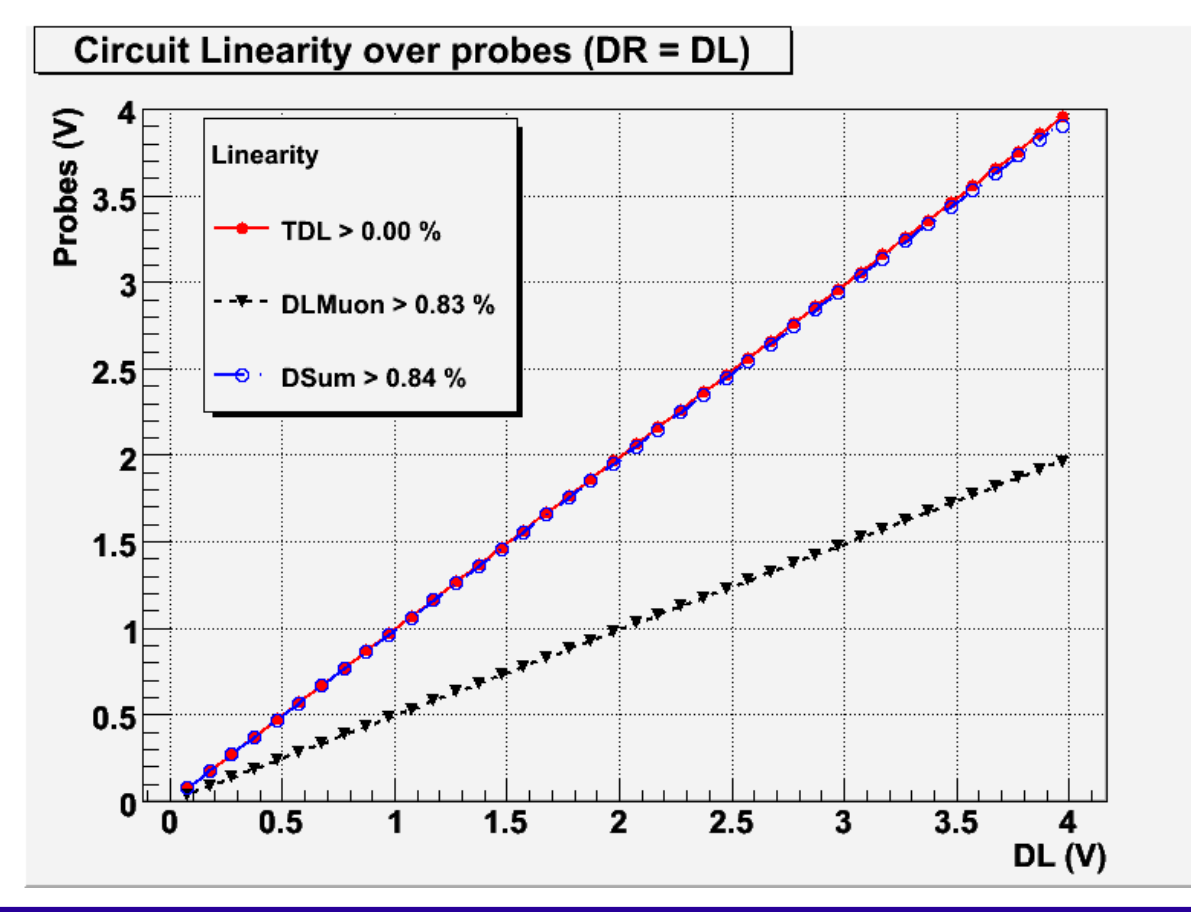


## 6. Circuit Simulations

### Simulation on Pspice

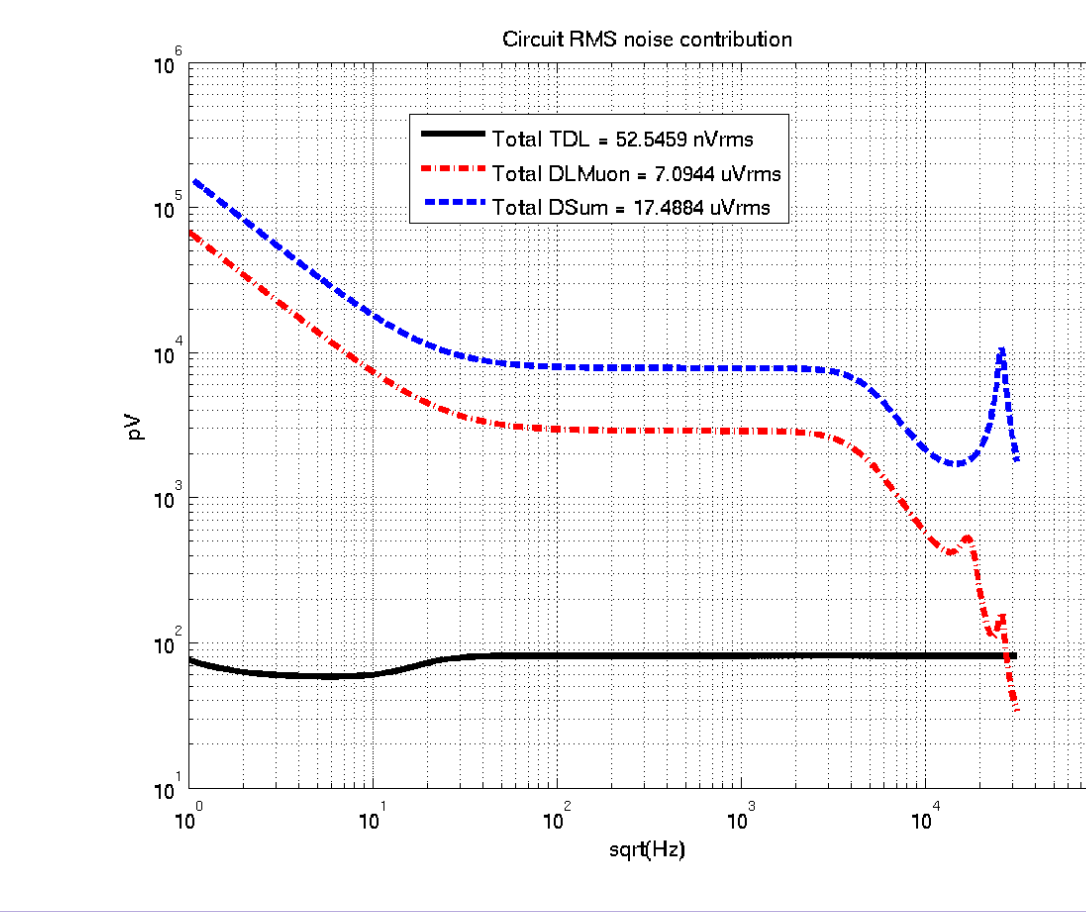
#### Circuit Linearity

- Non linearity smaller than 1 %



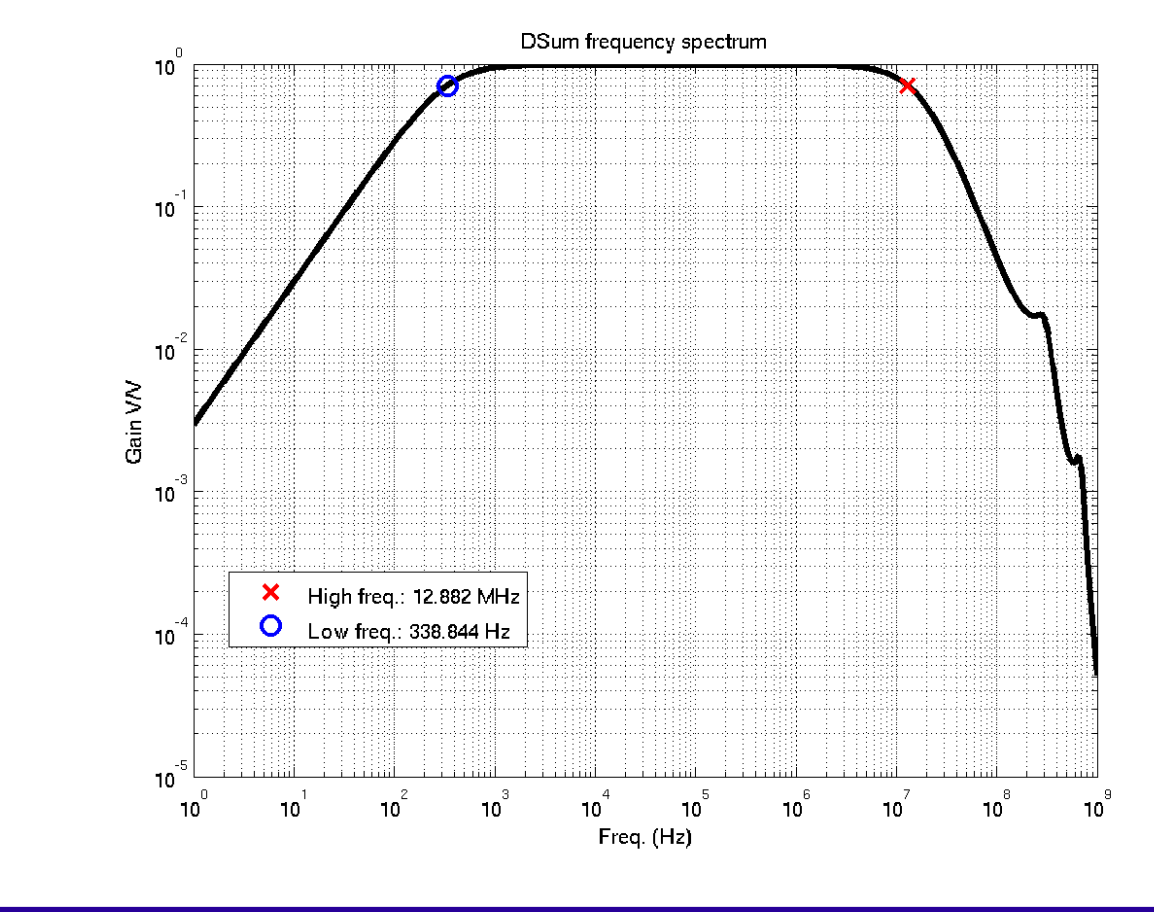
#### Circuit Noise Spectrum

- Contribution around 17 uVrms



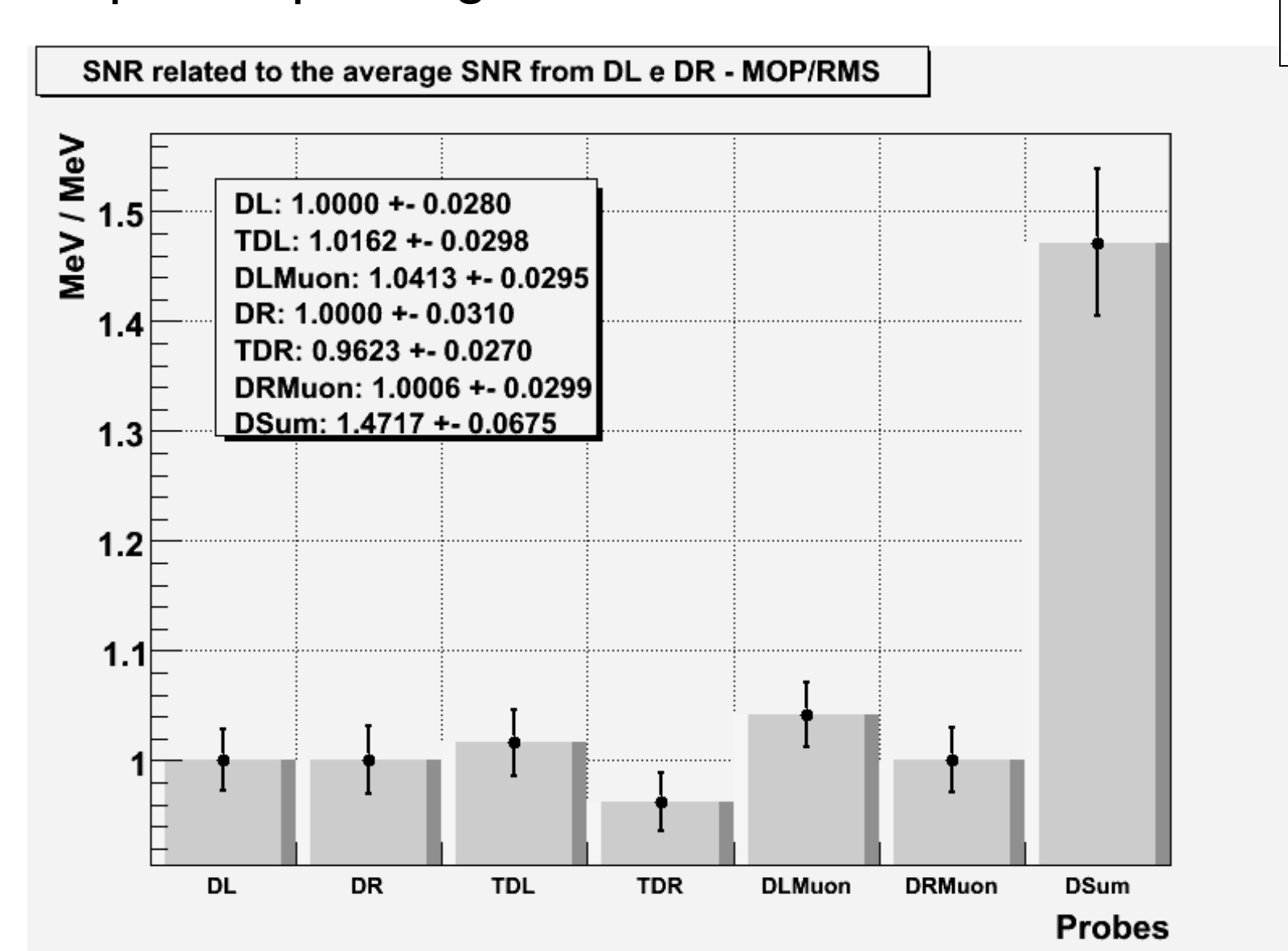
#### Frequency Response

- 2 poles: 12 MHz



### Signal-to-noise Ratio

- Input-output: a gain of ~1.5



### Muon Detection

- Sum: muon detection efficiency 5pp higher, with a 10% false alarm

