Expected signal in the ePIC CyMBaL tracker

CYlindric Micromegas BArrel Layer

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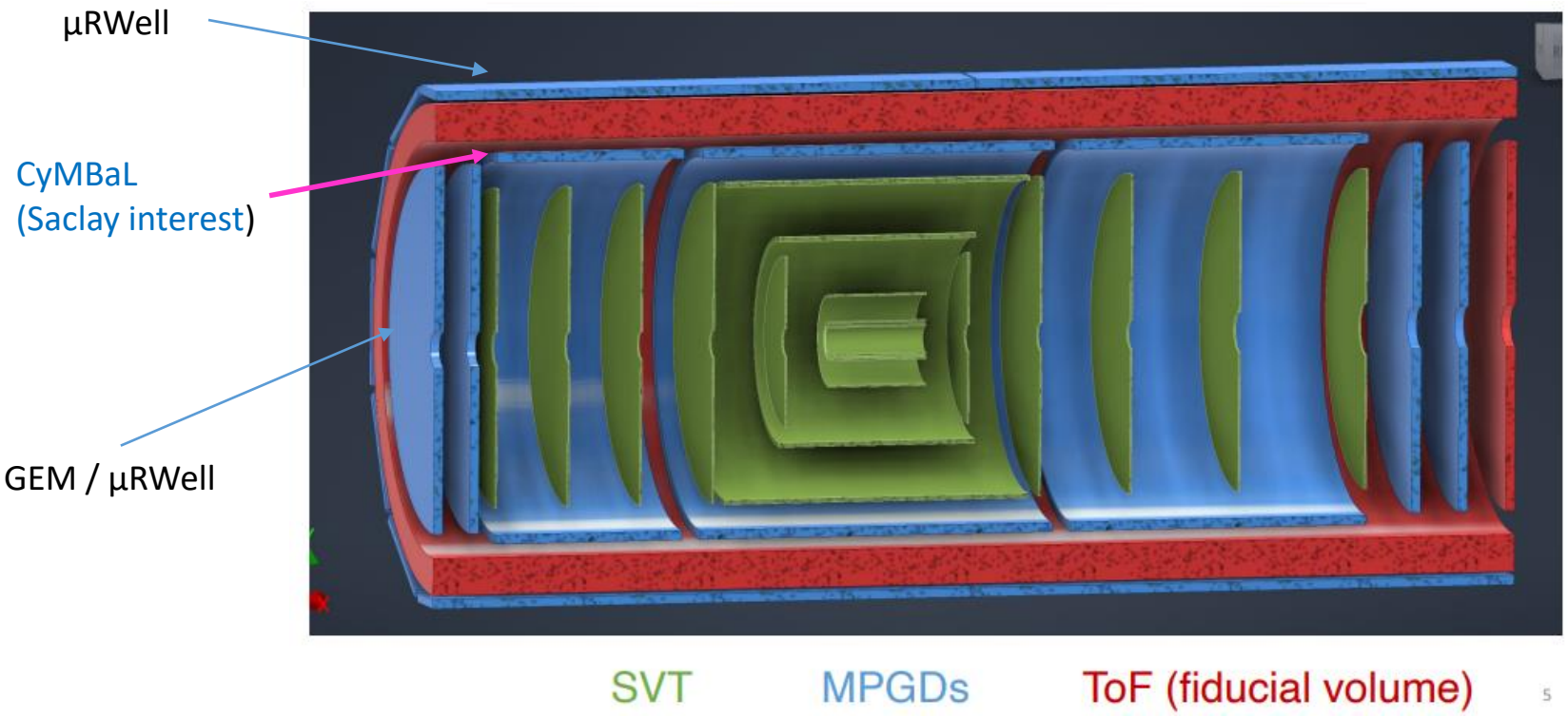
Quick reminder what it is all about

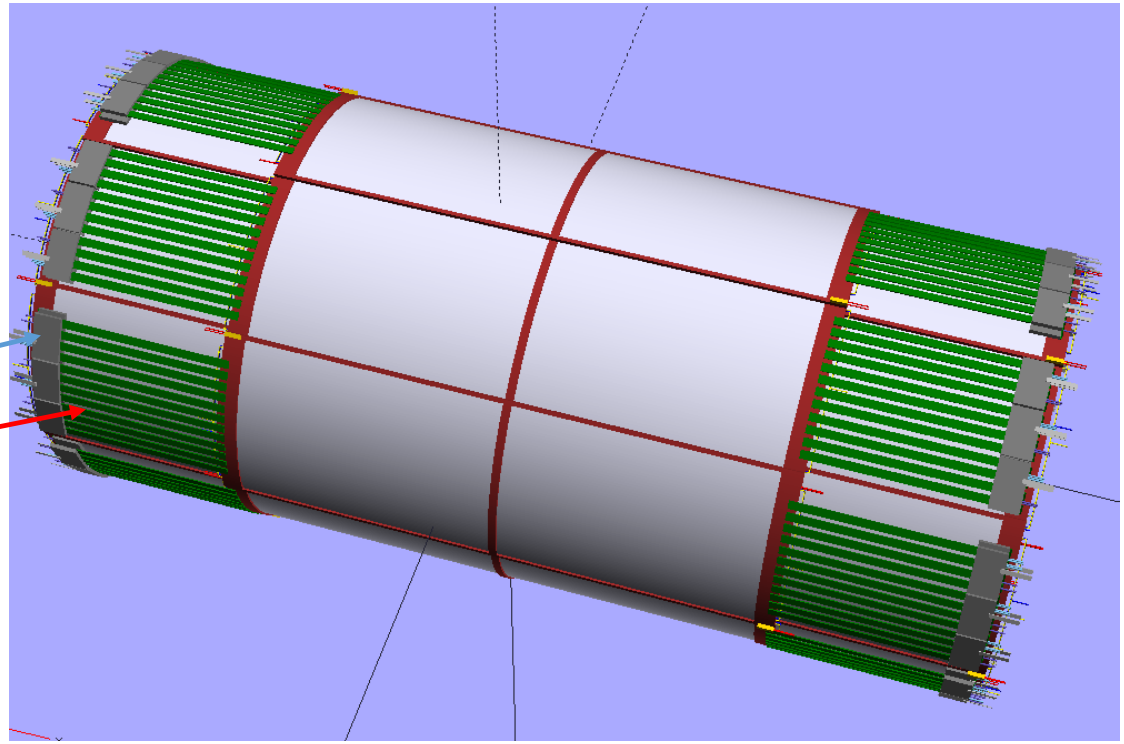
- CyMBaL – CYlindrical Micromegas BArrel Layer tracker
  → An MPGD



- Exact coverage, construction still under definition

One of the possible configurations currently under study

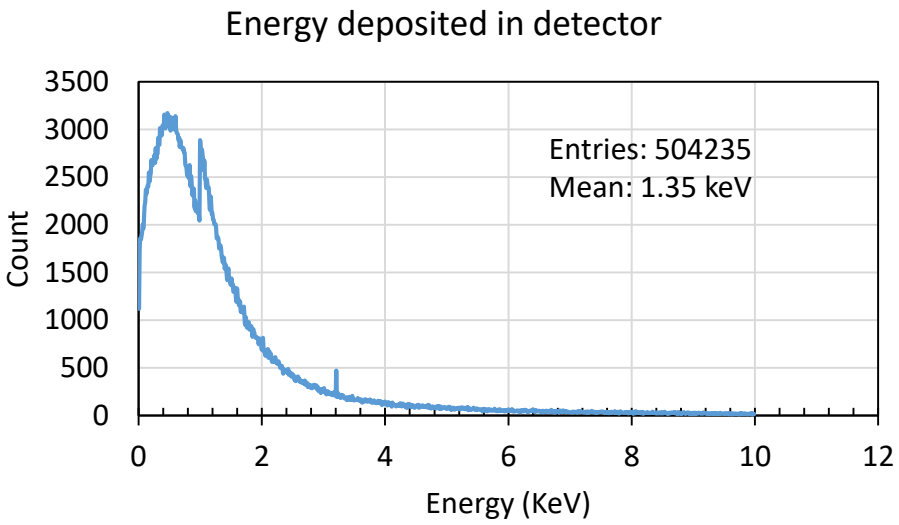
- Still under torment of optimisation
  → Just a snapshot to give an idea
- 32k channels
- 128 256-channel FEBs
  → Only central detector FEBs shown
    - Peripheral FEBs in a row bellow
    - Or in a second row

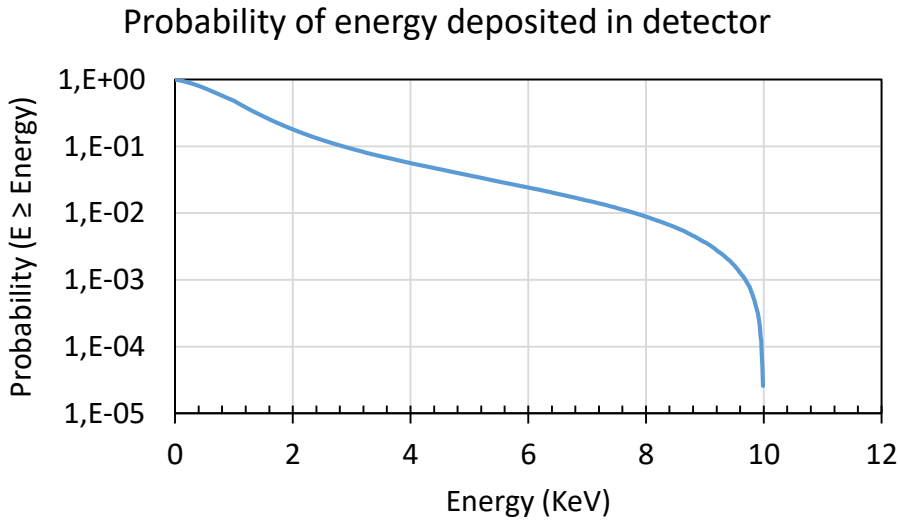


- This presentation: finding of working point for frontends

Energy deposit in detector

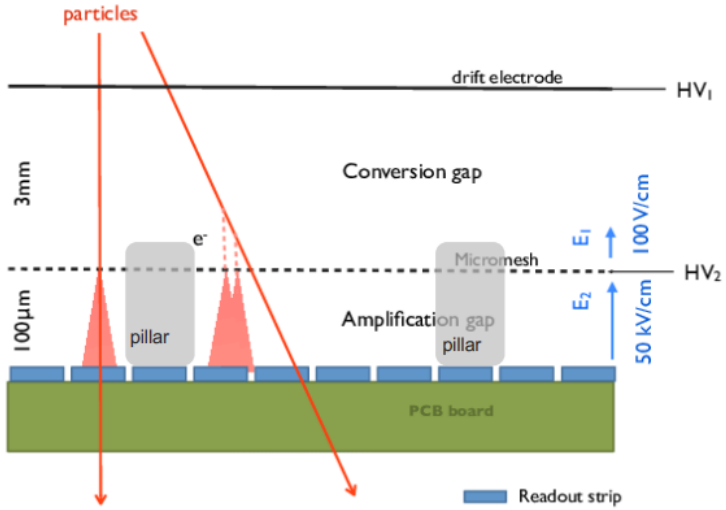
- Energy deposit simulations for physics events
  → Based on https://wiki.bnl.gov/EPIC/index.php?title=Deep_Inelastic_Scattering





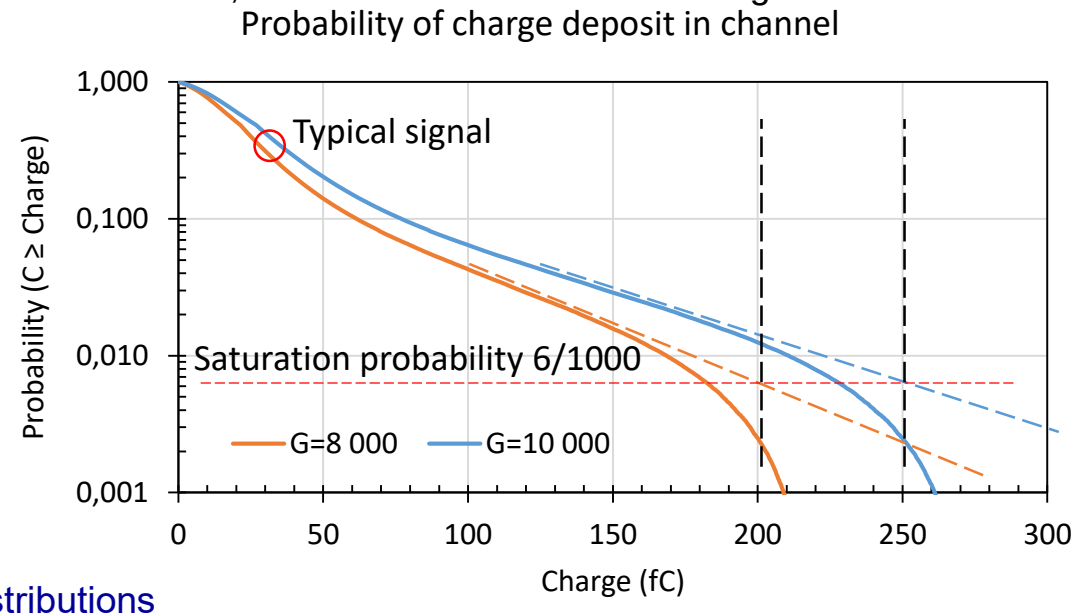
- Typical signal: ~1.35 keV

- Detector:
  → Conversion gap: 3 mm
    - Electrons in conversion gap: ~50
  → Amplification gain: 8 000 – 10 000
    - 400 – 500 ke$^-$



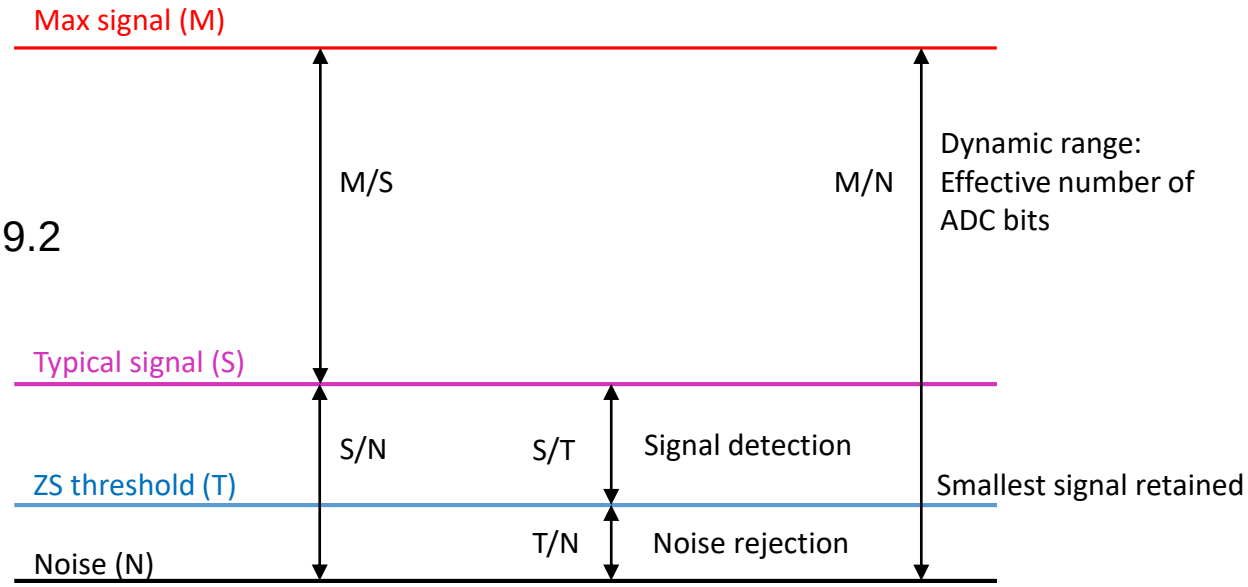
Charge on electronics channel

- Detector gain largely selectable
  - → Typical values of 8 000 – 10 000
- Hypothesis: cluster size: ~4 strips
  - → Strip with max energy: 65% of cluster energy
    - Parameters have to be known better
- Assume charge collection efficiency of the order of 70%
  - → Only this fraction reaches electronics channel
    - Due to detector capacitance, cable interconnect, cross-talk, …
      - Pessimistic estimate for the timing being
      - Will be known better with advances in detector, interconnect and frontend design
- Mean charge
  - → 30-35 fC for considered gain ranges
- Dynamic range large enough
  - → Acceptable saturation probability
    - Example only to give an idea →
  - → Acceptable loss of small charges
    - Low charge cluster members
    - Charges generated at “low end” of distributions



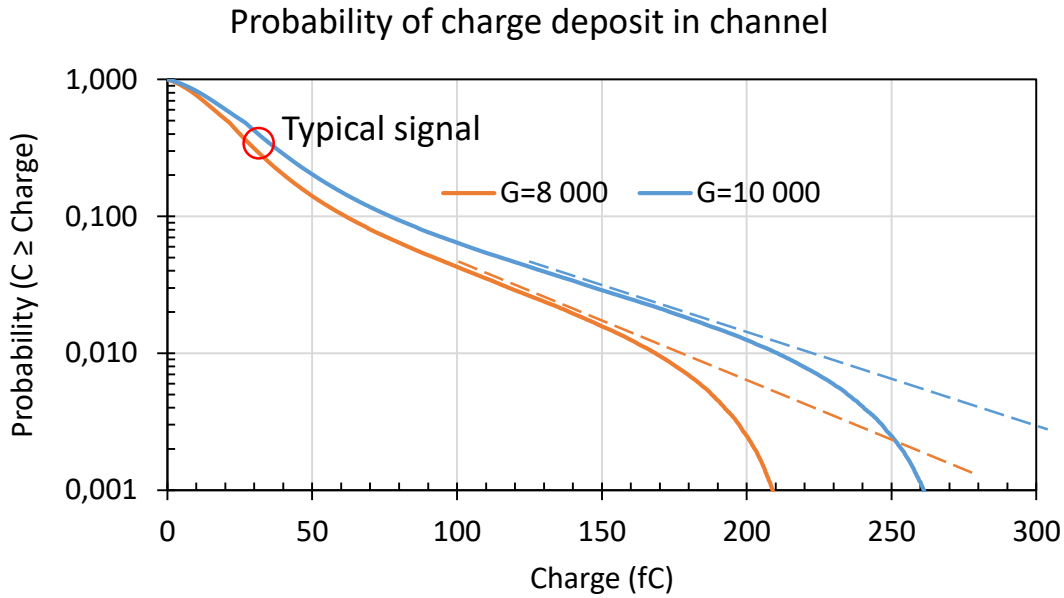
Charge measurement requirements

- Fix signal to threshold ratio as 10 for high detection efficiency : S/T = 10
  - → Detect channels with low charges in the cluster
- Efficient noise suppression with T/N = 6
  - → Streaming readout: no more a narrow trigger window to clean-up not in time noise hits
- Signal / Noise = 60
- Max signal to mean signal ~10
  - → Low probability of saturated signals
    - Accurate charge and timing measurements
  - → NB: These light saturations do not provoke dead time
- Dynamic range : 600
  - → Effective number of ADC bits: 9.2
    - 10-11-bit ADC



Targeted requirements for CyMBaL

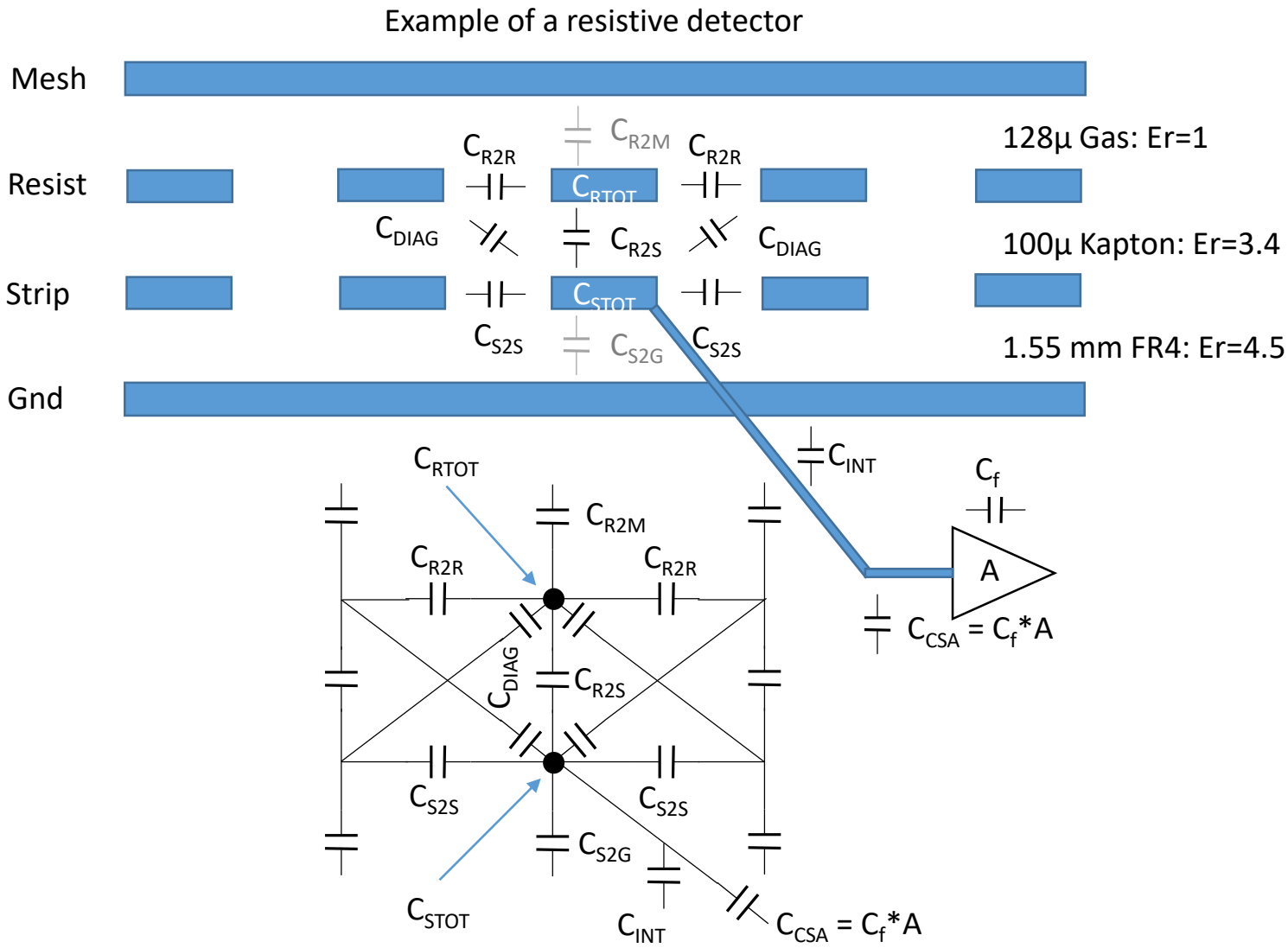
- Signal : 30 fC
  - → Detector gain of ~8 000
- Max / signal : ~10
  - → CSA range : 300 fC
    - Saturation probability ~1 / 1000
      - @ 10 kHz hit rate : ~ 100 ms



- Signal / threshold : ~10
  - → Threshold : 3 fC → ~100 eV
    - Assume charges are evenly distributed among all cluster channels but the channel with Max
      - Cluster size of 4
      - 65% of charges going to a single channel : ~19.5 fC
      - Others get ~5.2 fC > 3 fC threshold
- Threshold / noise : 6
  - → Noise : 0.5 fC
    - ENC: 3 100e^- – compatible with the envisaged detector capacitances
- Working point will be refined with better knowledge of physics / detector / electronics
  - → Configurable flexible very frontend accommodates changes

Backup

Simple illustration of charge division from strip to CSA



Simple illustration of charge division from strip to CSA