

# MPGD-based HCAL

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*with intellectual support from other INFN researchers*

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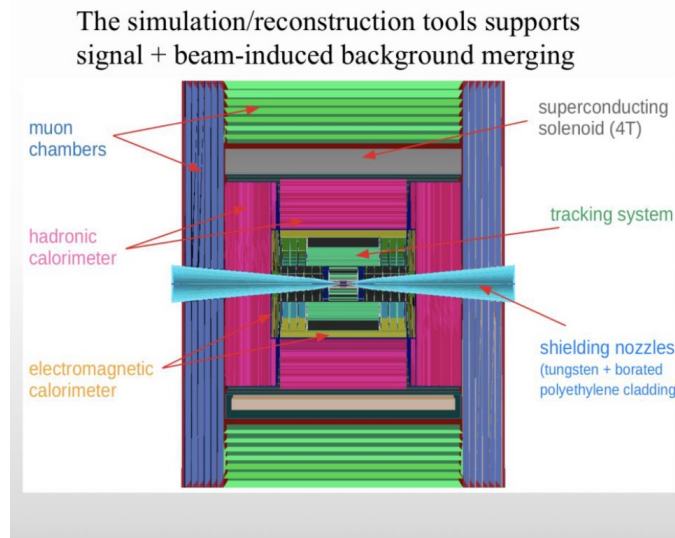
# Proto-MC Detector

(under optimization)

- CLIC detector adopted with some modifications for muon collider detector needs
  - CLIC: HCAL from CALICE R&D: mainline option is Scintillator + SiPM
  - CALICE alternative: FE absorber + Gaseous Detector (glass RPC)
- More detailed beam background simulations in Fluka are ongoing
- Preliminary studies indicate:
  - HCAL:  $10^{11} - 10^{15}$  1MeV n-equiv /cm<sup>2</sup> per year;

## Machine Parameters:

- 3 TeV c.o.m.
- $2 \times 10^{12}$  mu/bunch
- 200 days operation/year
- 100kHz bunch crossing



CLIC Detector adopted with modifications for muon collider needs.

Detector optimization is one of the future goal.

### Vertex Detector (VXD)

- 4 double-sensor barrel layers  $25 \times 25 \mu\text{m}^2$
- 4+4 double-sensor disks     "

### Inner Tracker (IT)

- 3 barrel layers  $50 \times 50 \mu\text{m}^2$
- 7+7 disks     "

### Outer Tracker (OT)

- 3 barrel layers  $50 \times 50 \mu\text{m}^2$
- 4+4 disks     "

### Electromagnetic Calorimeter (ECAL)

- 40 layers W absorber and silicon pad sensors,  $5 \times 5 \text{ mm}^2$

### Hadron Calorimeter (HCAL)

- 60 layers steel absorber & plastic scintillating tiles,  $30 \times 30 \text{ mm}^2$

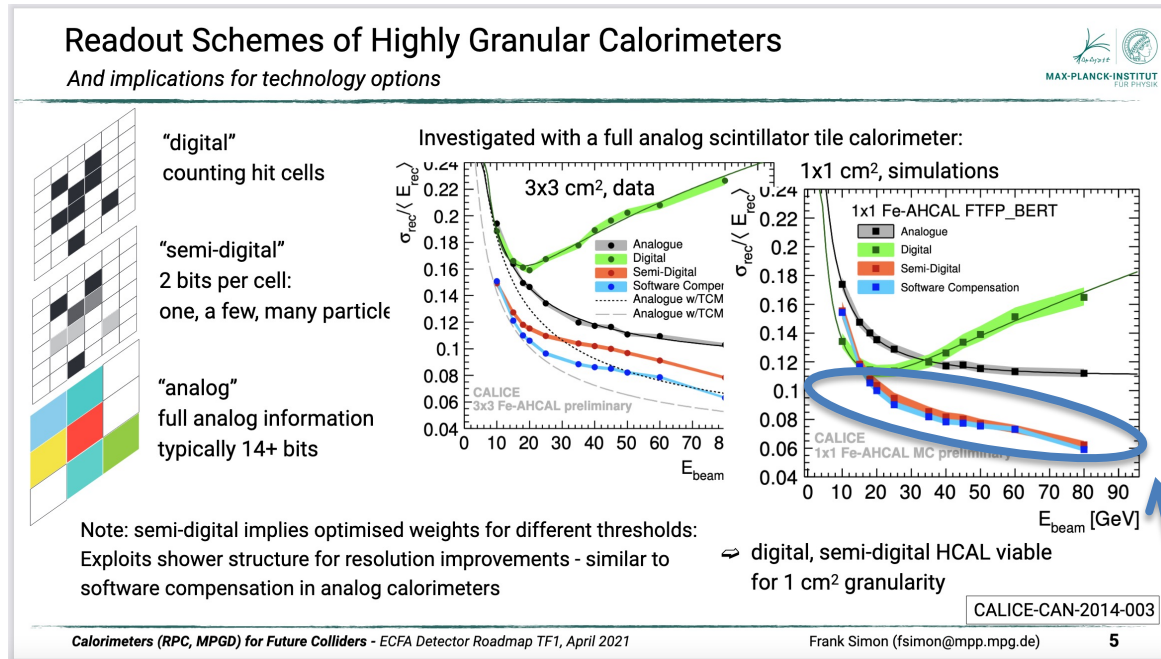
**We want to propose a more RAD-hard HCAL detector**

# Gaseous Imaging Calorimeters

*Gaseous detectors are naturally radiation hard. Can they provide equally good performance?*

Lot of work done within CALICE collaboration:

- AHCAL Scint+SiPM  
30 x 30 mm<sup>2</sup> granularity
- DHCAL glass RPC  
10 x 10 mm<sup>2</sup> granularity
- SDHCAL RPC  
10 x 10 mm<sup>2</sup> granularity  
also with few Micromegas



- Gaseous Detectors provide **high readout granularity** ( $\sigma_{xy} = 50\mu\text{m}$ ,  $\sigma_t = 5\text{ns}$ ) **at low cost**
- Energy resolution in 10x10 granularity is better w.r.t 30x30 granularity
  - 10x10 will allow also better imaging & better topological background removal
- Studies show that **Energy resolution obtained Semi-Digital HCAL is as good as AHCAL** with software compensation (*but note this is for 10x10 granularity!*)
- => *10x10 SDHCAL with gaseous detector is interesting option*
- => **we want to propose more radiation hard, 4D, low-cost HCAL detector.**

# Where does this proposal come from?

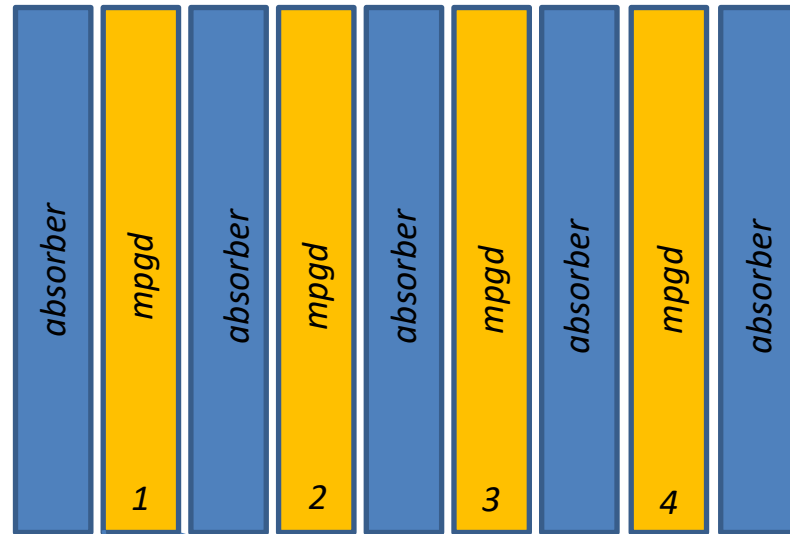
- **Historically: CALICE**

- SDHCAL w/ RPC obtains same resolution as AHCAL  
*(but with reduced cost)*
- However: RPCs operate with non-environmentally safe gas  
*(R&D ongoing – but detector constraints increase)*
- Some Micromegas modules built and inserted
  - Show better performance w.r.t. RPC: better rate capability, smaller clustersize, very radiation hard and Energy measurements are possible
- CEPC: R&D ongoing for Calorimeter with Resistive MPGD  
*(concentrated on RP-WELL Weissmann (Israel) USTC (China))*

- **We would like to propose R&D effort on resistive MPGD**

- Timing measurements of Gaseous detectors were not used
  - Interesting road to study shower development & remove backgrounds
  - RPCs naturally fast detectors, in MPGDs R&D is ongoing to improve on timing
- Unifies INFN groups working on resistive MPGDs (Na,LNF,Ba)
- Submitted Common Project for add. RD51 funding (15kEUR/anno)

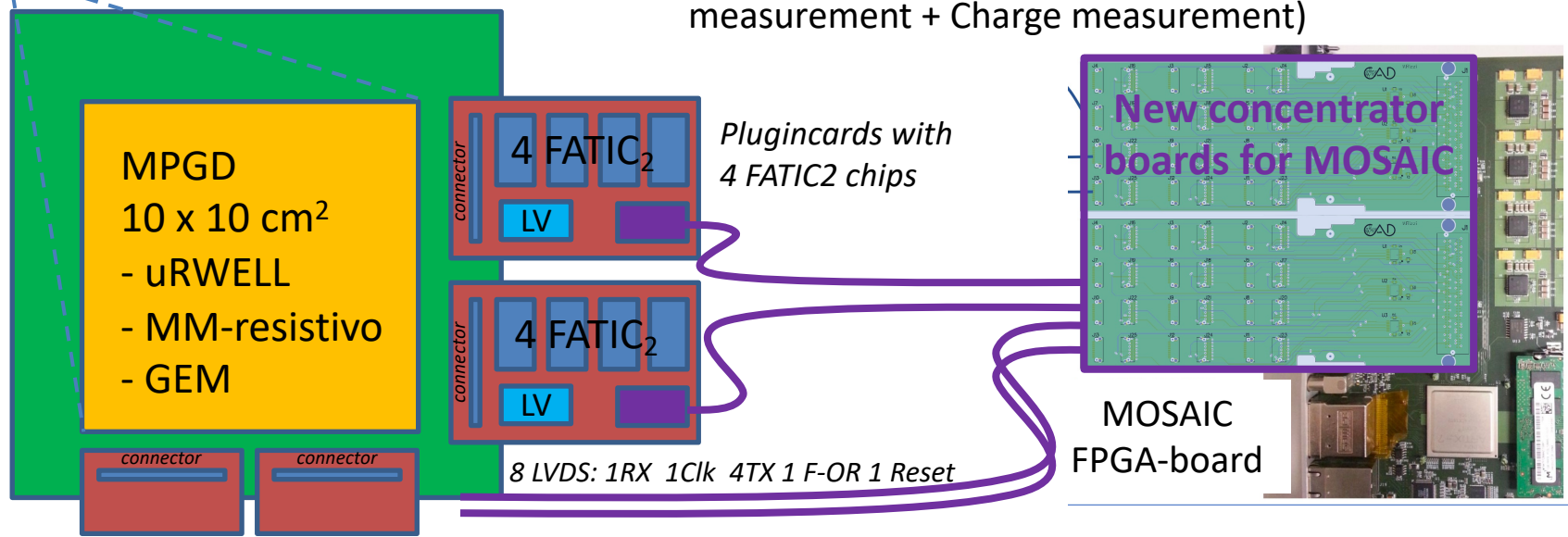
# Design of MPGD-based HCAL cell



We would like to propose a R&D program to validate the best technology in the next years.

- simulation studies – GEANT implementation
- test different MPGD technologies in a small-size stack with stainless steel absorbers:
  - Resistive Micromegas
  - Resistive micro-RWELL
  - Leave room for future resistive MPGDs with improved timing response

Read out all detectors with same FE electronics. Exploit new Front-End asic designed for FTM: FATIC (Time measurement + Charge measurement)



# Financial Requests

- **RD\_Mucoll:**

- 10kEUR for 2 resistive Micro-Megas (MM)
  - Need 10x10mm<sup>2</sup> pixel size
  - Design provided by Mauro Iodice (RM3)
- 7kEUR for Electronics to read-out 2 MM:
  - 4kEUR for 10 plugincards
  - 2kEUR for concentrator board
  - 1kEUR for high-speed cables
- 3kEUR for Mechanics
  - Fe absorber plates
  - Bosh profile structure

*Note: 30kEUR of ASIC already spent in CSN-V  
would be the first major use of FATIC chip  
(also considered for LHCb uRWELL readout R&D)*

- **RD51 Common Project:**

- Ask small extra funding to RD51 collaboration through “Common Project”
  - Will allow to make modifications to the prototypes – change Readout board for GEMs ...
- Collaborating institutes: **Roma 3** (ATLAS MM) & **LNF** (LHCb uRWELL)
  - Can however not pledge officially FTE to MuCOL but are very interested in the development of the hadron collider with MPGD readout
  - ... *remake of ALEPH PF-Calorimeter with state of the Art MPGDs ...*

# BACKUP

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