Status of SCEPCal Simulation

Flavia Cetorelli[2,3], Marco Lucchini[1,2], Wonyong Chung[4], Chris Tully[4]

1. Università degli Studi di Milano - Bicocca
2. INFN Milano-Bicocca
3. CERN
4. Princeton University

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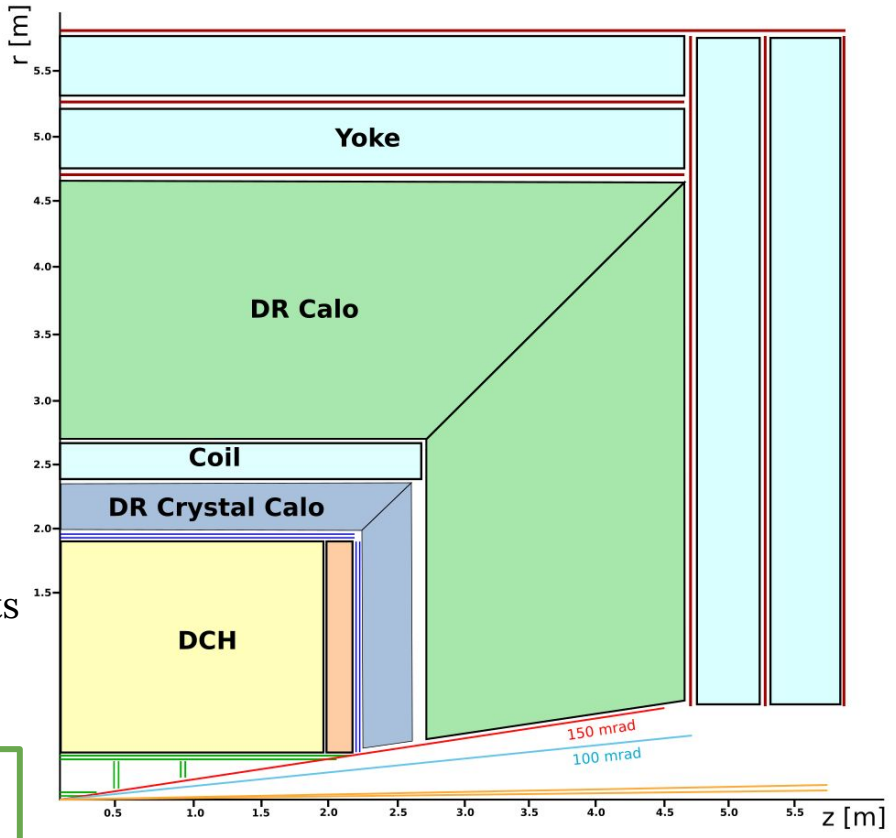
IDEA detector concept

IDEA detector for future e+e- circular colliders:

- Silicon pixel detector
- Drift chamber
- Layer of silicon micro-strip detectors
- Solenoidal magnet
- Preshower detector
- **DR Crystal calorimeter**
- **Sampling fiber calorimeter** exploiting the **dual-readout** of scintillation and Cherenkov light
  → **excellent** energy resolution for **hadrons** and jets
  → **BUT** moderate energy **EM** resolution
- Muon spectrometer within the magnet return yoke.



IDEA calorimeter w/o crystal option
σ_E /E (EM) ~**13%/√E**
σ_E /E (HAD) ~31%/√E
Jet resolution ~ 30%/√E

10.1393/ncc/i2020-20027-2

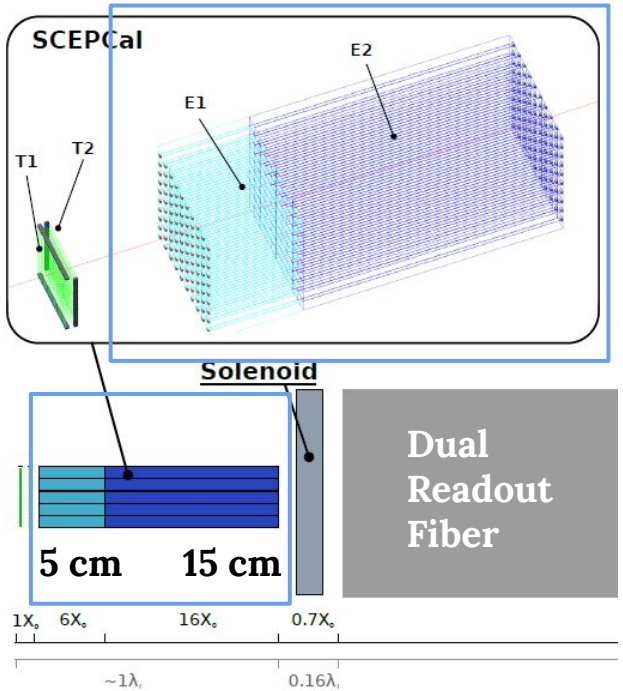
SCEPCal simulation

SCEPCal Repository:
https://github.com/SCEPCAL/SCEPCAL/tree/master

★ Implemented a geometry with **2 layers of crystals**:

- **Face width** of crystals = **3x3 cm²** → **to be tested**
  1x1 cm² and 0.5x0.5 cm²
- **Front** crystal length = 5 cm
- **Rear** crystal length = 15 cm
- Barrel **length** / 2 = 2.25 m
- Barrel **inner radius** = 2 m

★ To be implemented: **2 timing layers**



Sanity checks

Folder in my fork of FCC analysis repository

Ongoing work to produce performance plots of SCEPCal to **validate the simulation**:

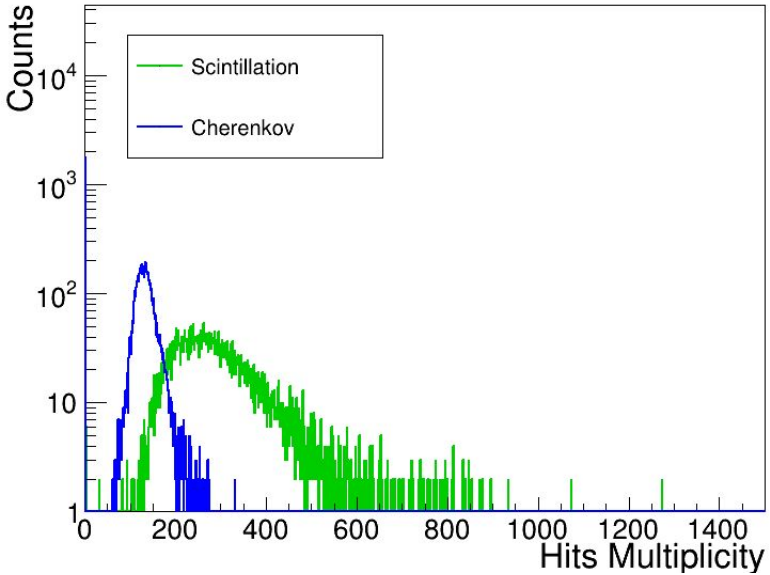
- Reconstructed energy resolution and linearity vs particle energy
- Comparison of energy deposits in front and rear segments
- Correlation between deposited energy and number of cherenkov photons produced
- Angular resolution (weighted eta of hits vs eta of MCtruth, and same for phi)
- ...

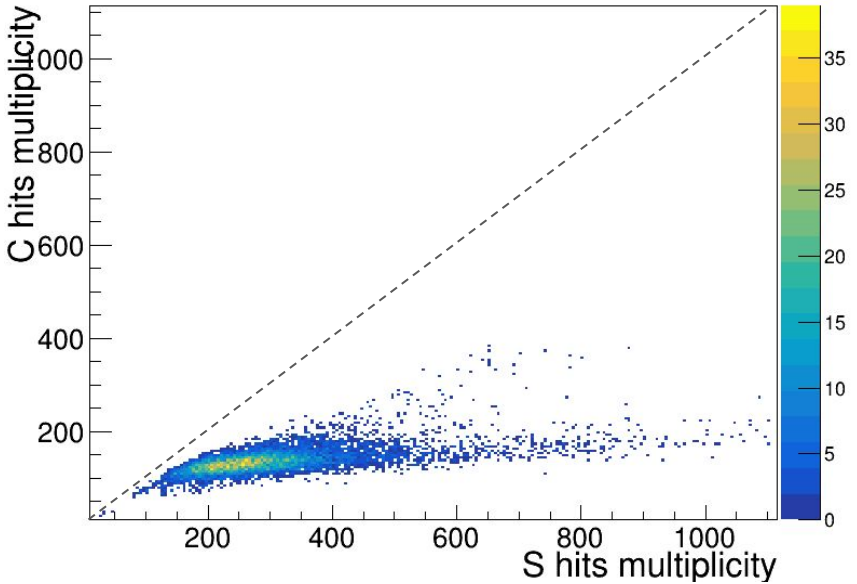
Some **very preliminary** results in the next slides.

Hits Multiplicity

20 GeV electrons, 10k events
3x3 cm² crystal size

Saving both the energy deposited in the crystals and the number of Cherenkov.

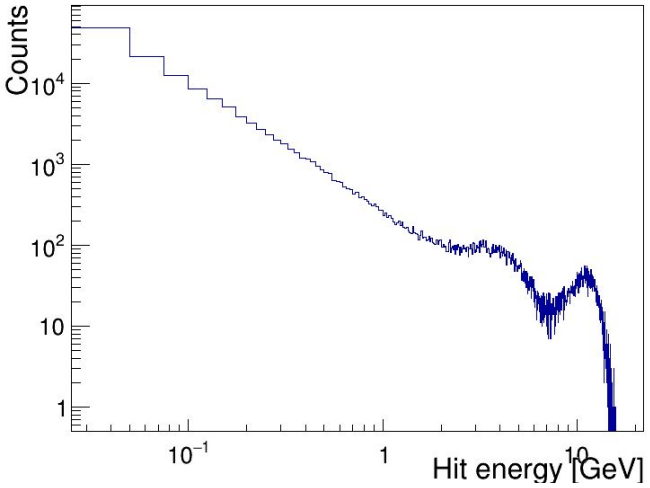


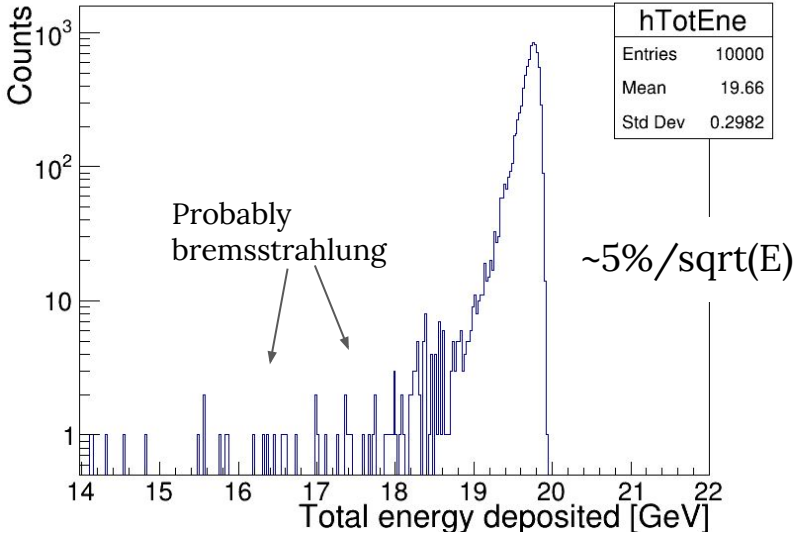


Energy - per Hits and Total

20 GeV electrons, 10k events
3x3 cm² crystal size

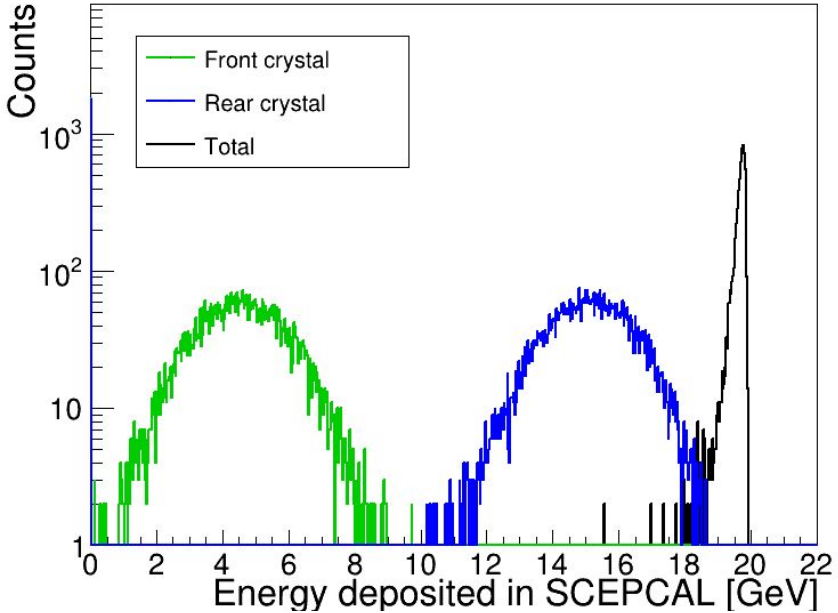
- ★ Sum all the energy hits of an event → **total reconstructed energy compatible with 20 GeV**
- ★ Some tail in the total reconstructed energy due to bremsstrahlung





Energy sharing

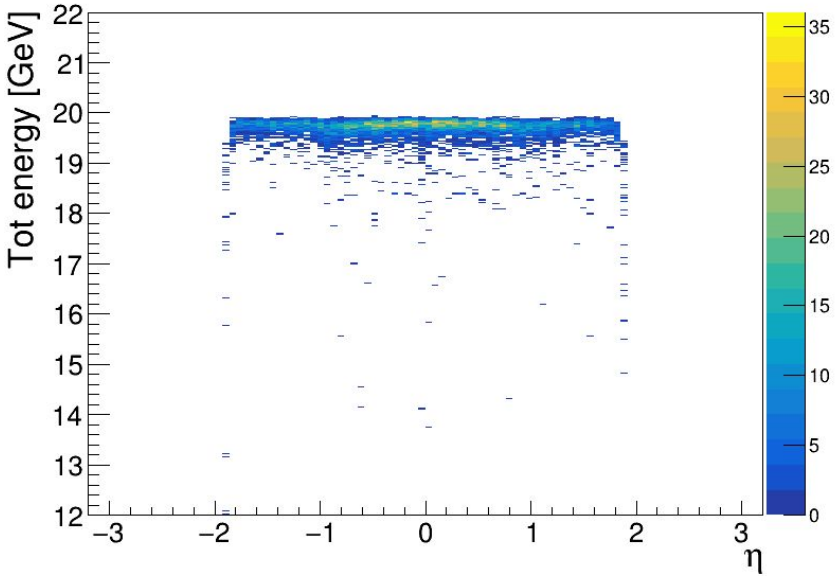
- **Total reconstructed energy** compatible with 20 GeV
- Deposits in **rear** and **front** crystals scale **~ length of crystal** (front 5 cm, rear 15 cm)

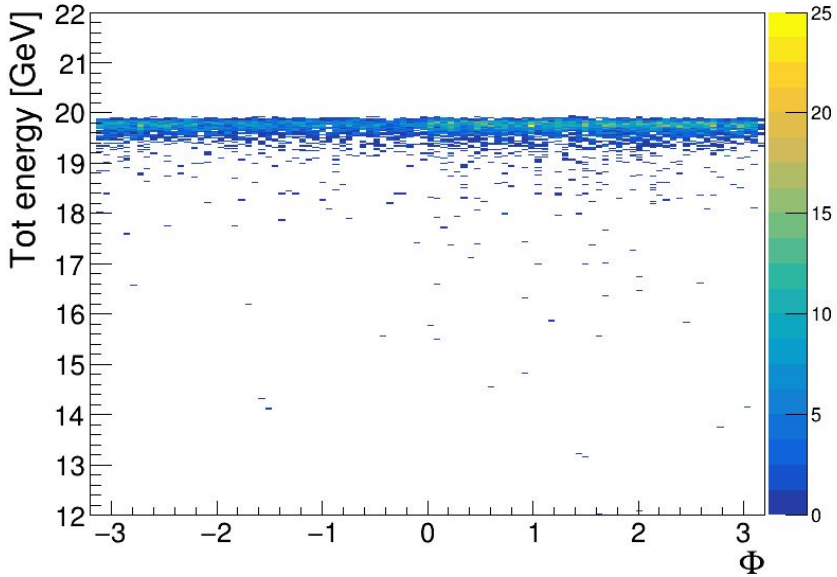


Total energy VS eta/phi

20 GeV electrons, 10k events
3x3 cm² crystal size

- ★ Looking at total reconstructed energy (sum of all hits) as a function of phi/eta of the Hit with maximum energy (“seed”)
- ★ **Response seems uniform**: need to repeat as a function of MC e- eta and with more granularity (and over full range with nominal geometry)





Work In Progress

- **Edm4hep Class:**
  - **Atm:** the SCEPCal simulation save the output using the edm4hep class: SimCalorimetrHit.
    - Info stored: cellID, energy, position. **Missing**: time info
    - **Two separated collections** for Cherenkov and Scintillation:
      - Some information (such as position) duplicated
      - Each class has different entry (number of crystals saved) for each event
  - **Next:** Storing all the information in **one collection**:
    - should be more easy to handle in RDF
    - for each event: cellID, energyScintillation, #Cherenkov, position, time.
    - Should ask to edm4hep people the feasibility of this?

- **Environment conflicts:**
  - the env needed to run the SCEPCal Simulation and the one needed for FCCAnalysis repo are in conflict, any ideas on how to make them compatible?

- Error in **`GeoSvc ERROR std::bad_alloc`** when going down to 2.5 cm geometry

Summary and ToDo's

SCEPCal Repository:
https://github.com/SCEPCAL/SCEPCAL/tree/master

★ We have in place the **simulation of the SCEPCal**, with 2 layers of crystal dual readout.

★ **To Do:**

- Testing the geometry with the nominal face width of crystals:
  - **1x1 cm^2 and 0.5x0.5 cm^2**
- Adding the timing layers

- Validating simulation (sanity checks with electron particle gun events)

★ When and where should we make a **pull request** to FCC IDEA central repository?