SAND Calibration WG

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WG organization

- **Since we have three subdetectors to calibrate, we decided to identify a reference person for each of the subdetectors**

  ECAL: P.Gauzzi
  GRAIN: A.Surdo
  Tracker: .....

- **Chair of the WG: P.Gauzzi**
  Co-chair: A.Surdo

- **Meeting time: Friday at 5:00 p.m. CET (10:00 CT)**
  meetings every three weeks (next meeting June 28th)

SAND Calibration WG

- **Calibration: from detector signals to physical variables**
  - **ECAL: energy, time and positions of the particles**
  - **Tracker : *r-t* relations, track momentum, dE/dx for PID, ...**
  - **GRAIN: tracks, time, energy, ...**
  - **Timing alignment among the subdetectors (for the determination of the interaction time)**

- **Start to define a strategy for each subdetector:**
  - **Sources: cosmics, particles from beam, (radioactive sources ?)**
  - **Choose suitable processes (given the expected fluxes of particles in the detector) (*e.g.* for the ECAL: cosmic μ's as MIPs, MIPs from the beam, electrons and photons ....)**
  - **Set a calibration procedure (at which level of precision ?**
    How much time expected for a calibration ?)

ECAL calibration strategy

Cell-by-cell calibration of both energy and time:

- **MIPs from cosmic rays**
- **MIPs from beam (rock, magnet and Fe yoke, upstream ECAL modules)**

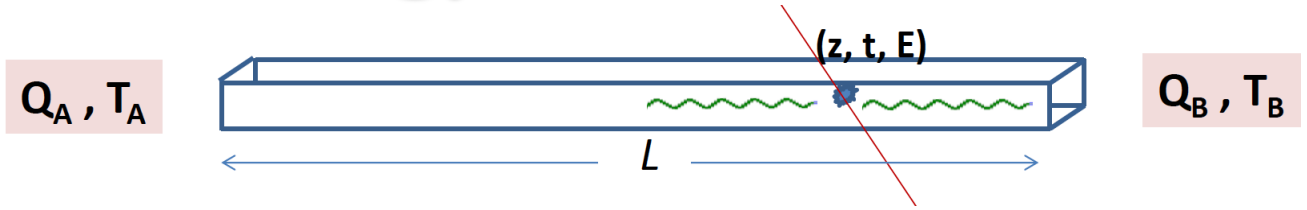
Set the energy scale and timing performance:

- **γ's from π^0 decays and electrons from beam events**

Additional study:

- **Look for possible periodic (day/night) variations of the energy constants during the KLOE data-taking**
- **This could suggest the implementation of probes to monitor temperature variations**

Energy reconstruction



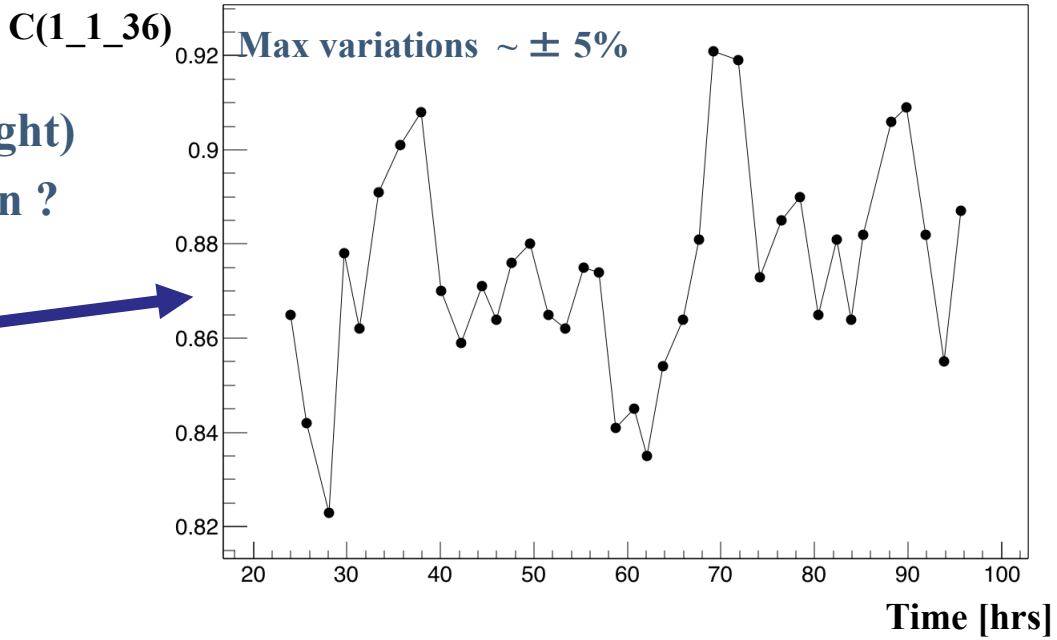
$$E_i^{(A,B)}[\mathrm{MeV}] = \frac{(Q_i^{(A,B)} - P_i^{(A,B)})[\mathrm{ADC\ counts}]}{C_i[\mathrm{ADC\ counts/MIP}]} K \times f_{MIP2MeV}[\mathrm{MeV/MIP}]$$

- C_i = peak of the MIP distribution
- Corrections to the C_i with the Bhabha scattering events ($e^+e^- \rightarrow e^+e^-$): showers of 510 MeV
- Absolute energy scale K fixed at cluster level with the $e^+e^- \rightarrow \gamma\gamma$ events

$$\Rightarrow \mathrm{Calib.\ Const.} = \frac{K}{C_i}$$

Energy calibration

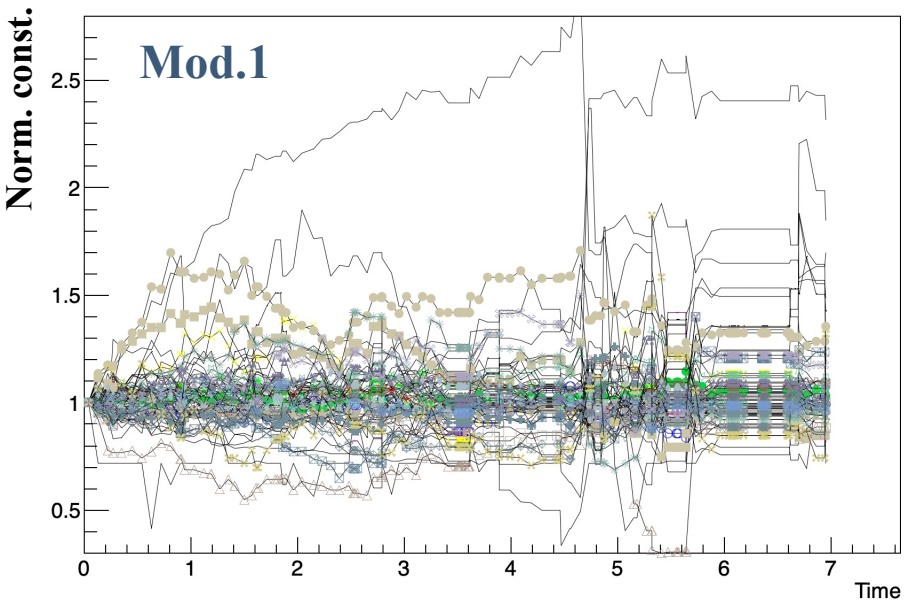
- Typical calibration constant variations in KLOE (1 barrel channel)

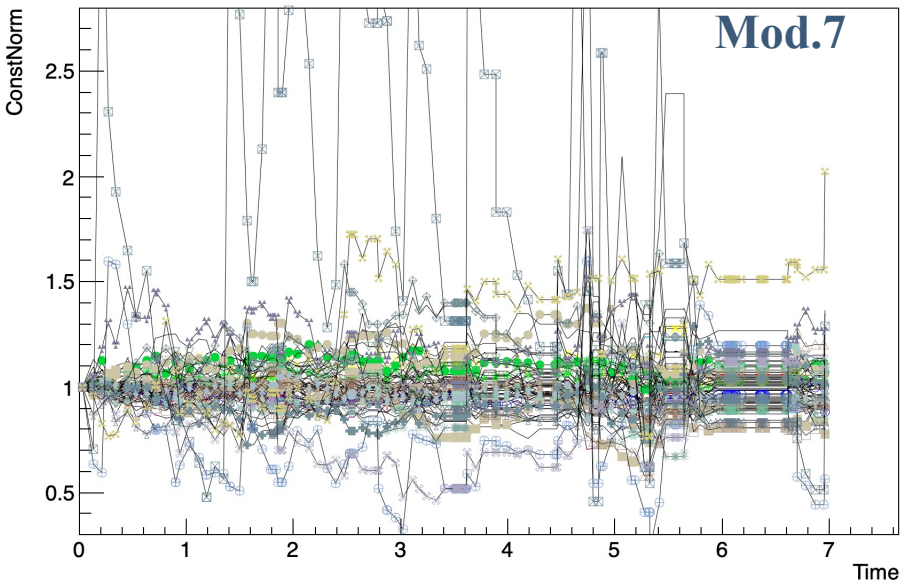


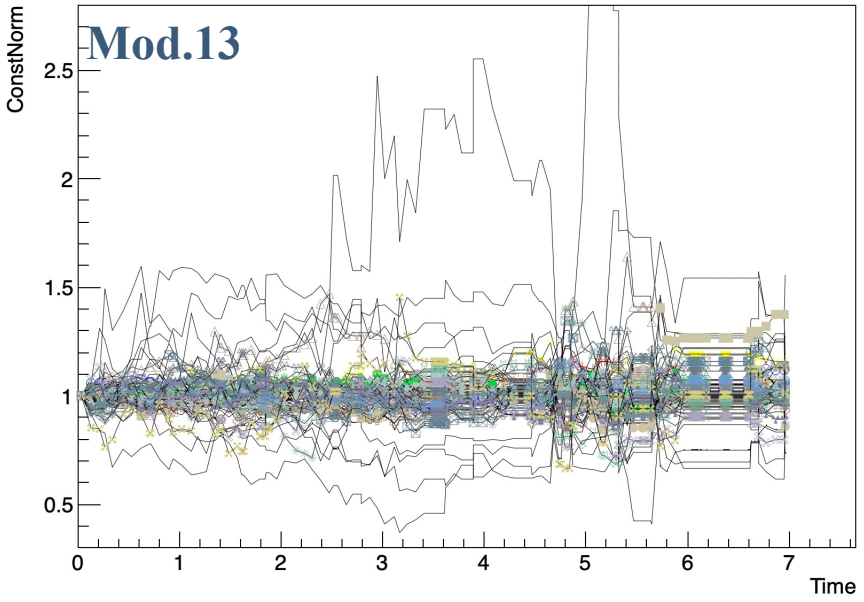
- Is there any periodic (e.g. day/night) variations in the whole gain chain ?
- One cell over ~ 100 hrs

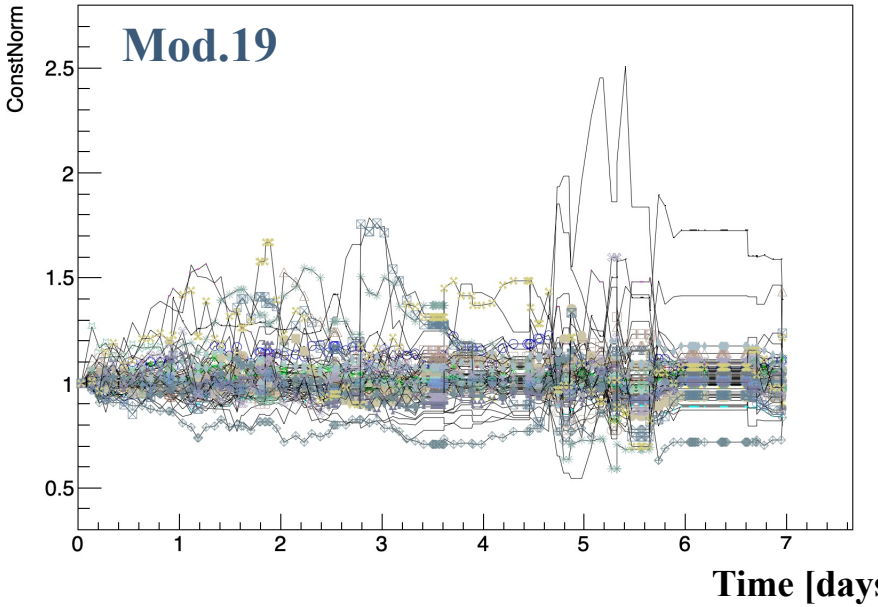
- Look for variations of the constants in one week time interval (1/12/2017 – 7/12/1017)

Constant variations



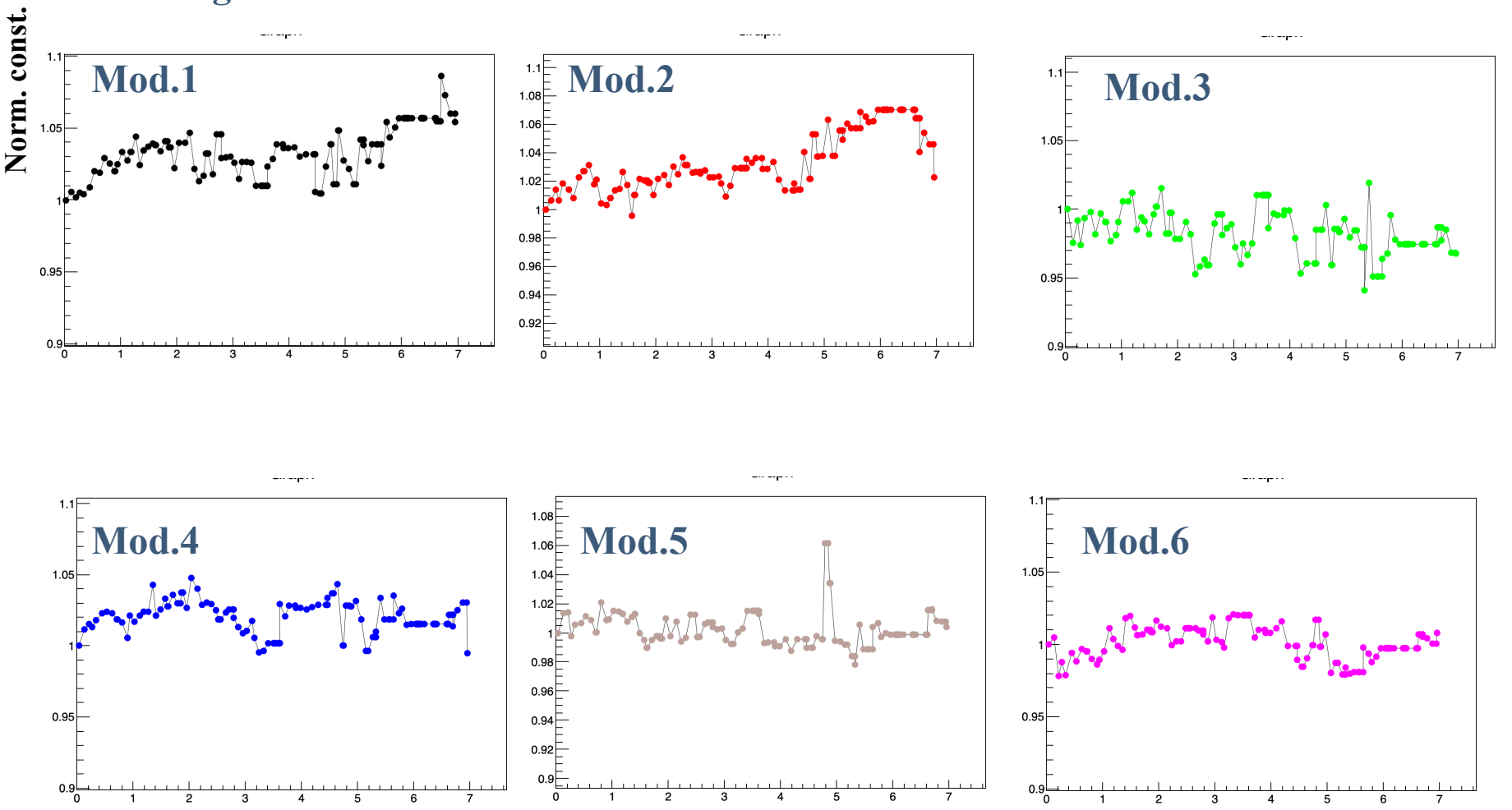






Average per module

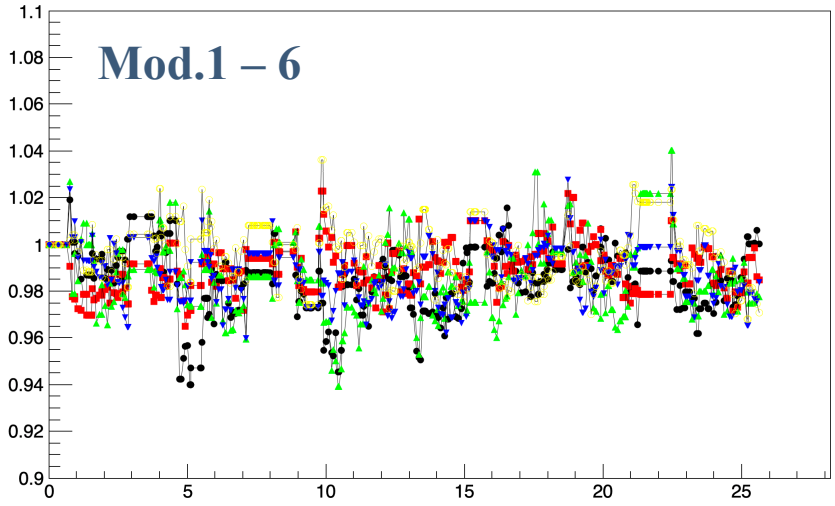
- Average over the 60 cells of a barrel module

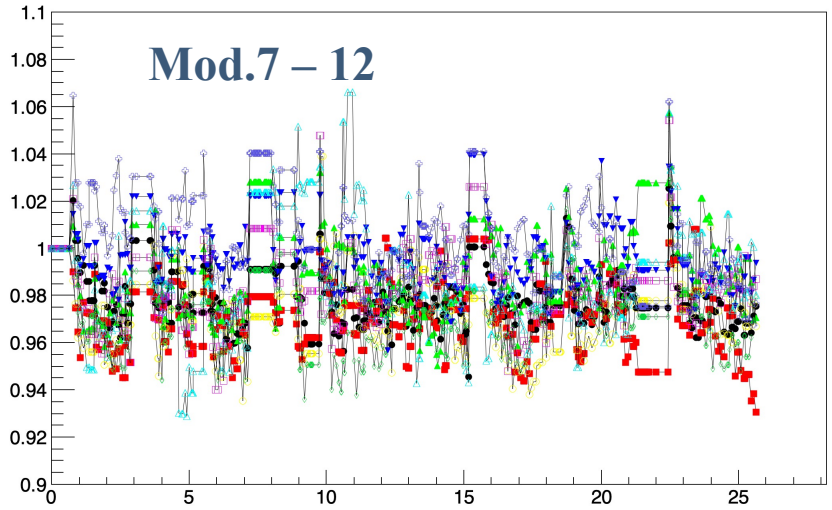


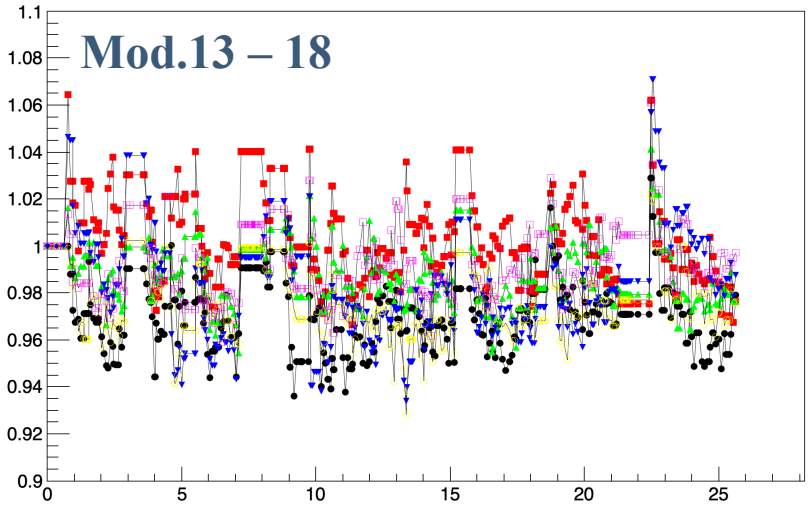
- No significative time dependences found

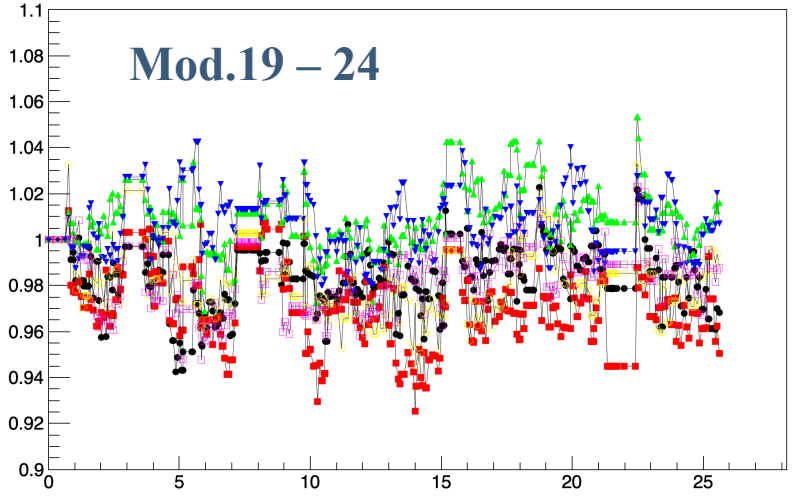
Average constants

- Variation on a larger period, ~ 1 month









Time [days]

ECAL next step: rock muons

MIPs from beam (rock, magnet and Fe yoke, upstream ECAL modules)

Cut	ECAL		Rock muons		Magnet events	
	Events	ε (%)	Events	ε (%)	Events	ε (%)
No cut	2.23	100.0	1447.26	100.000	50.82	100.000
μ in ECAL FV	2.23	100.0	12.73	0.880	18.92	37.229
STT & ECAL hits	1.63	72.9	6.05	0.420	3.443	6.775
NN cut	1.56	95.5	0.10	0.007	0.07	0.136

Table 40: Number of events per spill (9.6 μs, 7.5×10^{13} pot) and selection efficiency for the signal from ν_μ CC in the front barrel ECAL and the backgrounds from rock muons and magnet events.

(from DUNE-doc-13262, A Near Detector for DUNE)

~ 1.5 × 10^3 μ/spill (1 spill = 9.6 μs every 1.2 s) without any selection

- **The MC sample (produced by R.Petti) is not available anymore**
- **We must generate again these events**

- **R.D'Amico expressed interest to work on this item**

GRAIN

Work in progress …

✓ Start from the “most natural” physics process: a **MIP crossing LAr volume in GRAIN**

✓ To this aim:

Use of the Reconstruction program (“*SandReco*”), applied to a MC sample of nu_mu interactions in whole SAND, to measure the **Pathlenght (ΔL)** and the correnspondingEnergy Loss (ΔE_{loss})** in LAr of a muon crossing GRAIN

1st step: select the events where:

- the muon is generated outside ECAL (or in the outer layers) and crosses GRAIN
- only the muon track crosses GRAIN (no other particles enter the LAr volume)

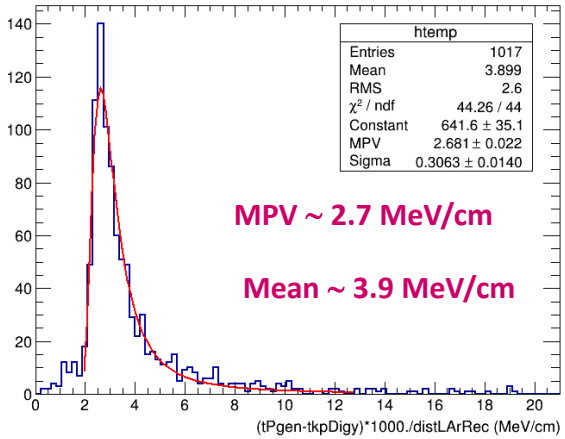
2nd step: evaluate ΔL and ΔE_{loss} from EdpSim information related to the muon trajectory

As an example, from previous simulations …

- **Precise determination of <dE/dx> by a muon crossing GRAIN**

From MC simulation (**FLUKA**) of SAND, for a μ crossing GRAIN (cryostat walls included):

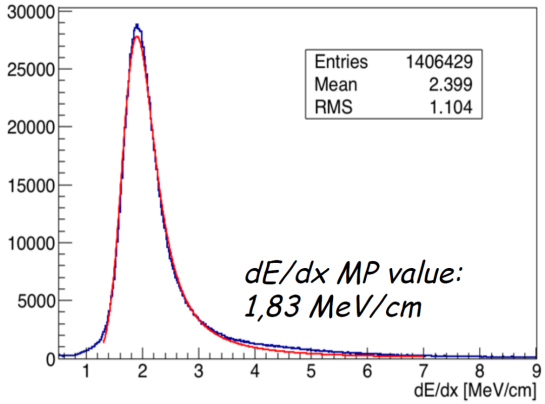
ΔE/ΔL (MeV/cm)



ΔL: distance between interaction Vertex in GRAIN and first hit in STT
ΔE: muon energy loss in ΔL

From ICARUS

Full 3D reconstruction on selected muon tracks crossing LAr volume



Conclusions

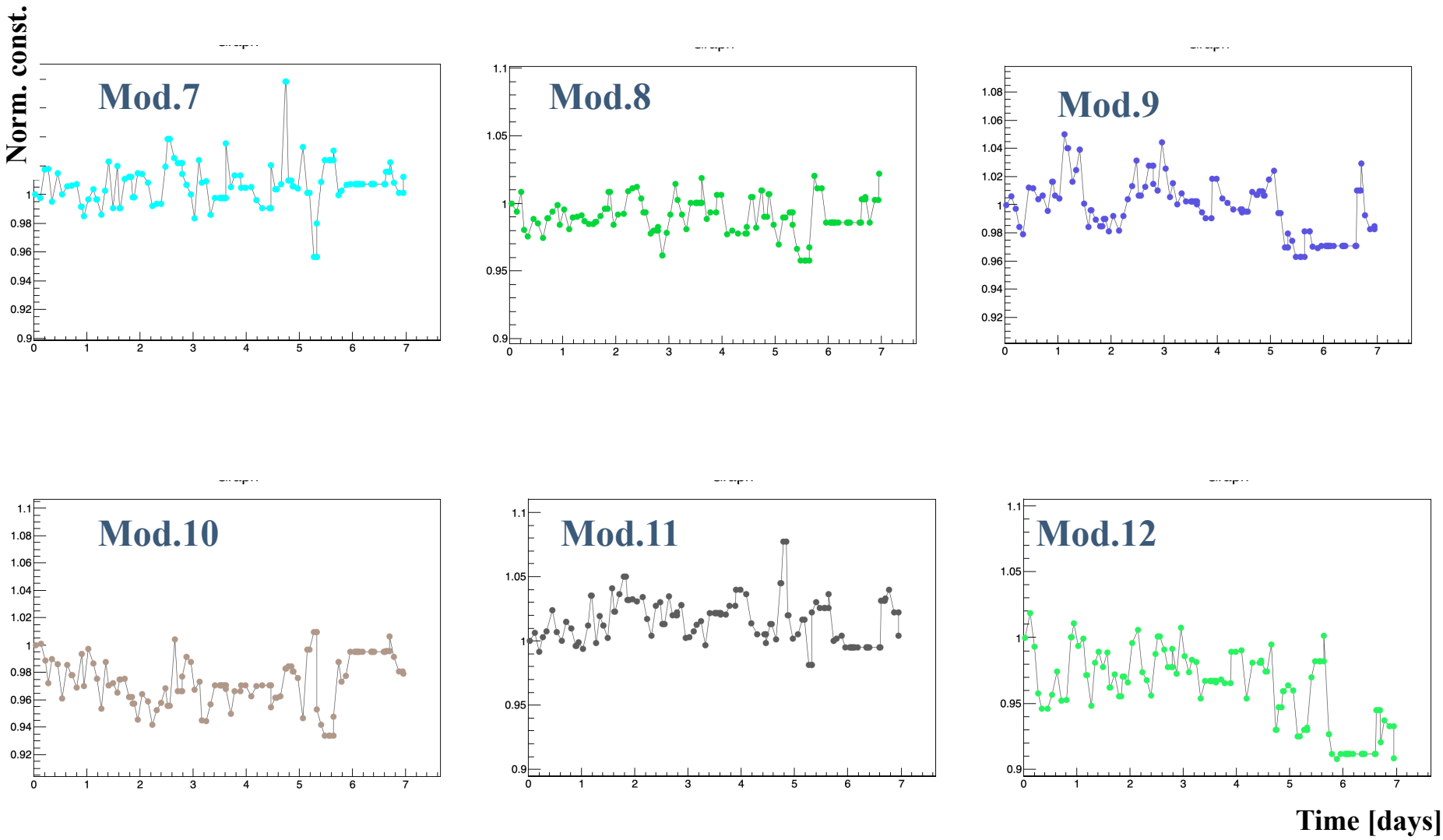
- **Sketching a strategy for GRAIN and ECAL calibration**
  - **Cosmic muons**
  - **Particles from beam / events from collected data**
  - **(Ad hoc sources, like radioactive sources, LED, ... ?)**

- **Tracker strategy still missing**

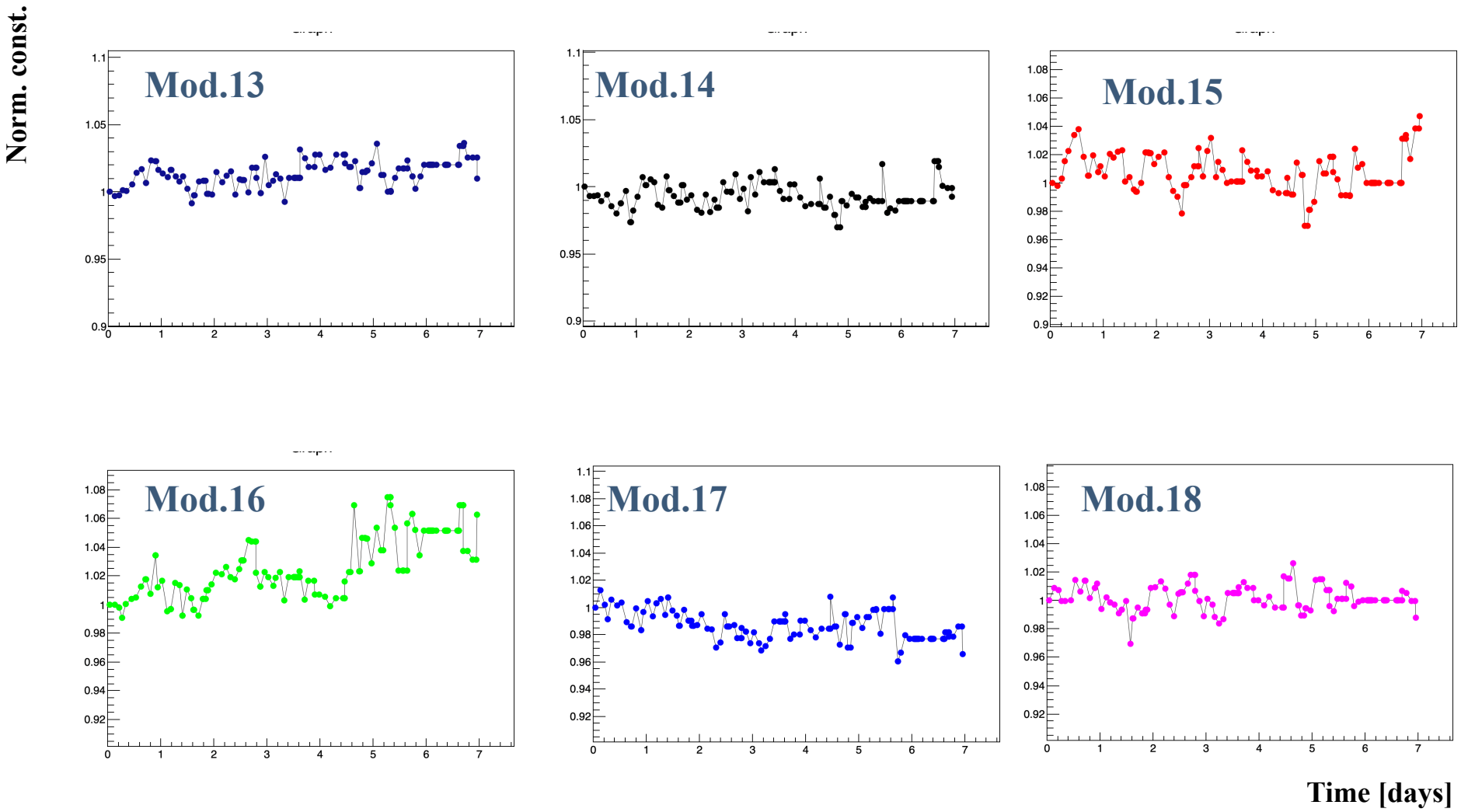
- **ECAL: study of the variation of the energy calibration constant with time in the KLOE data**
  ⇒ No significative time dependences (day/night) found

Spare

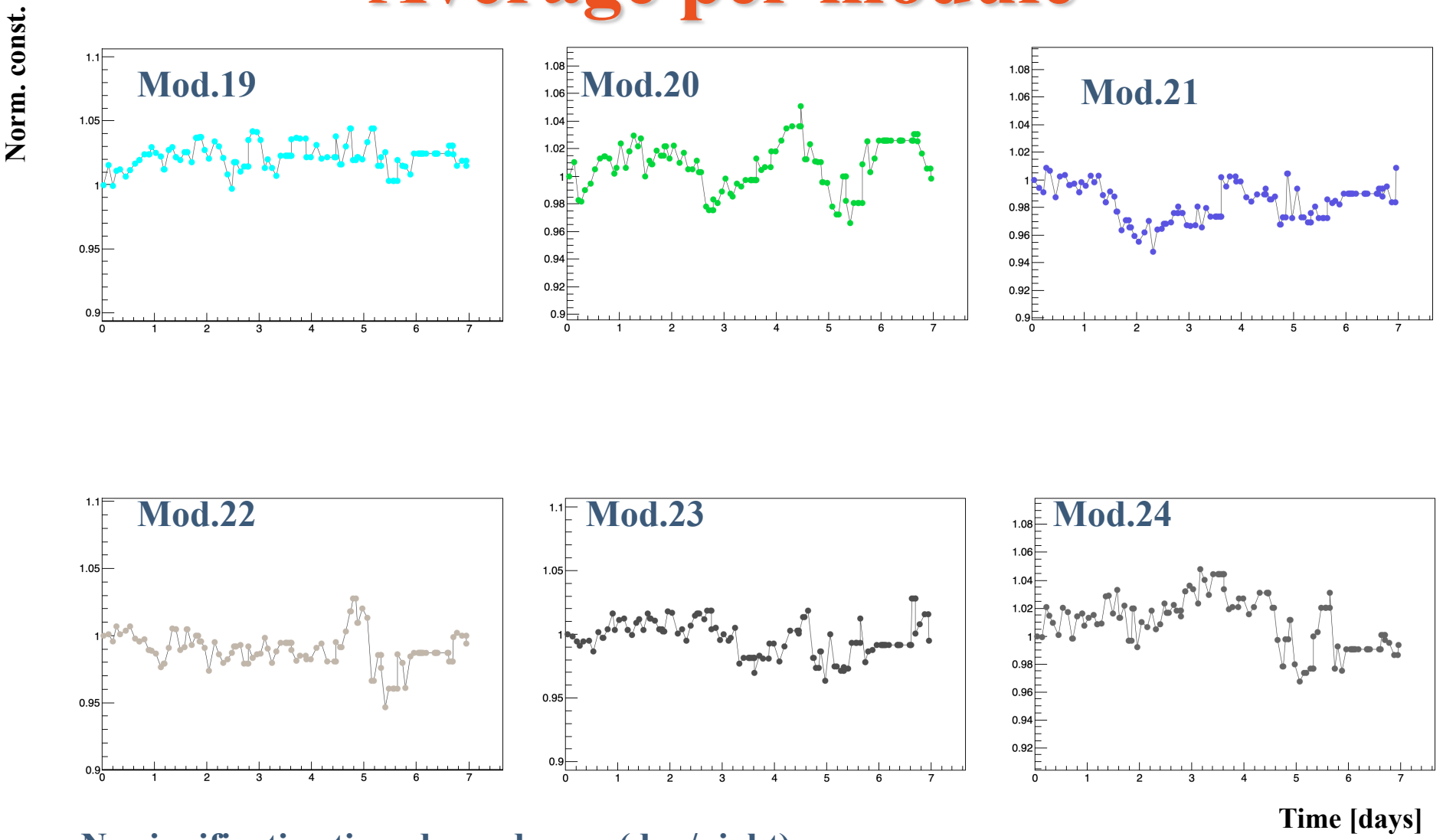
Average per module



Average per module



Average per module



- **No significative time dependences (day/night)**