



# the FOOT Calorimeter @ Torino

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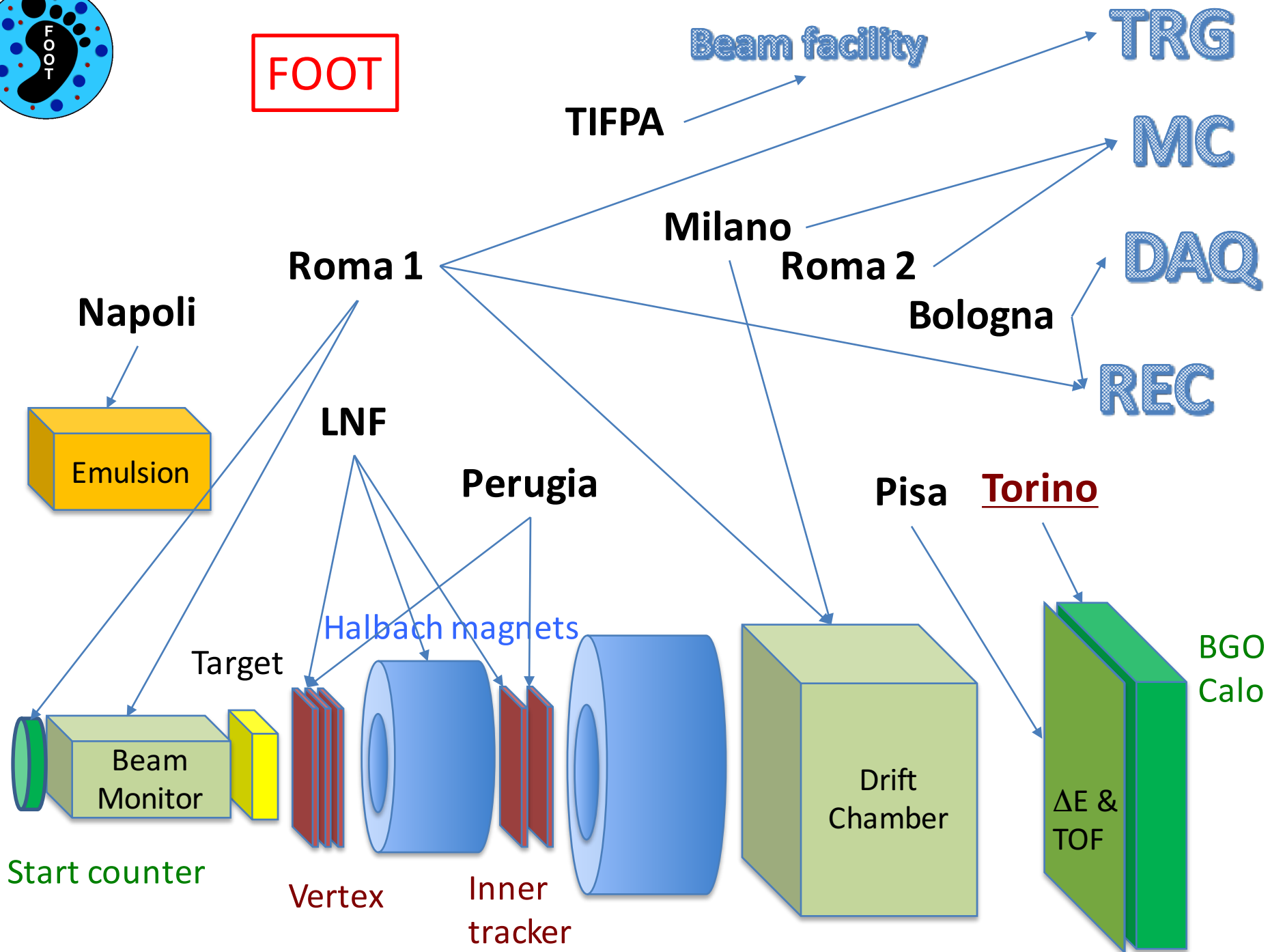
a new one entering now

....

(\*) Thanks for preparing the material  
All errors are my responsibility <sup>1</sup>



**FOOT**





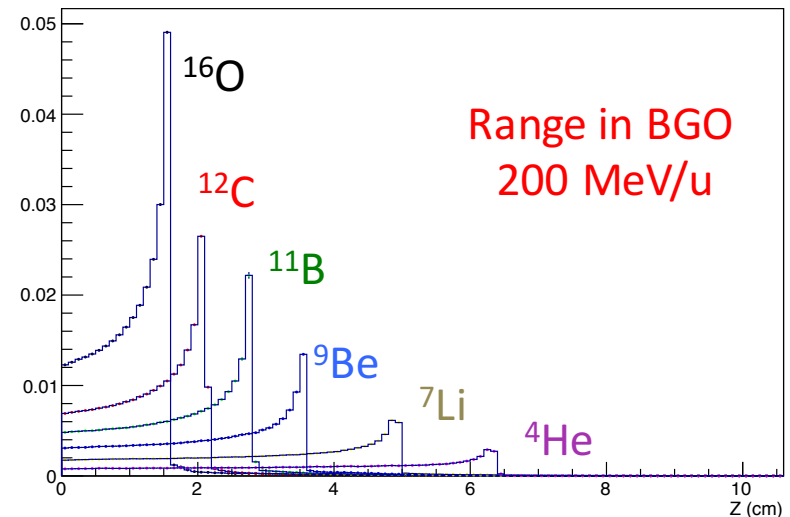
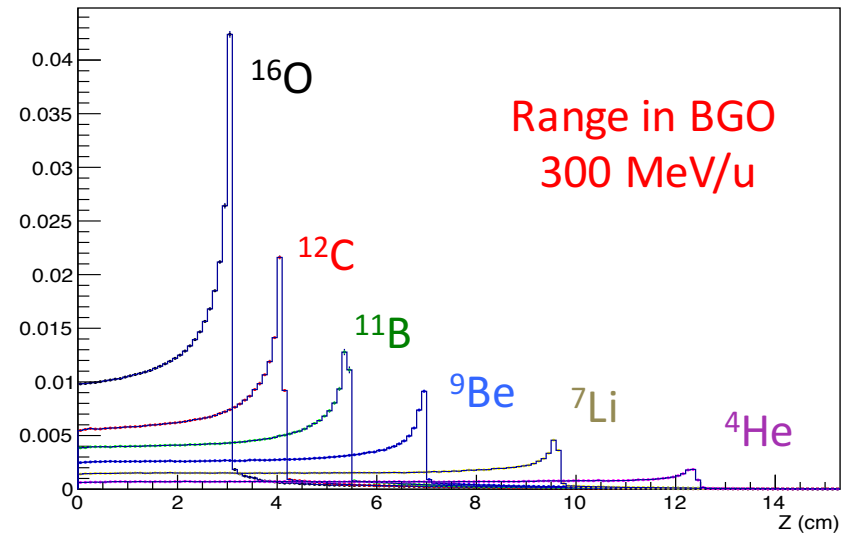
# the FOOT Calorimeter

- Coverage:  $\sim 40 \times 40 \text{ cm}^2$  (circular, 40 cm diameter). Maybe extra coverage to recover some of the laterally escaping neutrons
  - 320  $\rightarrow$  400 channels
- Thickness
  - 7 - 21 cm. Simulations show the recovery of neutrons does not significantly change when increasing the thickness. The final choice will depend on the source of BGO crystals
    - Buying or recycling?



# the FOOT Calorimeter

- High density and good energy resolution -> BGO
- TOF asks for 1.2 m lever arm
- ->  $R = 20$  cm with  $10^0$  angular aperture of the fragments
- A  $2 \times 2$  cm<sup>2</sup> granularity is due to the minimum track separation (1deg)
- Thickness must contain the lighter fragment @ 200 MeV/u  
-> 7 cm
- $2 \times 2 \times 7$  cm<sup>3</sup> BGO units -> ~ 320 channels



Read-out: not critical due to the high light yield, low rate (PMT, APD, SiPM)



# the FOOT Calorimeter: questions

- Trigger source? How we trigger?
- Number of channels:  $\sim 320$  cristalli
  - PMT: 320
  - SiPM (5 mm pitch):  $320 * 16 = 5120$
- Event volume:
  - PMT: 2-3 bytes
  - SiPM:  $\sim 50 - 100$  bytes
- Maximum acquisition rate
  - BGO: decay time: 300 ns  $\rightarrow \times 3 \sim 1 \mu\text{s} \rightarrow 1 \text{ MHz}$
- Deadtime:  $\sim 1 \mu\text{s} \rightarrow$  occupancy  $\sim 0.01$
- How we read-out?
  - To be defined: VME, fiber, ?
  - Which infos (time, position, energy, etc...) and precision?



# the FOOT Calorimeter: plans

- Crystals assembly
  - Optical isolation?
  - Readout: PMT o SiPM?
- To do: SiPM investigation - next 12 months
  - Crystals: « Vincenzo will take care »...
  - SiPM: FBK (AdvansiD) to be contacted
  - Readout chip: TOF-PET-v2 ASIC available in Torino (charge integration). Dynamic range to be verified if compatible with BGO signal amplitudes.
  - Prototype construction: 2x2, test in lab
    - ??3x3 test beam at CNAO with p and  $^{12}\text{C}$
- PMT: backup solution HZC Photonics



# The prototype

- The prototype
  - BGO: 4 crystals ( $2 \times 2 \times 7 \text{ cm}^3$ ) available, tested on  $^{60}\text{Co}$  source in lab. with old PMTs
  - PMTs: arrived on May, 25<sup>th</sup>.
  - SiPM: to be evaluated
- Test: CNAO, end of July
  - Energy scan with protons and carbon ions
    - Energy resolution, linearity





# Conclusions

- Outcome CSN3
- Simulations (Cristina / Giuseppe)
- Prototype construction:
  - BGO
  - PMT
  - SiPM?
- Test: CNAO available
- Tasks/Timeline