# Emulsion Cloud Chamber for the FOOT experiment

INFN_Napoli

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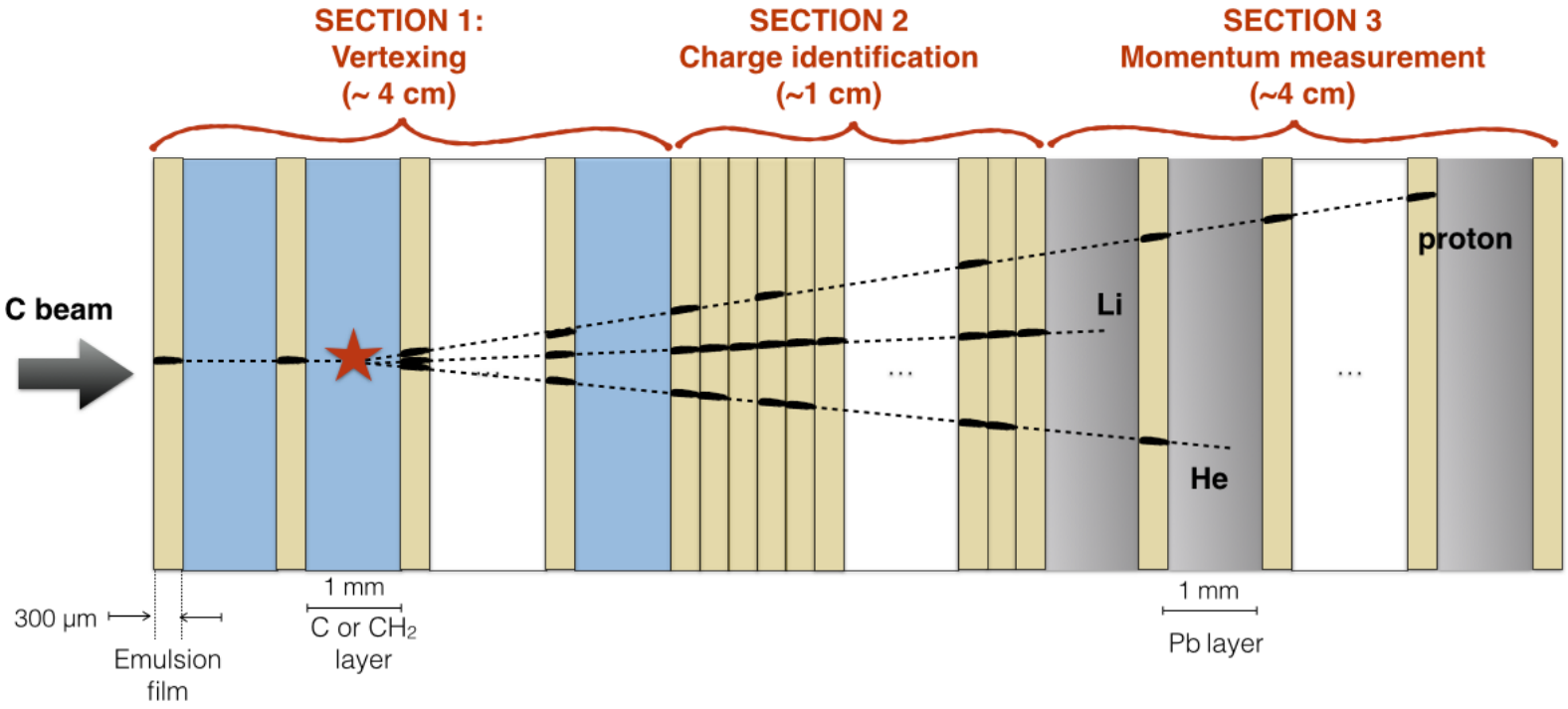
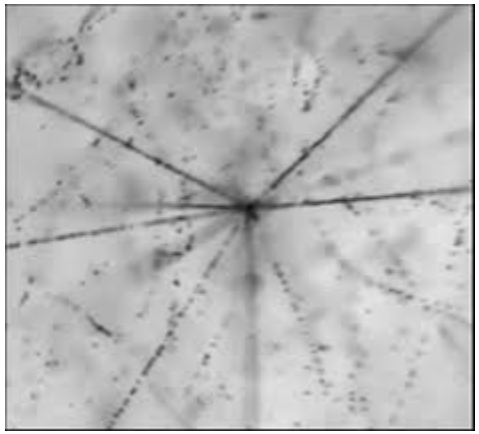
# 1. Detector structure: layout

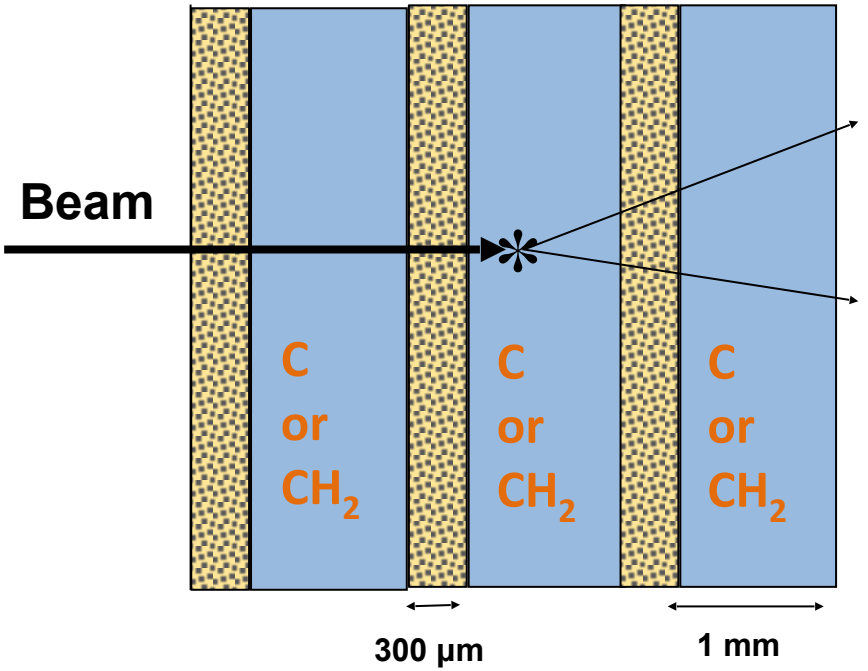
- Section 1: alternated layers of emulsions and target ($C/CH_2$)
  - vertex detector
  - tracking of all charged particles produced;
- Section 2: made of emulsion films only
  - charge identification for low Z fragments (H, He, Li)
- Section 3: alternated layers of emulsions and lead
  - Momentum measurement by range



# 1.Detector structure: Section 1 (vertexing)

- Alternate target layers of C or $CH_2$ (1 mm) and emulsion (300 μm)
- Vertex detector and particle tracking
- Chamber thickness defined by the interaction length → obtain a sufficiently high number of interactions fully contained in the detector
- 20% of Carbon ions interacting in 3 cm Lexan
- Total length ~ 30 cells = 39 mm

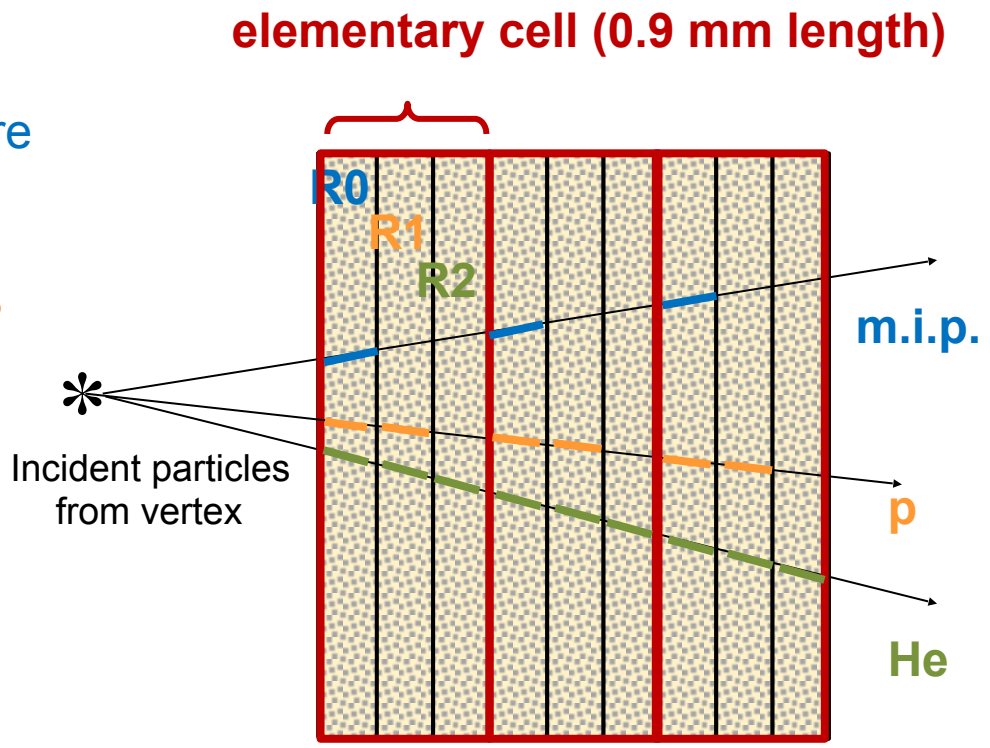




# 1. Detector structure: section 2 (charge id)

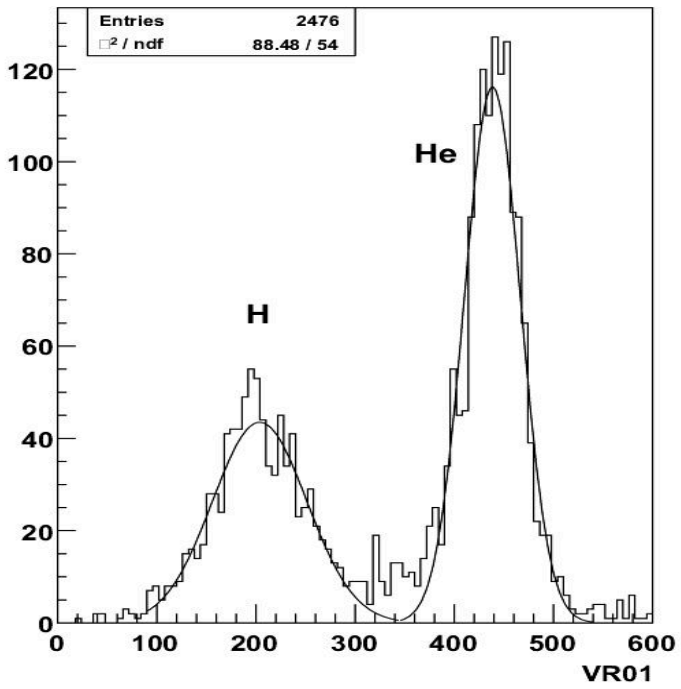
- Charge identification for low Z fragments (H, He, Li)
- Emulsion were differently treated after the exposure and before the chemical treatment according to their position in the elementary cell (**0**, **1**, **2**)

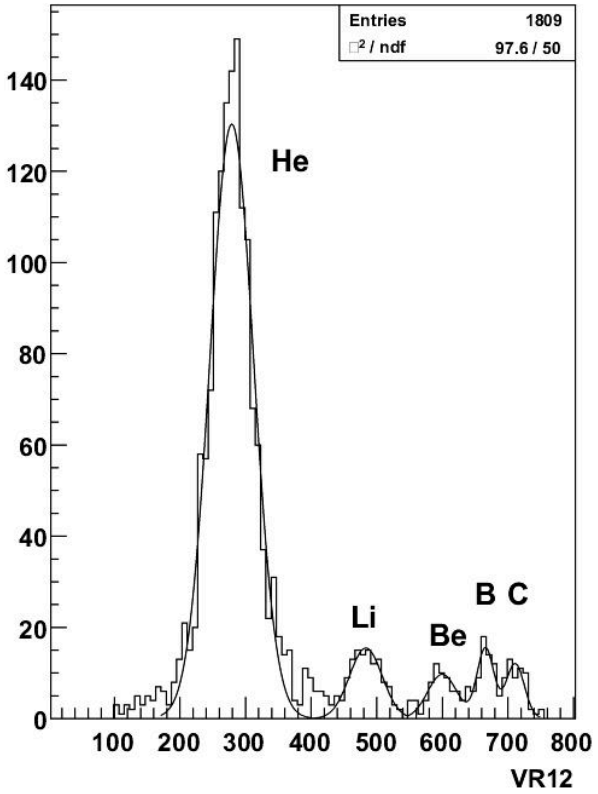
- **R0:**
  - Not refreshed
  - Developed soon after the exposure
  - **Sensitive to m.i.p.**
- **R1:**
  - Appropriate refreshing for protons
  - Insensitive to m.i.p.
  - **Sensitive to protons**
- **R2:**
  - Appropriate refreshing for He
  - **Sensitive to He**



# 1.Detector structure: Section 2

## Charge separation




| Cells | 3 | 9 | 13 | 20 |
|---|---|---|---|---|
| H-He | 3.3 | 4.5 | 6.5 | |
| He-Li | 2.6 | 3.9 | 4.3 | 5.0 |
| Li-Be | 1.7 | 2.7 | 3.1 | 3.5 |

*JINST 2 (2007) P06004*

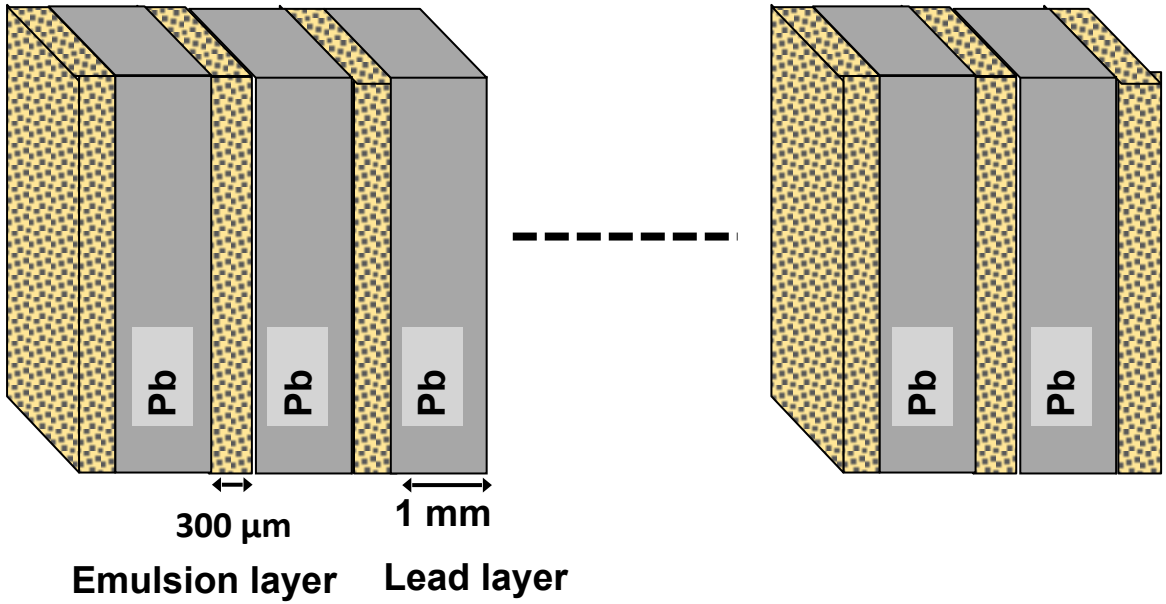
# 1.Detector structure: Section 2

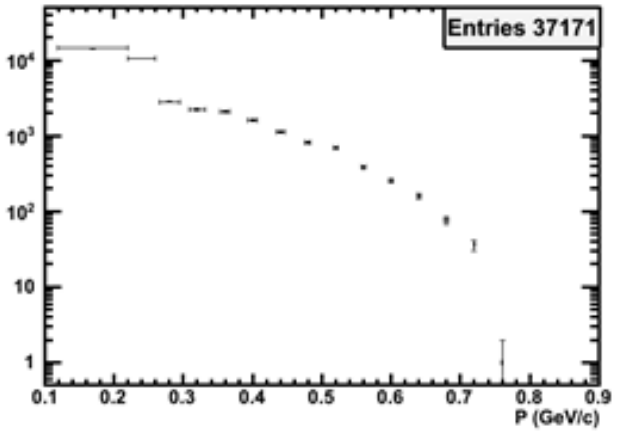
## Activities to do:

- New emulsion batch
- different sensitivity to mip: ~50 grains/100 μm
- Test to do to characterise emulsions thermal response

# 1.Detector structure: Section 3 (momentum)

- Emulsion films interleaved with 1 mm thick lead plates
- Lead plates from ~10 to ~50 according to the incident beam energy




*MST 26 (2015) P94001*

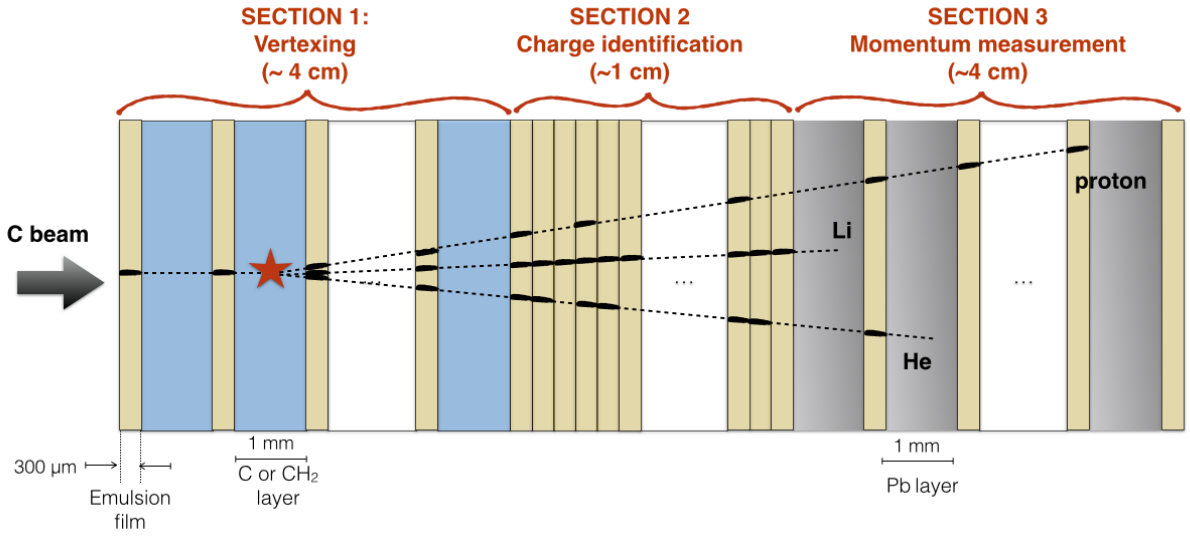
# 2. 2017 Activity

## for the whole detector:

- layout sw simulation
- mechanical design (packaging, support, movement)

## R&D for section 2:

- preparation of the LNS exposure
- LNS measurements

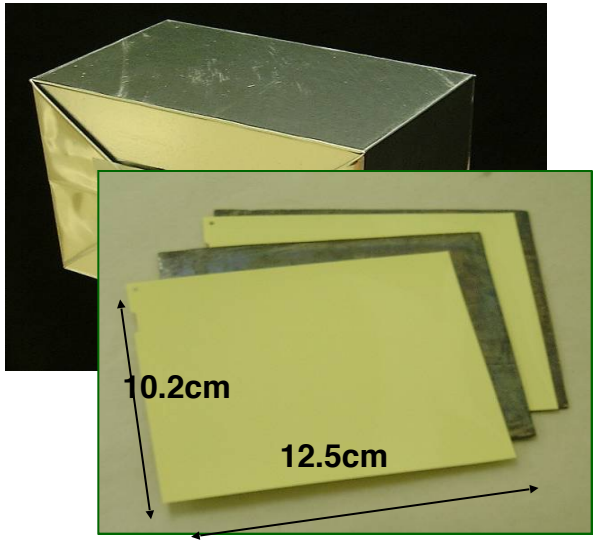


# 3. Refreshing machine

- Emulsions must be differently treated after the exposure and before the chemical treatment
- **Climatic chamber GENVIRO 120C**
- **February-march 2017**: purchase and installation at LNGS in a dark room
- Technical characteristics:
  - Temperature range: -40°C to 180°C (+- 0.1 °C to +-0.3)
  - Humidity range: 10% to 98% (+- 0.5%)
  - Internal volume: 120 l

# 4. Emulsions from Japan

- ~ **march 2017**: arrive 100 emulsions from Japan
- Preliminary tests at LNGS with cosmic-rays in preparation of the run at LNS



# 5. Exposure at LNS

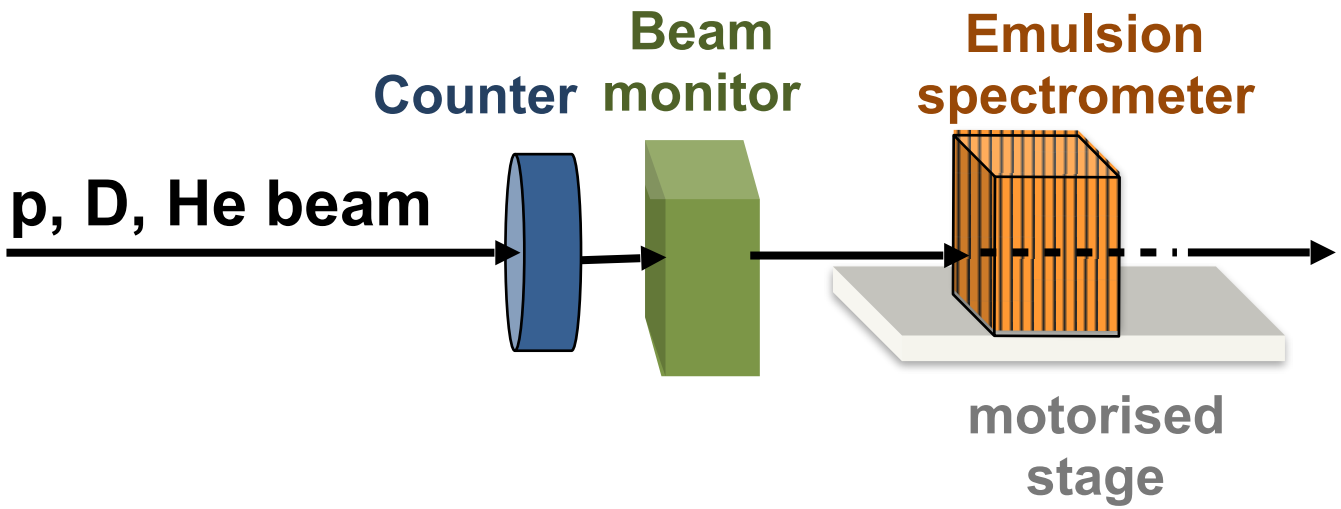
- 9 BTU (1 BTU=8 hours) allocated in total to test the following detectors:
  1) Emulsions (Naples)
  2) Scintillator with SipM (Pisa)
  3) Silicon tracker (Perugia-LNF)
- Assumed to be after June 2017 in the request
- Coordinated effort among the three labs

# 5. ECC Exposure at LNS

Beam monitoring:

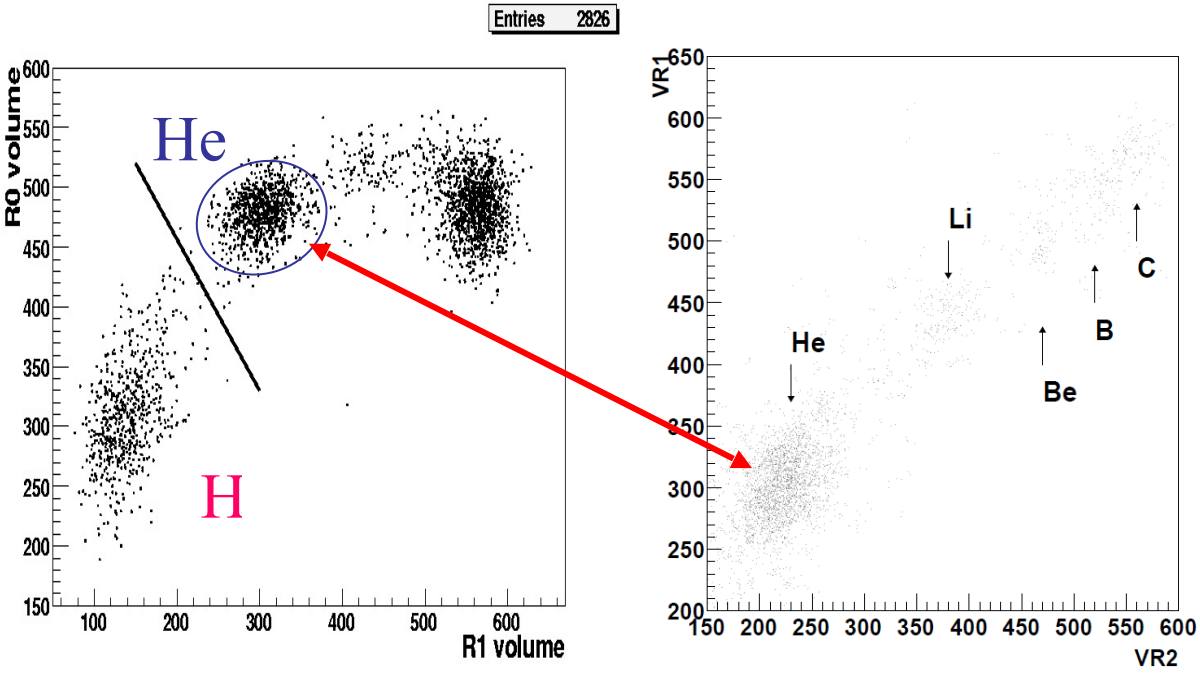
- **Scintillator counter** for flux monitoring
- **Chamber** for spatial distribution with ~ mm resolution

Depending on the rates, ECC may be moved by a motorised 2D stage



# 5. ECC Exposure at LNS

- Exposure of ECC (section 2) made of ~30 emulsions in order to measure the sensitivity to p, alpha




*Journal of Instrumentation 2 (2007) P06004*

# The end

# Back up slides

# 2. Section 2: how many elementary cells for charge separation?

The standard deviation for the separation of pair of nuclei, as function of number of elementary cells, is reported in the table.

- 1 cell = 0.9 mm length
- E.g., to obtain a $3\sigma$ He-Li separation, 9 cells are necessary, (total thickness ~8.1 mm)

| Cells | 3 | 9 | 13 | 20 |
|---|---|---|---|---|
| H-He | 3.3 | 4.5 | 6.5 | |
| He-Li | 2.6 | 3.9 | 4.3 | 5.0 |
| Li-Be | 1.7 | 2.7 | 3.1 | 3.5 |

# 3. Detector construction: material

| | ECC (C or $CH_2$) | | | TOT |
|---|---|---|---|---|
| | Section 1 (em+C) | Section 2 (em) | Section 3 (em+Pb) | |
| Emulsion films | 30 | 30 | 20-50 | 80-110 |
| C or $CH_2$ layers | 30 | 0 | 0 | 30 |
| Pb plates | 0 | 0 | 20-50 | 20-50 |

- At least 2 ECC (C or $CH_2$) for each energy exposure

# 4. Schedule

| TASK | TIME |
|---|---|
| Film preparation for calibration test @ CERN | 1 week |
| Calibration test at Trento/Catania | 1 week |
| Film treatment for calibration test @ CERN | 2 weeks |
| Film preparation for the run @ CERN | 1 week |
| RUN at Heidelberg/CNAO | 1 week |
| Film treatment for run @ CERN | 2 weeks |

- 3 persons for each task → 3 months men in 2017 (calibration) and in 2018 (run)
- Test with He, Li could be useful for calibration purposes