

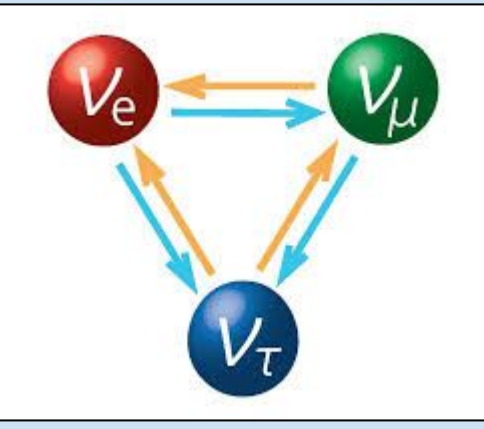
Yegor Vereshchaka, Mathis Granjon, Laurent Simard  
IJCLab– Orsay – France & LP2I – Bordeaux – France  
On behalf of the SuperNEMO Collaboration



## Search for $0\nu\beta\beta$

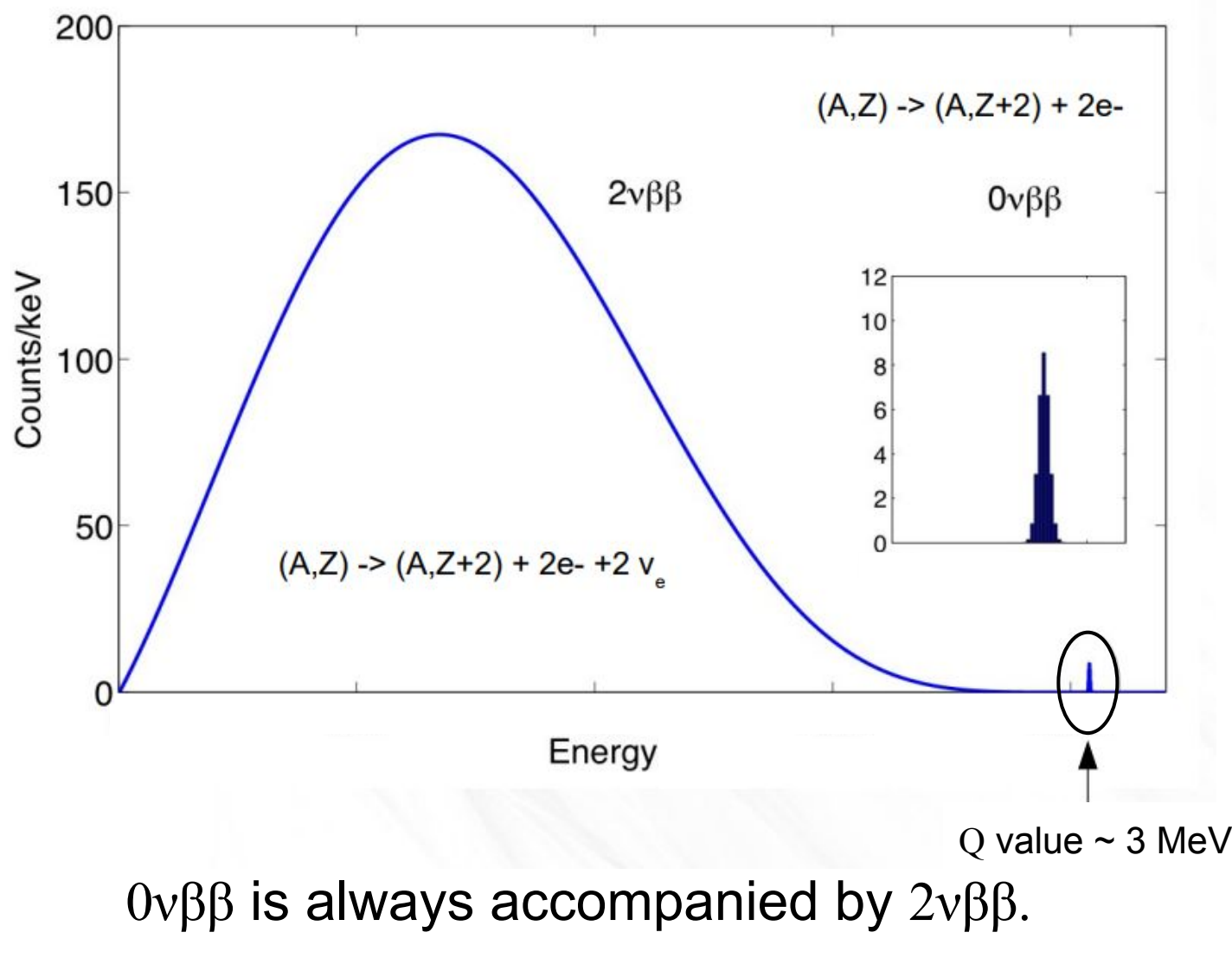
### Nature of the neutrino

- **Fundamental neutral fermion** with spin  $\frac{1}{2}$ , was long thought to be massless, but it is massive.
- Neutrino undergoes **weak interaction** only.
- **3 neutrino flavours** exist ( $\nu_e, \nu_\mu, \nu_\tau$ ).
- Neutrino flavours can oscillate.
- **Dirac neutrino**: different from its antiparticle or **Majorana neutrino**: equal to its own antiparticle.
- **How to prove the Majorana nature of neutrino?**

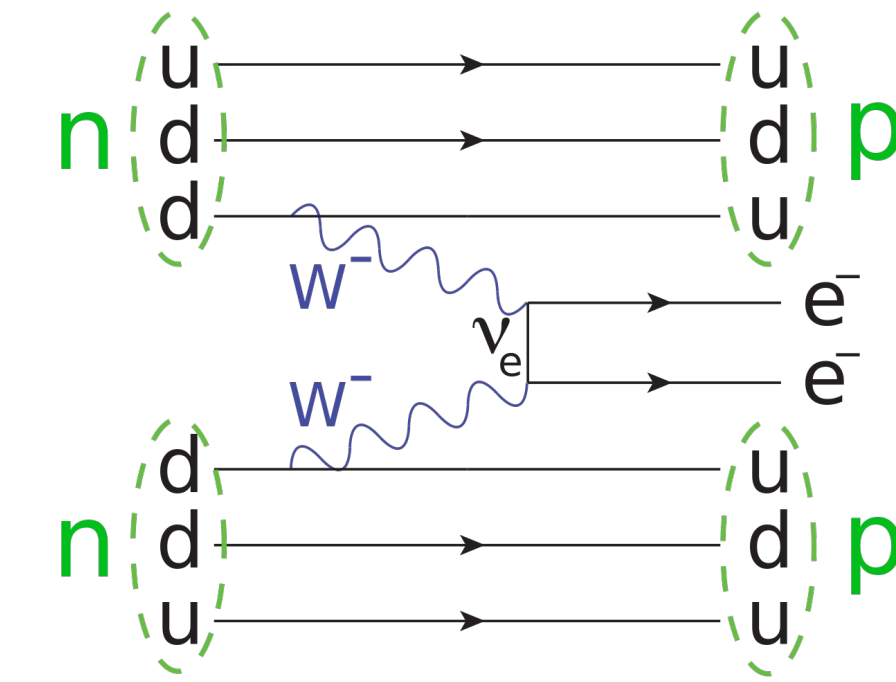


Search for **neutrinoless double-beta decay**!

### Neutrinoless double-beta decay ( $0\nu\beta\beta$ )

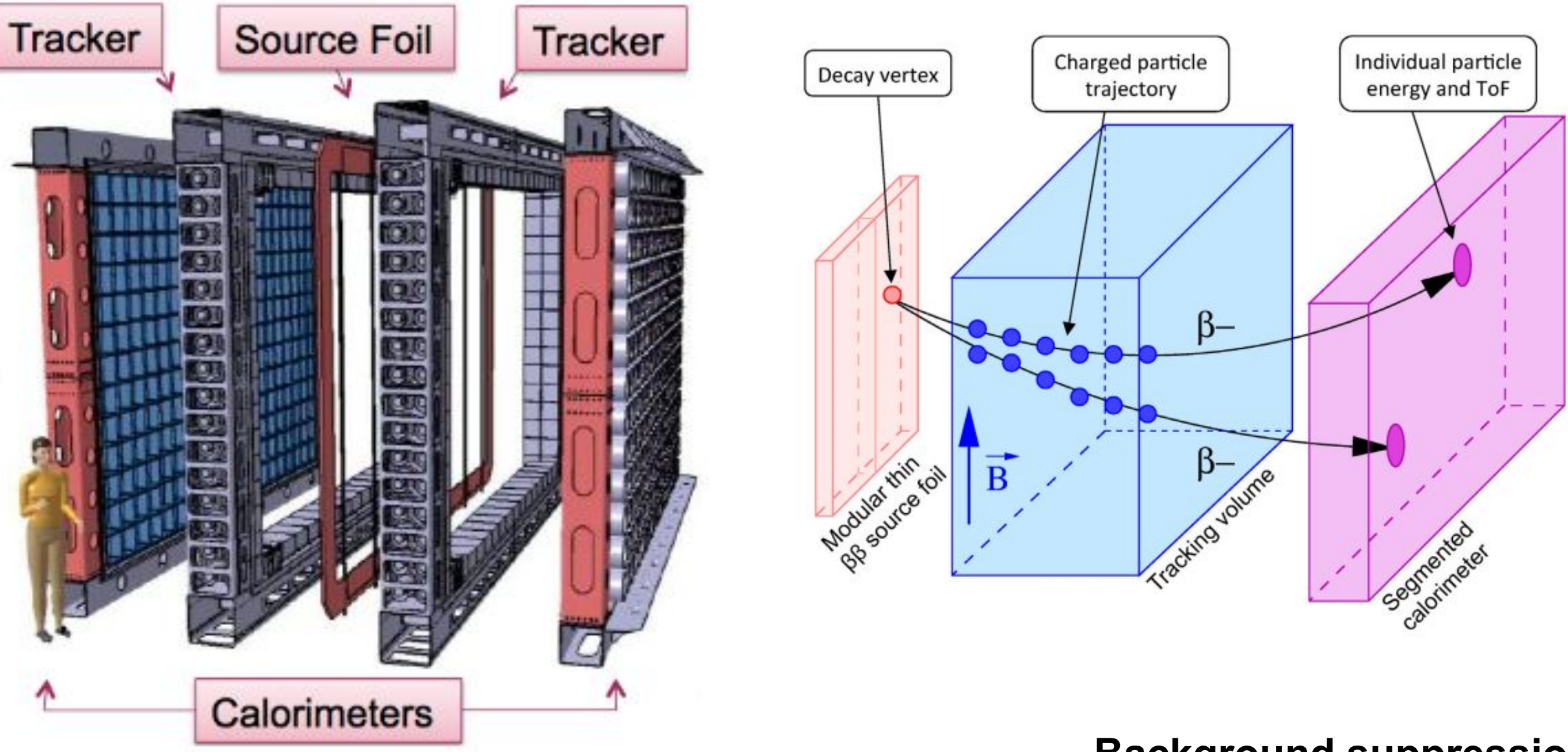


- $0\nu\beta\beta$  decay – process **beyond the Standard Model**, violates the lepton number conservation.
- $0\nu\beta\beta$  has not been observed yet, as it is **hypothetical & very rare**:  $T_{1/2} > 10^{24} - 10^{26}$  yr.



## SuperNEMO demonstrator

### Tracko-cal principle of particle detection



- Specificity of SuperNEMO:**
- signature of two electrons topology
  - high background rejection
  - study of  $0\nu\beta\beta$  mechanism
  - search for exotic physics & understanding nuclear structure with  $2\nu\beta\beta$

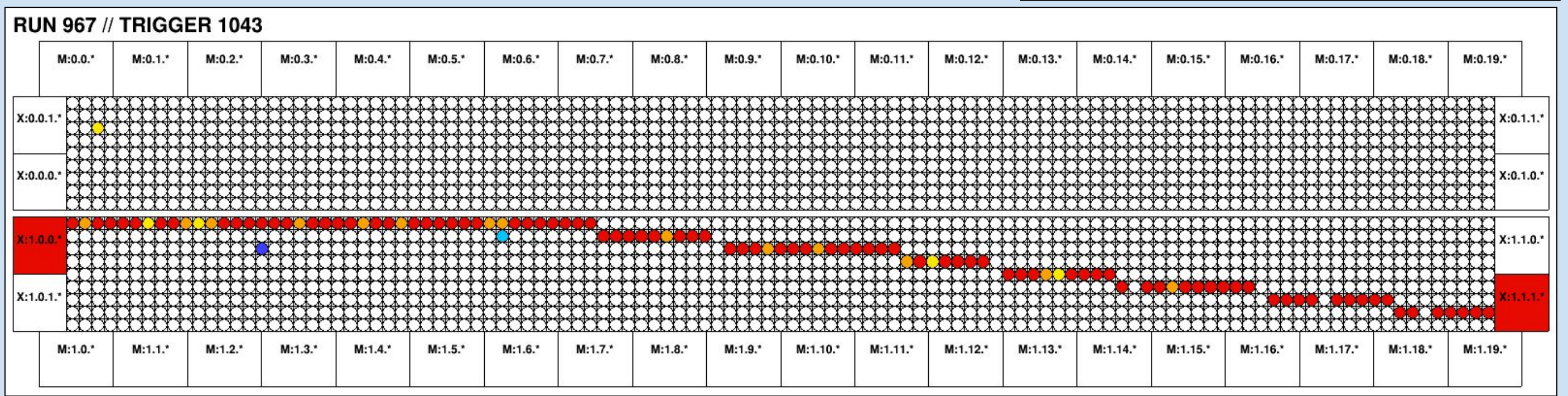
- Background suppression strategies:**
- use of radiopure materials
  - antiradon tent
  - iron (gamma) shielding
  - water + polyethylene (neutron) shielding

- **Tracker**: 2034 Geiger cells
- **Calorimeter**: 712 OMs (Scintillator + PMT)
- **Source foil**: 6.11 kg of  $^{92}\text{Se}$

### Demonstrator installed and running

- installation in Modane underground laboratory (LSM)
- calorimeter + tracker fully operational since Dec. 2022
- remaining part to be installed: gamma & neutron shieldings

Less than 1.4% of Geiger cells are currently off.



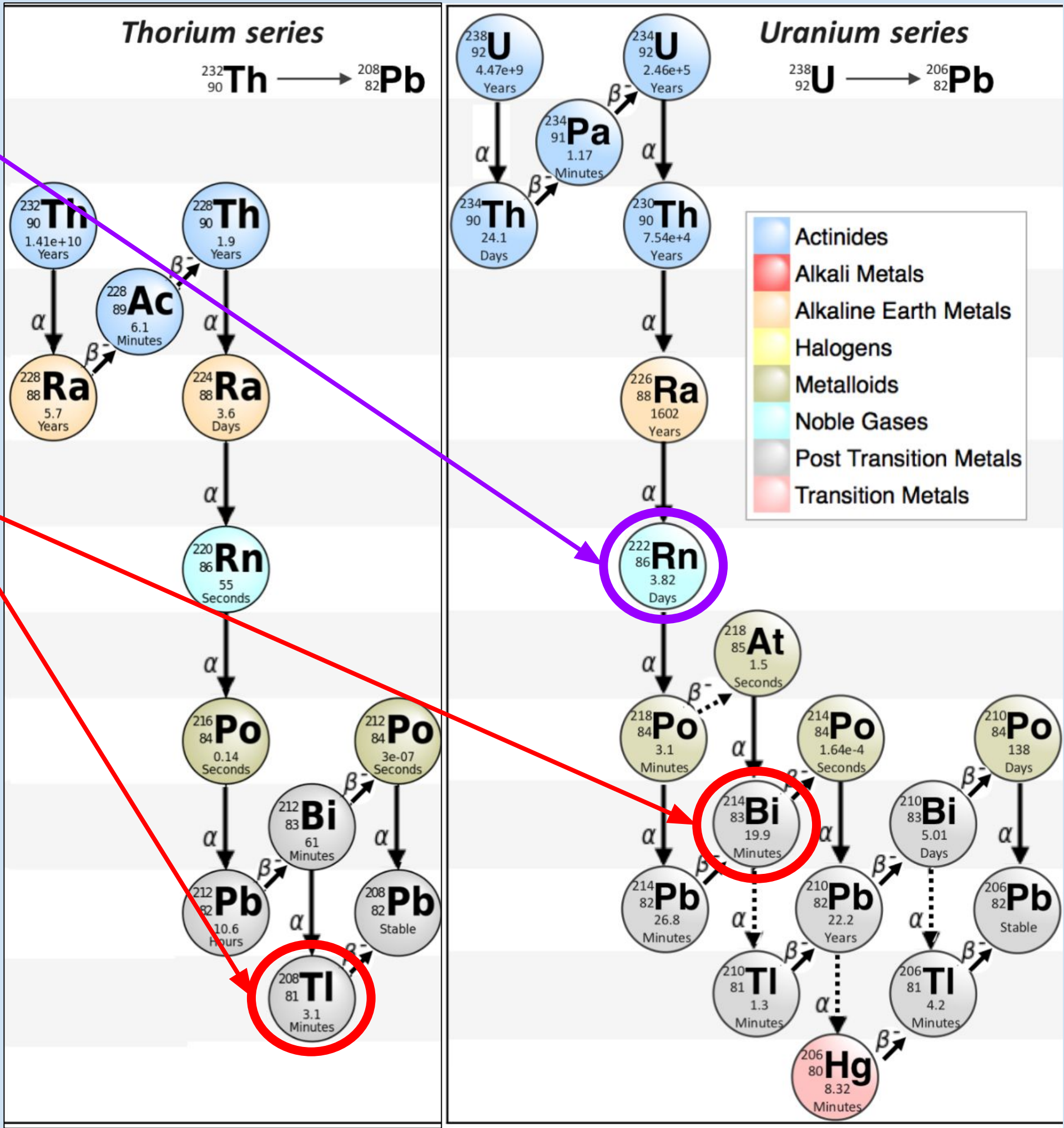
Crossing electron event

## $^{222}\text{Rn}$ background

### Background sources for $0\nu\beta\beta$

Gaseous isotope with  $T_{1/2} = 3.8$  days, can **emanate** from materials or **diffuse** through them.

Isotopes contributing to the background for  $0\nu\beta\beta$

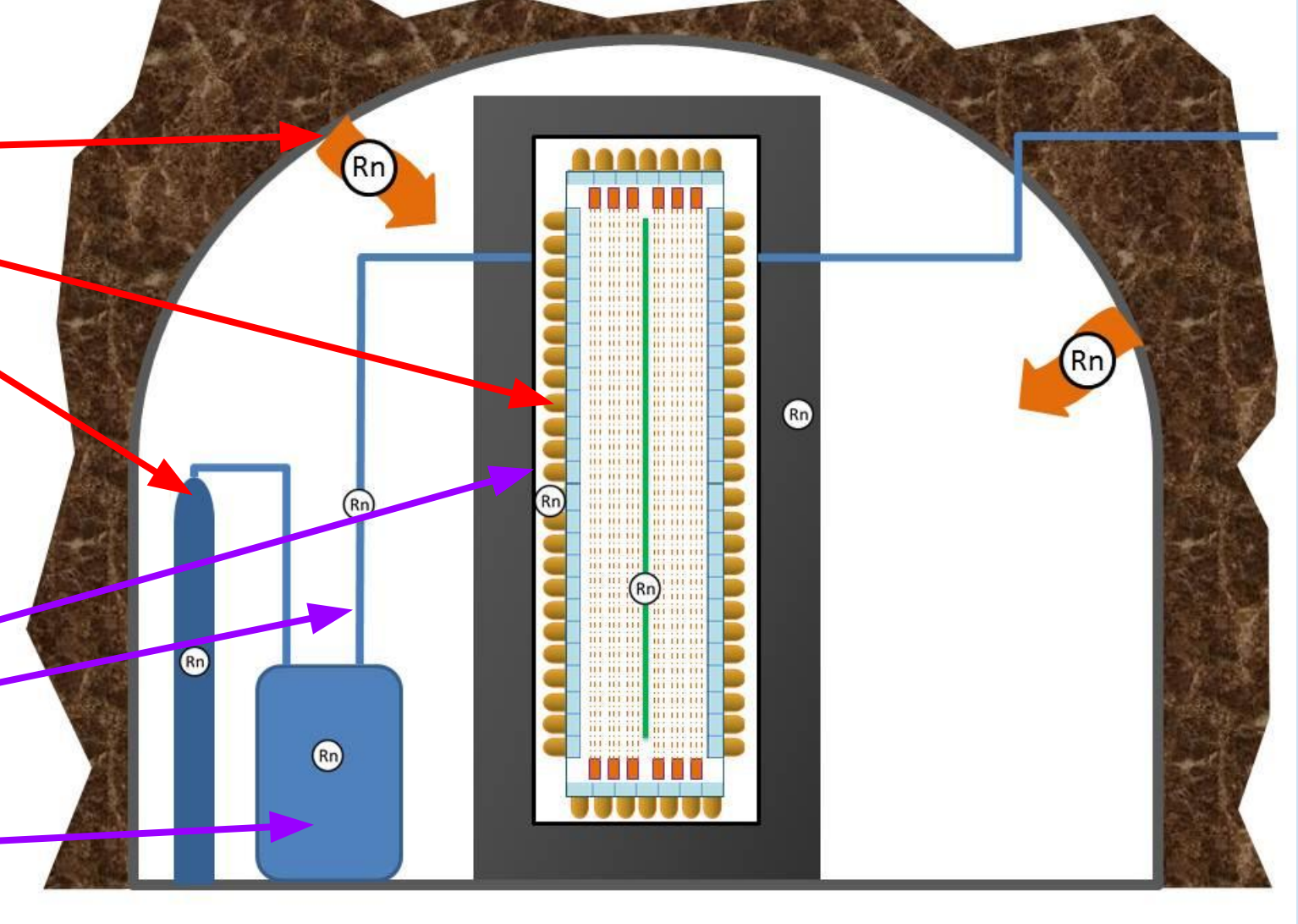


#### Sources of $^{222}\text{Rn}$ :

- emanation from the rock of the lab & diffusion towards the detector
- emanation from the detector materials
- contamination of the entrance gas of the tracker

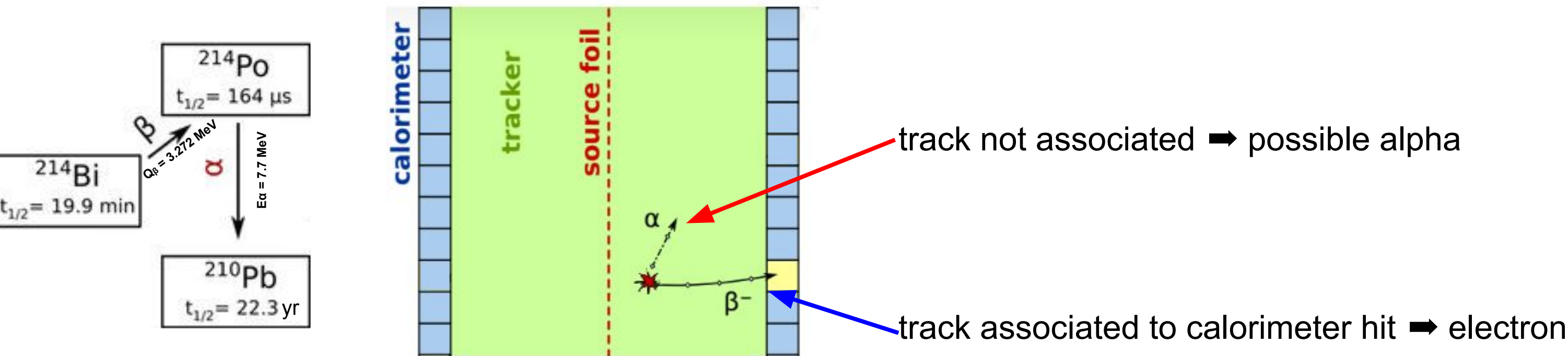
#### Future plans to reduce contamination:

- install antiradon tent & flush radon-free air inside
- increase the gas flux
- use the radon trap

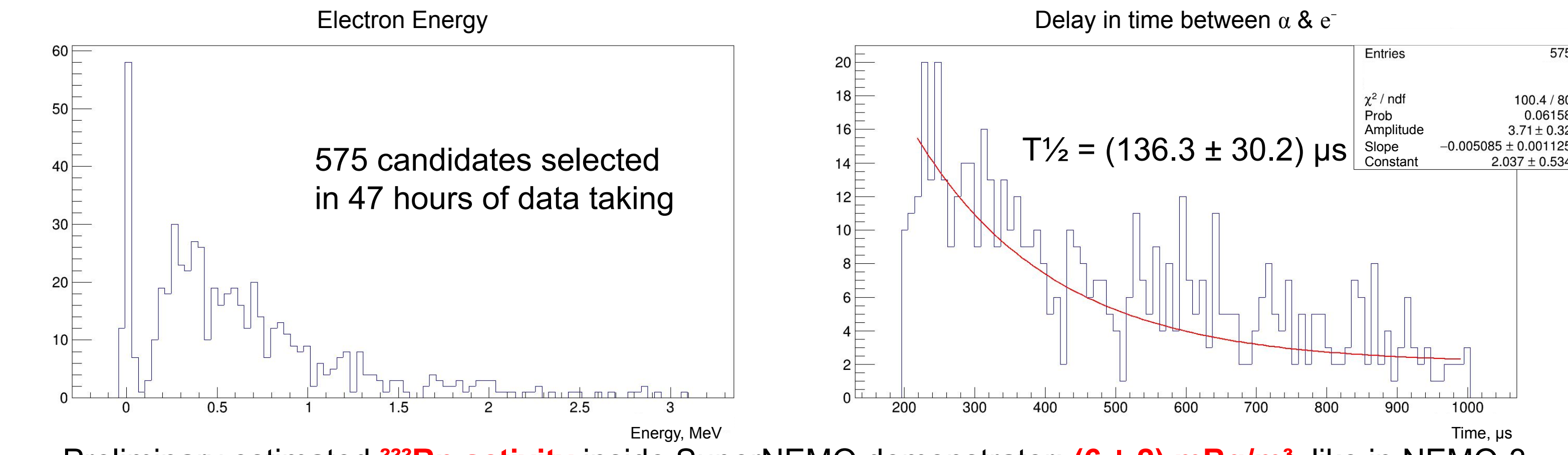
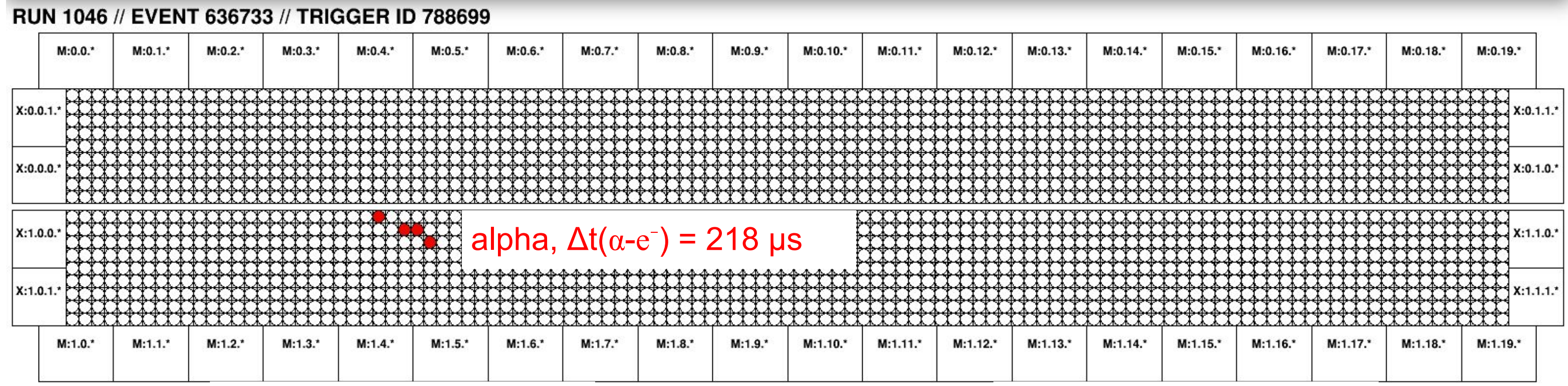
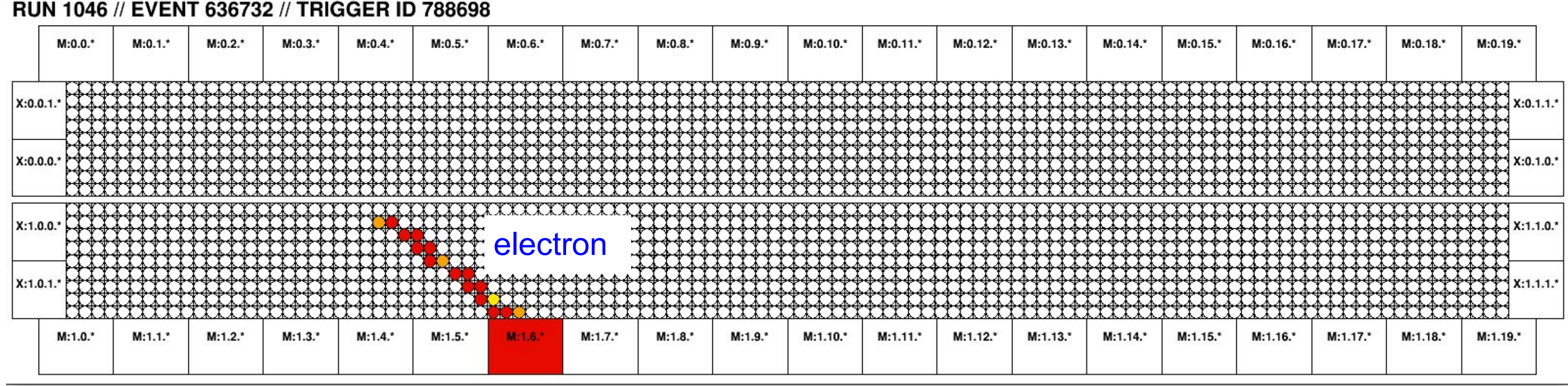


### Preliminary measurement of the $^{222}\text{Rn}$ background

#### $^{214}\text{Bi} - ^{214}\text{Po}$ cascades



**Selection of  $^{214}\text{Bi} - ^{214}\text{Po}$  candidates:**  
1 alpha candidate (2-6 cell hits) with a **common vertex** as an electron-like track in the previous event:  
distance between vertices: horizontal < 10 cm & vertical < 15 cm;  $200 \mu\text{s} < \Delta t(\alpha - e^-) < 1000 \mu\text{s}$



Preliminary estimated  $^{222}\text{Rn}$  activity inside SuperNEMO demonstrator:  **$(6 \pm 2)$  mBq/m<sup>3</sup>**, like in NEMO-3  
**SuperNEMO goal** after future improvements: **< 0.15 mBq/m<sup>3</sup>**