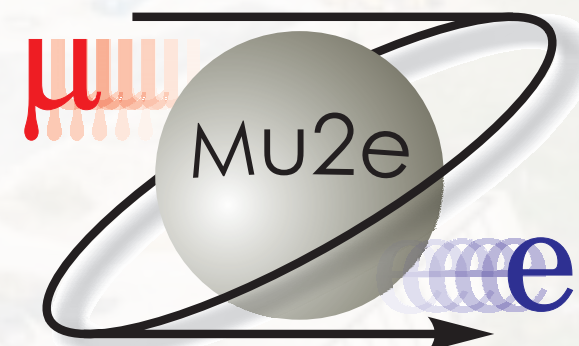


L'esperimento Mu2e al FNAL



E. Diociaiuti, R. Gargiulo, S. Giovannella, S. Miscetti, D. Paesani



 **Fermilab**

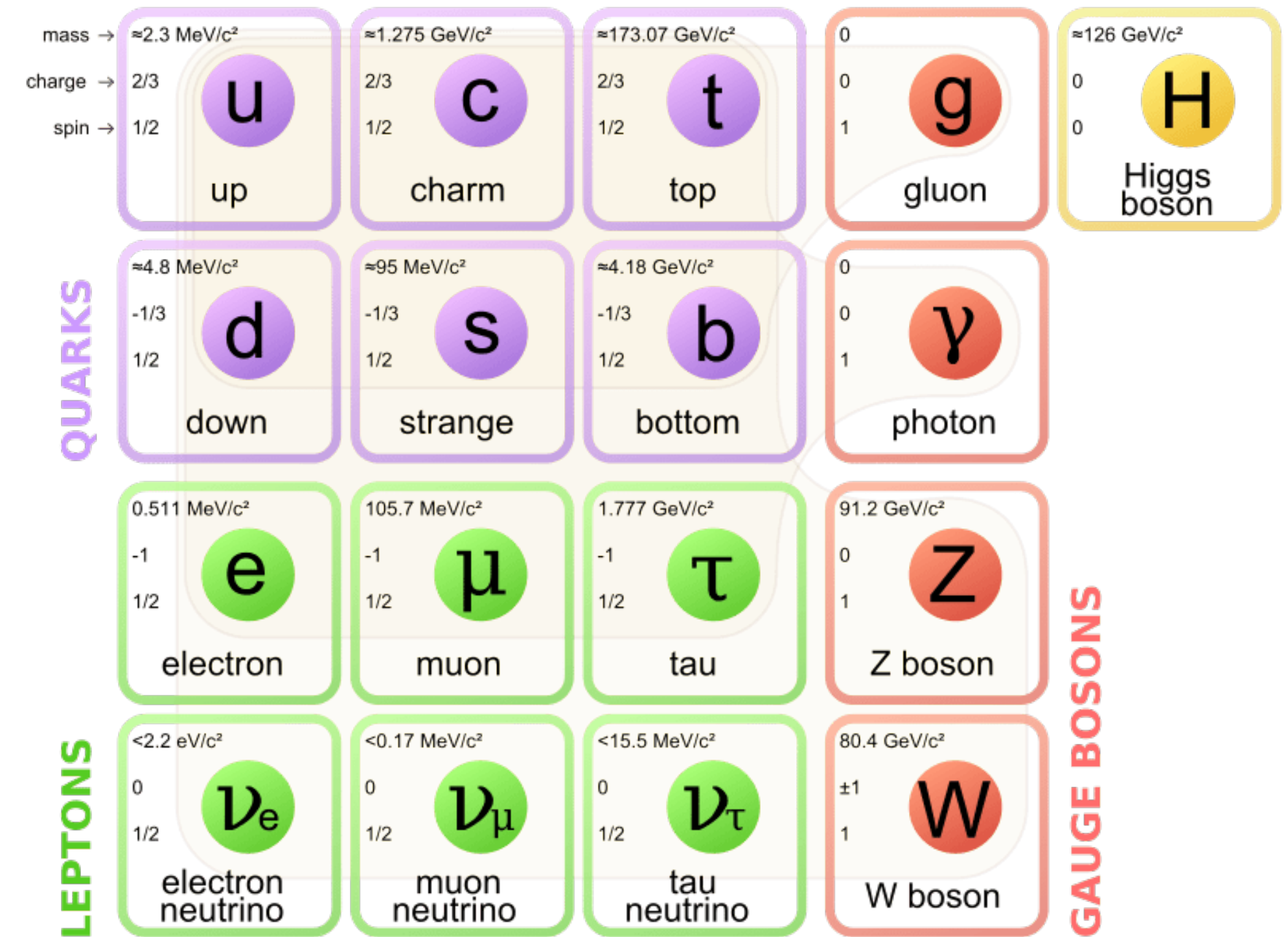
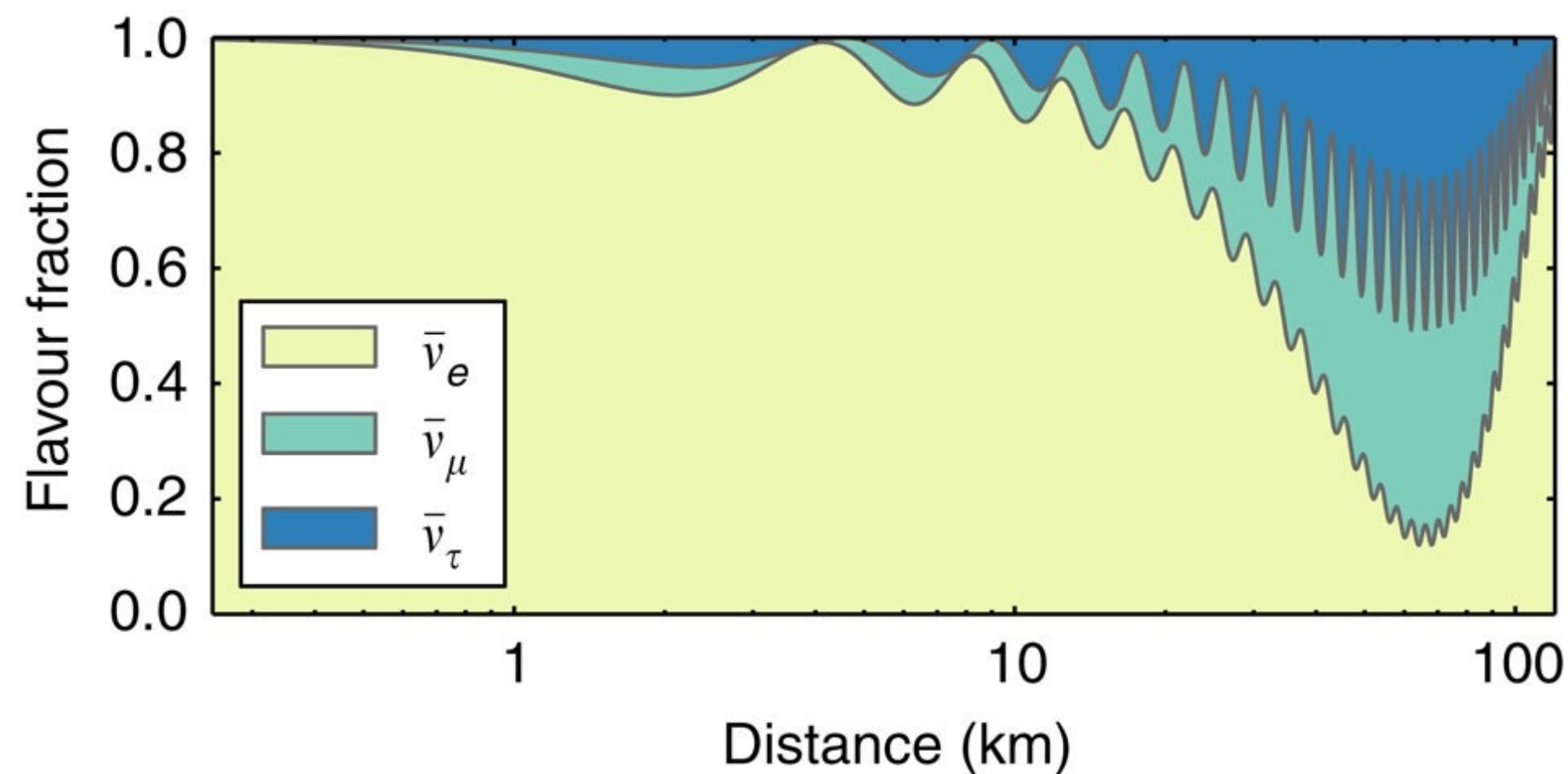
 **INFN**
Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

Leptoni

- Particelle elementari (fermioni) dello SM
- 3 generazioni (e, mu, tau)
- 1 leptone carico + 1 neutrino in ogni generazione
- Un particolare numero quantico di sapore è associato a ogni coppia leptone carico + neutrino

Conservazione del sapore

- Questo numero si conserva in tutte le interazioni dei leptoni?
- Mixing dei neutrini → Super-Kamiokande, 1998
- **Cosa succede per i leptoni carichi?**



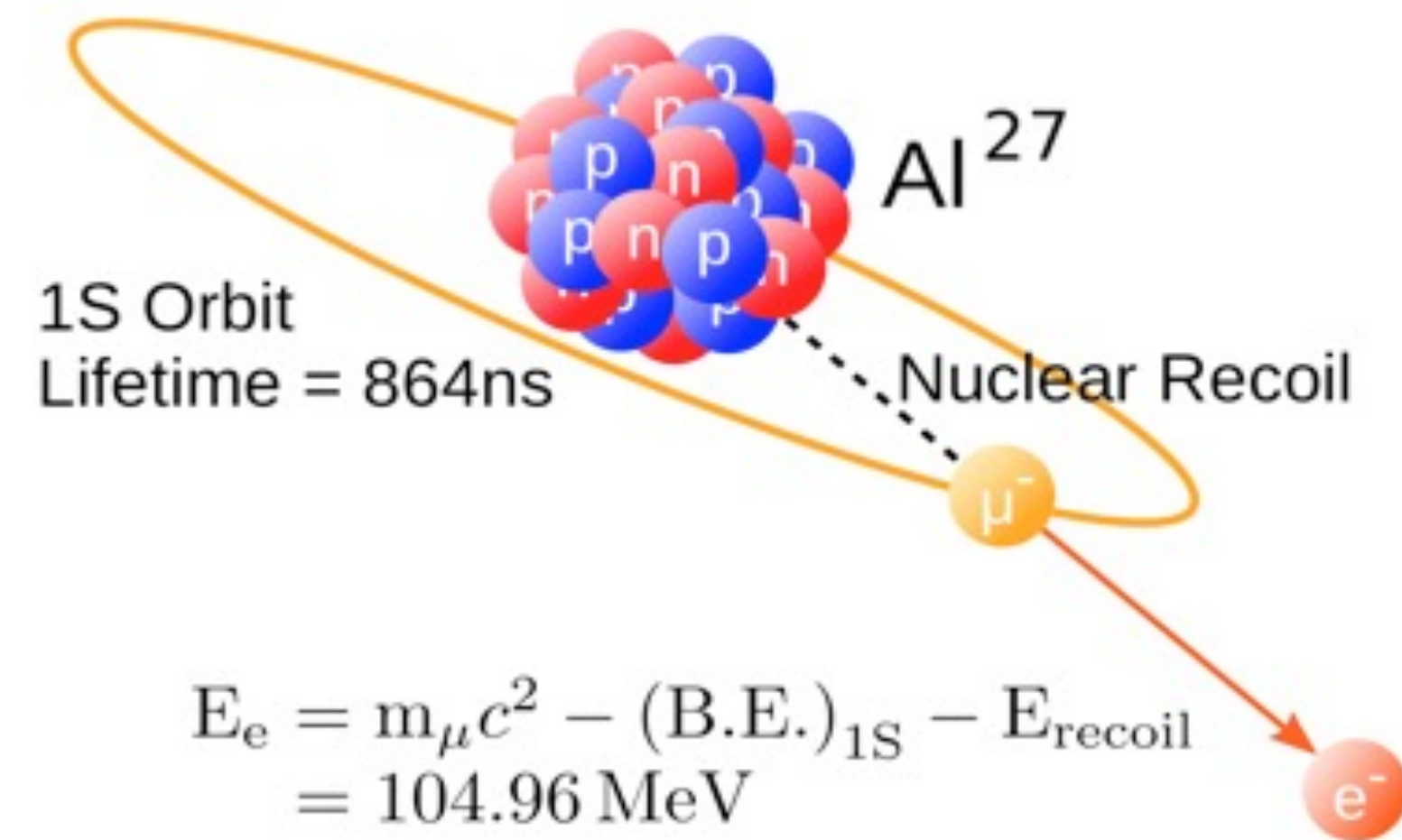
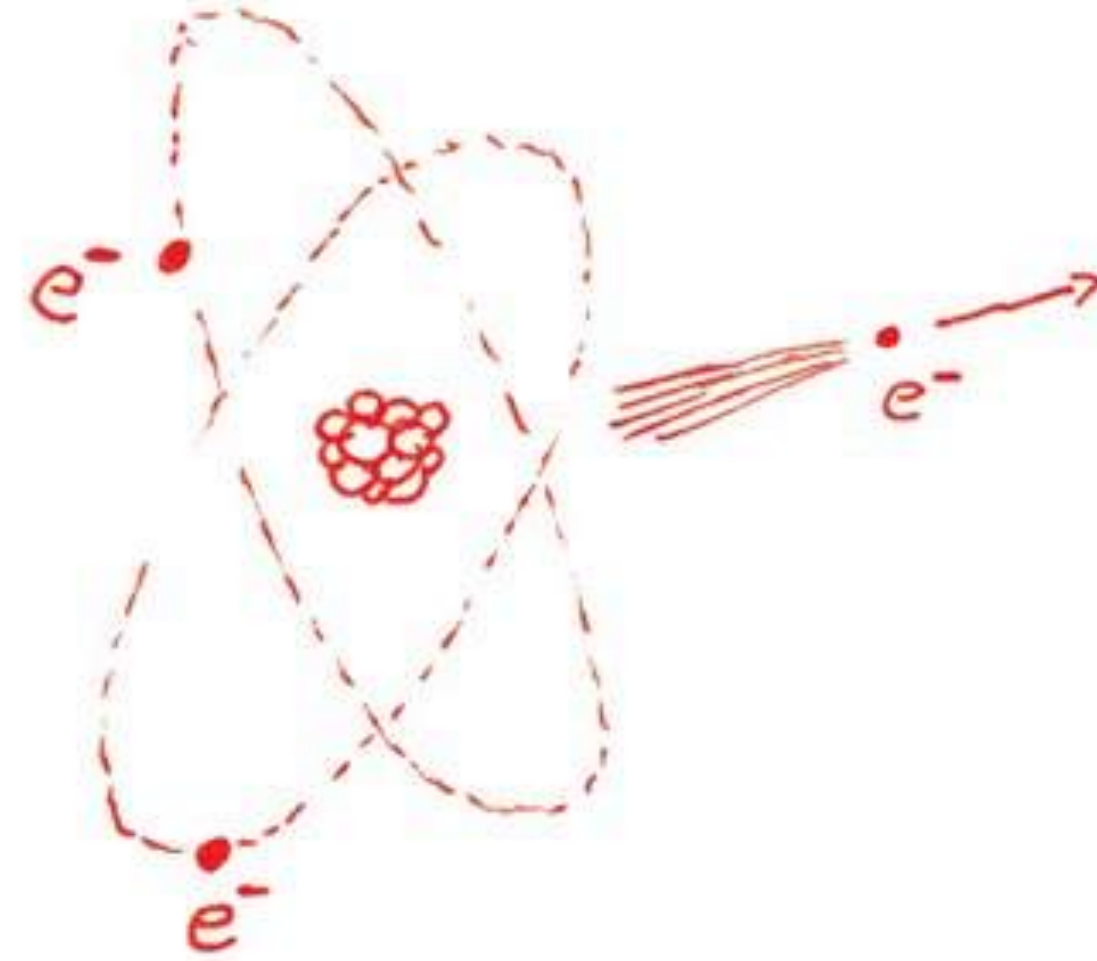
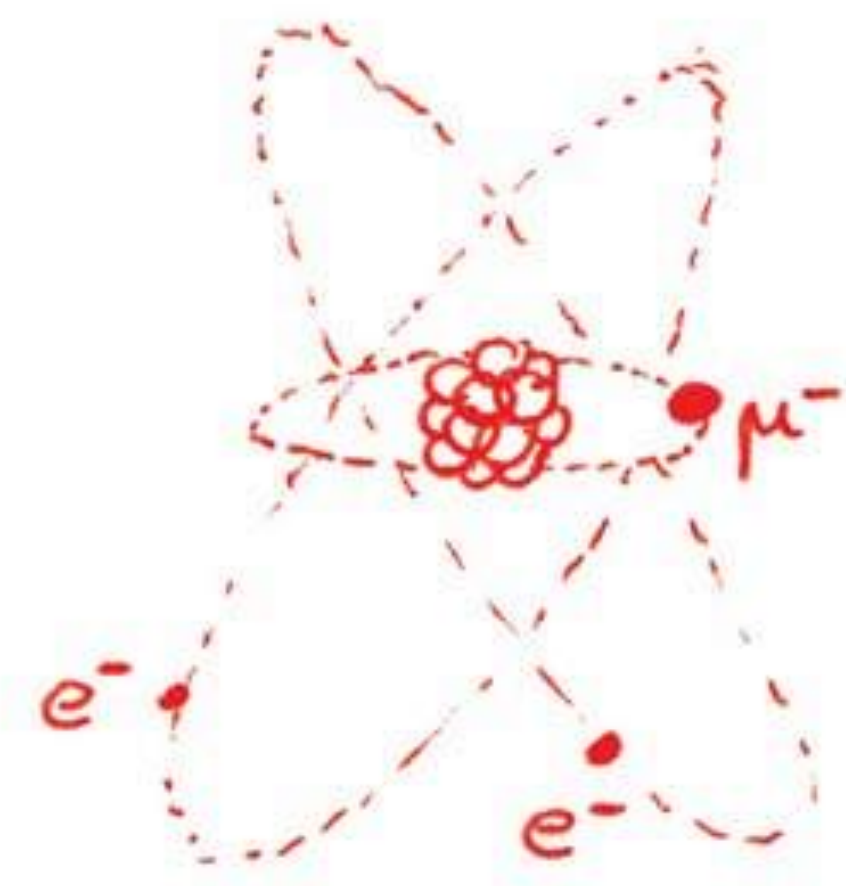
$$\begin{bmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{bmatrix} = \begin{bmatrix} U_{e1} & U_{e2} & U_{e3} \\ U_{\mu1} & U_{\mu2} & U_{\mu3} \\ U_{\tau1} & U_{\tau2} & U_{\tau3} \end{bmatrix} \begin{bmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{bmatrix}$$

Cosa cerchiamo di osservare

- Una conversione coerente **muone** → **elettrone in presenza di un nucleo atomico**

Quante ne aspettiamo di trovare?

- Secondo il MS → **una per ogni 10^{-54}** muoni che interagiscono con questo nucleo → questo numero è praticamente non osservabile sperimentalmente!!
- Secondo modelli di Nuova Fisica → circa **una per ogni 10^{-17} muoni** → numero minuscolo, ma sperimentalmente «fattibile»



Probability of...	
rolling a 7 with two dice	1.67E-01
rolling a 12 with two dice	2.78E-02
getting 10 heads in a row flipping a coin	9.77E-04
drawing a royal flush (no wild cards)	1.54E-06
getting struck by lightning in one year in the US	2.00E-06
winning Pick-5	5.41E-08
winning MEGA-millions lottery (5 numbers+megaball)	3.86E-09
your house getting hit by a meteorite this year	2.28E-10
drawing two royal flushes in a row (fresh decks)	2.37E-12
your house getting hit by a meteorite today	6.24E-13
getting 53 heads in a row flipping a coin	1.11E-16
your house getting hit by a meteorite AND you being struck by lightning both within the next six months	1.14E-16
your house getting hit by a meteorite AND you being struck by lightning both within the next three months	2.85E-17

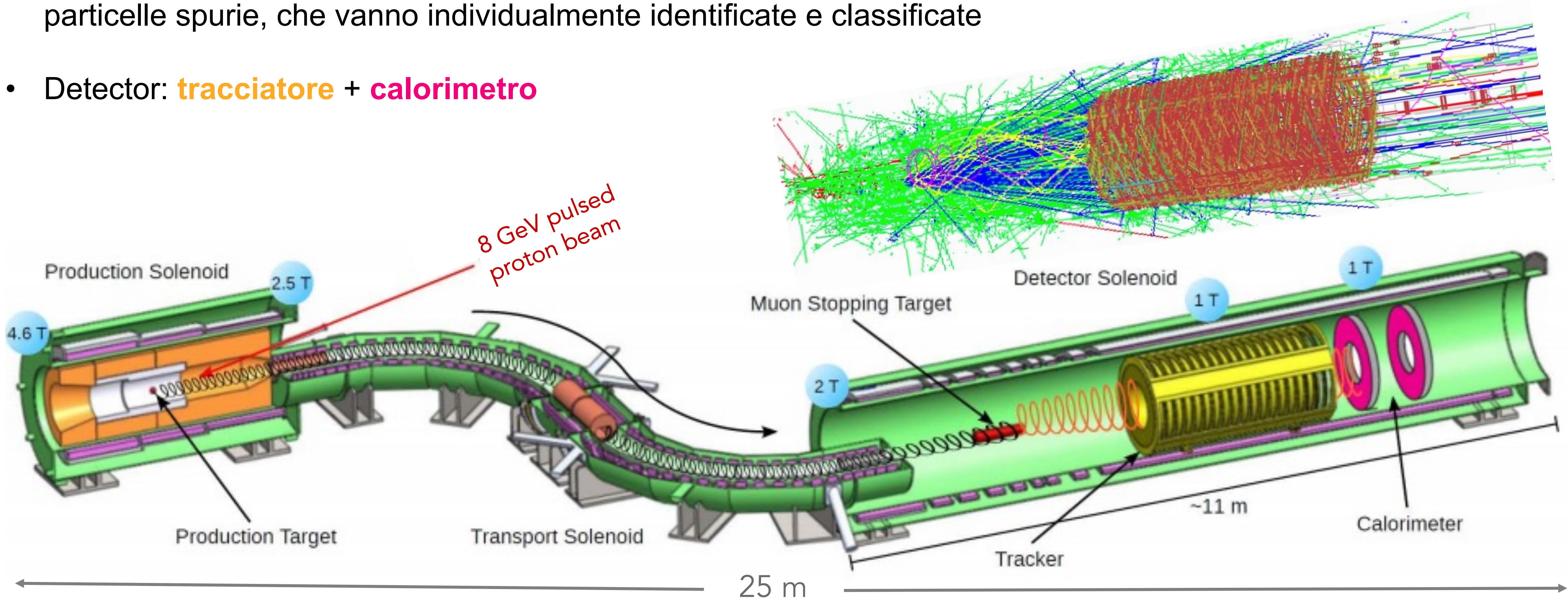


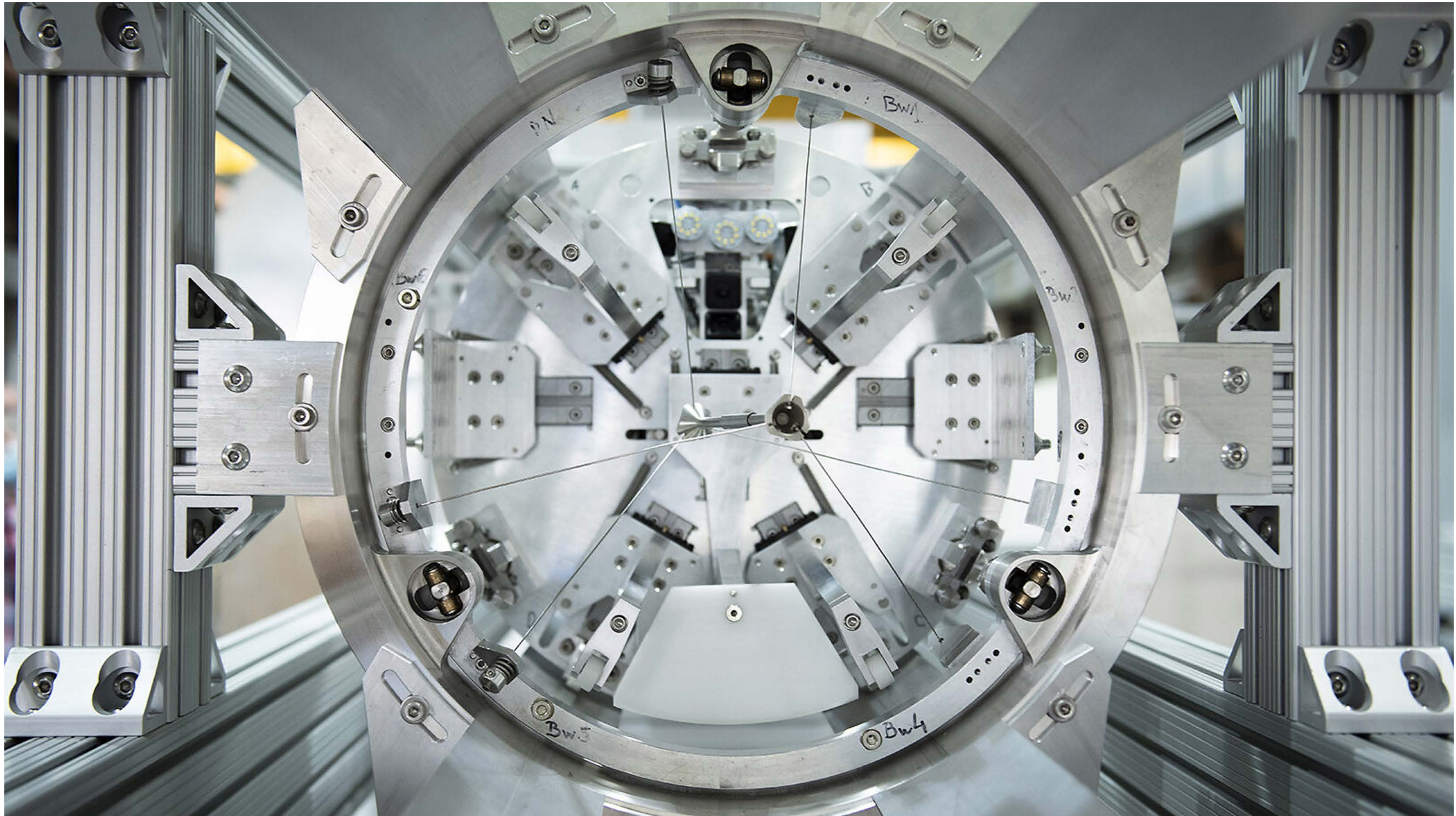
~90% C.L. goal

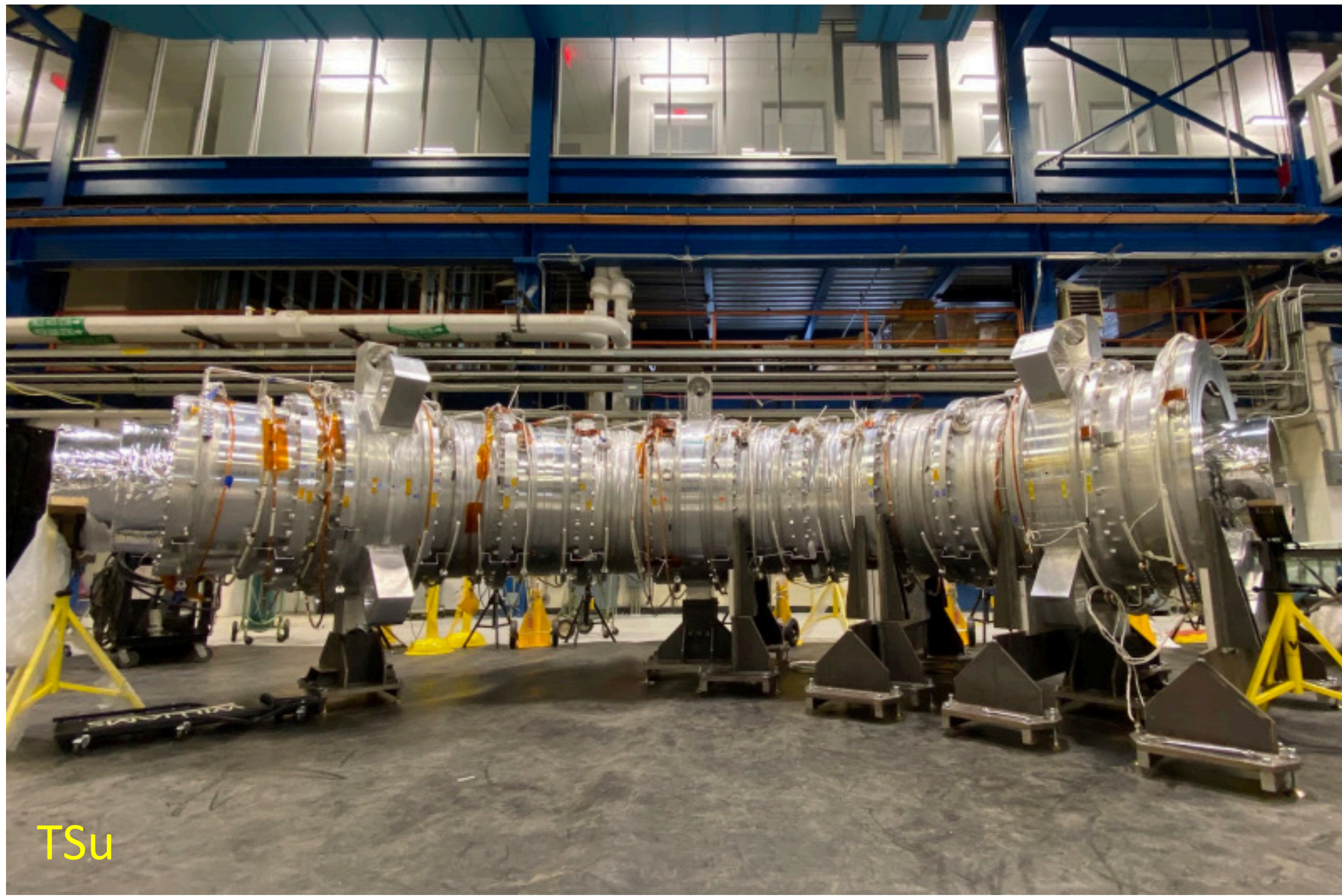
Single event sensitivity of Mu2e

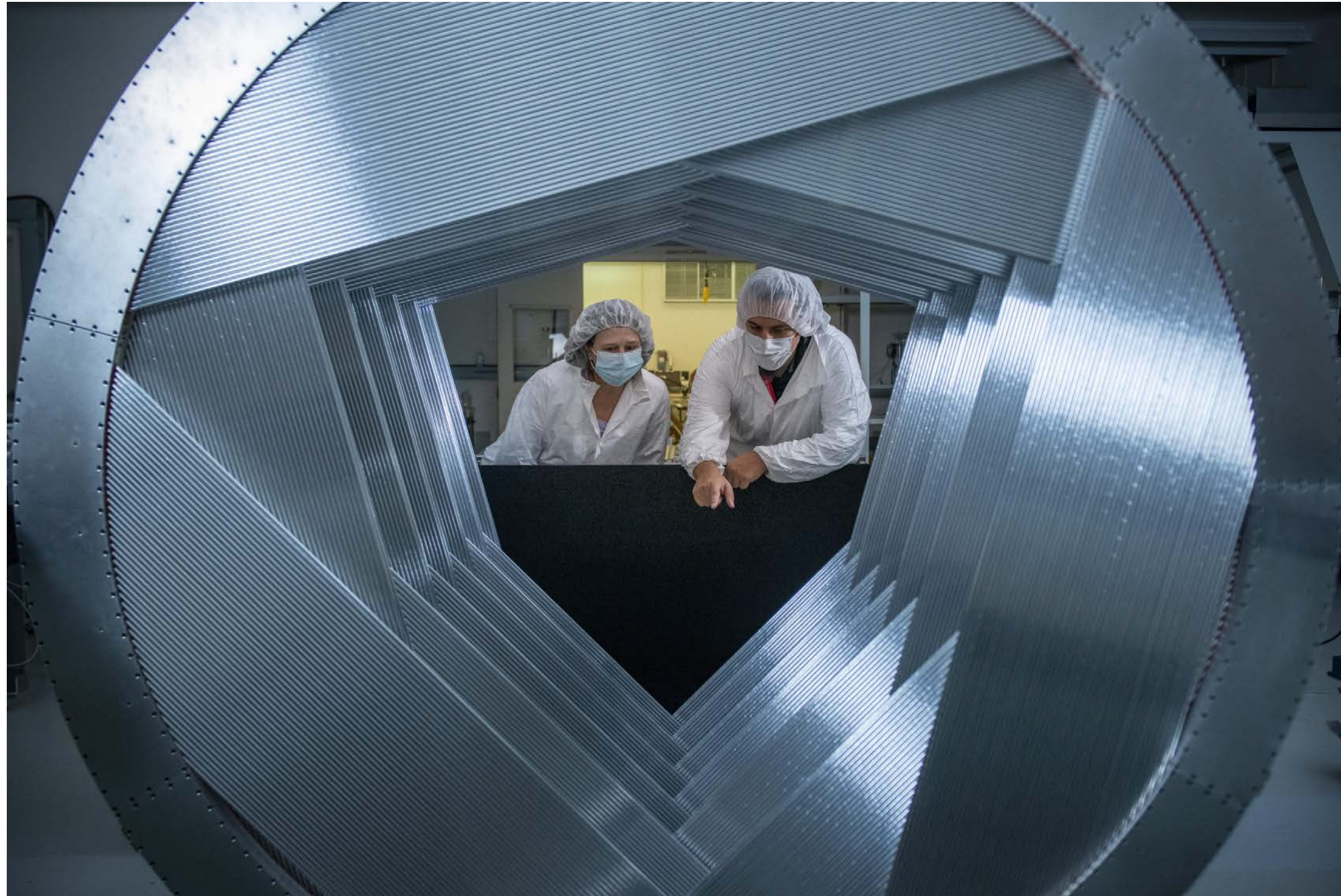


- Misura di altissima precisione ad altissima intensità (intensity frontier)
- Il più intenso fascio di muoni a basso impulso mai realizzato → **10^{10} muoni / secondo**
- 25 metri di magneti superconduttori con campi fino a 4.5 T
- Necessità di estrarre il rarissimo segnale dell'elettrone da un fondo composto da innumerevoli particelle spurie, che vanno individualmente identificate e classificate
- Detector: **tracciatore** + **calorimetro**

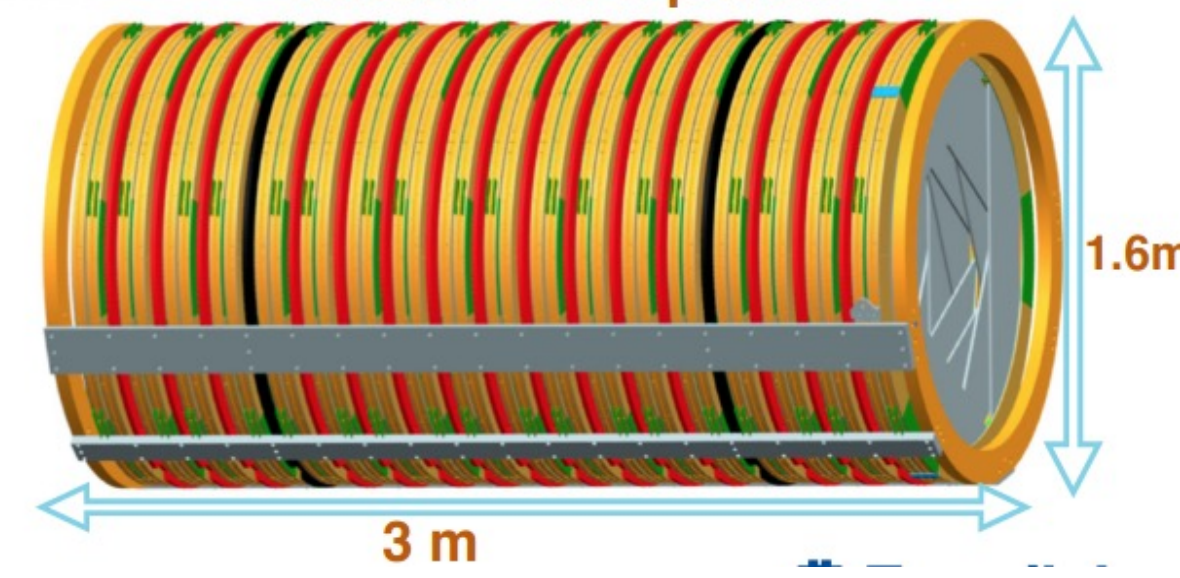
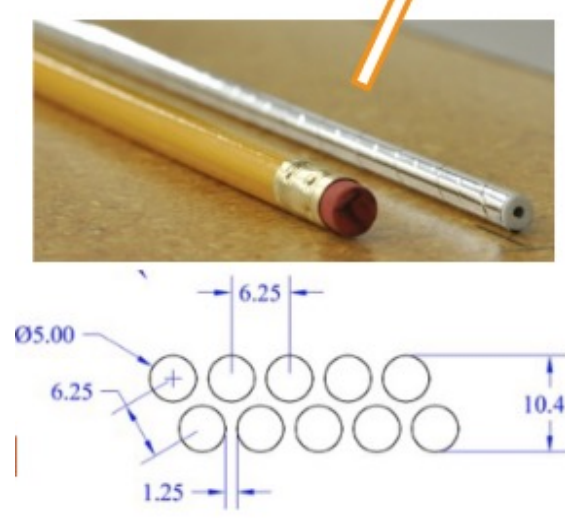
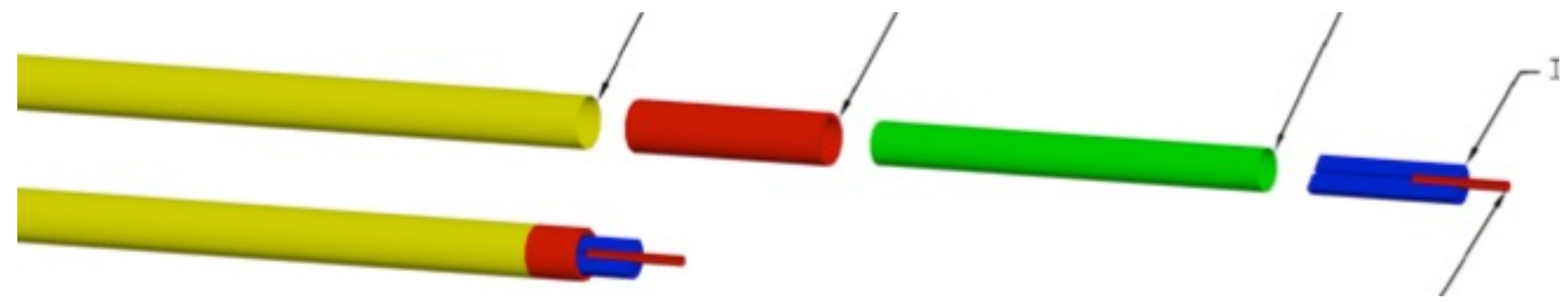
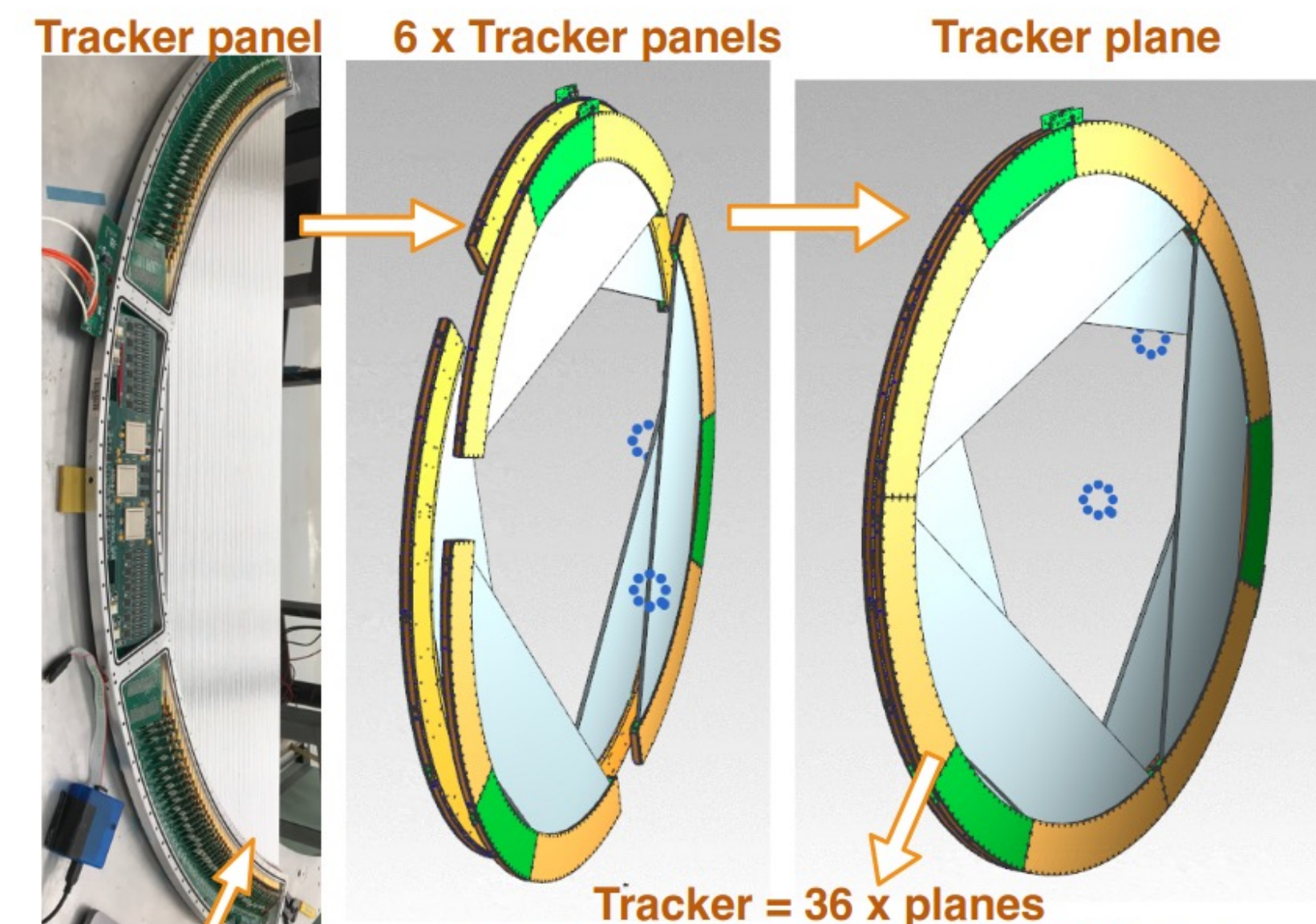
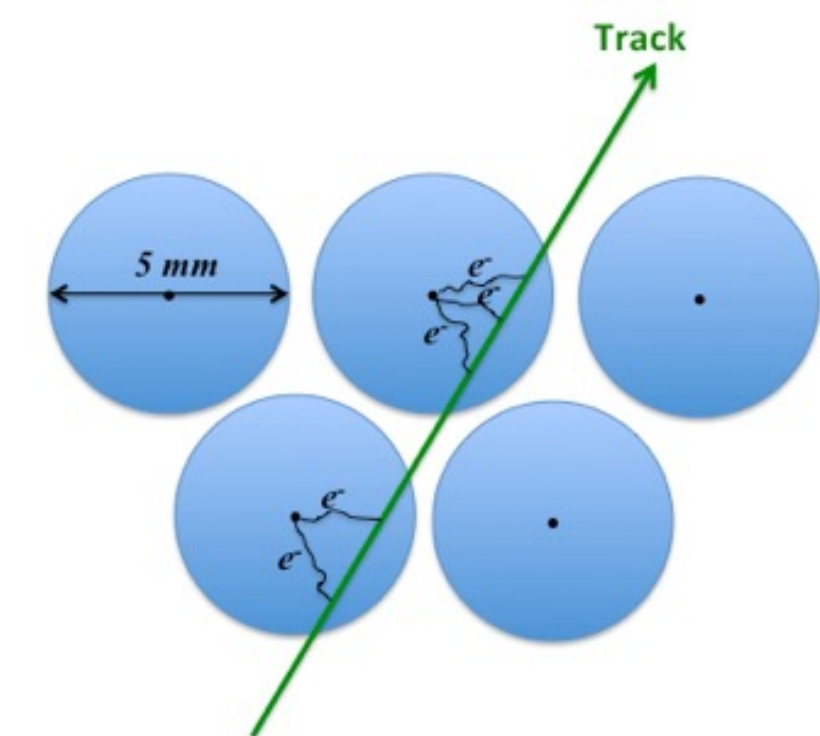






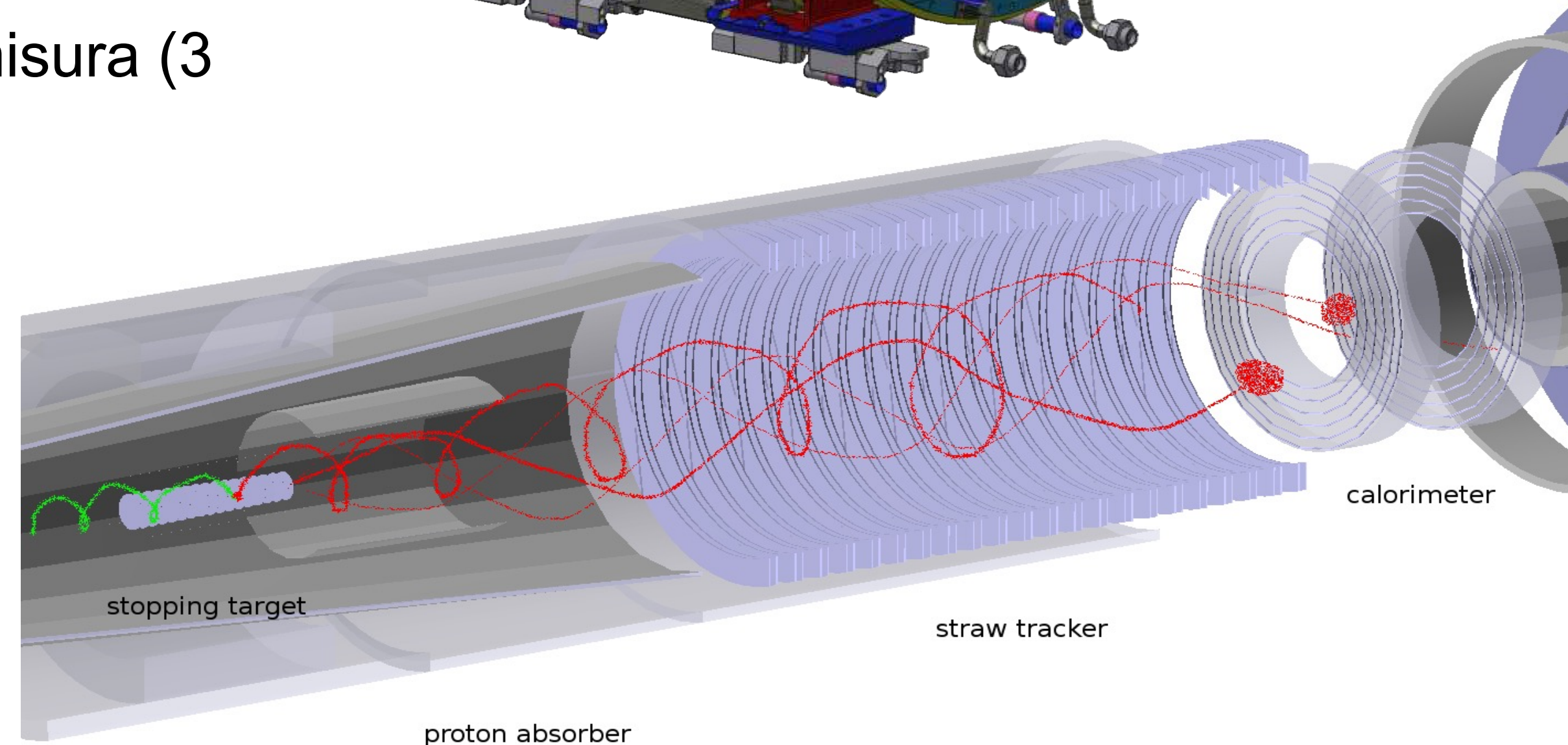
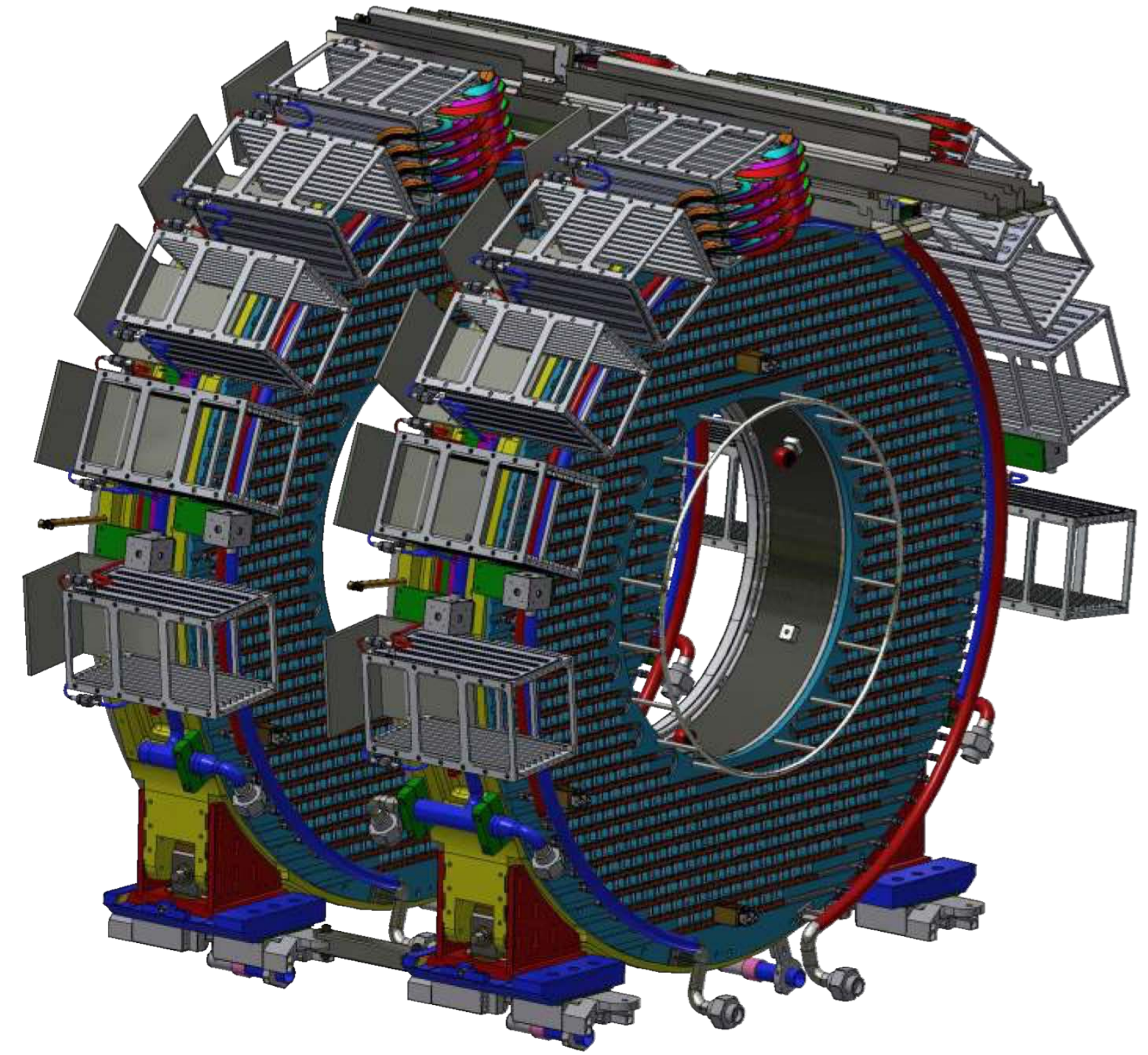


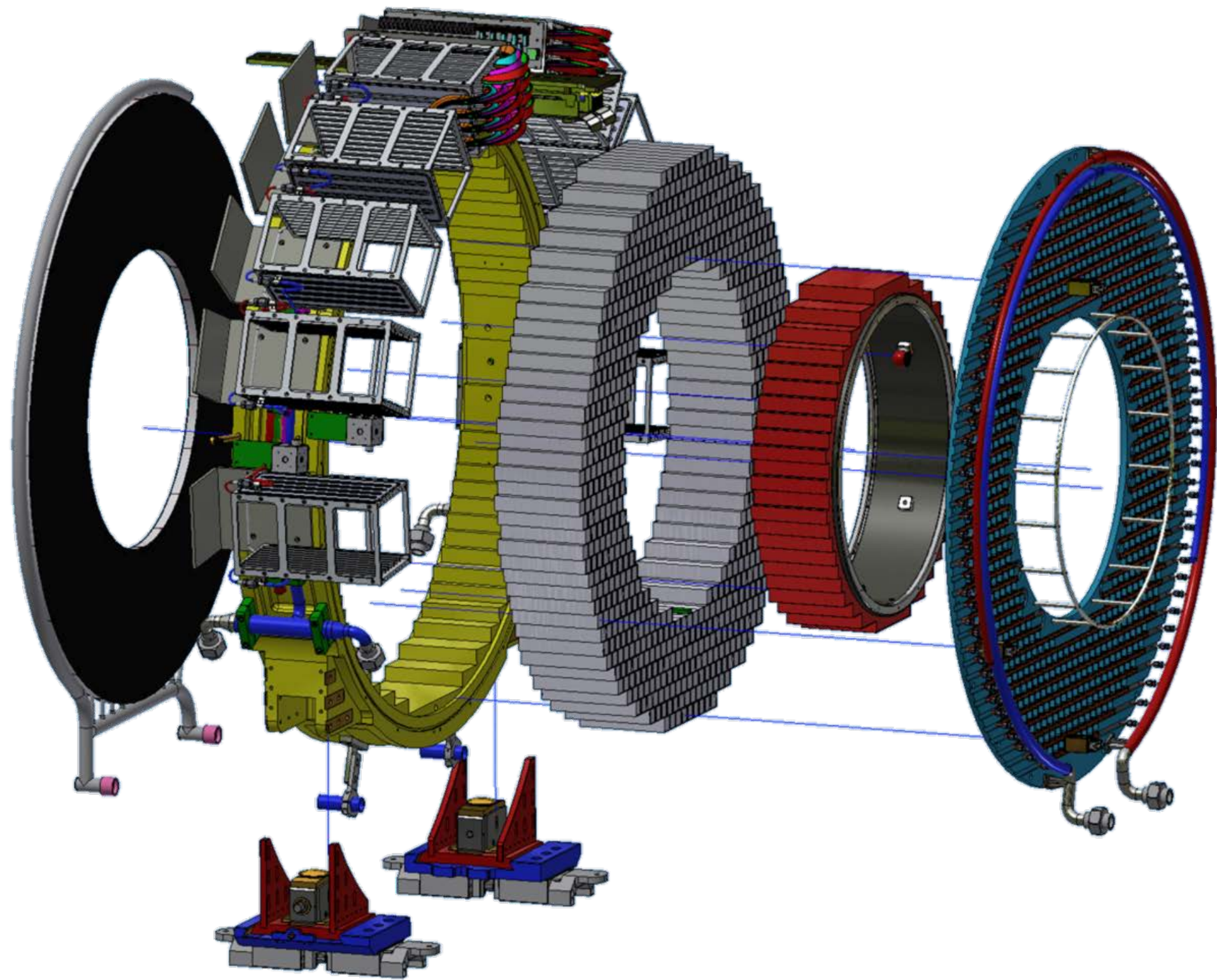
- Tracciatore a tubi straw
- Misurerà la traiettoria, e quindi il momento delle particelle



Compiti

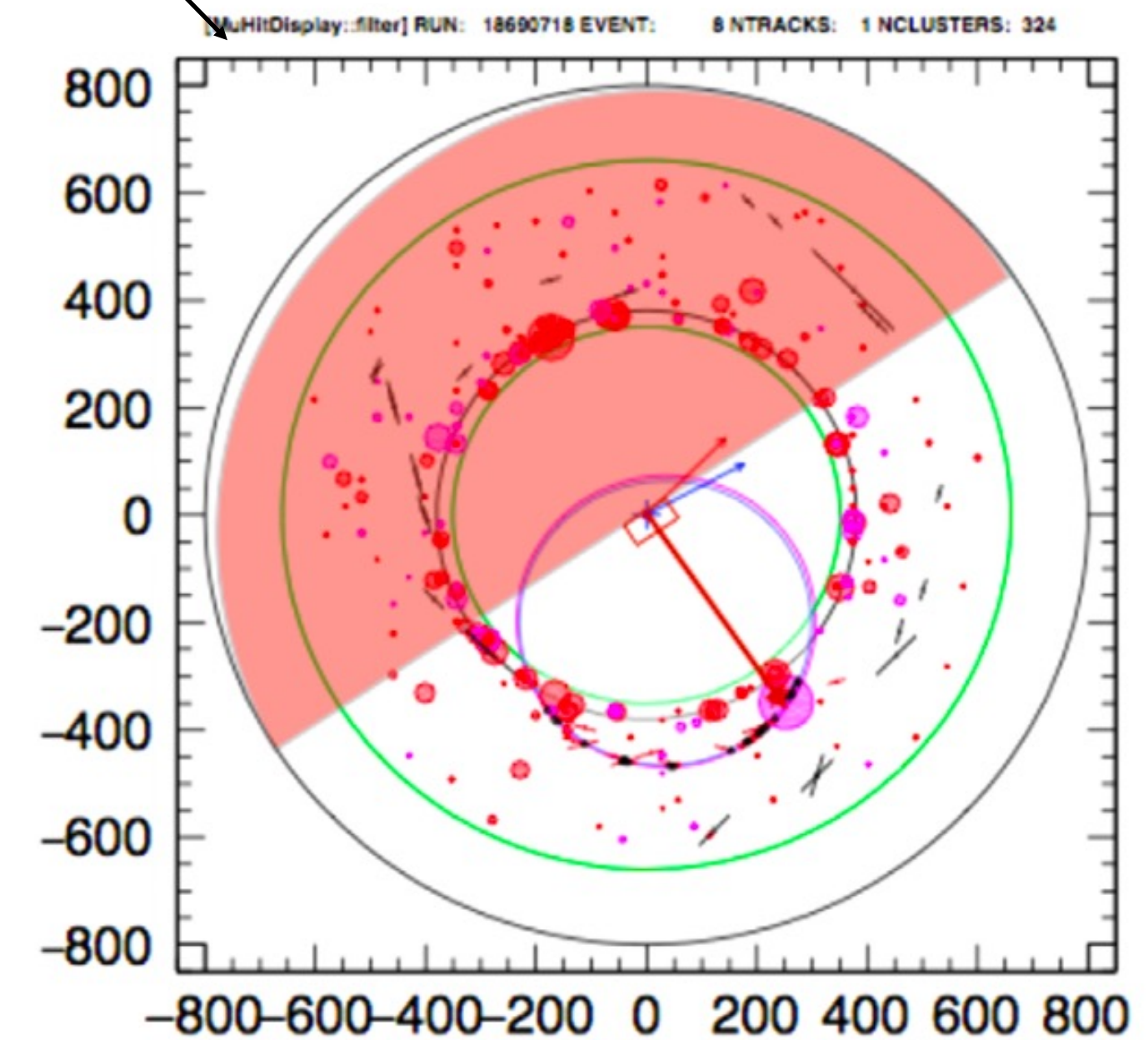
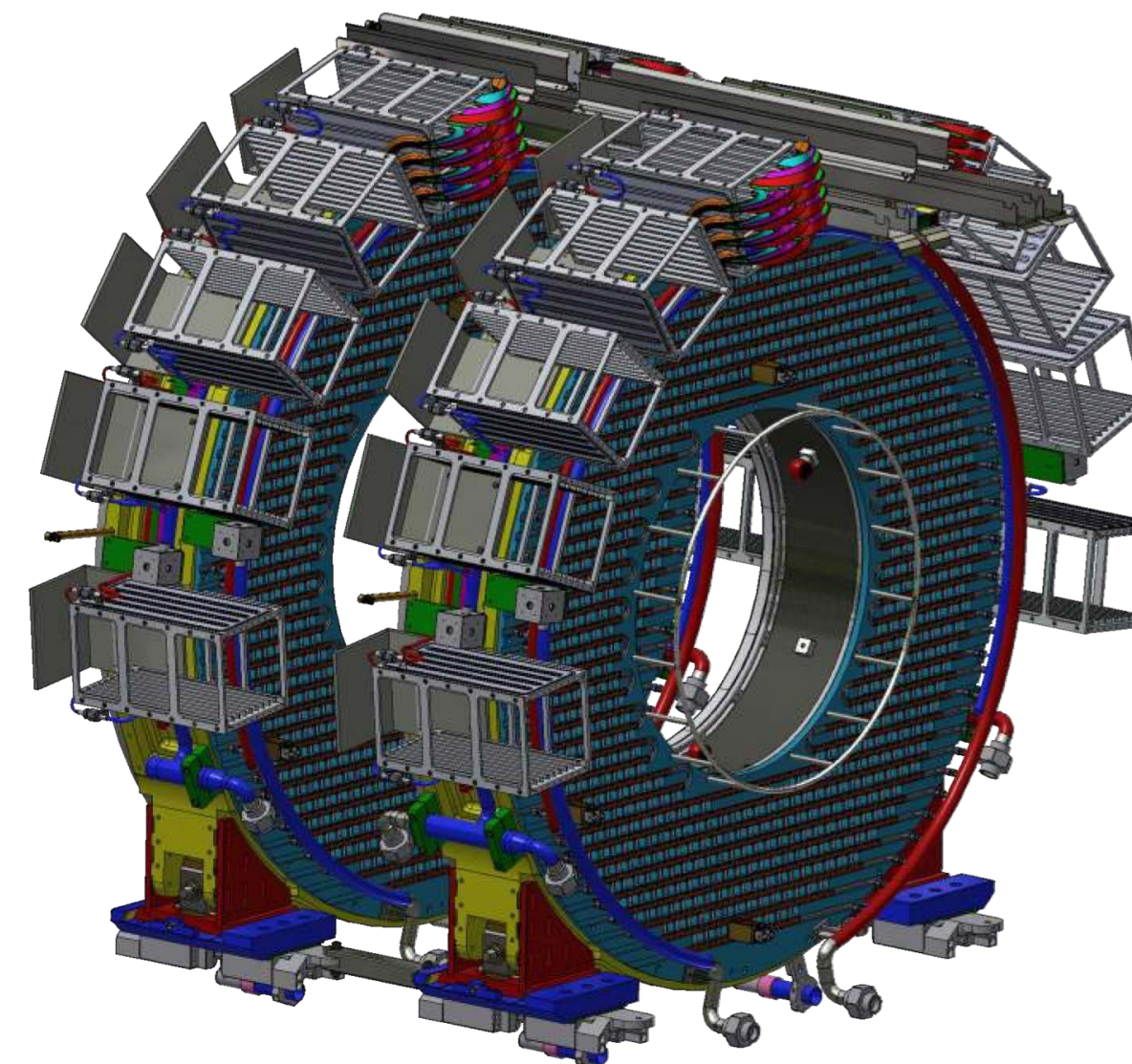
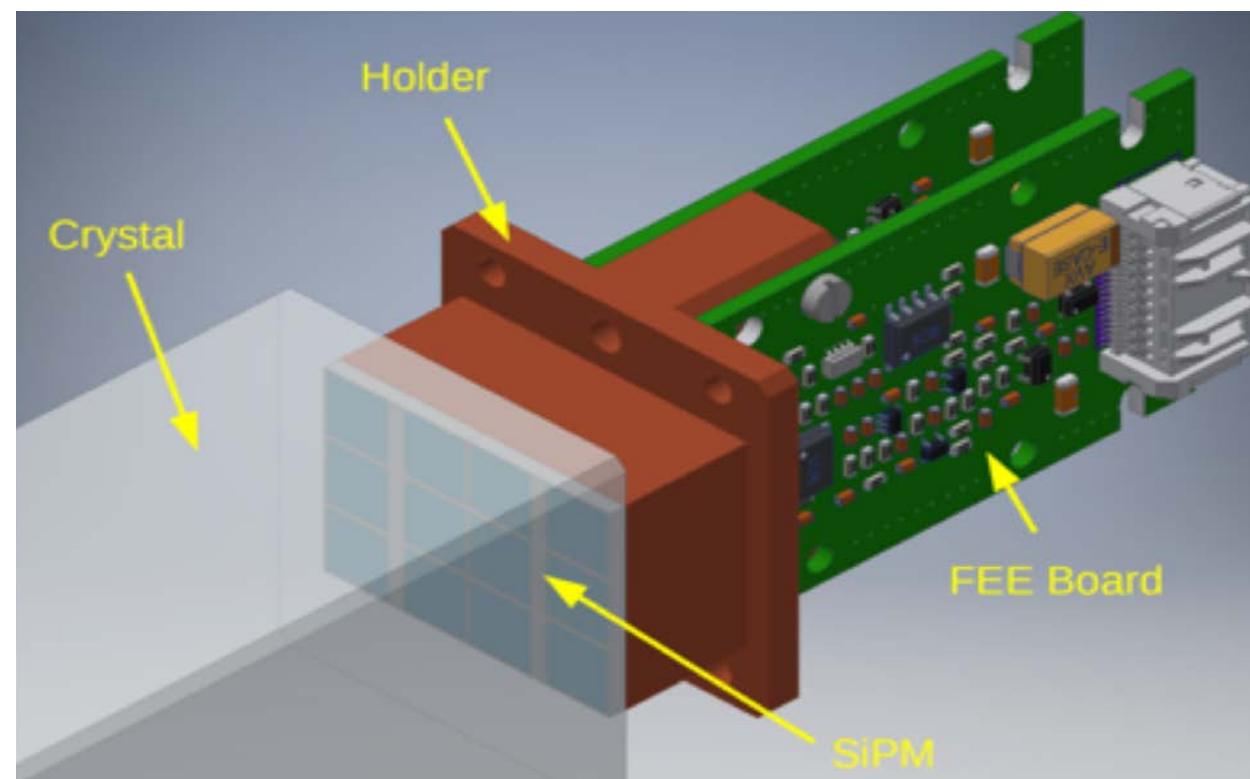
- Misurare l'energia delle particelle assorbendole (calorimetria distruttiva)
- Avere buona risoluzione in termini
 - Energetici → per poter identificare l'elettrone dal fondo
 - Temporali → per poter confrontare e sincronizzare la propria misura con quella del tracciatore
 - Spaziali
- Mantenere un'ottima stabilità e precisione nel tempo della misura (3 anni) e in un ambiente con
 - Intensi campi magnetici
 - Alte dosi di radiazioni
 - Alto vuoto

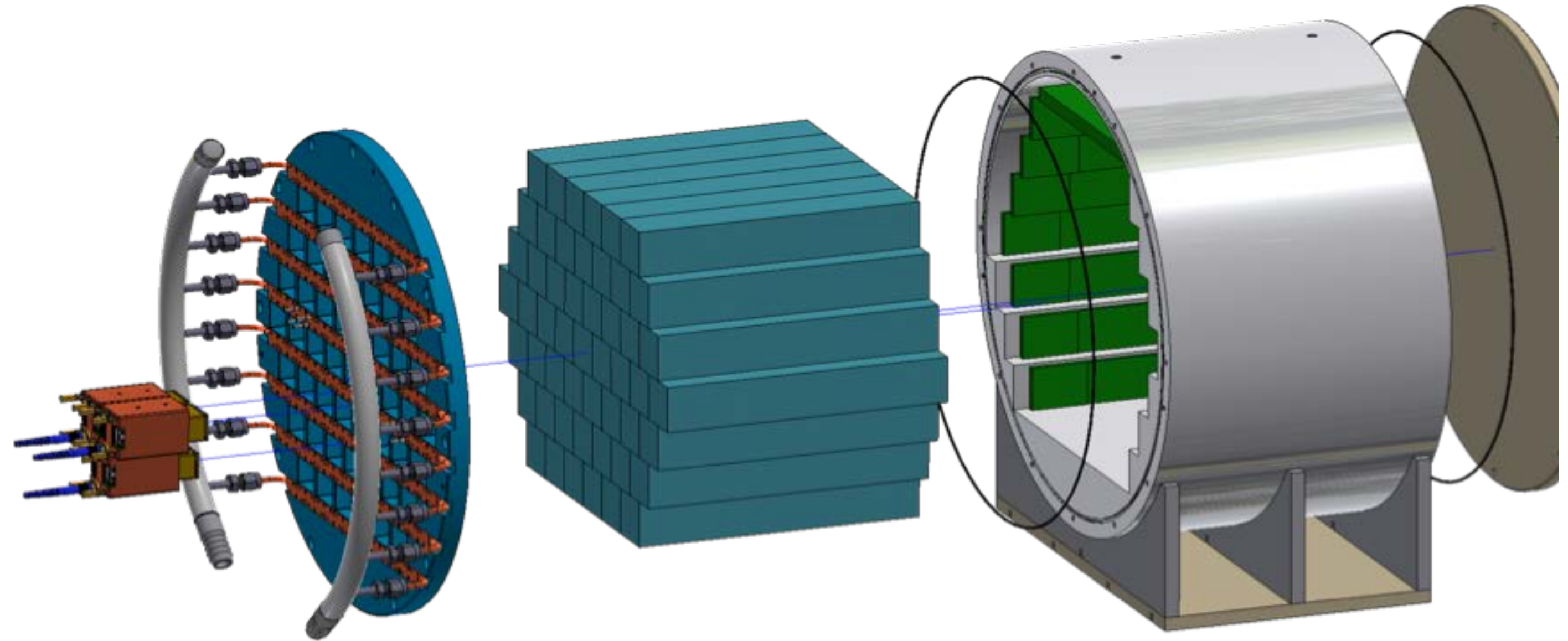
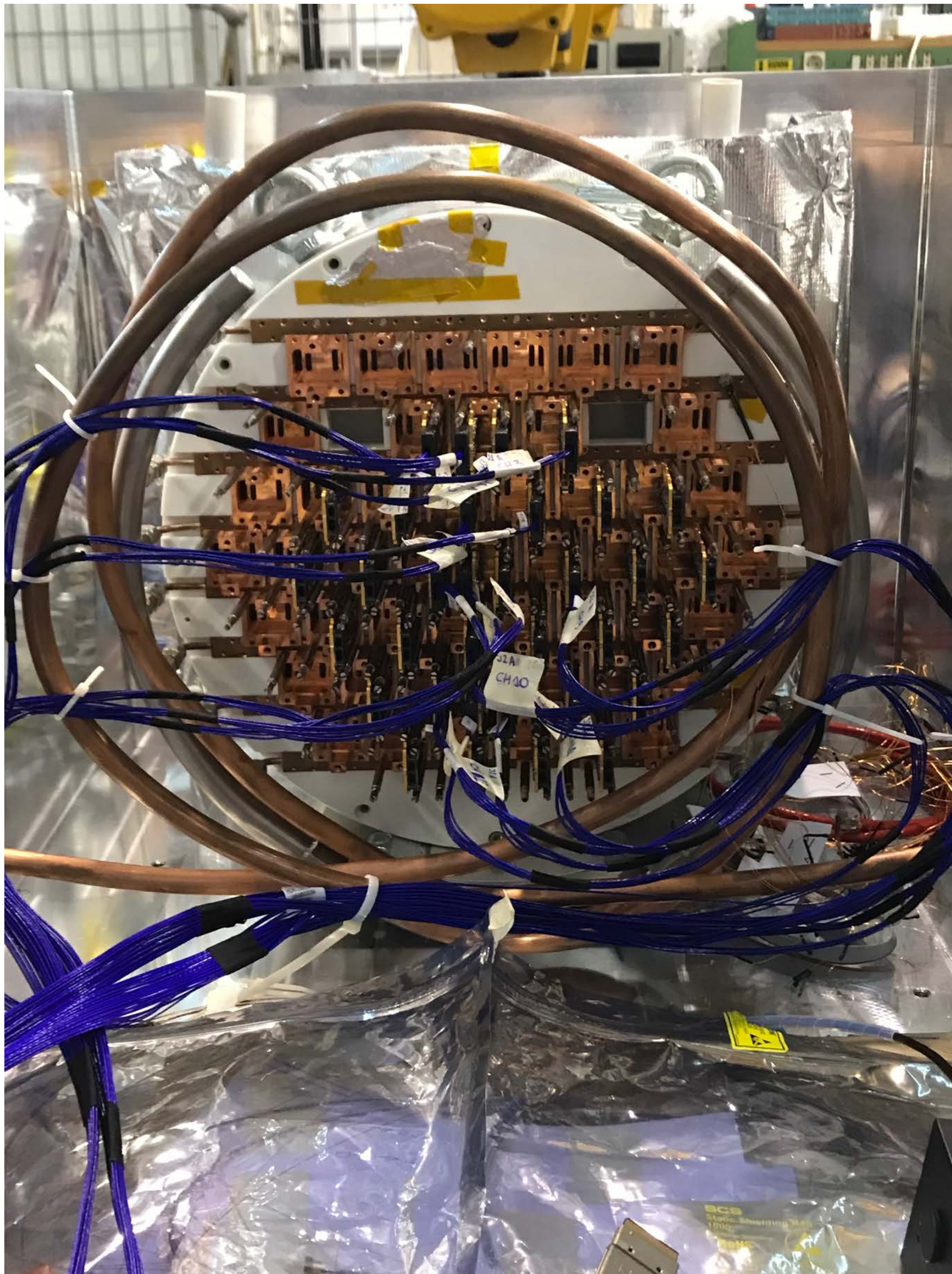




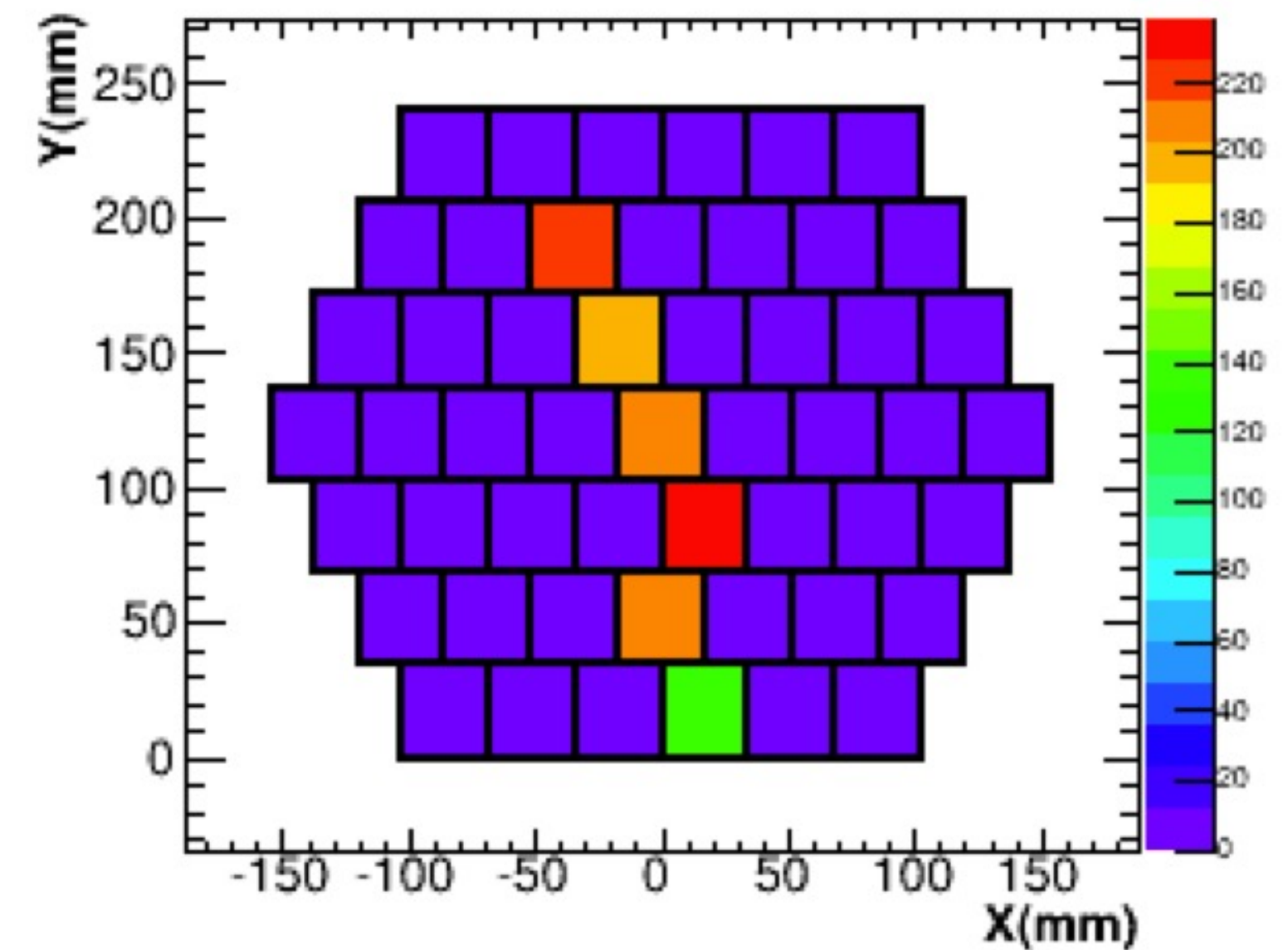
- Due dischi
- 674 cristalli di CsI(34 x 34 x 200) mm³ per disco
- Lettura con SiPM sensibili all'ultravioletto

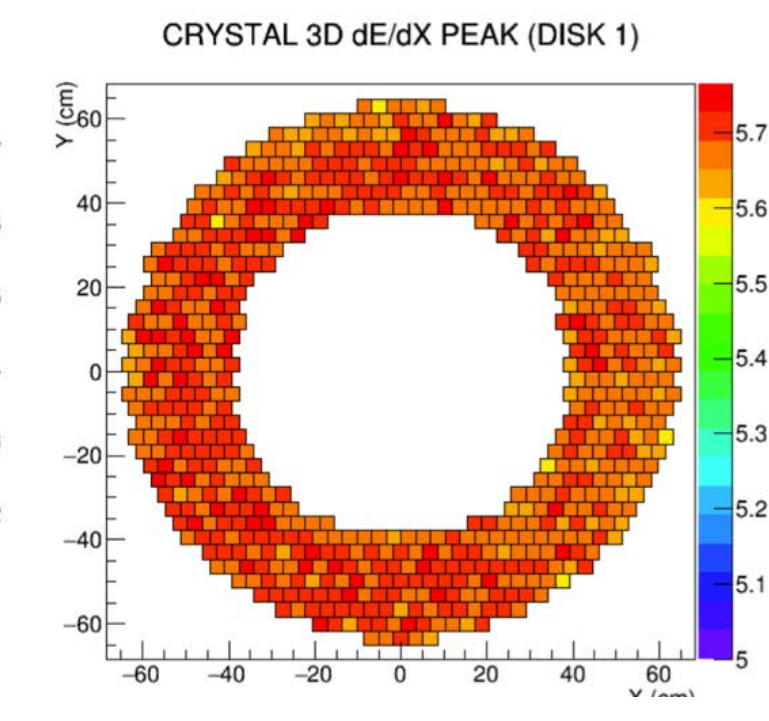
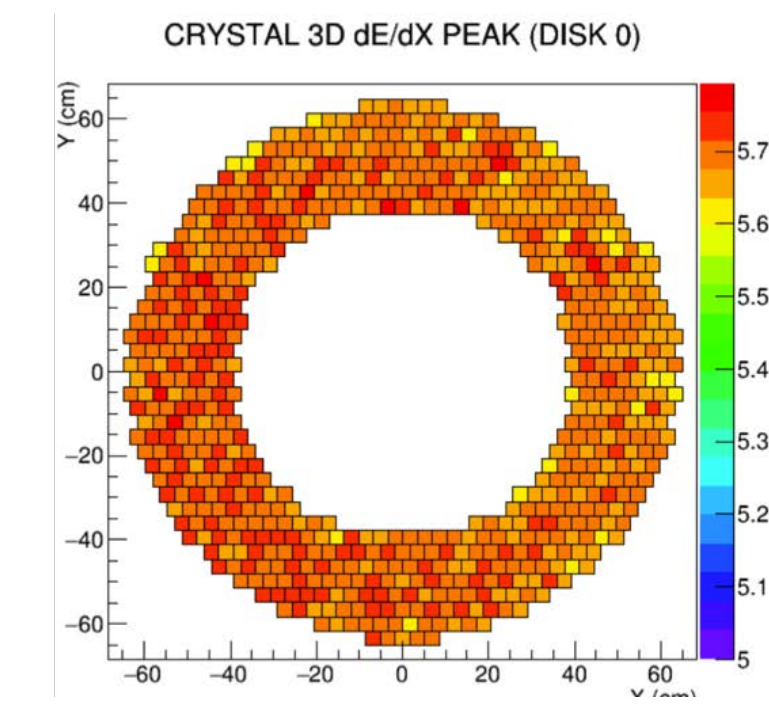
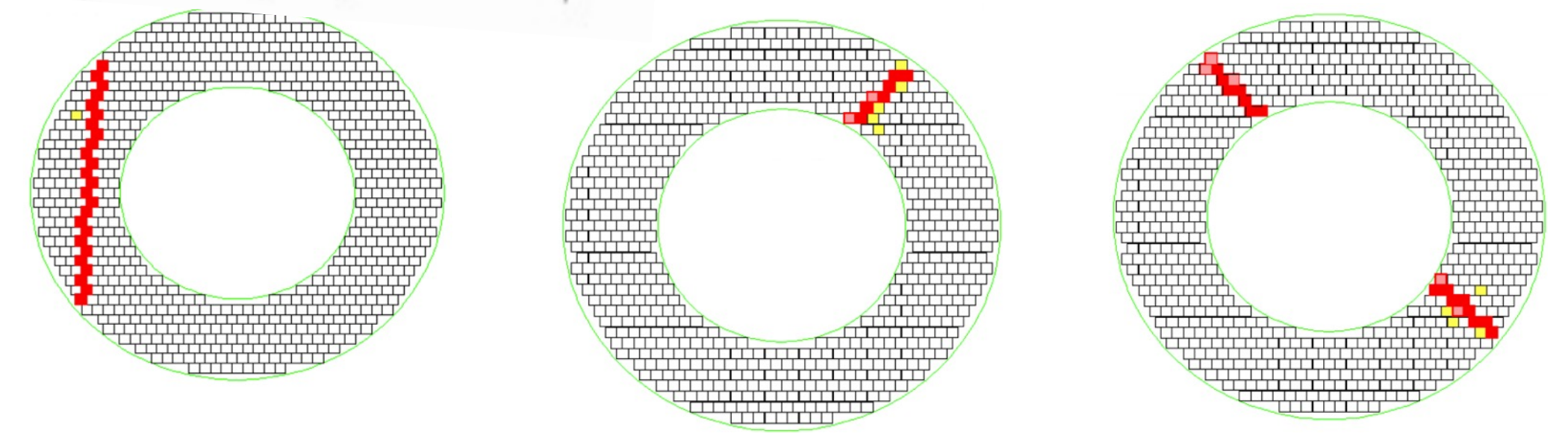
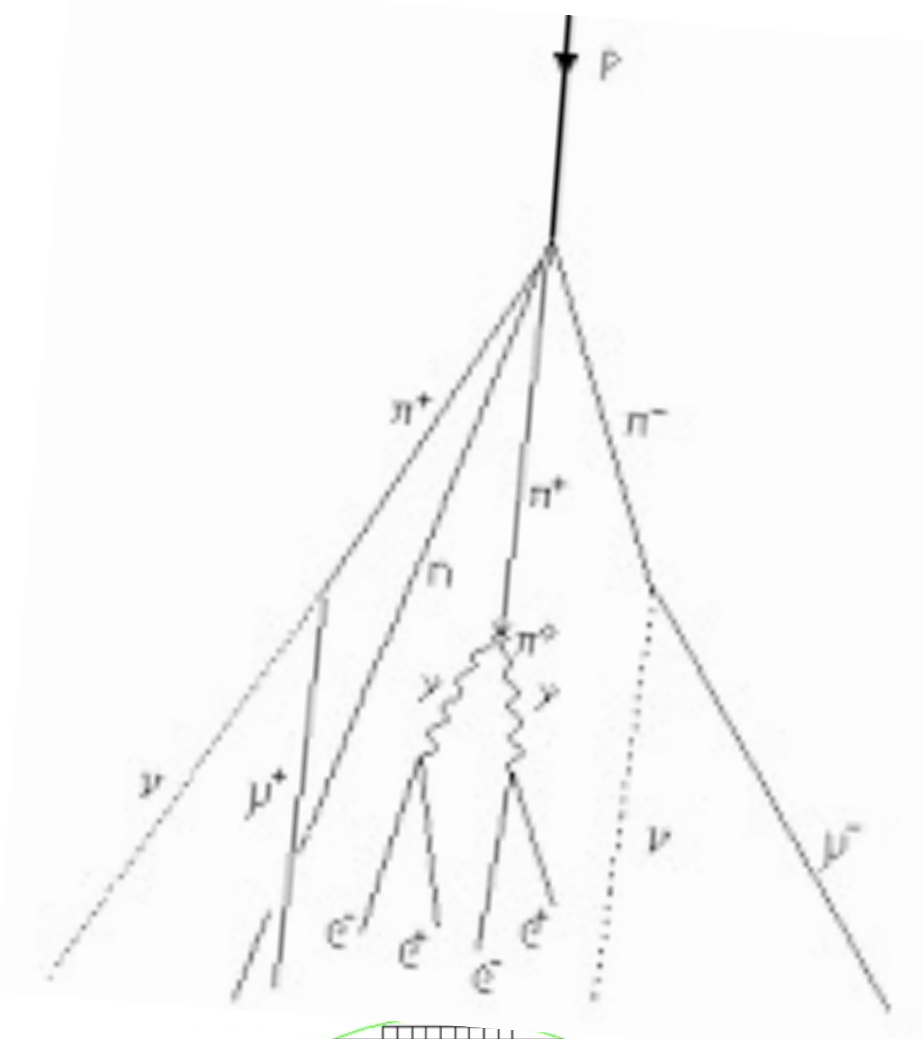
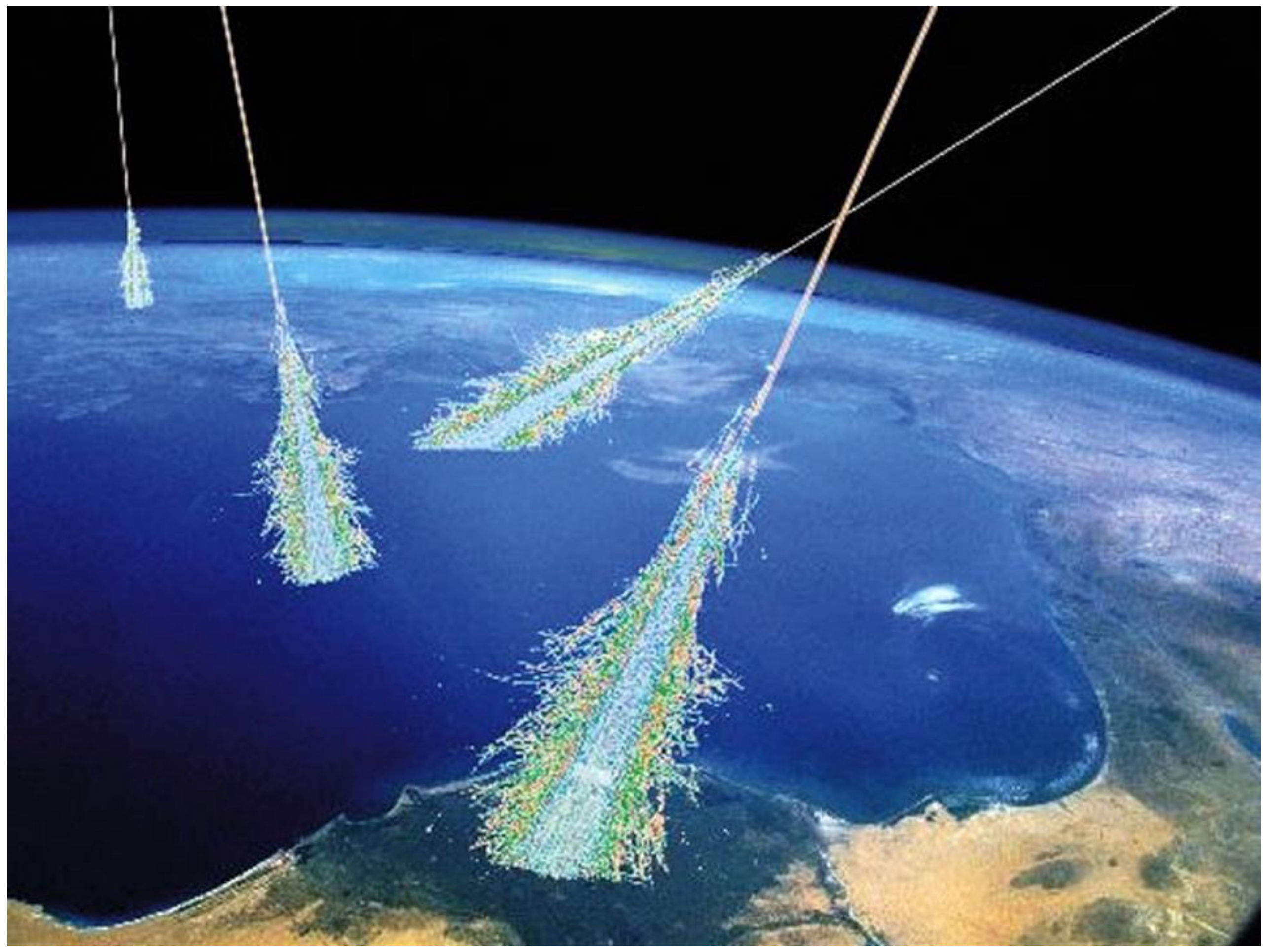
• Cosa «vede» il calorimetro?



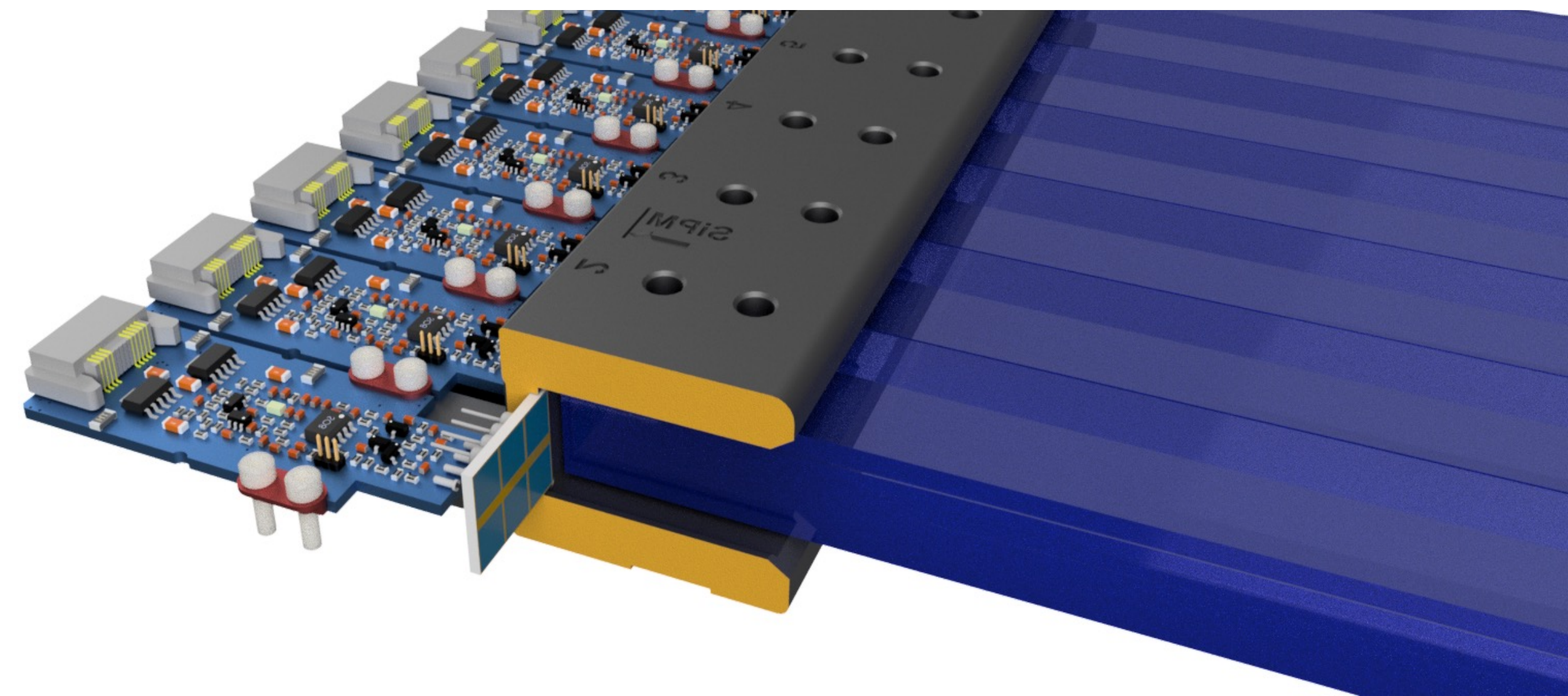
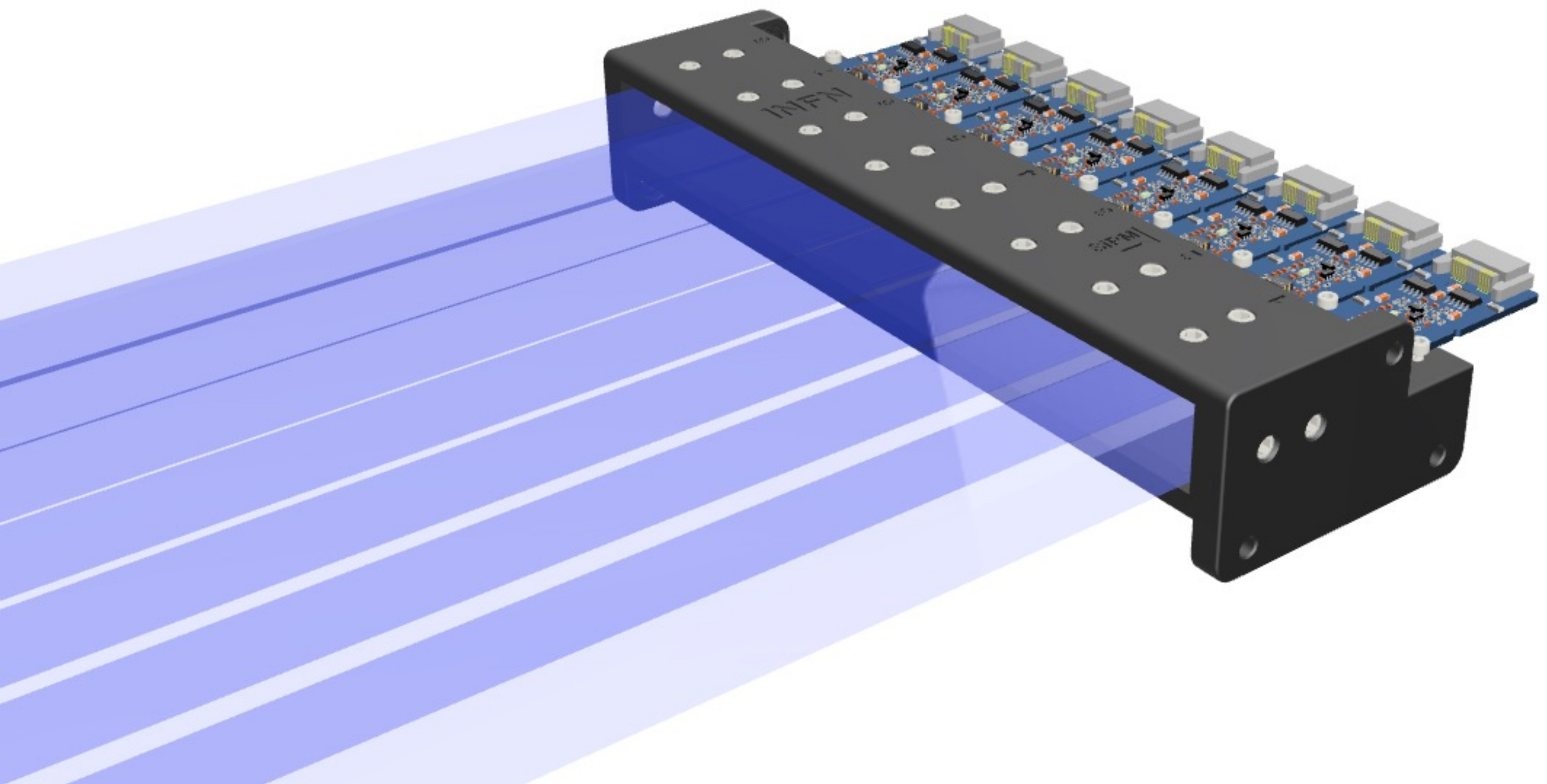


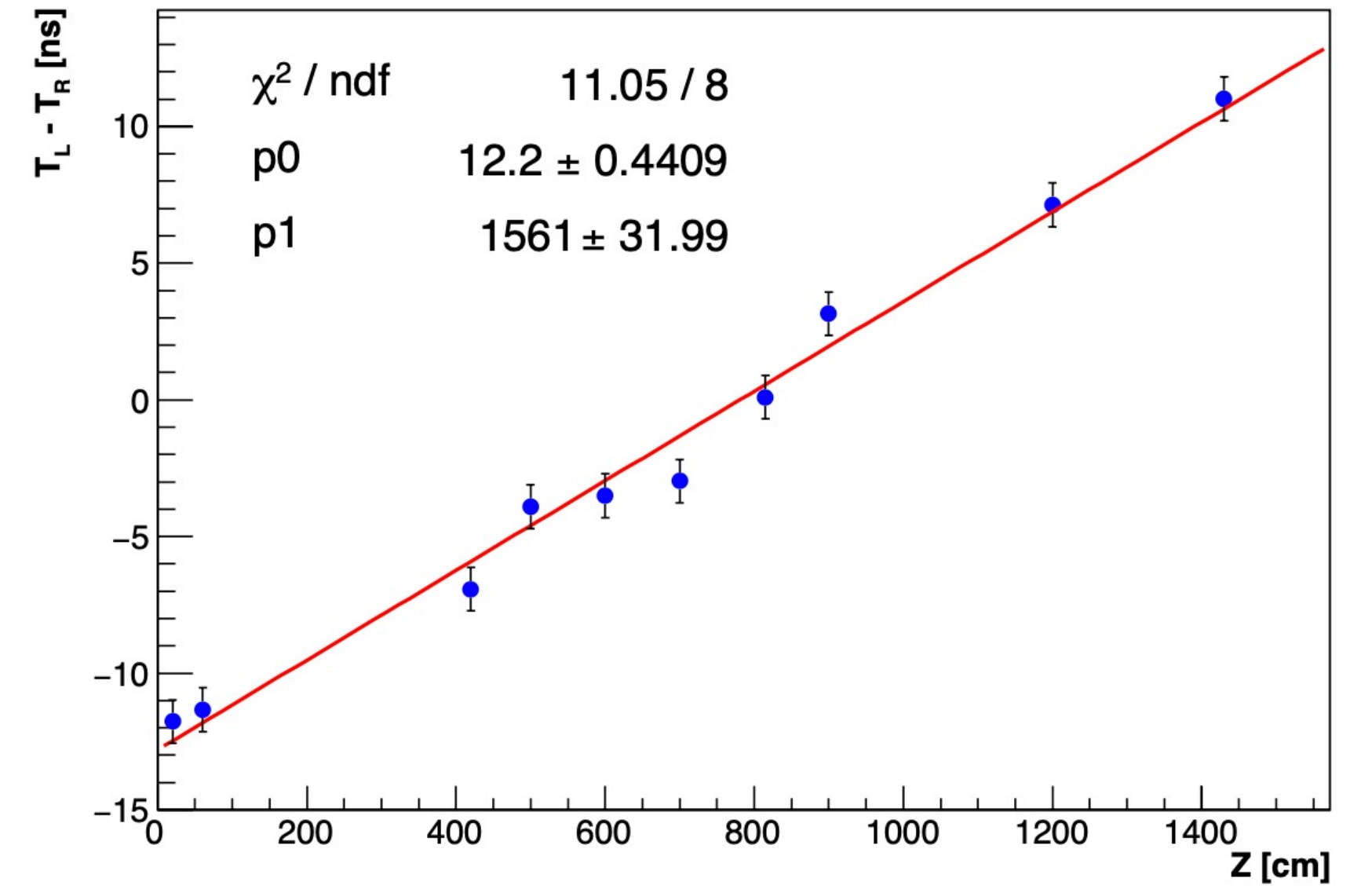
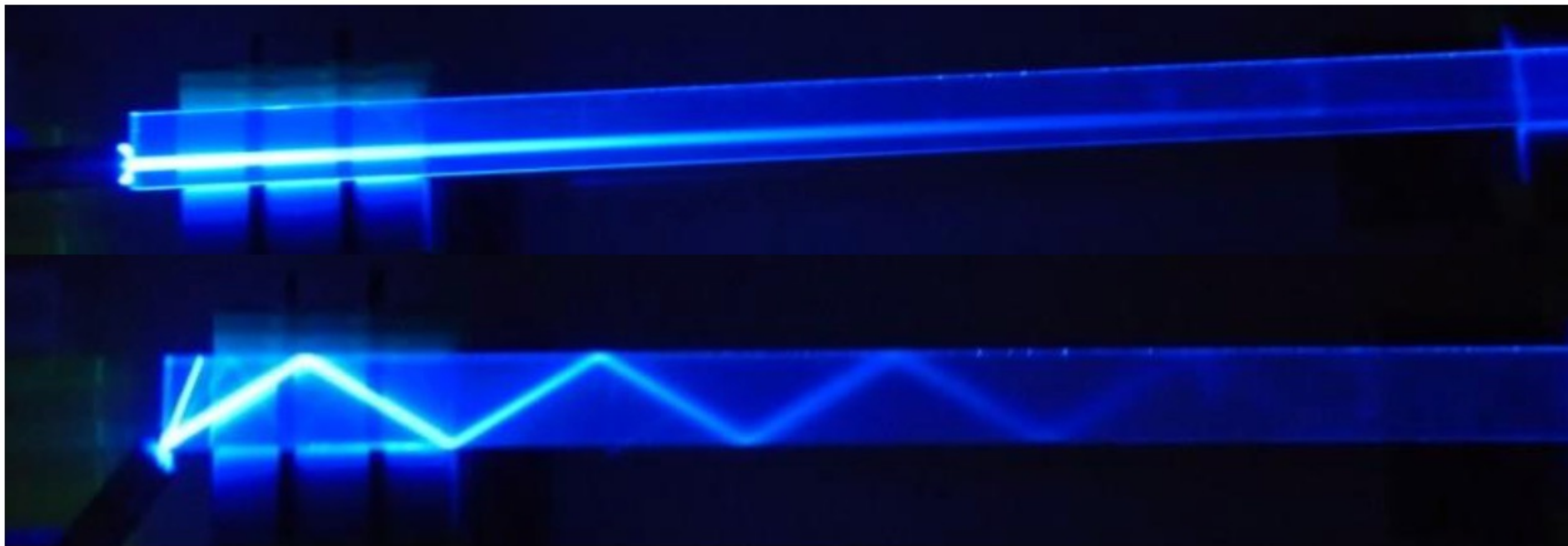
- 51 crystals
- Dual readout
- Final Mu2e SiPM readout
- Cooling system
- Laser calibration system



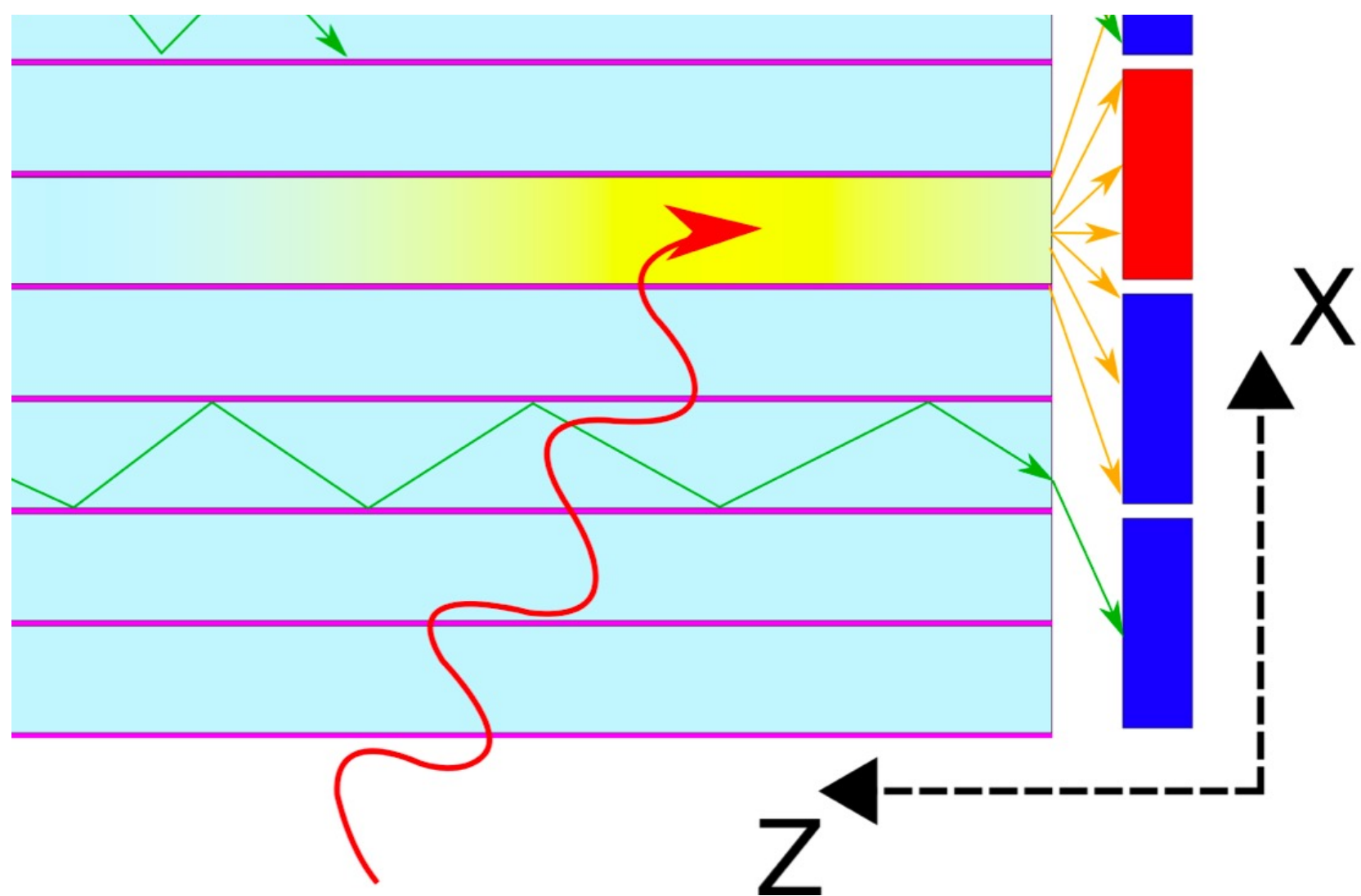


- Vedrete il nostro COSMIC RAY TAGGER
- Due moduli con 8 barre scintillanti l'uno
- Lettura dual-side con 1 Mu2e SiPM





$$T_L - T_R = 2 \cdot z / \langle v_p \rangle - L / \langle v_p \rangle$$



$$\langle \theta_p \rangle = \left(\frac{n \cdot \langle v_p \rangle}{c} \right) \approx 49.9^\circ$$

