

Bosone X17

Krasznahorkay, A.J.; et al.:

"Observation of Anomalous Internal Pair Creation in ^8Be : A Possible Indication of a Light, Neutral Boson".

[*Physical Review Letters*](#). **116** (42501): 042501 (2016).

Krasznahorkay, A.J.; et al.:

"New evidence supporting the existence of the hypothetical X17 particle".

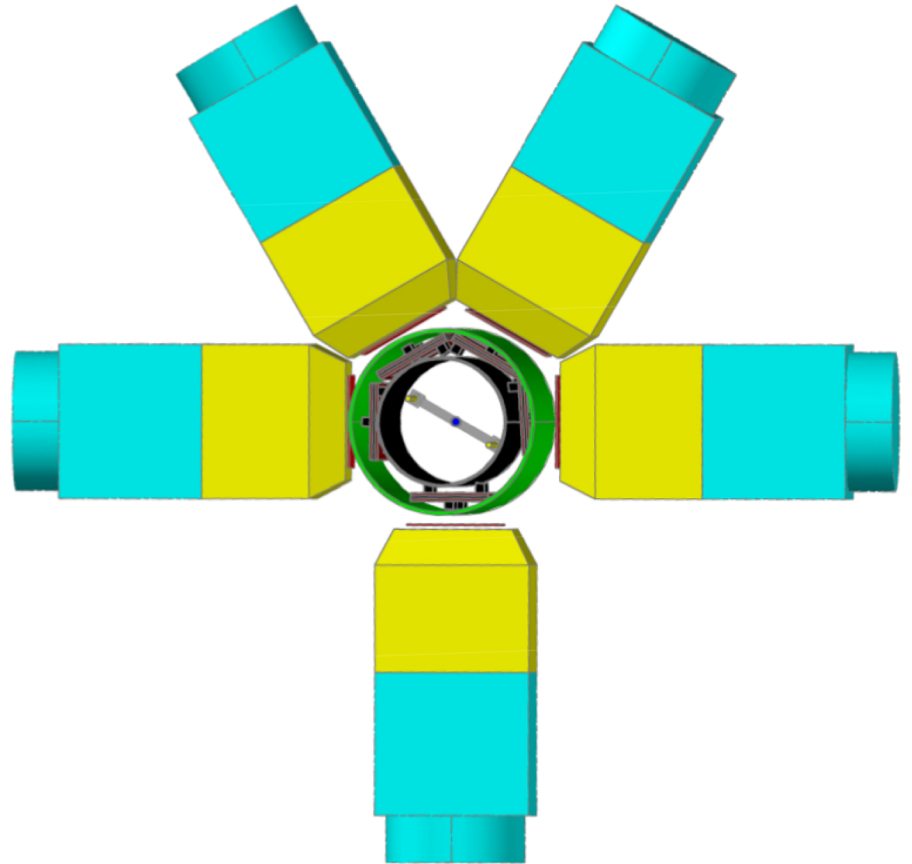
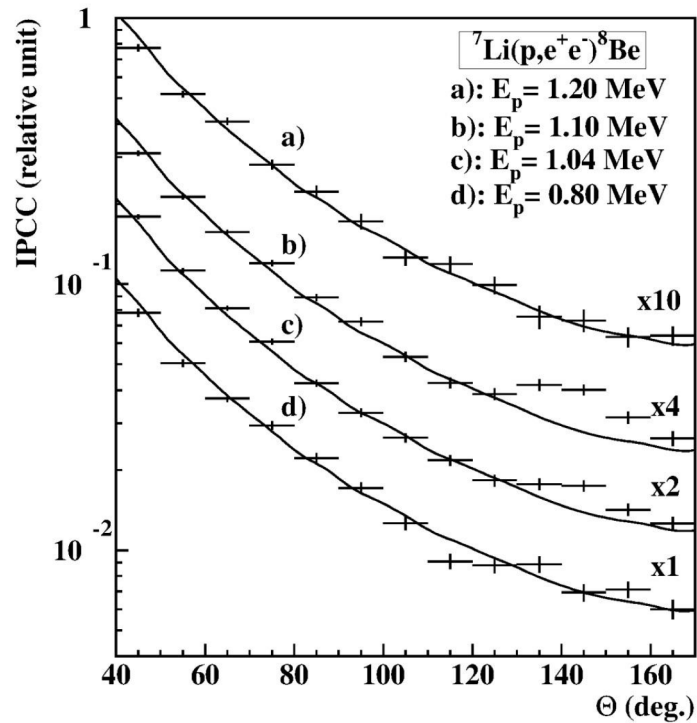
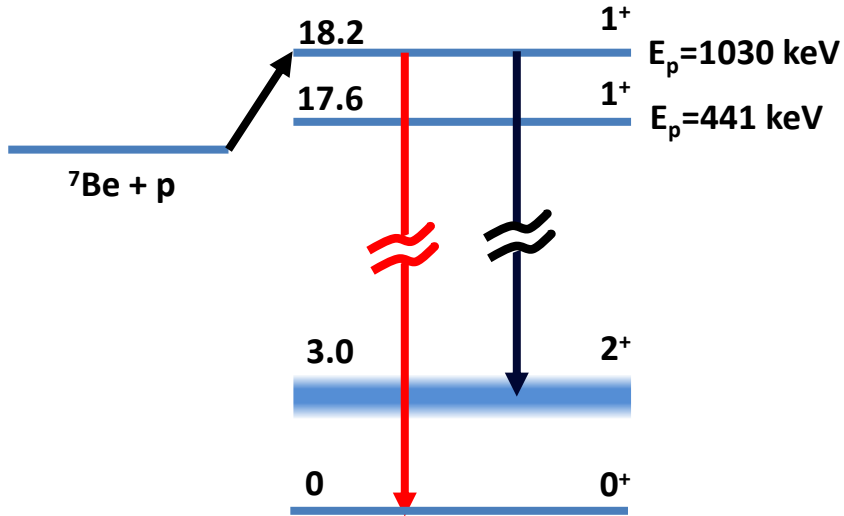
[arXiv:1910.10459v1](#) [[nucl-ex](#)] (23 October 2019).

REAZIONE	M_{X17}	ΔM_{X17_STAT}	ΔM_{X17_SYST}	TAU (s)	EVIDENZA
$^7\text{Li}(p, e^+e^-)^8\text{Be}$	16,70	0,35	0,50	$1E^{-14}$	>5 sigma
$^3\text{H}(p, e^+e^-)^4\text{He}$	16,84	0,16	0,20		>7,2 sigma

Carlo Gustavino, INFN Roma

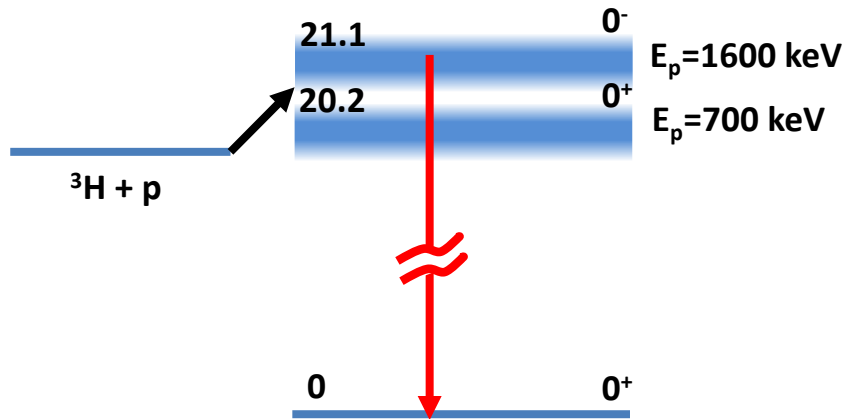
(grazie ad Alberto, Cristian, Nicola, Annamaria per discussioni e contributi)

REAZIONE ${}^7\text{Li}(p, e^+e^-){}^8\text{Be}$



NIM, A808, 21 (2016)

REAZIONE ${}^3\text{H}(p, e^+e^-){}^4\text{He}$



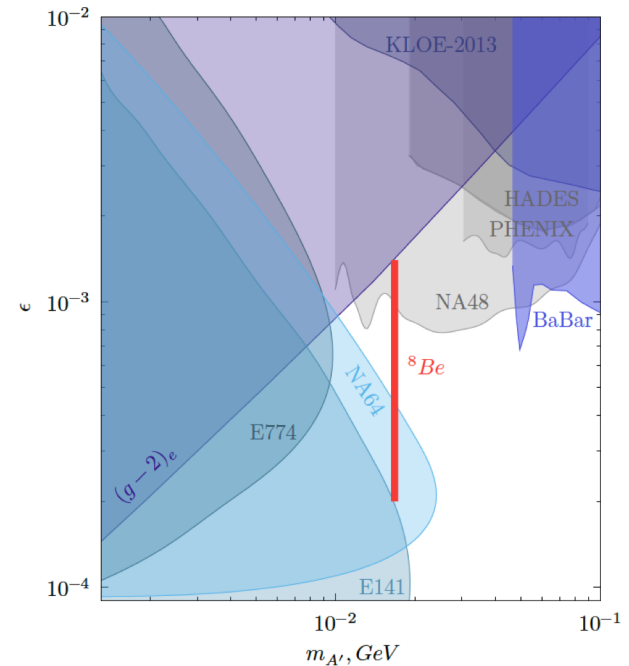
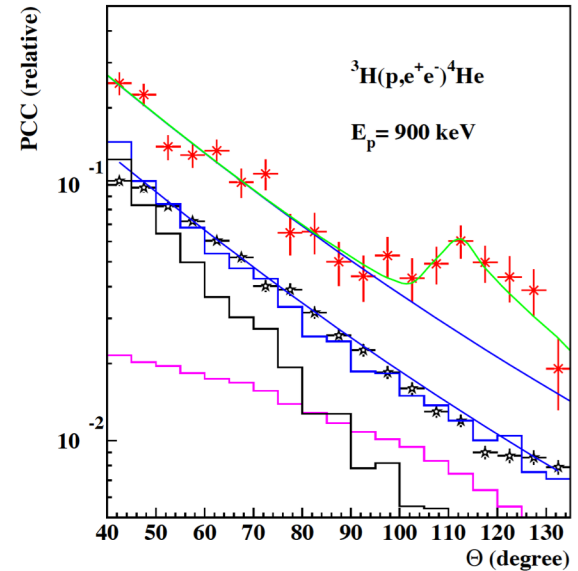
${}^3\text{H}(p, e^+e^-){}^4\text{He}$

$E_g = 21,01$ MeV

$\Gamma_\gamma = 0,84$ MeV

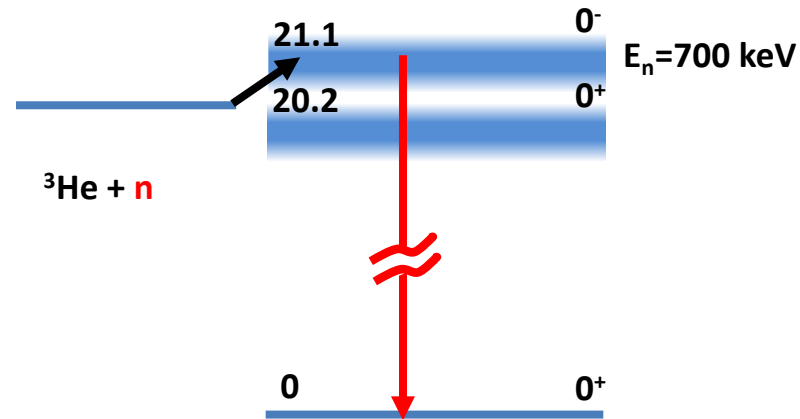
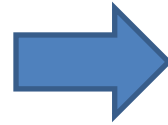
$E_p(\text{exp}) = 0,9$ MeV

$E_p(\text{nom}) = 1,6$ MeV



X17 @ nToF

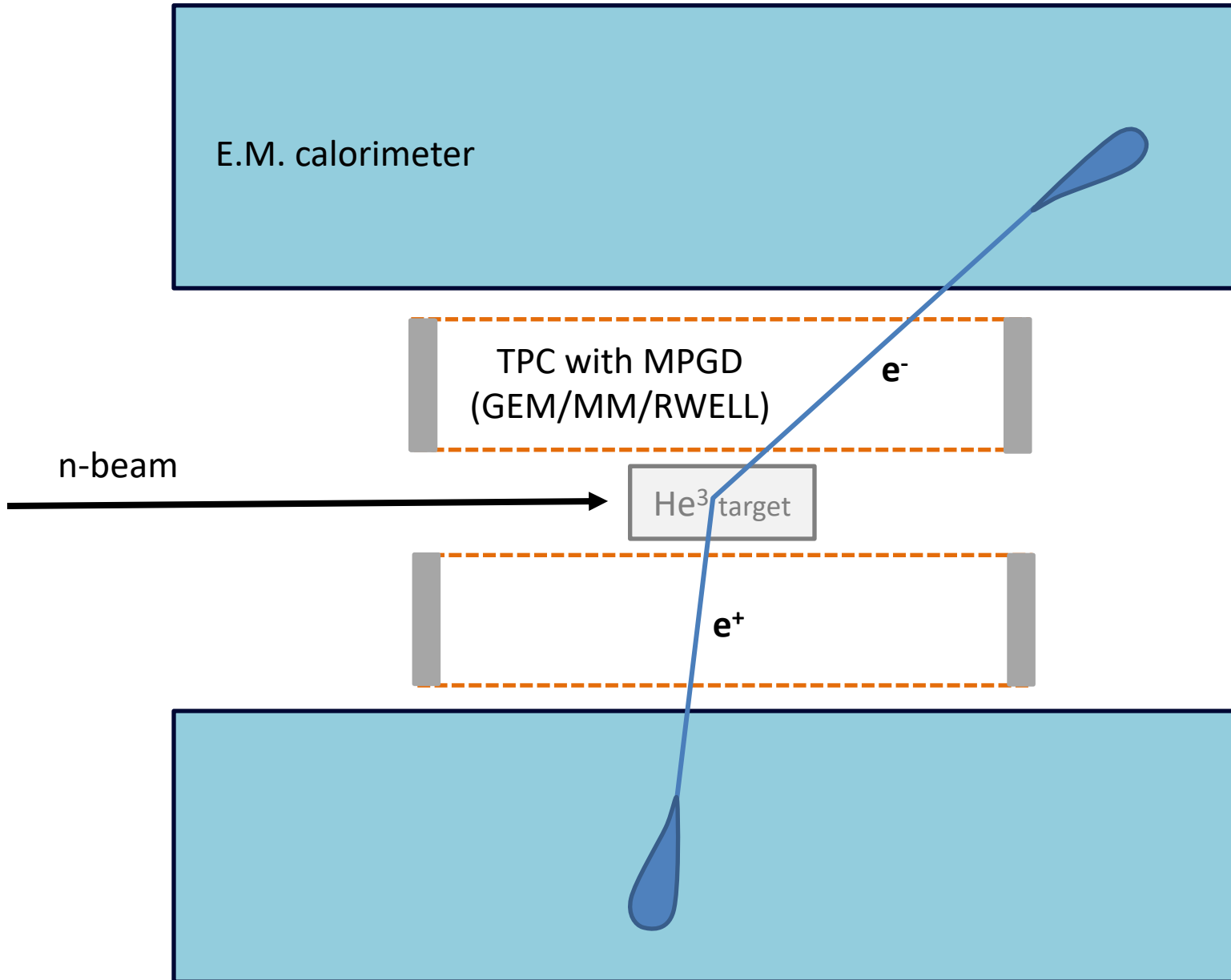
Idea di base: Misura indipendente sfruttando la reazione coniugata:



Fisica:

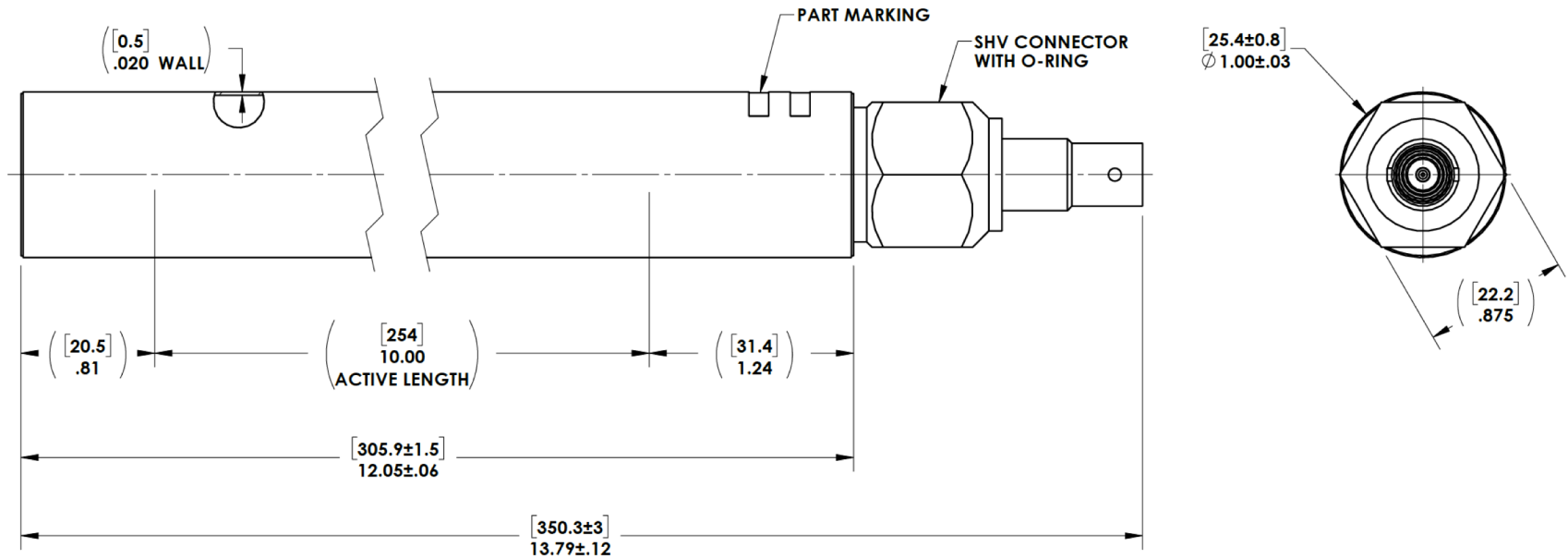
- Conferma (o esclusione) di X17
- Massa, numeri quantici, coupling, vita media di X17
- Misura $\sigma(E) {}^3\text{He}(n, \gamma){}^4\text{He}$, $\sigma(E) {}^3\text{He}(n, e^+e^-){}^4\text{He}$

Possible setup



Target

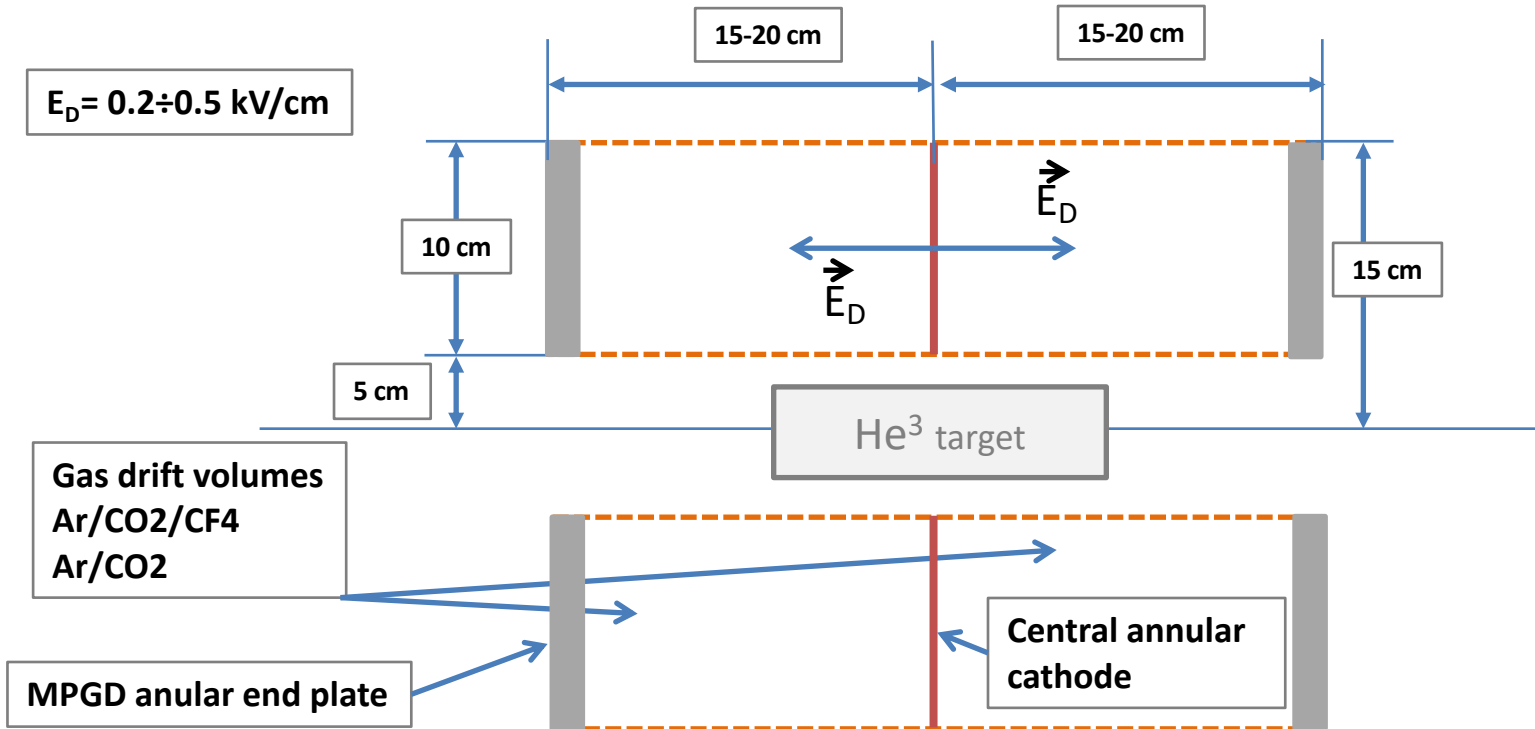
Tube ^3He @ 30 bar (diametro 2,54 cm, acciaio 344 da 0,5 mm) prodotto commercialmente



Line	Item Number	Description	Qty.	Unit Price	Total Price
1	RS-P4-0810-250	He ³ Proportional Counter	1	\$7,095	\$7,095
		1 inch Diameter x 10 inch Active Length			
		10 atm RS He ³	3	\$4,999	\$14,997
		Stainless Steel Body, SHV Connector			

Tracciatore

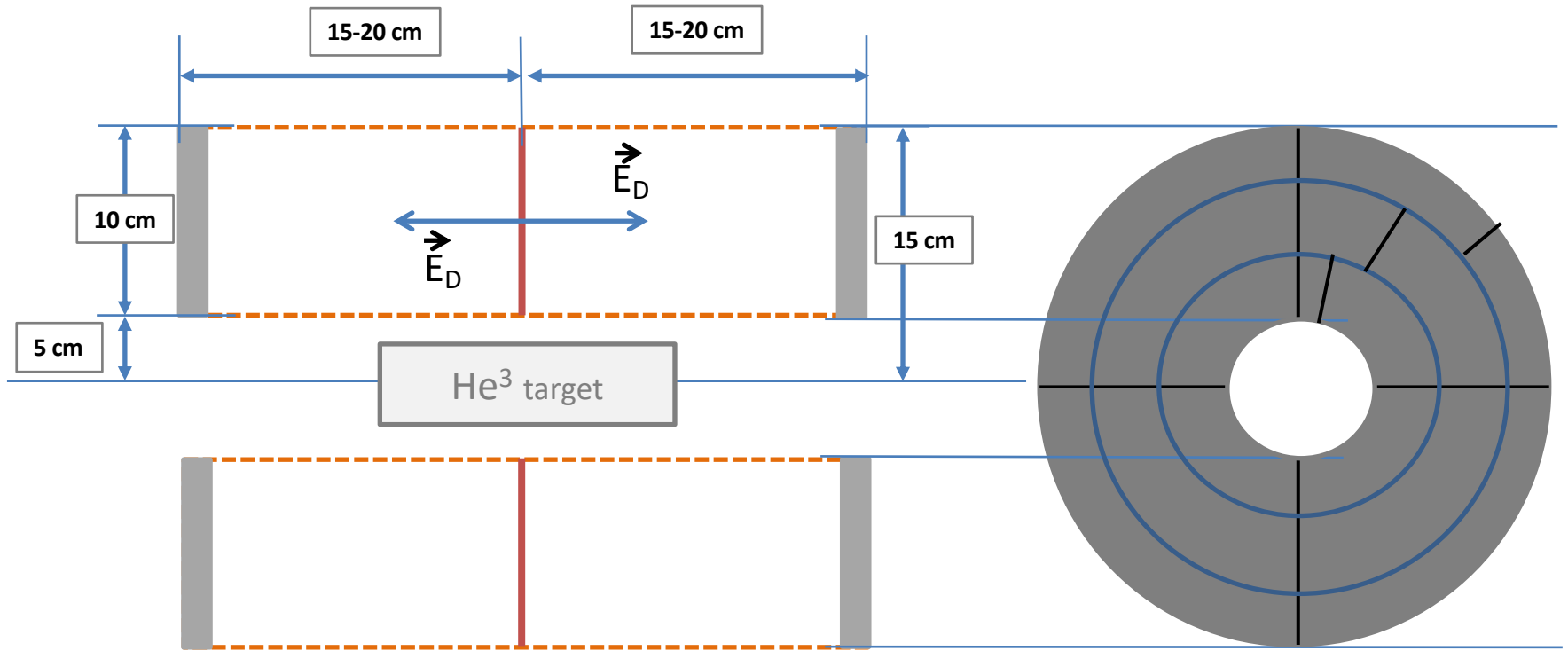
TPC con lettura MPGD (GEM/MM/RWELL)



		Thickness (um)	X0 (cm)	% X0
Cylindrical Support	Cu	3	1,43	0,021
	kapton	50	28,6	0,017
	glue	30	33,5	0,009
	MILLIFOAM/honeycomb	3000	1312,5	0,023
	glue	50	33,5	0,015
	kapton	30	28,6	0,010
				0,096

Layering of inner/outer cylinder including field cage (in Cu)
Field cage (inner/outer) cylinders ~0.1 lunghezze di radiazione

Tracciatore

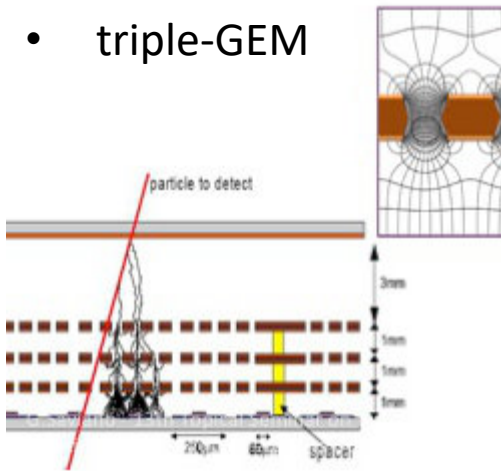


If the rate and then the occupancy is not so high each quadrant could be divided in n.128 r-strips (0,78 mm pitch – max length ~ 15 cm) and n.640 (128-192-320) ϕ -strips with a pitch of 12 – 8 – 5 mrad (roughly 0,58 – 0,62 – 0,53 mm). Globally each quadrant will be readout with 768 (analog) electronic channels **768x4=3072 channel**

MPGD END PLATES

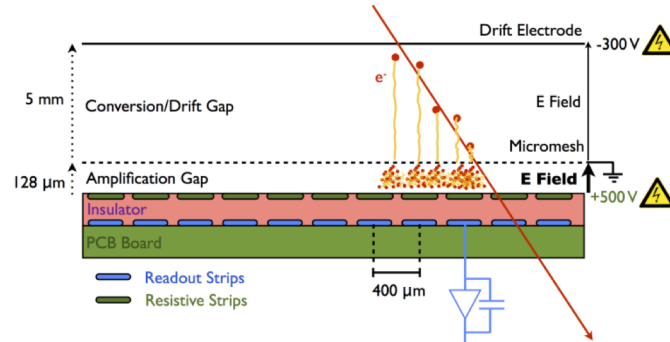
The most common MPGD as readout options:

- triple-GEM



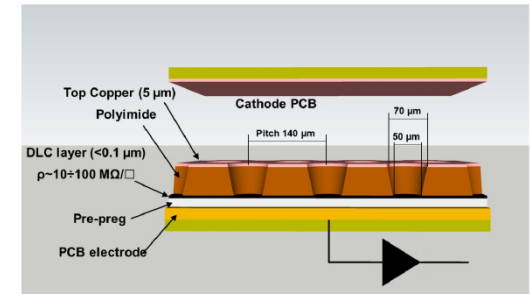
ALICE TPC

- MicroMegas



KEK TPC

- μ -RWELL



never used as TPC readout.
foreseen as Cylindrical-
RWELL for CREMLIN-plus

FEE & DAQ (tentative estimate)

- 768 chs/quadrant (n.128 r-strips + n.640 ϕ -strips) \rightarrow n.6 APV25
- 3072 chs/end-plate \rightarrow n.24 APV25
- 6144 chs/TPC \rightarrow n.48 APV25 (n.3 x (8 master + 8 slave)) 7152 CHF
- n.3 ADC 3708 CHF
- n.3 FEC 4785 CHF
- n.1 SRS-crate 809 CHF
- Connectors, cables etc 3000 CHF

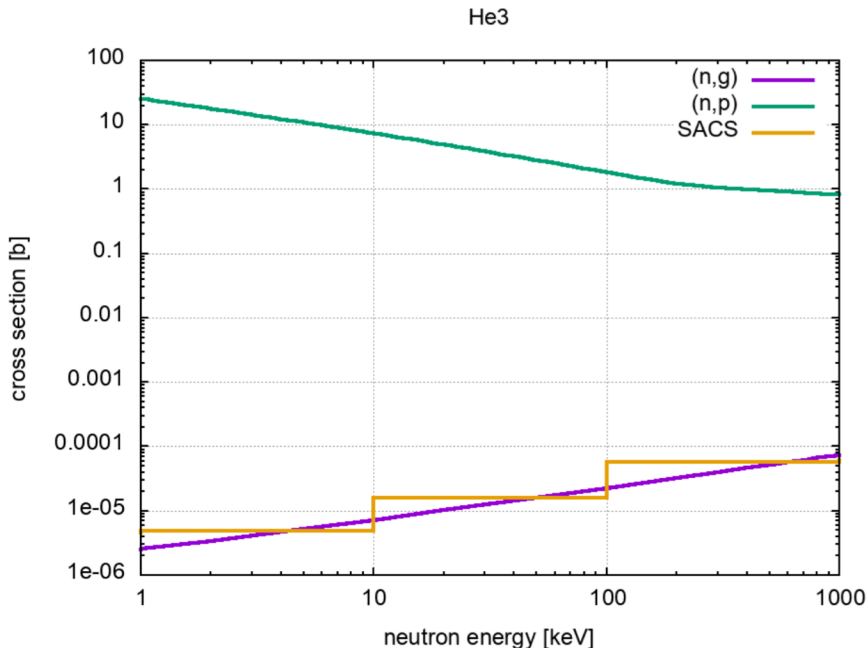
TOT **19454 CHF**

Rates

Background:

The e+e pairs ($E_{\text{tot}} \sim 9+9$ MeV) are a **unique signature**. However :

- Gamma flash (1,3 μs in advance in the worst case ($E_n=1$ MeV @ EAR2))
- ${}^3\text{He}(n,\gamma){}^4\text{He}$ (~ 18 MeV, single shower, no IPC tracks)
- ${}^3\text{He}(n,p){}^3\text{H}$ (not a problem, maybe can be exploited)
- Cosmic rays (not a problem, asynchronous trigger)



ratio	6,00E-06
barn/cm2	1,00E-24
volume mole (cc)	22000
Navogadro	6,00E+23
PiGreco	3,14
Lunghezza (cm)	20
raggio (cm)	1,75
sup. Front (cm2)	9,62
pressione (bar)	30
volume (cc)	1,92E+02
Volume mole (cc)	2,2E+04
Navogadro	6,02E+23
bersagli	1,57E+23
efficienza	1,00
Sigma ${}^3\text{He}(n,p)\text{T}$	5,70
Sigma $n({}^3\text{He},g)$	5,7E-05
rate p (s-1)	4,6E+06
rate gamma (s-1)	46
rate e+e- (s-1)	2,77E-04
rate e+e- (day-1)	24

	${}^3\text{He}(n,g){}^4\text{He}$	EAR1	EAR2
energy range [keV]	SACS [b] (*)	nflux [n/cm2/s]	nflux [n/cm2/s]
1 - 10	4.9E-06	2.43E+03	8.78E+04
10 - 100	1.6E-05	3.73E+03	1.57E+05
100 - 1000	5.7E-05	1.09E+04	5.34E+05
1 - 1000	4.1E-05	1.71E+04	7.79E+05
full	4.4E-05	3.99E+04	1.65E+06

(*) SACS - spectral averaged cross section

Prossimi passi

- R&D (targhetta, tracciatore, calorimetro)
- Theoretical framework (invitare Attila per un seminario?)
- Simulation
- Executive design/costs...
- Fondi esterni (Prin, ERC..)
- Analisi rischi (targhetta ad alta pressione)
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Grazie per l'attenzione