ICTR-PHE 2016

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Fast calibration of the range of Carbon ions with in-beam PET of Boron-8 nuclei

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TERA foundation

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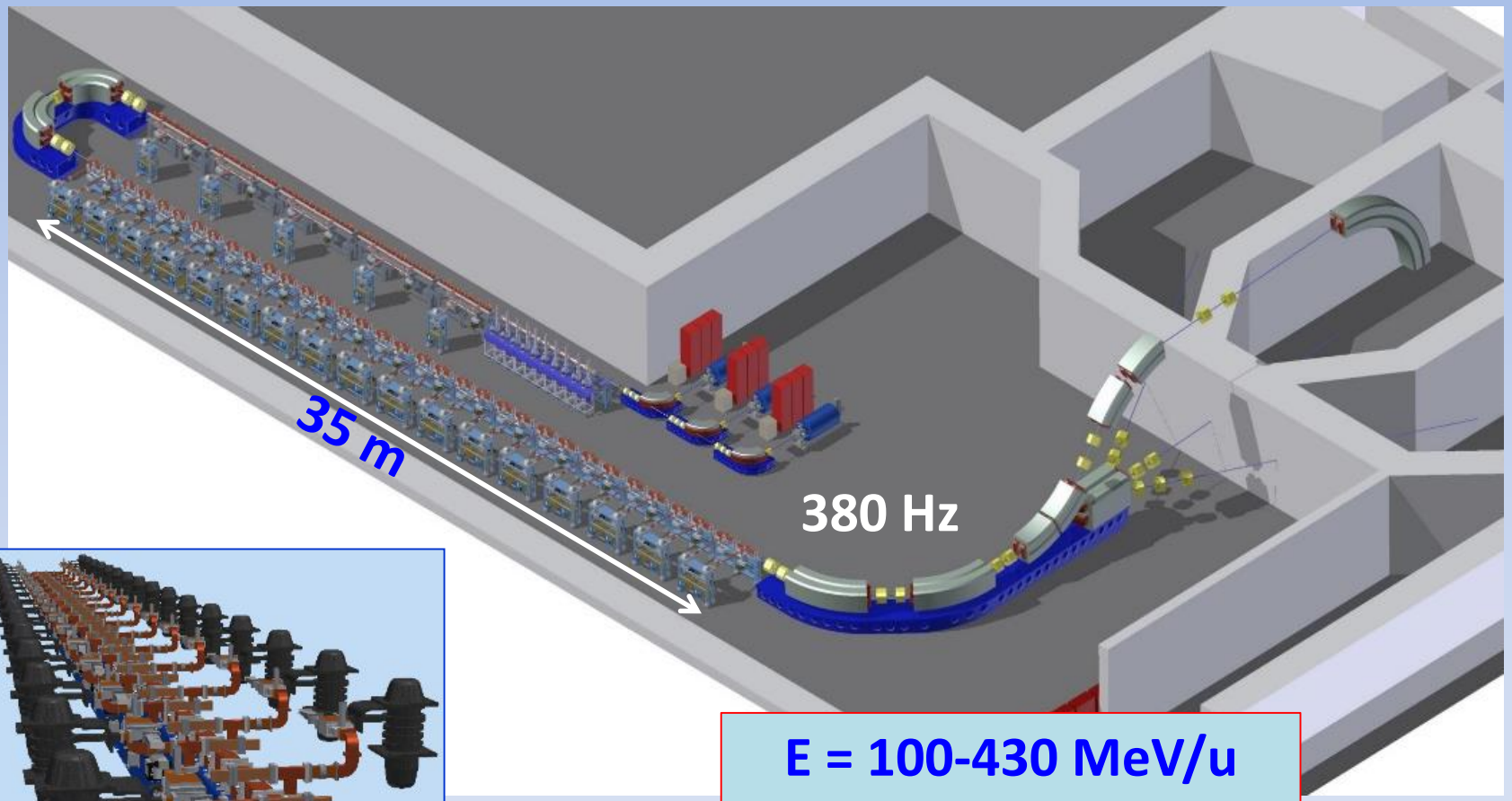
➢The linacs of the TERA Foundation

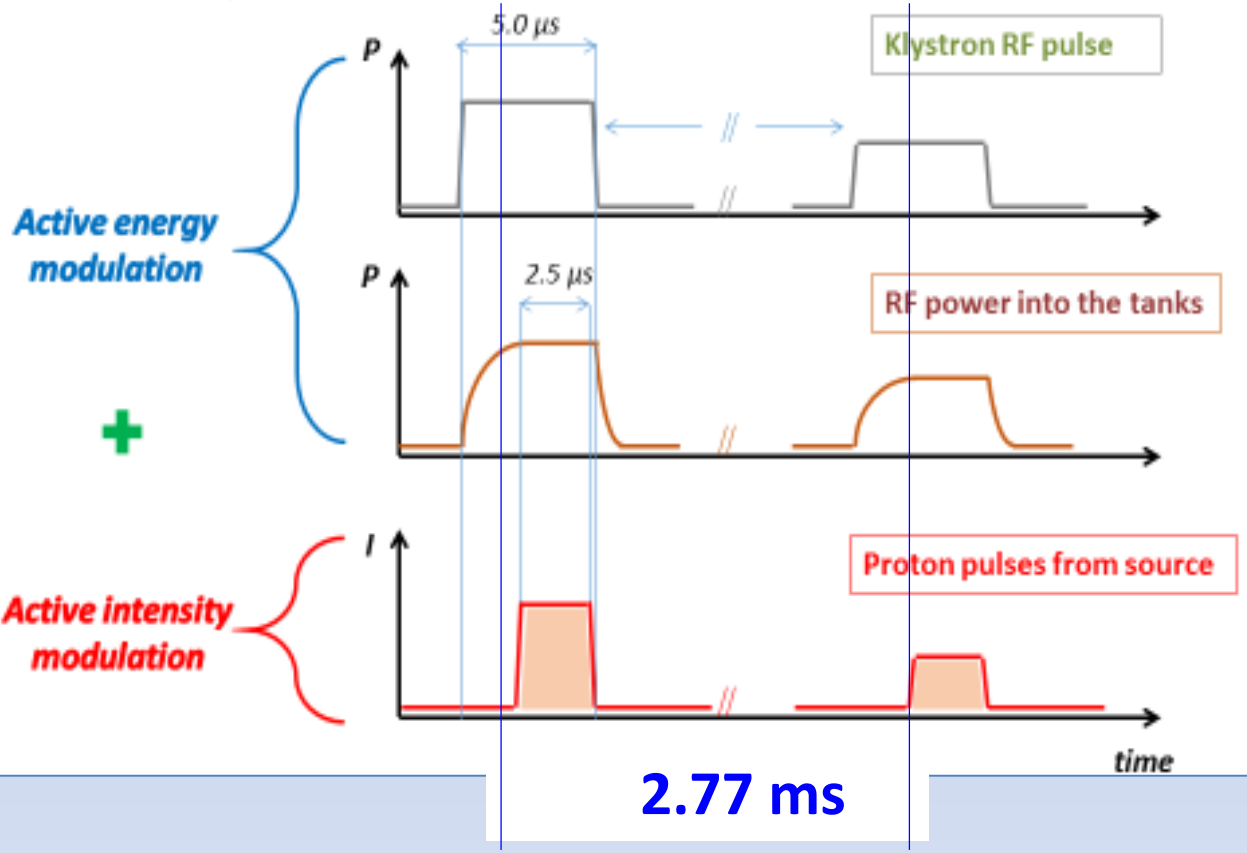
CABOTO = CArbon BOoster for Therapy in Oncology
designed by a CERN-TERA Collaboration



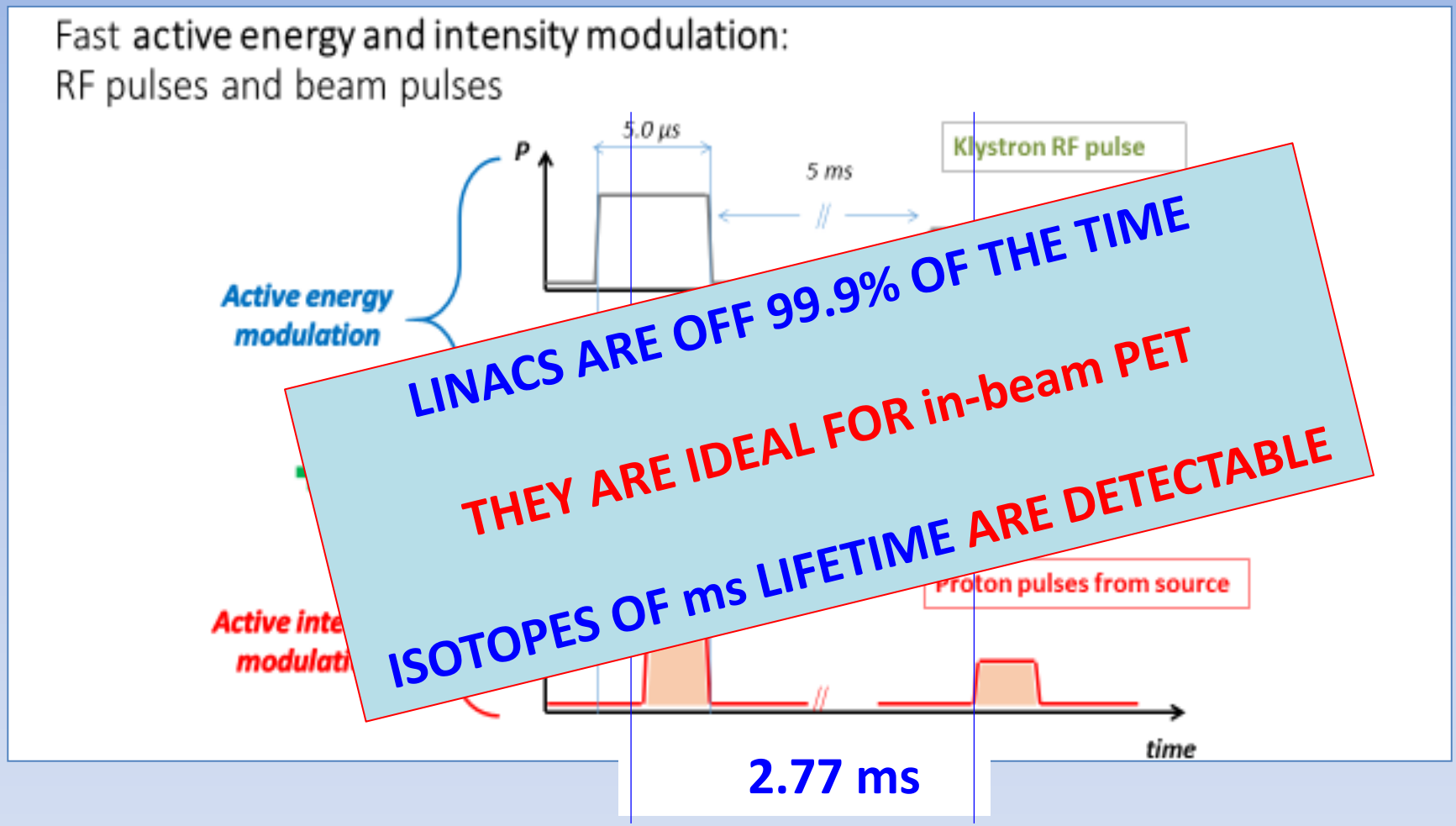
E = 100-430 MeV/u
variable every 2.77 ms

➢The linacs of the TERA Foundation

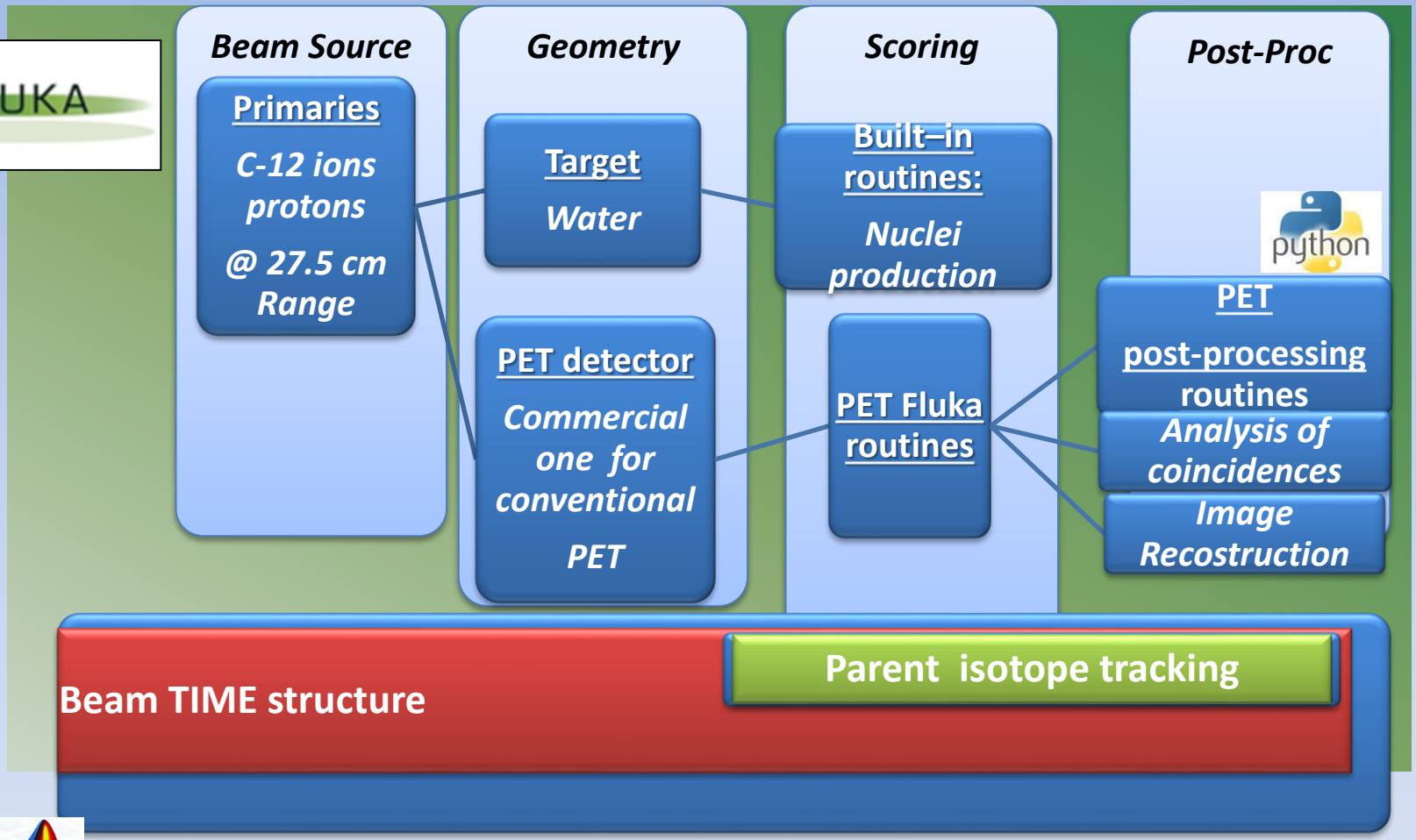
Fast active energy and intensity modulation:
RF pulses and beam pulses



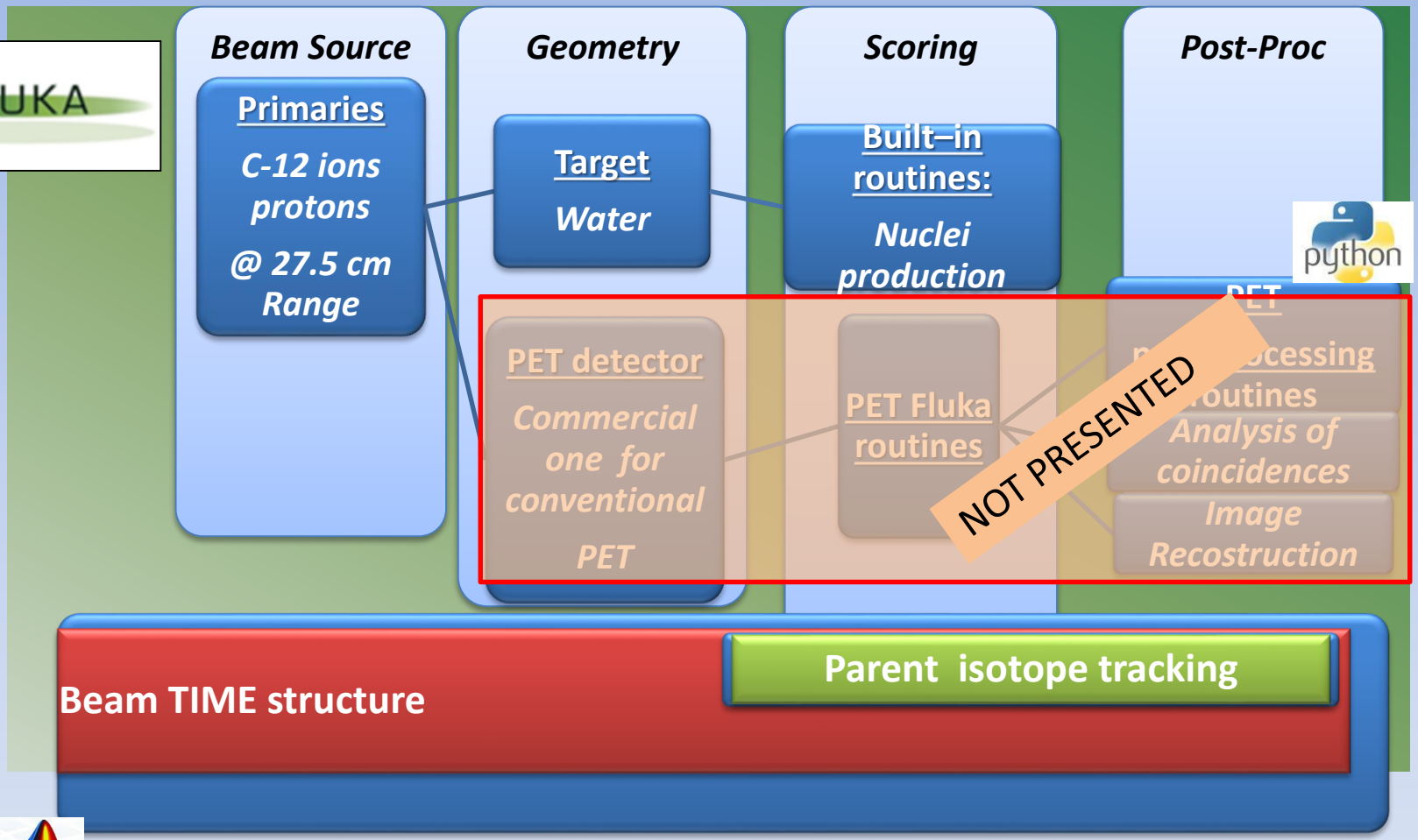
The linacs of the TERA Foundation



FLUKA MONTECARLO

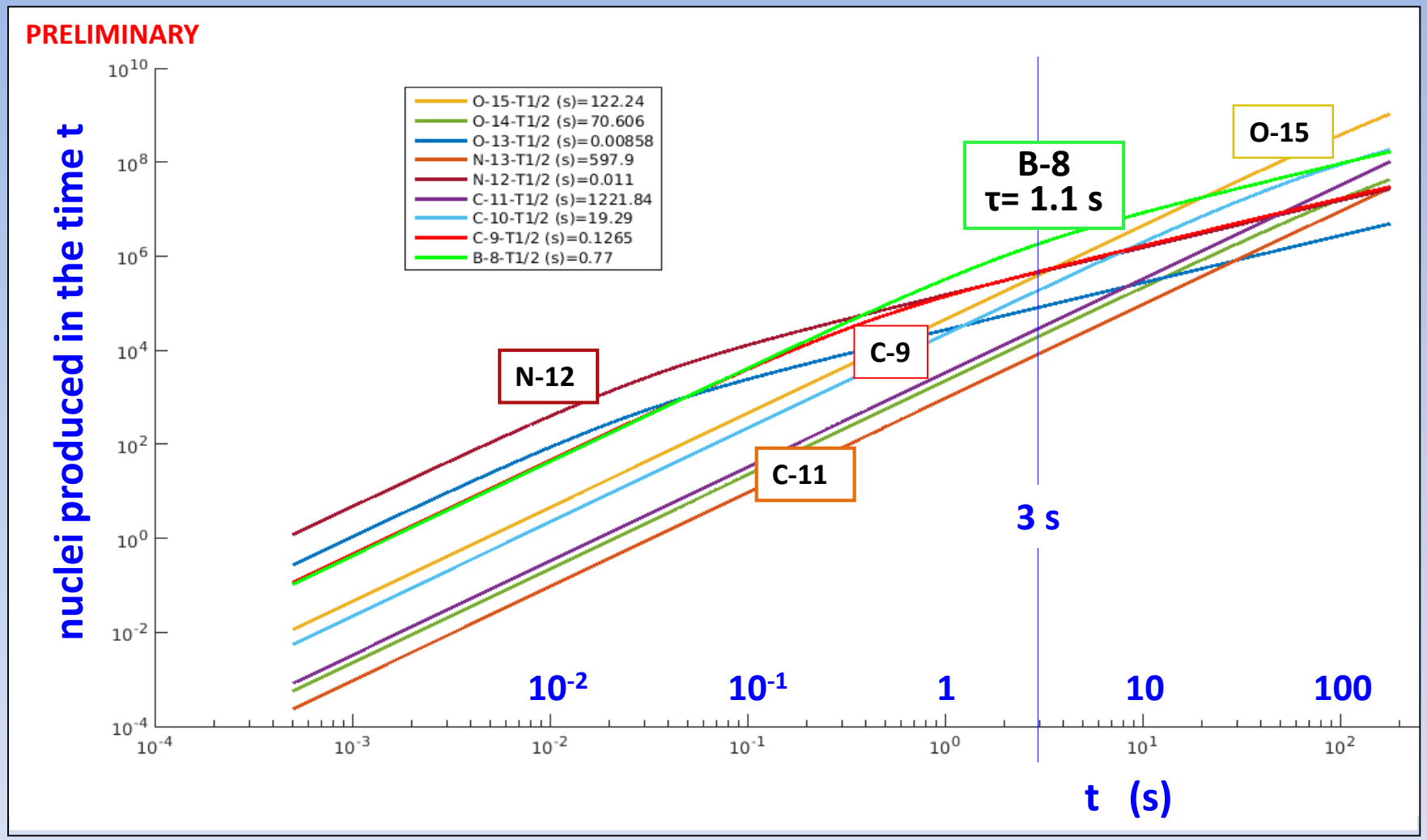


FLUKA MONTECARLO



Results with C12

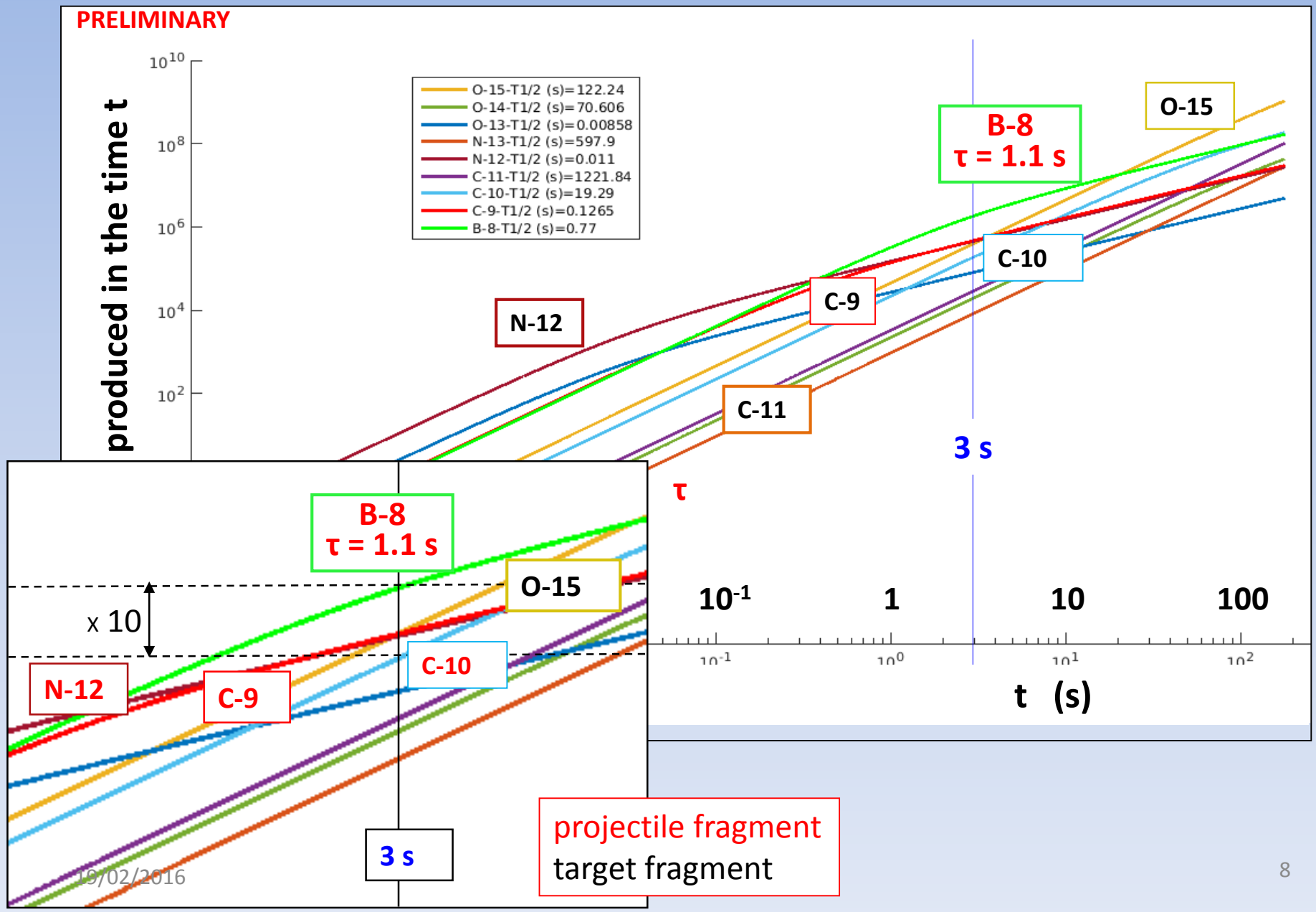
water target with a continous C-12 beam



$\tau = T_{1/2}/\ln(2)$

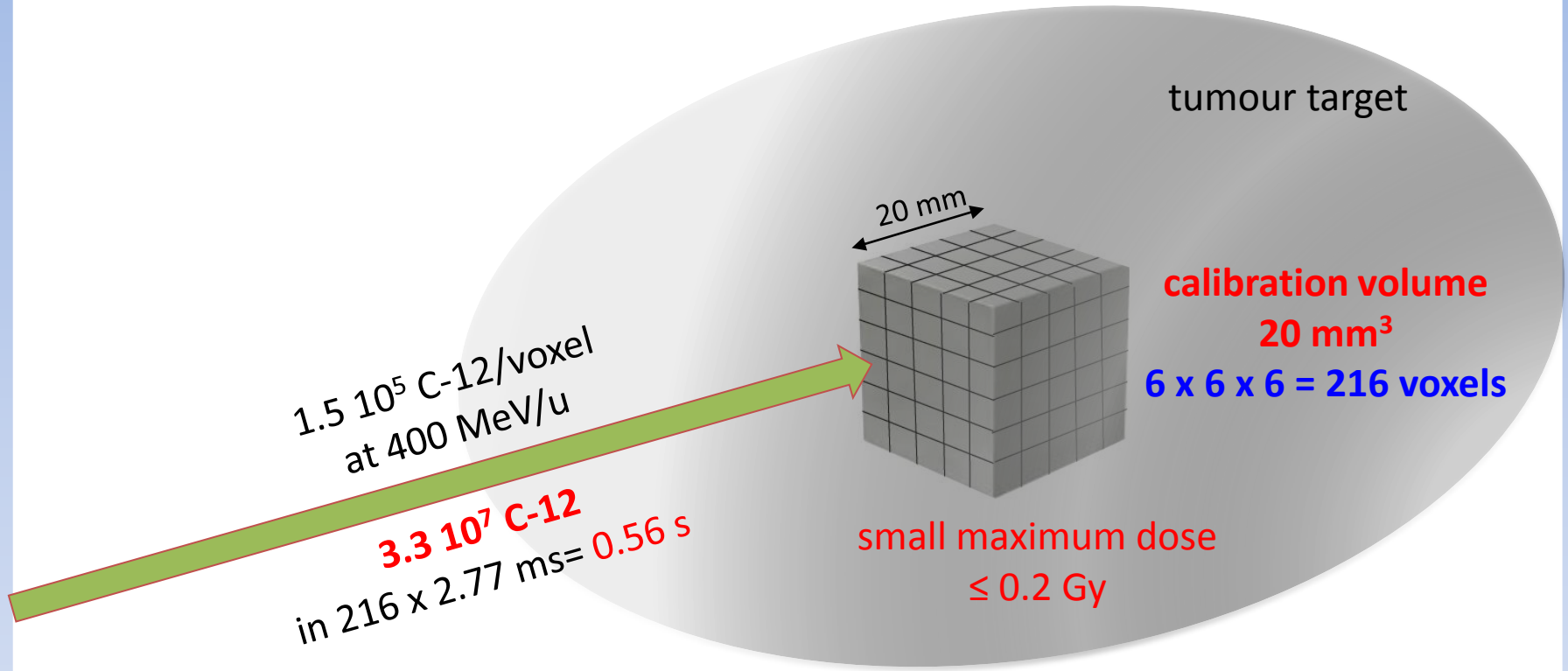
Results with C12

water target with a continous C-12 beam

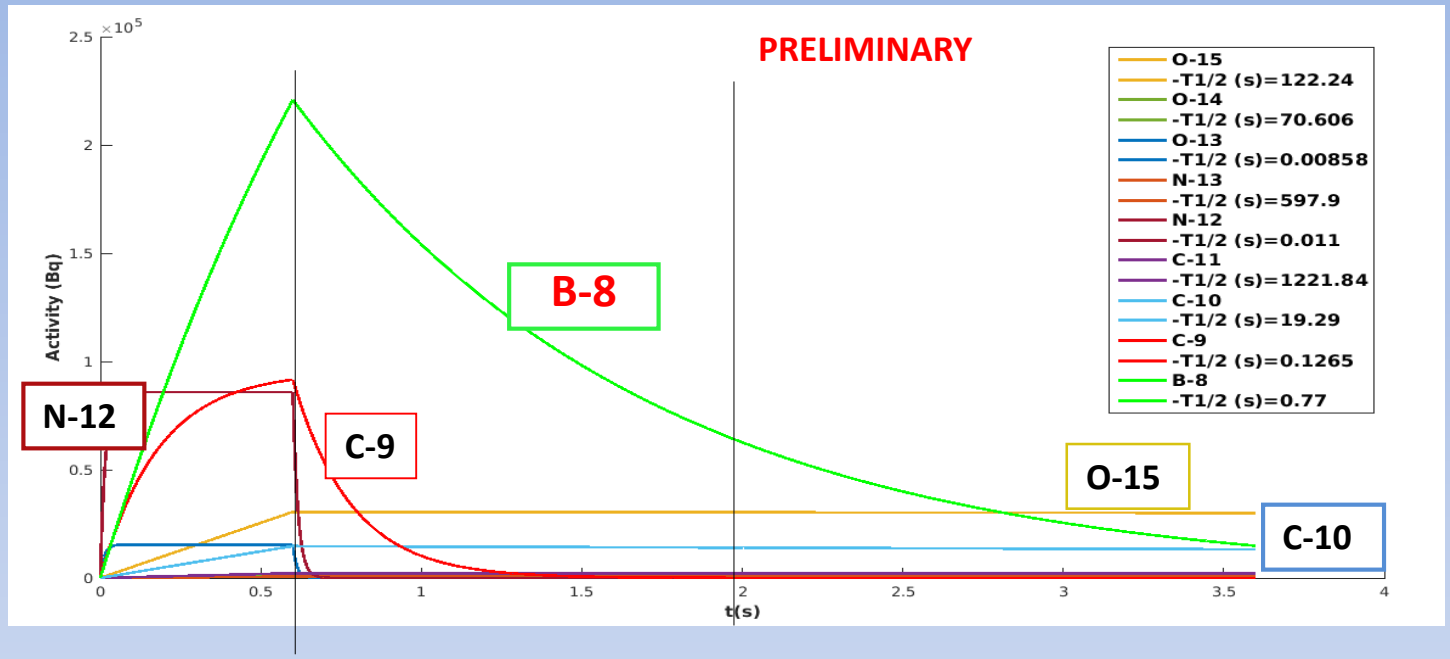


projectile fragment
target fragment

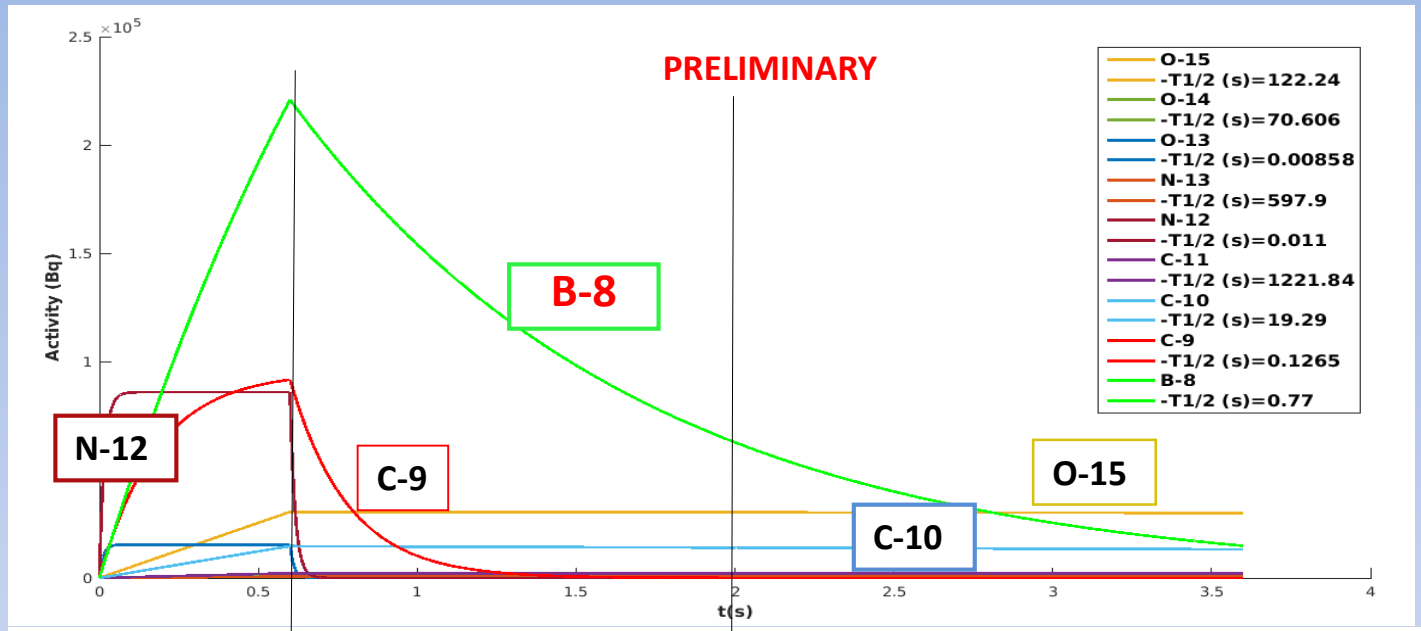
➢ Proposal : a 2 s “range verification run”

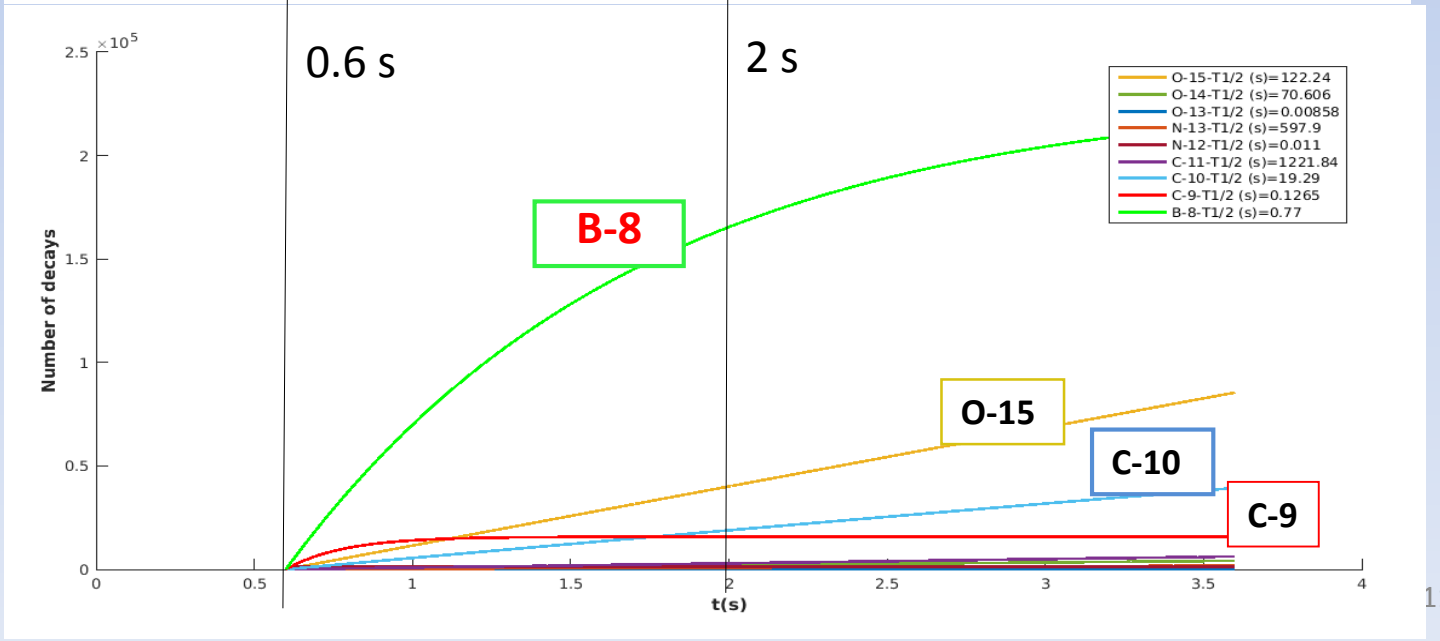


Results with C12



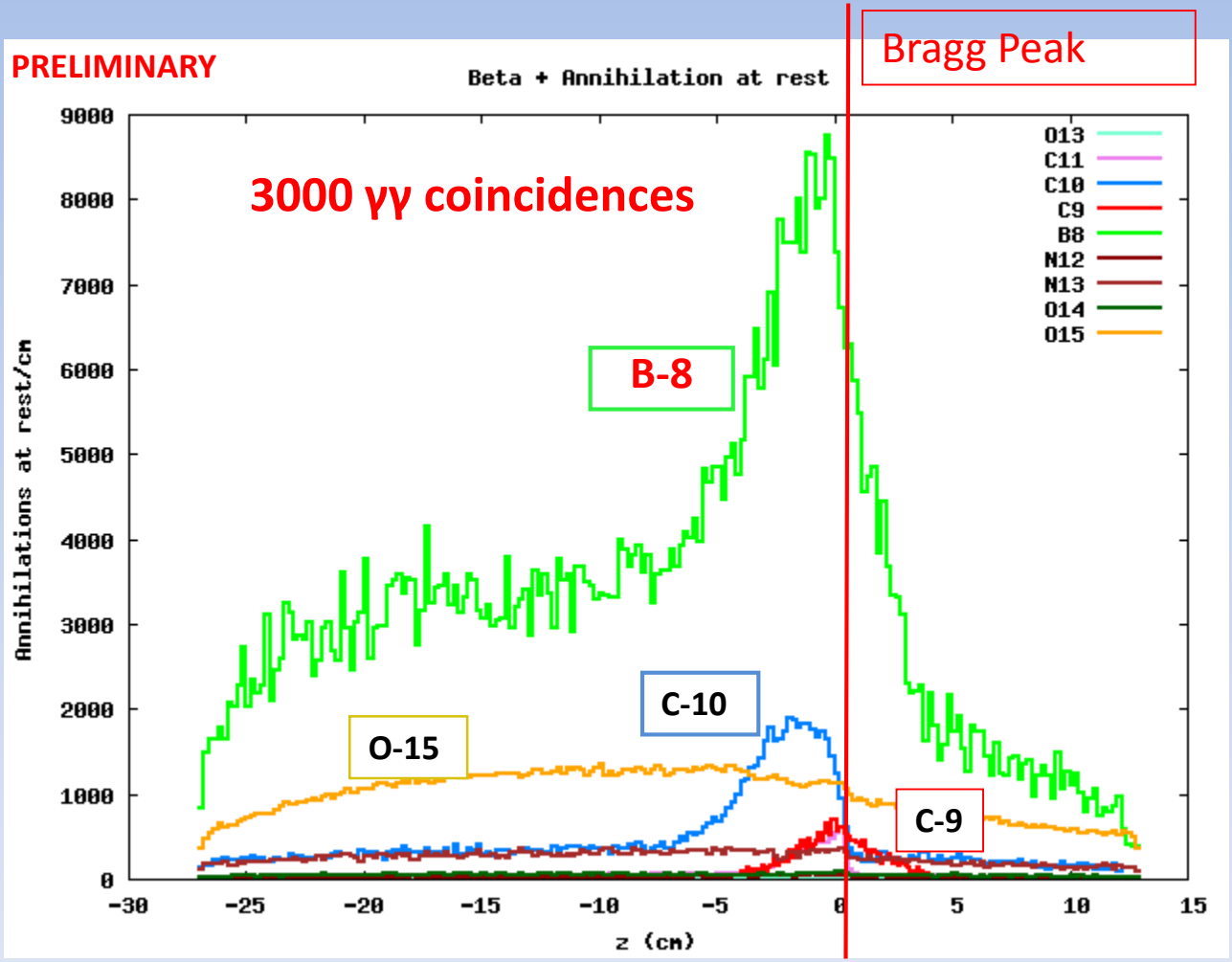
Results with C12





Results Analysis

Distribution of the decays along the beam direction with a PET system having overall efficiency = 2%



Conclusions

In a range verification run of 2 seconds the position of the

Bragg peak can be determined with an error
≤ ± 1 mm

Since the lifetime of B-8 is 1.12 s the technique can be applied also to cyclotrons and synchrotrons

In-beam PET measurements of the B-8 yield are needed

Thanks for your attention !

Coming together is a beginning
keeping together is progress
working together is success Henry Ford

References

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Fraction of nuclei per primary proton (p) from RESNUCLEI card
Carbon (^{12}C) beam with a *water* tank T 400MeV/u

	Nuclei/p	Error(%)	T1/2 (s)	Decay	Branching(%)	Qdec(MeV)
O-15	1.59E-01	0.050367	122.24	B+	99.9003	1.73217
O-14	4.48E-03	0.2336	70.606	B+	99.878	4.12204
O-13	2.72E-04	1.42	0.00858	B+P	100	14.80447
N-13	1.60E-02	0.1783	597.9	B+	99.8036	1.19847
N-12	1.51E-03	0.6207	0.011	B+	100	16.31607
C-11	1.14E-01	0.059217	1221.84	B+	99.7669	0.96041
C-10	1.22E-02	0.2792	19.29	B+	99.9671	2.62607
C-9	1.68E-03	0.3909	0.1265	B+	3.60998	15.47248
C-9	1.68E-03	0.3909	0.1265	B+A	34.7898	13.78517
C-9	1.68E-03	0.3909	0.1265	B+P	61.5997	15.65833
B-8	9.34E-03	0.2524	0.77	B+	99.552	16.95791
F-17	3.58E-04	1.184	64.49	B+	99.854	1.73847
Ne-10	1.00E-06	28.61	0.1092	B+P	100	12.92648
F-18	9.33E-04	0.7435	6586.2	B+	96.73	0.63393
Ne-18	5.55E-05	3.286	1.672	B+	99.9687	3.42251
Ne-19	1.03E-04	2.329	17.22	B+	99.8999	2.2175
Na-11	5.68E-06	8.929	0.4479	B+	79.9988	12.87054
Na-11	5.68E-06	8.929	0.4479	B+A	19.9997	8.14069
Mg-12	3.68E-07	47.38	0.0908	B+P	100	7.49564
Na-21	1.48E-05	6.337	22.49	B+	99.9019	2.52514
Mg-12	9.47E-07	26.12	0.122	B+	67.3963	12.07615
Mg-12	9.47E-07	26.12	0.122	B+P	32.5982	9.64448
Na-22	4.06E-05	4.77	82135000	B+	90.382	1.8212
Mg-12	6.05E-06	12.28	3.8755	B+	99.9183	3.75958
Mg-23	2.28E-05	4.185	11.317	B+	99.9215	3.03459