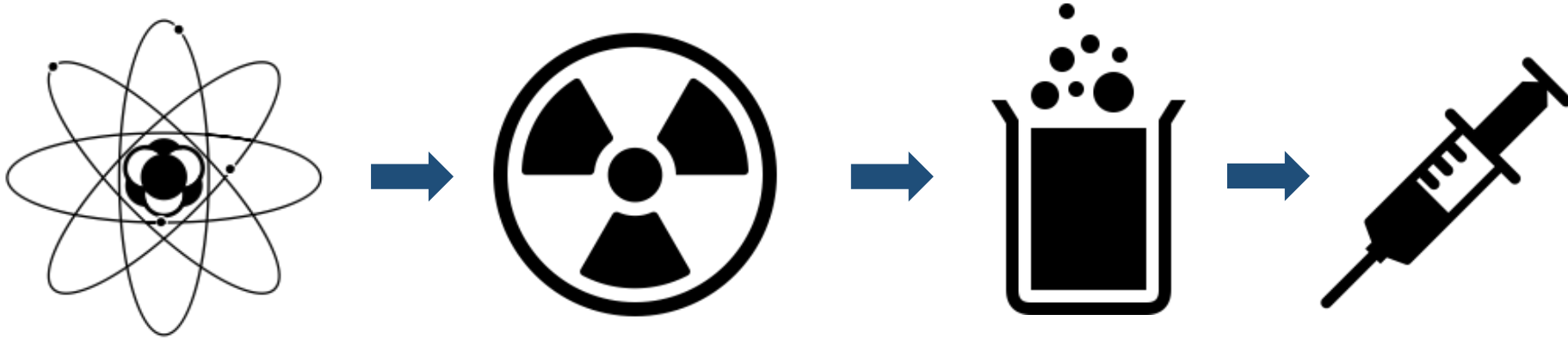


The ISOLPHARM project at INFN-LNL



Alberto Andrichetto
INFN Laboratori di Legnaro

The New SPES/ISOLPHARM Infrastructure



New Building:

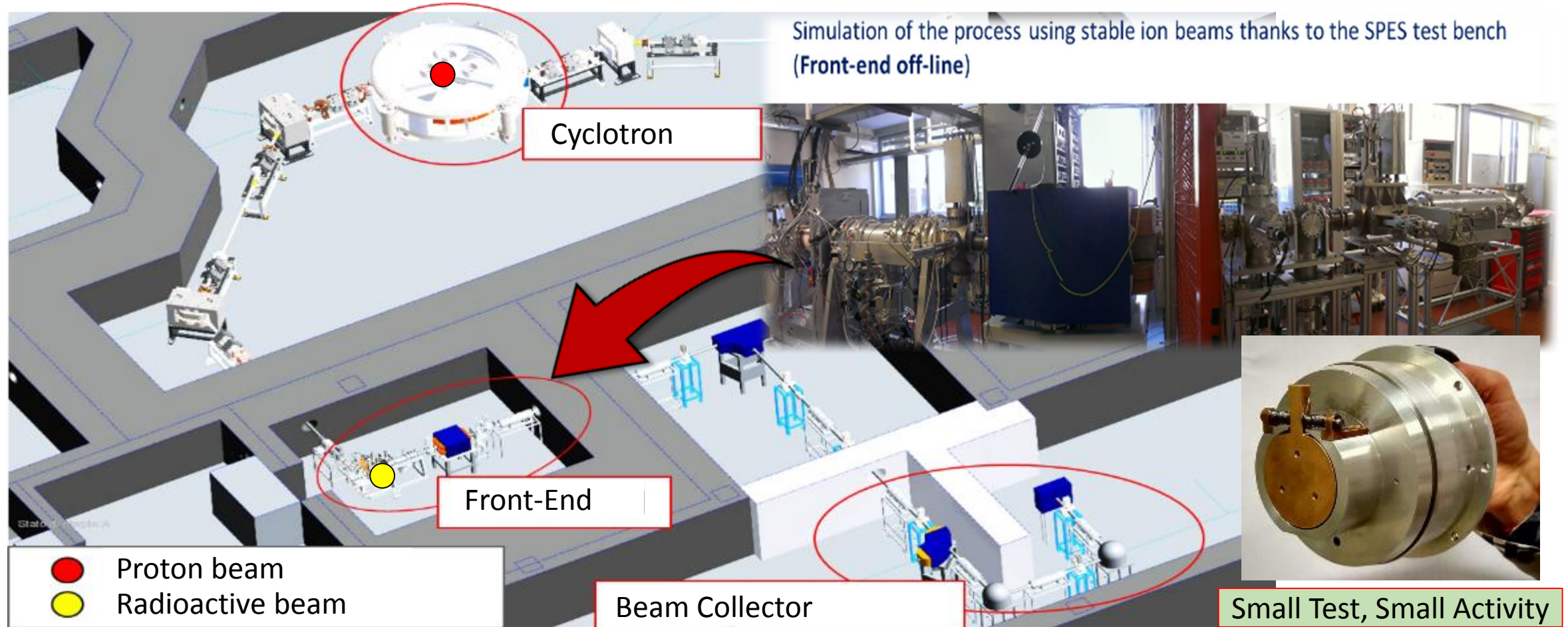
Project financed by INFN

- **Application Facility**
- Cyclotron
- RIB facility (2th generation ISOL)



ISOLPHARM set-up (Test Facility)

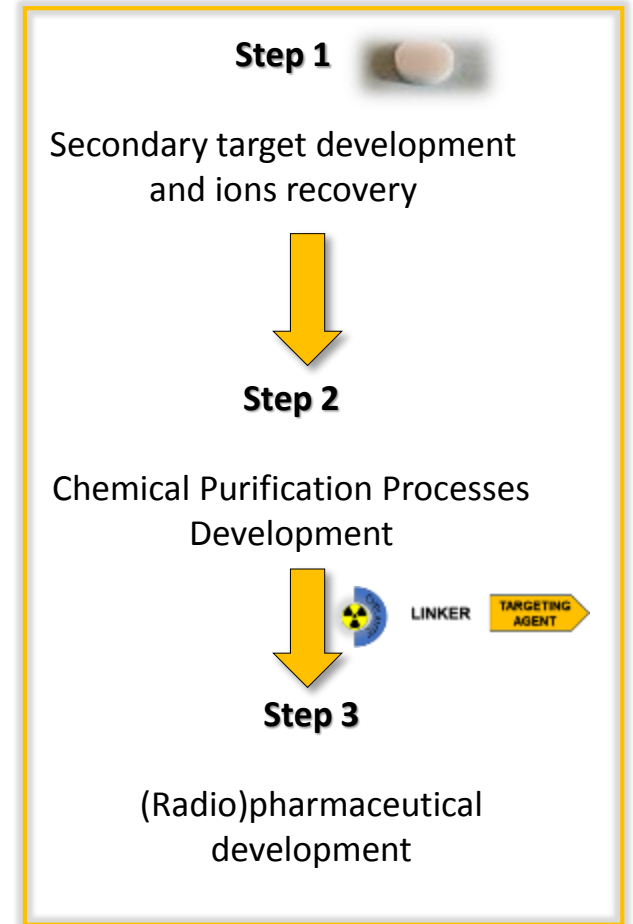
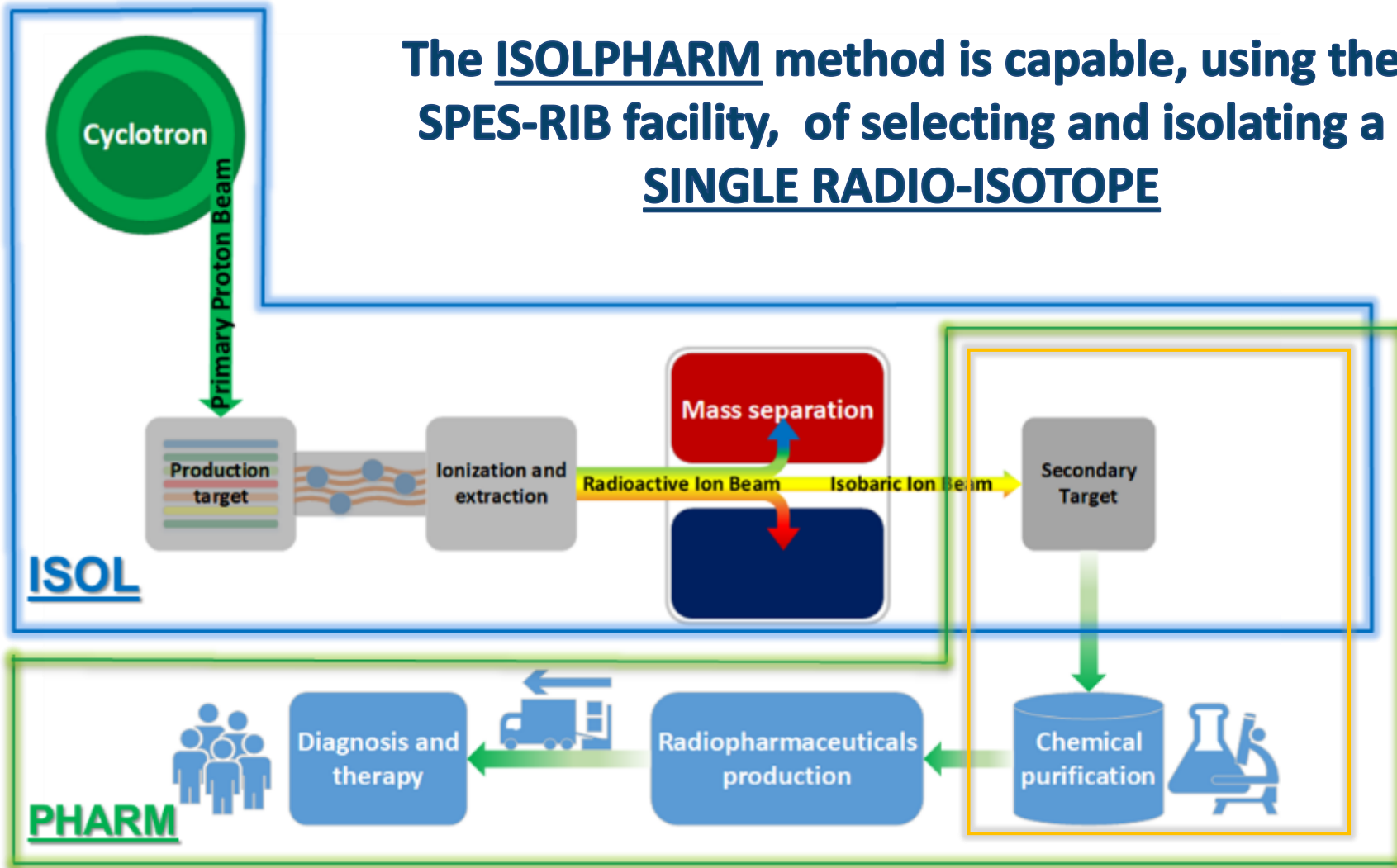
Starting Point: Some tens of mCi are sufficient to start a R&D on radiopharmaceuticals



low costs, easy set-up, possibility to 'parasitize' the beam...

The ISOLPHARM method

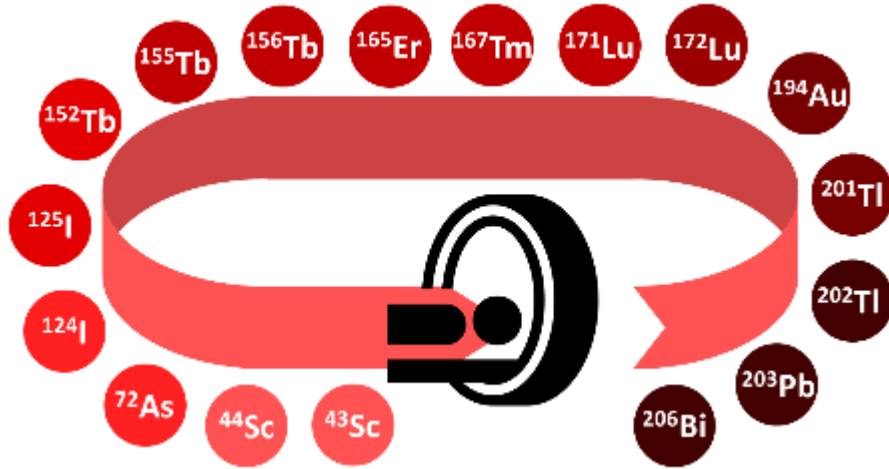
The ISOLPHARM method is capable, using the SPES-RIB facility, of selecting and isolating a SINGLE RADIO-ISOTOPE



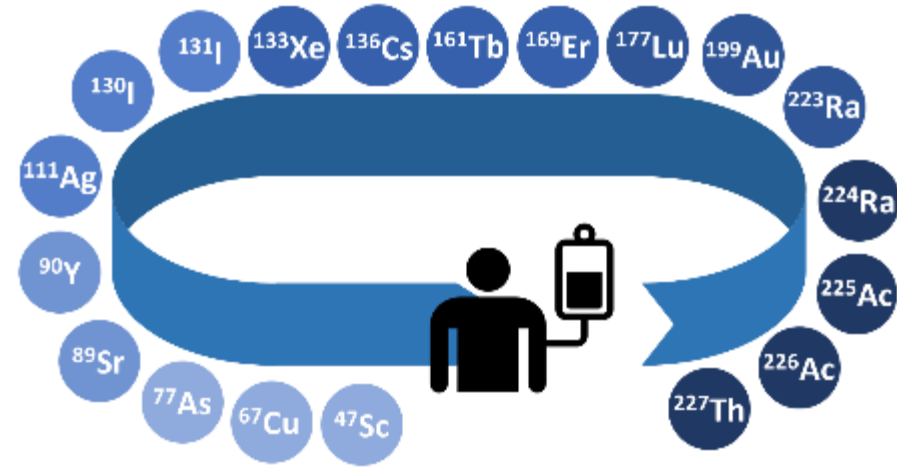
Flexible production, high specific activity & radionuclidic purity

Possible ISOL isotopes of medical interest

Diagnostic isotopes



Therapeutic isotopes



Theragnostic isotopes

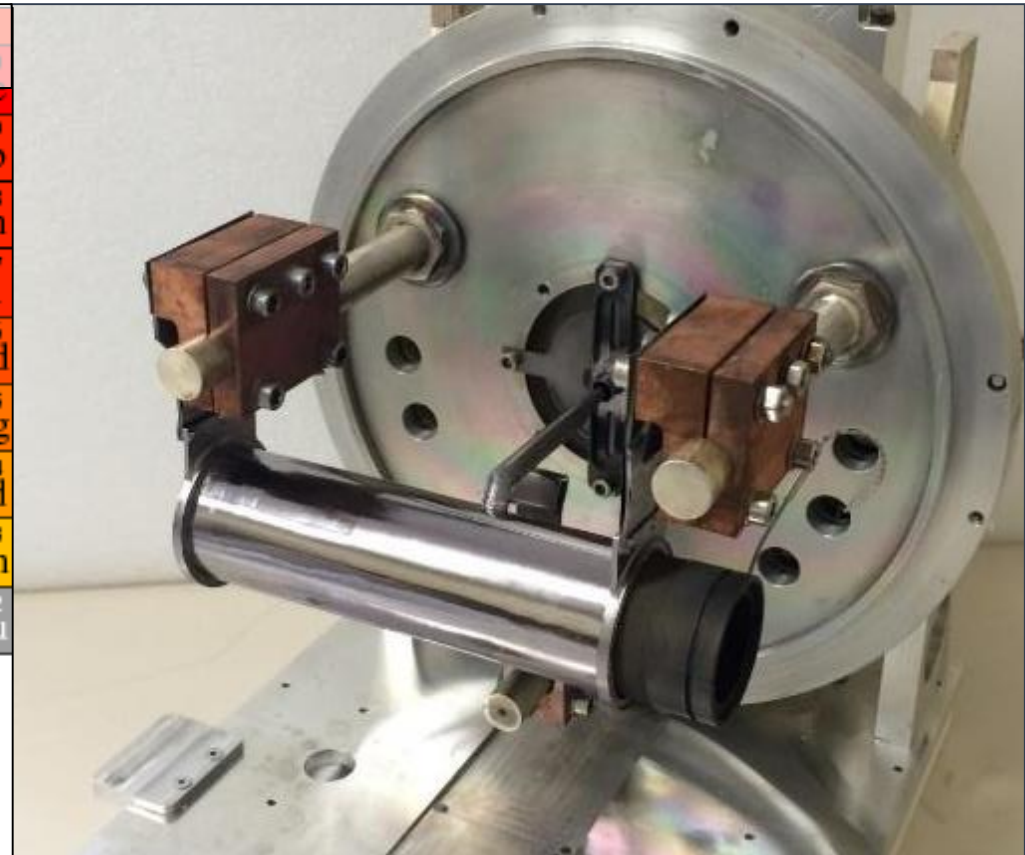


Among the wide set of **ISOL producible nuclides**, almost **60** show relevant properties for medicine, in terms of **half-life**, **decay radiation** and **chemical behavior**

Production target development: ^{111}Ag from UC_x

40 MeV 200 μA Proton beam on SPES UC_x target

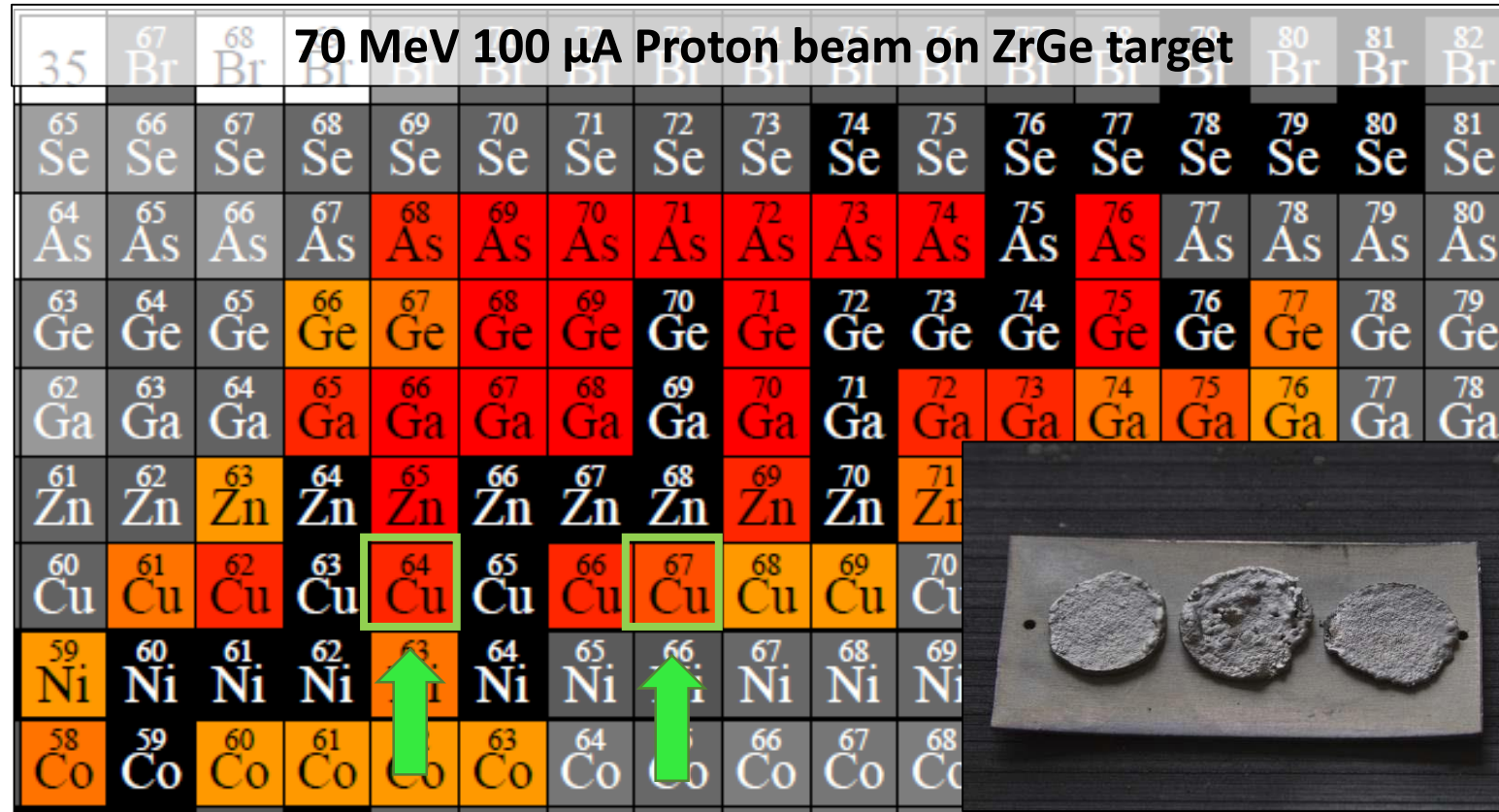
110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130		
Te	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	
109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	
Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	
108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	
Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	Sn	
107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	
In	In	In	In	In	In	In	In	In	In	In	In	In	In	In	In	In	In	In	In	In	In	
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	
Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	
105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	
Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	
104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	
Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	Pd	
103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	
Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	
102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	
Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru	Ru
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	
Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	Tc	
100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	
Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo	Mo
99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	
Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb	Nb



■	$> 10^{11}$	■	$10^9 - 10^{10}$	■	$10^7 - 10^8$	■	$10^5 - 10^6$	■	$10^3 - 10^4$	■	$10 - 10^2$
■	$10^{10} - 10^{11}$	■	$10^8 - 10^9$	■	$10^6 - 10^7$	■	$10^4 - 10^5$	■	$10^2 - 10^3$	■	< 10

[nuclide/s]

Production target development: ^{64}Cu and ^{67}Cu from ZrGe



Production target development: ^{43}Sc and ^{47}Sc from TiC

40 MeV 200 μA Proton beam on TiC target

		24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55			
	23	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V		
22	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti		
36	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc		
35	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca		
34	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K		
33	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	Ar	
32	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl
31	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	
30	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P



Production target development: ^{149}Tb , ^{152}Tb and ^{155}Tb from GdB_4

70 MeV 100 μA Proton beam on GdB_4 target

¹⁴⁹ Ho	¹⁵⁰ Ho	¹⁵¹ Ho	¹⁵² Ho	¹⁵³ Ho	¹⁵⁴ Ho	¹⁵⁵ Ho	¹⁵⁶ Ho	¹⁵⁷ Ho	¹⁵⁸ Ho	¹⁵⁹ Ho	¹⁶⁰ Ho	¹⁶¹ Ho	¹⁶² Ho	¹⁶³ Ho	¹⁶⁴ Ho
¹⁴⁸ Dy	¹⁴⁹ Dy	¹⁵⁰ Dy	¹⁵¹ Dy	¹⁵² Dy	¹⁵³ Dy	¹⁵⁴ Dy	¹⁵⁵ Dy	¹⁵⁶ Dy	¹⁵⁷ Dy	¹⁵⁸ Dy	¹⁵⁹ Dy	¹⁶⁰ Dy	¹⁶¹ Dy	¹⁶² Dy	¹⁶³ Dy
¹⁴⁷ Tb	¹⁴⁸ Tb	¹⁴⁹ Tb	¹⁵⁰ Tb	¹⁵¹ Tb	¹⁵² Tb	¹⁵³ Tb	¹⁵⁴ Tb	¹⁵⁵ Tb	¹⁵⁶ Tb	¹⁵⁷ Tb	¹⁵⁸ Tb	¹⁵⁹ Tb	¹⁶⁰ Tb	¹⁶¹ Tb	¹⁶² Tb
¹⁴⁶ Gd	¹⁴⁷ Gd	¹⁴⁸ Gd	¹⁴⁹ Gd	¹⁵⁰ Gd	¹⁵¹ Gd	¹⁵² Gd	¹⁵³ Gd	¹⁵⁴ Gd	¹⁵⁵ Gd	¹⁵⁶ Gd	¹⁵⁷ Gd	¹⁵⁸ Gd	¹⁵⁹ Gd	¹⁶⁰ Gd	¹⁶¹ Gd
¹⁴⁵ Eu	¹⁴⁶ Eu	¹⁴⁷ Eu	¹⁴⁸ Eu	¹⁴⁹ Eu	¹⁵⁰ Eu	¹⁵¹ Eu	¹⁵² Eu	¹⁵³ Eu	¹⁵⁴ Eu	¹⁵⁵ Eu	¹⁵⁶ Eu	¹⁵⁷ Eu	¹⁵⁸ Eu	¹⁵⁹ Eu	¹⁶⁰ Eu
¹⁴⁴ Sm	¹⁴⁵ Sm	¹⁴⁶ Sm	¹⁴⁷ Sm	¹⁴⁸ Sm	¹⁴⁹ Sm	¹⁵⁰ Sm	¹⁵¹ Sm	¹⁵² Sm	¹⁵³ Sm	¹⁵⁴ Sm	¹⁵⁵ Sm	¹⁵⁶ Sm	¹⁵⁷ Sm	¹⁵⁸ Sm	¹⁵⁹ Sm
¹⁴³ Pm	¹⁴⁴ Pm	¹⁴⁵ Pm	¹⁴⁶ Pm	¹⁴⁷ Pm	¹⁴⁸ Pm	¹⁴⁹ Pm	¹⁵⁰ Pm	¹⁵¹ Pm	¹⁵² Pm	¹⁵³ Pm	¹⁵⁴ Pm	¹⁵⁵ Pm	¹⁵⁶ Pm	¹⁵⁷ Pm	¹⁵⁸ Pm
¹⁴² Nd	¹⁴³ Nd	¹⁴⁴ Nd	¹⁴⁵ Nd	¹⁴⁶ Nd	¹⁴⁷ Nd	¹⁴⁸ Nd	¹⁴⁹ Nd	¹⁵⁰ Nd	¹⁵¹ Nd	¹⁵² Nd	¹⁵³ Nd	¹⁵⁴ Nd	¹⁵⁵ Nd	¹⁵⁶ Nd	¹⁵⁷ Nd
¹⁴¹ Pr	¹⁴² Pr	¹⁴³ Pr	¹⁴⁴ Pr	¹⁴⁵ Pr	¹⁴⁶ Pr	¹⁴⁷ Pr	¹⁴⁸ Pr	¹⁴⁹ Pr	¹⁵⁰ Pr	¹⁵¹ Pr	¹⁵² Pr	¹⁵³ Pr	¹⁵⁴ Pr	¹⁵⁵ Pr	¹⁵⁶ Pr



Summary







	TiC/TiB ₂ target, 40MeV 200 μA p ⁺ beam						ZrGe target, 70MeV 100 μA p ⁺ beam					
	⁴³ Sc			⁴⁷ Sc			⁶⁴ Cu			⁶⁷ Cu		
Time	Activity		Nuclei	Activity		Nuclei	Activity		Nuclei	Activity		Nuclei
[days]	[Bq]	[Ci]	[#]	[Bq]	[Ci]	[#]	[Bq]	[Ci]	[#]	[Bq]	[mCi]	[#]
0.5	5.70E+10	1.54	1.15E+15	2.48E+10	0.67	1.04E+16	2.66E+10	0.72	1.75E+15	2.37E+08	6.40	7.61E+13
1	6.37E+10	1.72	1.29E+15	4.72E+10	1.28	1.97E+16	4.03E+10	1.09	2.66E+15	4.44E+08	11.99	1.43E+14
1.5	6.45E+10	1.74	1.30E+15	6.74E+10	1.82	2.81E+16	4.75E+10	1.28	3.13E+15	6.24E+08	16.87	2.01E+14
2	6.46E+10	1.75	1.30E+15	8.56E+10	2.31	3.57E+16	5.12E+10	1.38	3.38E+15	7.82E+08	21.15	2.52E+14
3	6.46E+10	1.75	1.31E+15	1.17E+11	3.16	4.87E+16	5.42E+10	1.46	3.57E+15	1.04E+09	28.14	3.35E+14
4	6.46E+10	1.75	1.31E+15	1.42E+11	3.84	5.93E+16	5.50E+10	1.49	3.62E+15	1.24E+09	33.49	3.99E+14
5	6.46E+10	1.75	1.31E+15	1.63E+11	4.40	6.78E+16	5.52E+10	1.49	3.64E+15	1.39E+09	37.58	4.47E+14
	SPES UC _x target			GdB ₄ target, 70 MeV 100 μA p ⁺ beam								
	¹¹¹ Ag			¹⁴⁹ Tb			¹⁵² Tb			¹⁵⁵ Tb		
Time	Activity		Nuclei	Activity		Nuclei	Activity		Nuclei	Activity		Nuclei
[days]	[Bq]	[Ci]	[Nuclei]	[Bq]	[Ci]	[#]	[Bq]	[Ci]	[#]	[Bq]	[Ci]	[#]
0.5	9.46E+09	0.26	8.78E+15	3.16E+10	0.85	6.76E+14	4.26E+11	11.51	3.87E+16	1.43E+11	3.86	9.48E+16
1	1.92E+10	0.52	1.78E+16	3.58E+10	0.97	7.67E+14	6.92E+11	18.70	6.29E+16	2.77E+11	7.49	1.84E+17
1.5	2.85E+10	0.77	2.65E+16	3.64E+10	0.98	7.79E+14	8.57E+11	23.17	7.79E+16	4.02E+11	10.88	2.67E+17
2	3.74E+10	1.01	3.47E+16	3.65E+10	0.99	7.80E+14	9.60E+11	25.95	8.73E+16	5.20E+11	14.06	3.45E+17
3	5.40E+10	1.46	5.02E+16	3.65E+10	0.99	7.81E+14	1.06E+12	28.75	9.67E+16	7.33E+11	19.82	4.86E+17
4	6.92E+10	1.87	6.42E+16	3.65E+10	0.99	7.81E+14	1.10E+12	29.83	1.00E+17	9.21E+11	24.89	6.11E+17
5	8.29E+10	2.24	7.70E+16	3.65E+10	0.99	7.81E+14	1.12E+12	30.25	1.02E+17	1.09E+12	29.33	7.20E+17

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 Istituto Nazionale di Fisica Nucleare
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