TEXAS A&M UNIVERSITY
Cyclotron Institute

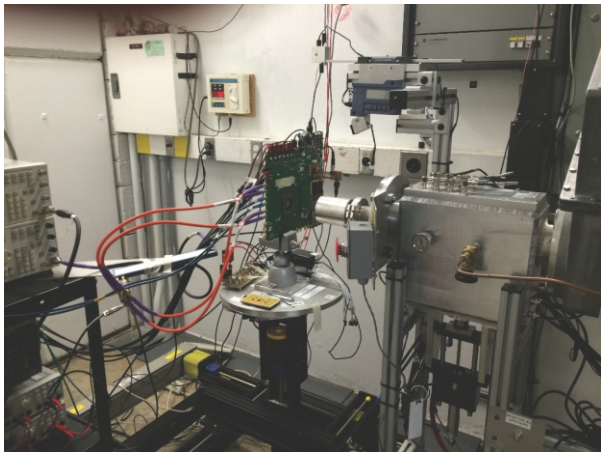
Radiation Effects Facility

cyclotron.tamu.edu/ref 979.845.1411

The Cyclotron Institute's Radiation Effects Facility provides a convenient and affordable solution to commercial, governmental and educational customers in need of studying, testing and simulating the effects of ionizing radiation on electronic and biological systems. The facility features a dedicated beam line with diagnostic equipment for complete dosimetry analysis and beam quality assurance. A beam energy degrader system allows for a change of linear energy transfer (LET) without cyclotron re-tuning or target rotations. As a part of the Cyclotron Institute the facility is fully staffed, and includes electronic and machine shops that are readily available for customer assistance.

The Cyclotron Institute's K500 superconducting cyclotron in combination with an advanced ECR ion source allows for the acceleration of ions to energies as high as 60 MeV per nucleon. Featured at the facility is a set of 15 MeV/u ion beams. These beams provide a broad LET range of 1 to 93 MeV•cm^2/mg in silicon at normal incidence and allow for quick ion changes. For greater range needs, two sets of higher-energy beams (24.8 MeV/u and 40 MeV/u) are also available.

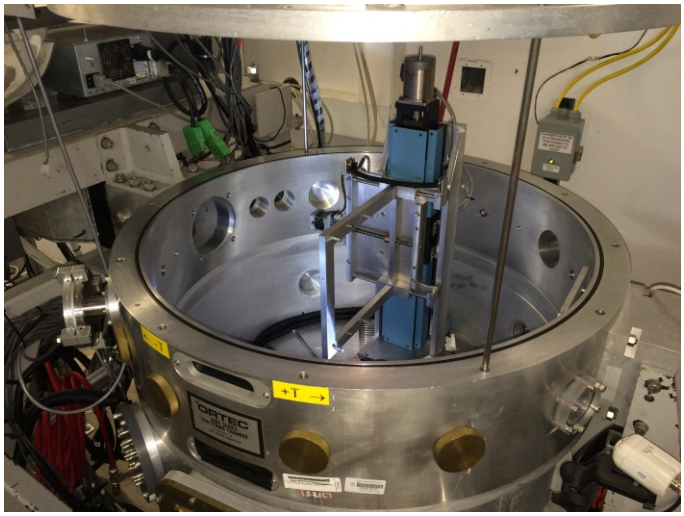
In-Air Test Station



With our high-energy beams it is possible to conduct testing in air. An in-air test station is installed at the end of our dedicated beam line. The station consists of a 10” x 10” removable mounting frame attached to a 15” diameter platter capable of supporting up to 40 lbs. Positioning in x, y, and z directions in addition to rotations in the plane of the target (θ) and about a vertical axis (φ) are computer controlled. In most cases targets may be positioned as close as one centimeter from the beam exit window. Target position verification is provided by the means of a CCD camera aligned with the beam path. The in-air test station offers several advantages compared to vacuum-chamber testing. These advantages include quick setup changes, shorter cabling with no vacuum feed-throughs, and ease of heating and cooling.

Vacuum Test Chamber

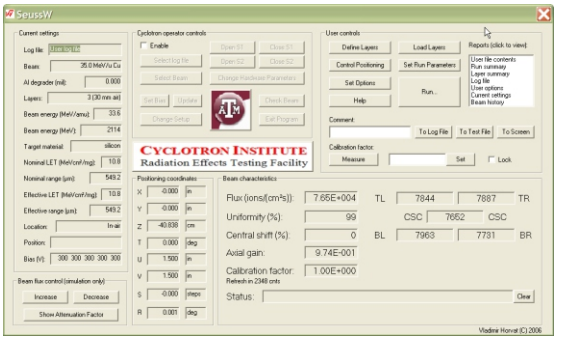
A vacuum chamber is also available for radiation testing. The chamber has an inside diameter of 30” and a height of 30”. Inside the chamber is a target mounting fixture measuring 10” x 10”. Movement of the frame in x, y, z, and θ directions is computer controlled. Pumping time to an operating pressure in the low 10^{-4} Torr range is approximately ten minutes, while the chamber vents in two and a half minutes. Target position verification is provided by means of a CCD camera aligned with the beam path. The size of the exposed area (up to 1.5” x 1.5”) is controlled by a pair of remotely adjustable horizontal and vertical slits. Five 50-pin hermetically sealed D-shell male connectors and 19 BNC connectors are provided for communication with the devices under test.



Please visit our website at **cyclotron.tamu.edu/ref** for more information.

Dosimetry and Beam Quality

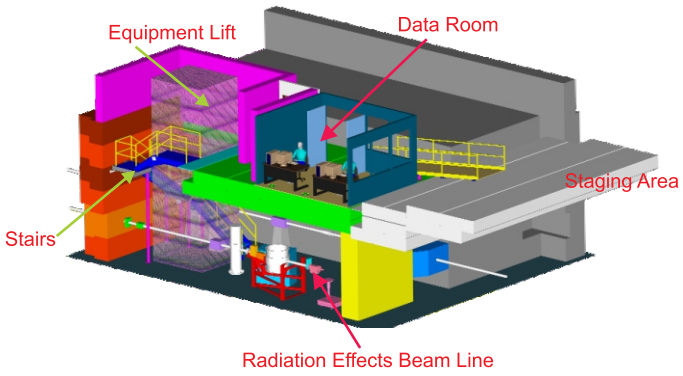
Beam uniformity and dosimetry are determined using an array of five detectors comprised of plastic scintillators coupled to photo-multiplier tubes. These detectors are located in the diagnostic chamber adjacent to and upstream from the target. The control software determines beam uniformity, axial gain, and beam flux (in particles/cm^2•s) based on detector count rates. The results are displayed and updated once every second. Beam exposure can be limited to a certain amount of time, limited to total fluence, stopped by an external signal, or stopped manually. A demo version of the control software (SeussW) can be downloaded from our website (http://cyclotron.tamu.edu/ref).



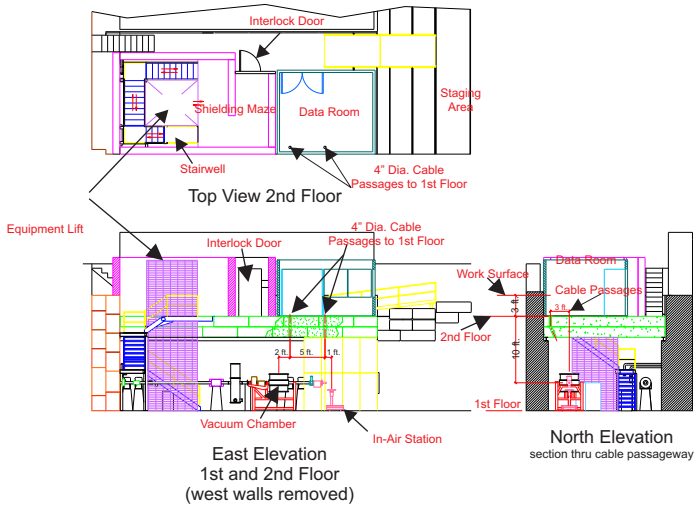
Screen capture of SeussW software.

Testing at our Facility

Staging Area and Data Room.



Close-up view of Data Room.



The Radiation Effects Facility is located on a dedicated beam line within the Cyclotron Institute building. A climate-controled data room is situated directly above the beam line area. This has been designed so that the required cable lengths between the data room and the beam line area can be as short as16-feet. A staging area located directly outside of the data room includes tables and work benches for test preparation and set-up. Both the staging area and the data room are wired for internet access. For your convenience, a coffee maker, full-sized refrigerator, and microwave oven are provided. Users' equipment can be transferred to the beam line area using a lift that is located in the stairwell descending to the beam line area and is easily accessible immediately outside of the data room.

For beam-time scheduling and for current rates please contact Dr. Henry Clark.

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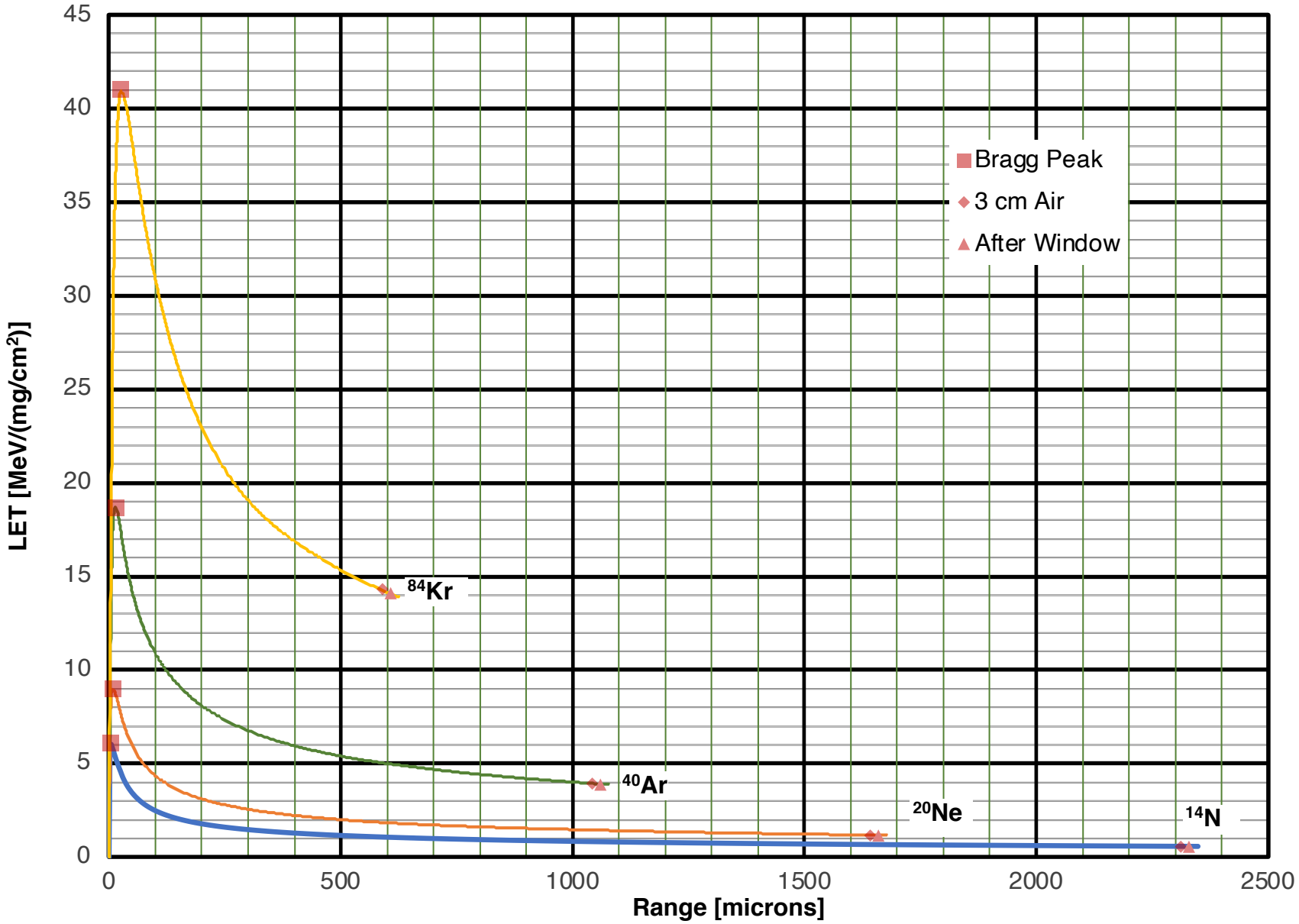
LET vs Range in Silicon for K500 40 MeV/u Beams



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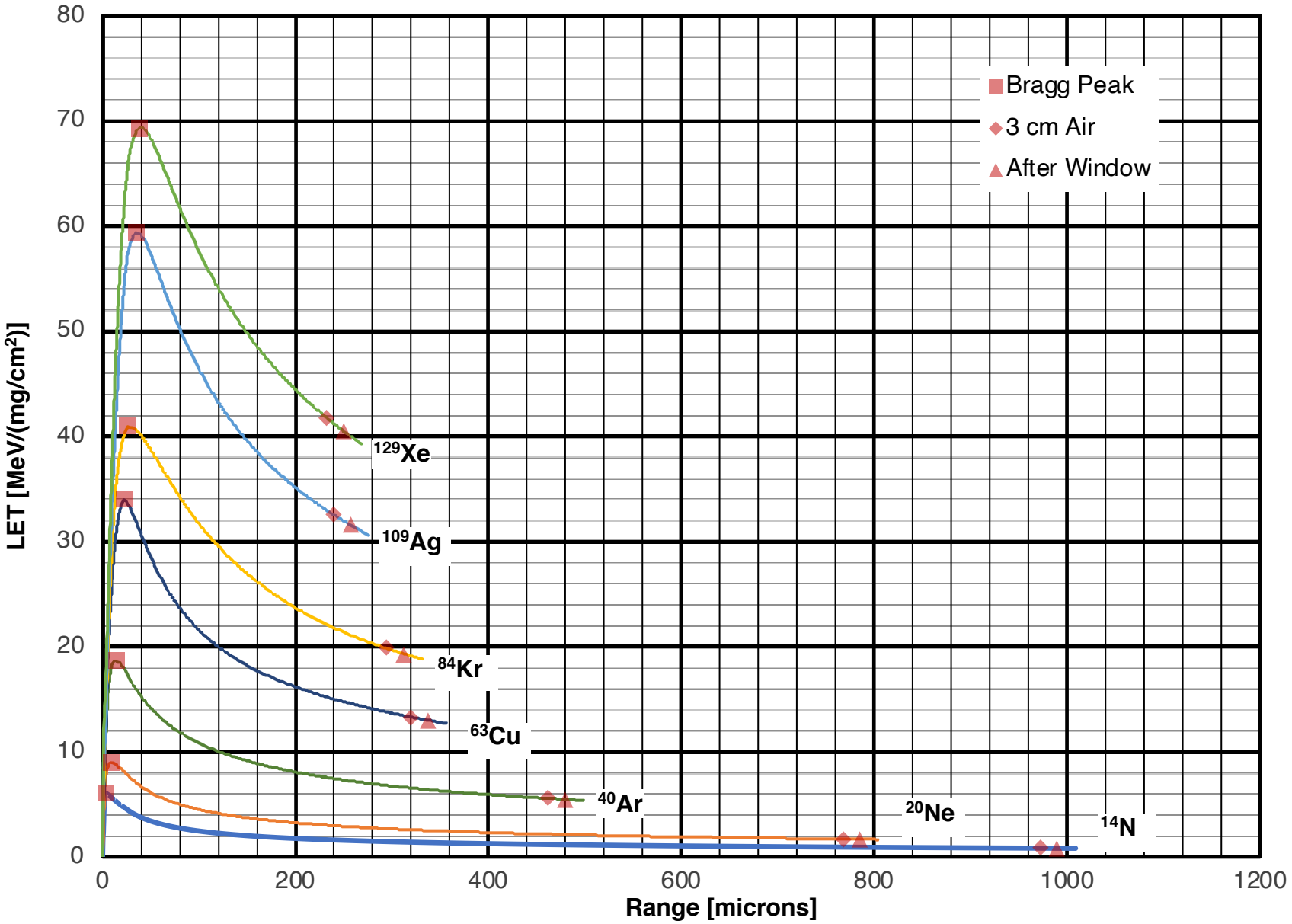
LET vs Range in Silicon for K500 24.8 MeV/u Beams



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Available K500 Heavy Ion Beams

(LET and range values are for Si)

	Ion	Mass [amu]	A MeV	Total Energy [MeV]	Energy at Bragg Peak [MeV]	Range to Bragg Peak [microns]	Range in vacuum [microns]	LET in vacuum [MeV/(mg/cm2)]	Range after window [microns]	LET after window [MeV/(mg/cm^2)]	Range after 3 cm air [microns]	LET after 3 cm air [MeV/(mg/cm2)]	Range at Bragg [microns]	LET at Bragg Peak [MeV/(mg/cm2)]
15 A MeV	^{4}He	4.003	15	60	0.5	1446.9	1449.2	0.10	1430	0.10	1412	0.10	2.3	1.5
	^{14}N	14.003	15	210	4	418.0	421.7	1.3	403	1.3	385	1.3	3.7	6.1
	^{20}Ne	19.992	15	300	14	302.9	311.3	2.5	292	2.6	274	2.7	8.4	9.0
	^{40}Ar	39.962	15	599	45	217.5	231.0	7.6	212	7.9	194	8.2	13.5	18.7
	^{63}Cu	62.930	15	944	130	151.7	174.4	17.1	155	18.0	137	18.9	22.7	34.0
	^{84}Kr	83.912	15	1259	180	142.0	168.0	25.7	149	27.0	131	28.6	26.0	41.0
	^{109}Ag	108.905	15	1634	351	112.9	148.5	40.0	130	42.3	111	44.9	35.6	59.4
	^{129}Xe	128.905	15	1934	451	107.0	145.5	50.4	126	53.1	108	56.1	38.5	69.3
	^{141}Pr	140.908	15	2114	651	99.2	154.8	55.8	135	58.4	117	61.3	55.6	70.8
	^{165}Ho	164.930	15	2474	699	102.4	150.8	67.0	132	69.6	114	72.4	48.4	82.3
	^{181}Ta	180.948	15	2714	698	110.9	158.9	70.0	140	72.3	122	74.8	48.0	87.7
	^{197}Au	196.967	15	2954	800	107.6	158.7	77.9	140	80.5	121	83.3	51.1	94.4
25 A MeV	^{4}He	4.003	24.8	99	0.5	3520.5	3523.0	0.07	3504	0.07	3486	0.07	2.3	1.5
	^{14}N	14.003	24.8	347	4	1004.9	1008.6	0.8	990	0.9	972	0.9	3.7	6.1
	^{22}Ne	21.991	24.8	545	16	794.8	804.2	1.7	785	1.7	768	1.7	9.4	9.0
	^{40}Ar	39.962	24.8	991	45	485.2	498.7	5.4	480	5.5	462	5.6	13.5	18.7
	^{63}Cu	62.930	24.8	1561	130	333.9	356.6	12.7	338	13.0	320	13.3	22.7	34.0
	^{84}Kr	83.912	24.8	2081	180	305.3	331.3	18.9	312	19.3	295	19.9	26.0	41.0
	^{107}Ag	106.905	24.8	2651	351	240.5	275.9	30.7	257	31.6	239	32.6	35.4	59.4
	^{129}Xe	128.905	24.8	3197	451	230.3	268.7	39.3	250	40.5	232	41.8	38.4	69.3
40 A MeV	^{14}N	14.003	40	560	4	2345.1	2348.7	0.6	2330	0.6	2312	0.6	3.6	6.1
	^{20}Ne	19.992	40	800	14	1670.4	1678.9	1.2	1660	1.2	1642	1.2	8.1	9.0
	^{40}Ar	39.962	40	1598	45	1064.7	1078.2	3.9	1060	3.9	1042	3.9	13.5	18.7
	^{78}Kr	77.920	40	3117	170	602.4	626.9	13.9	608	14.1	590	14.3	24.5	41.0

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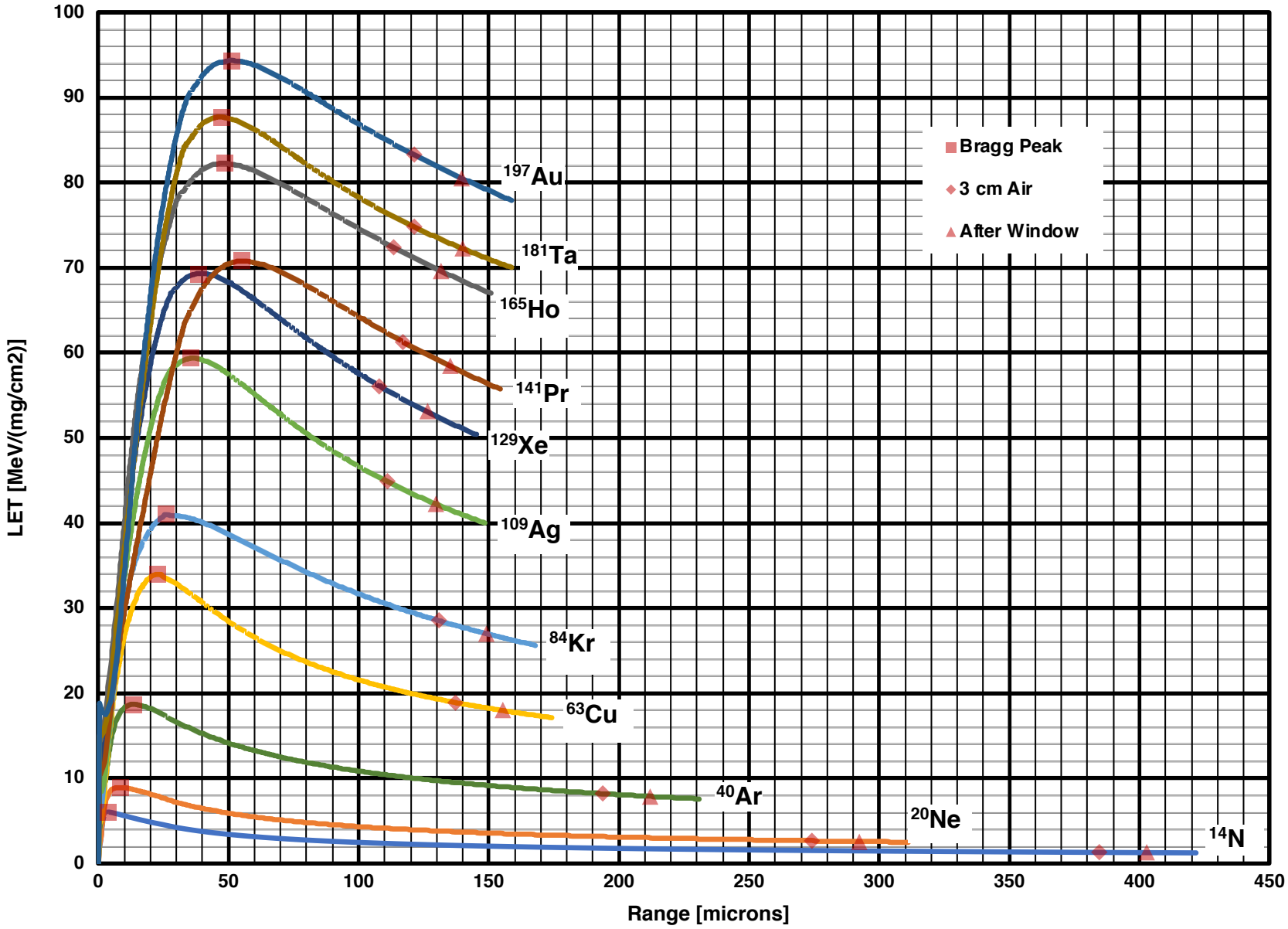

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