

Can we harvest isotopes with FRIB?

Daniel Votaw

PHY 802

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Bottom line: Yes.

Why do we need various isotopes?

- ▶ Radioactive sources for calibrations/experiments in nuclear physics.
- ▶ Imaging (PET scan).
- ▶ Radiotherapy, radioactive tracers, other medical uses. [1]
- ▶ Food irradiation.
- ▶ Environmental science.
- ▶ “Designer nuclei.” [2]

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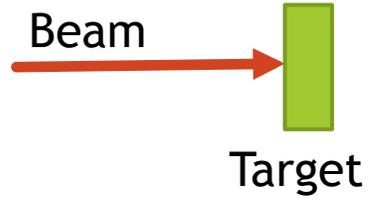
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But what about the ones we can't find in nature?

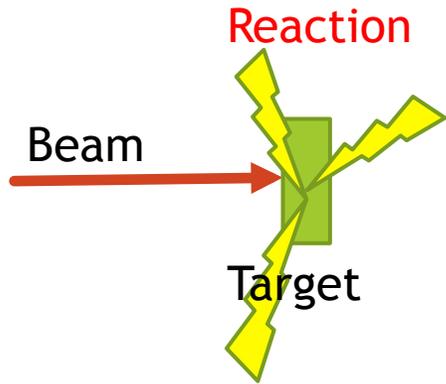
Examples of useful isotopes:

- ▶ Beryllium-7 (radioactive tracer used to study sediment deposition) [4].
- ▶ Silicon-32 (radioactive dating from ~ 100 - 1000 years) [5].
- ▶ Copper-67 (radioactive isotope used in cancer treatment) [1].
- ▶ Terbium-149 (used for cancer treatment, discussed in class).

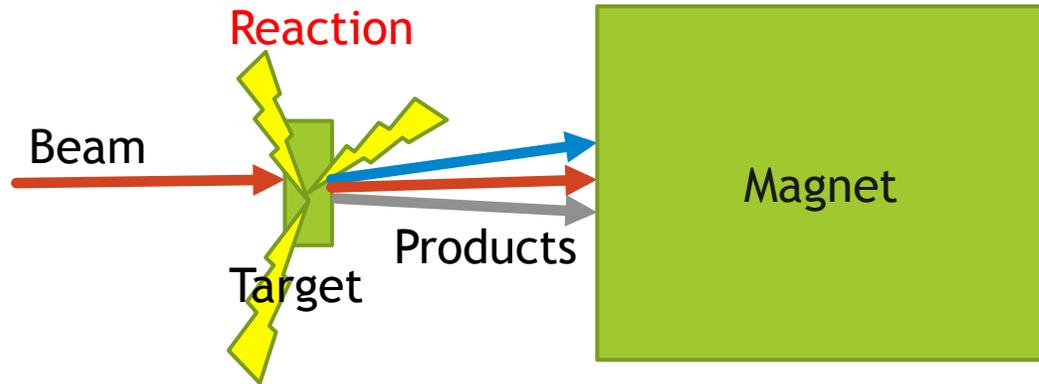
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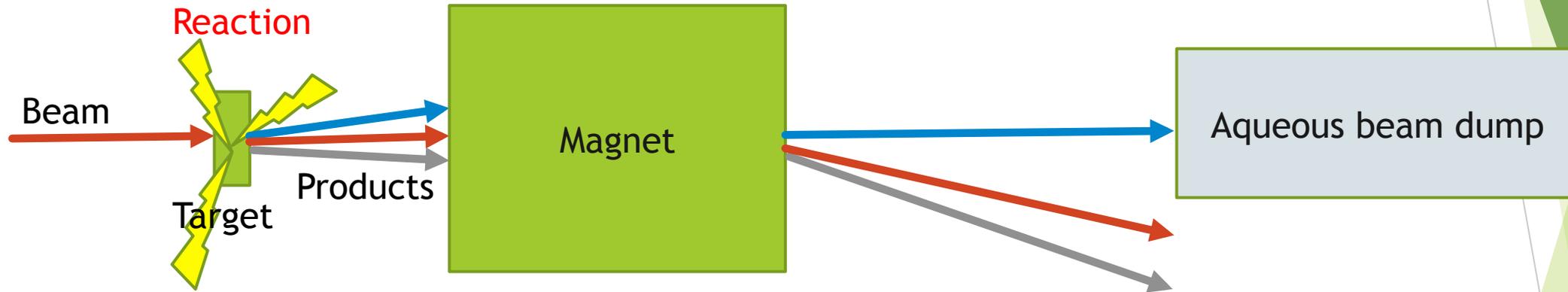
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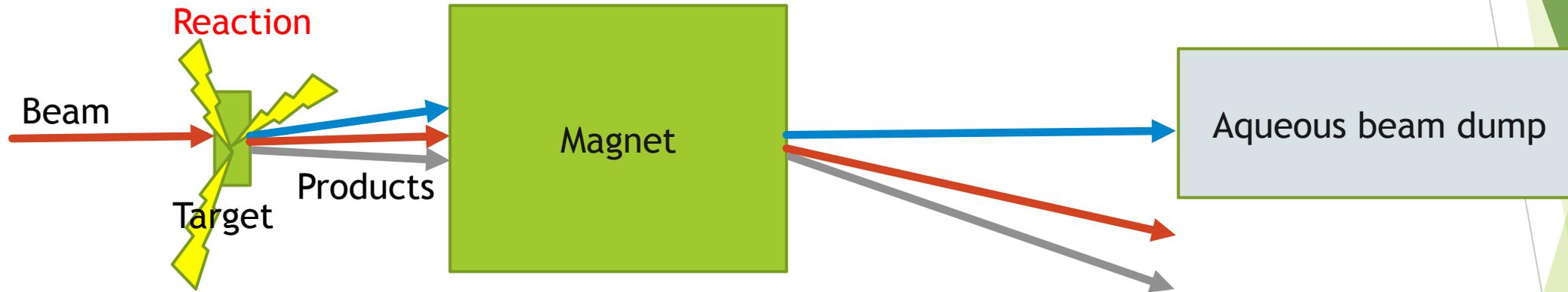
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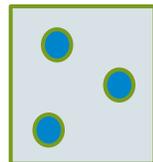
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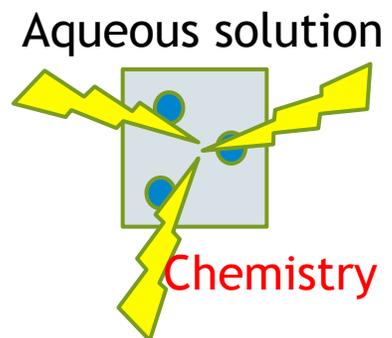
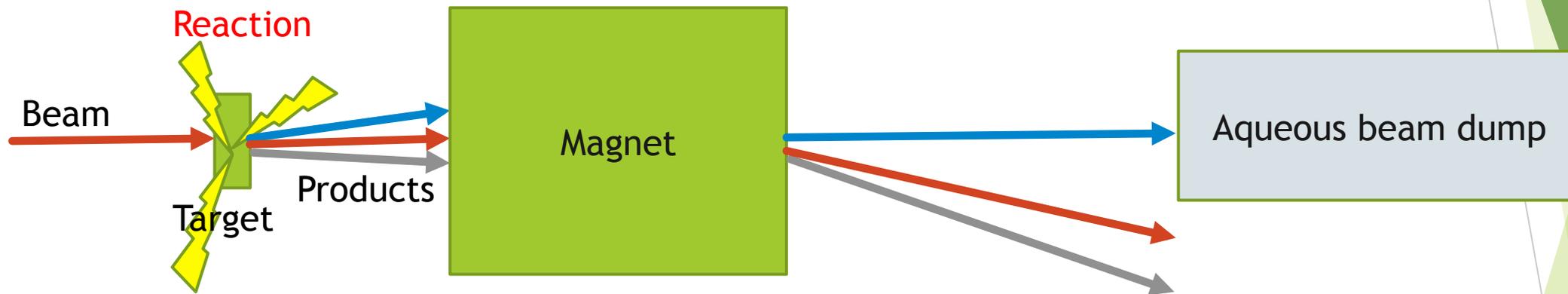
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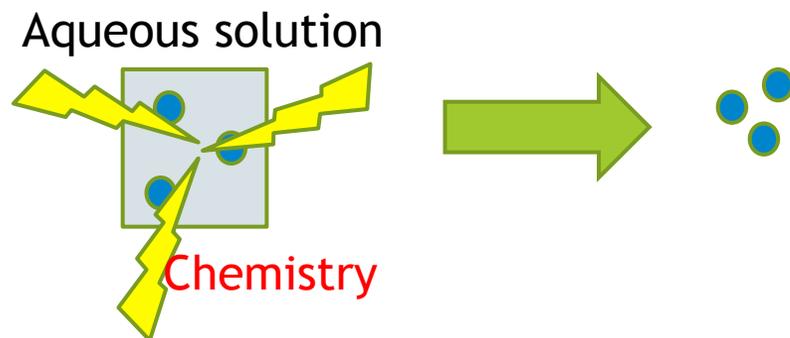
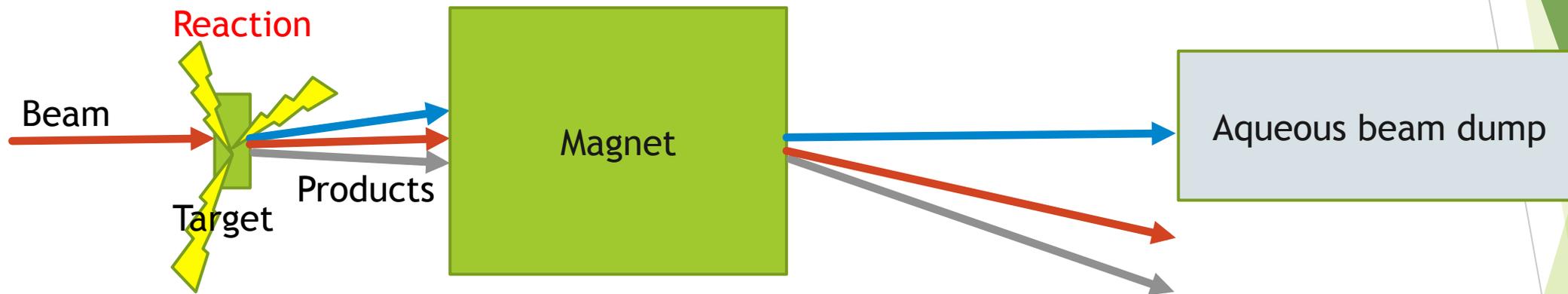
Aqueous solution



How to create ●:



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Results (from 2014 [1]):

- ▶ Beam: ^{76}Ge , 130 MeV/u, 25 pA.
- ▶ Target: Beryllium, $\sim 510 \text{ mg/cm}^2$.
- ▶ Magnet: A1900 fragment separator.
- ▶ Isotope of interest: ^{67}Cu (radioisotope of medical interest).
- ▶ Extraction efficiency: $\sim 88\%$.
- ▶ Radiochemical yield: $\geq 95\%$.

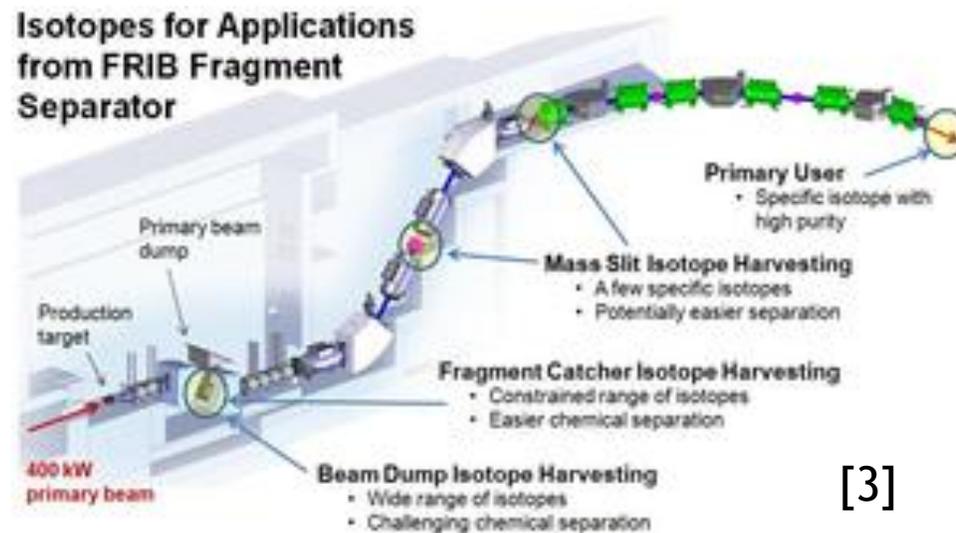
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- ▶ It has been shown that isotopes can be harvested using existing technology at NSCL.

What about FRIB?

- ▶ There have been workshops in recent years (2010, 2012, 2014) about harvesting isotopes with FRIB. There is a lot of interest in the nuclear science community.
- ▶ “FRIB will access to the full spectrum of known, important radioisotopes, such as ^7Be , ^8Li , ^{11}Be , ^{32}Si , and many others. More importantly, FRIB can enable future advances in the applied sciences by providing scientists access to thousands of radioactive isotopes that are not normally available.” [3]



[3]

What about FRIB?

- ▶ There is another workshop this summer.
- ▶ Stay tuned!

Citations:

- [1] Feasibility of Isotope Harvesting at a Projectile Fragmentation Facility: ^{67}Cu .
T. Mastren, et. al. DOI: 10.1038/srep06706
- [2] Challenges in nuclear structure theory.
W. Nazarewicz. 2016 J. Phys. G: Nucl. Part. Phys. 43 044002
- [3] <http://www.frib.msu.edu/content/isotope-harvesting-workshop-msu>
Georg Bollen.
- [4] <http://www.ncbi.nlm.nih.gov/pubmed/11347601>
S. A. Fitzgerald, et. al.

Citations:

[5] <http://www.sciencedirect.com/science/article/pii/S187110140900017X>

L. K. Fifield.