Isotope Needs for ATLAS Operations and CARIBU

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Workshop on The Nation's Needs for Isotopes: Present and Future

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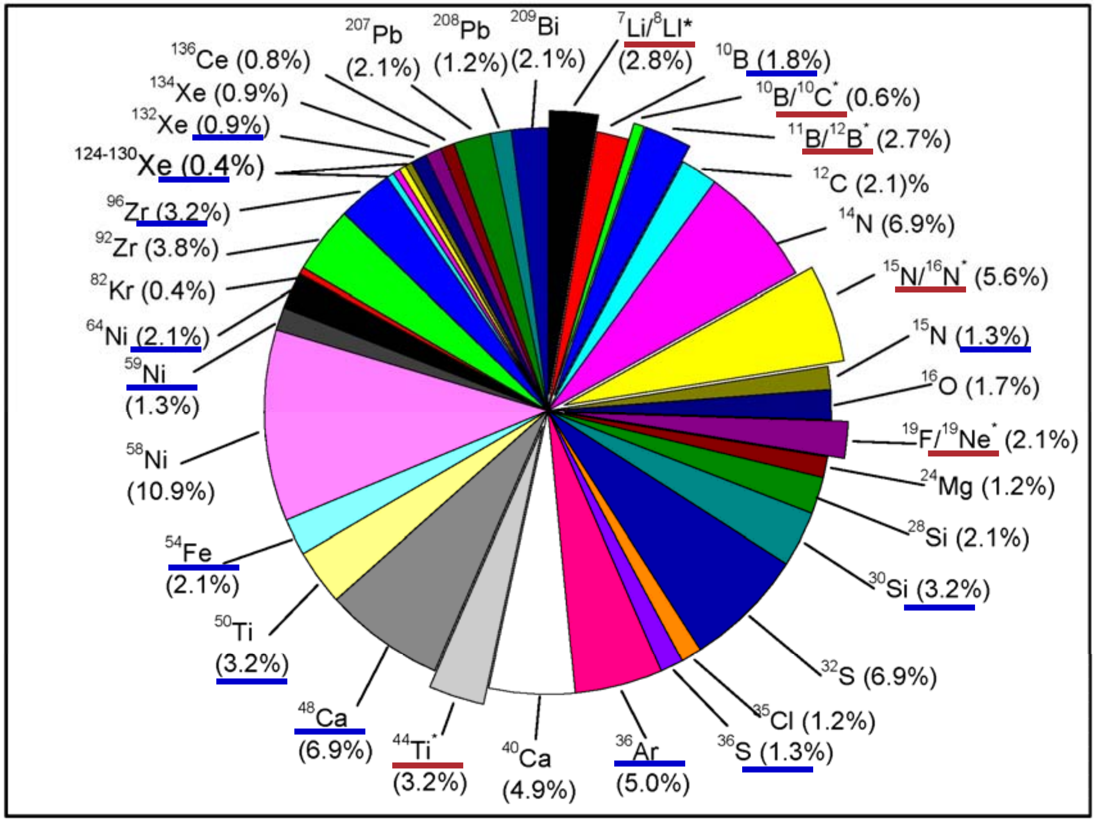
Exploring Nuclear Matter - Quarks to Stars

Present ATLAS Operation

- ATLAS typically provides beams of 30-40 different isotopes each year.
- In FY06, 17% of ATLAS research was with radioactive beams
- Mostly short-lived RIBs made in-flight from stable beam.
- High intensity stable beams often need enriched stable isotopes for ion source.

ATLAS Beams for FY2006

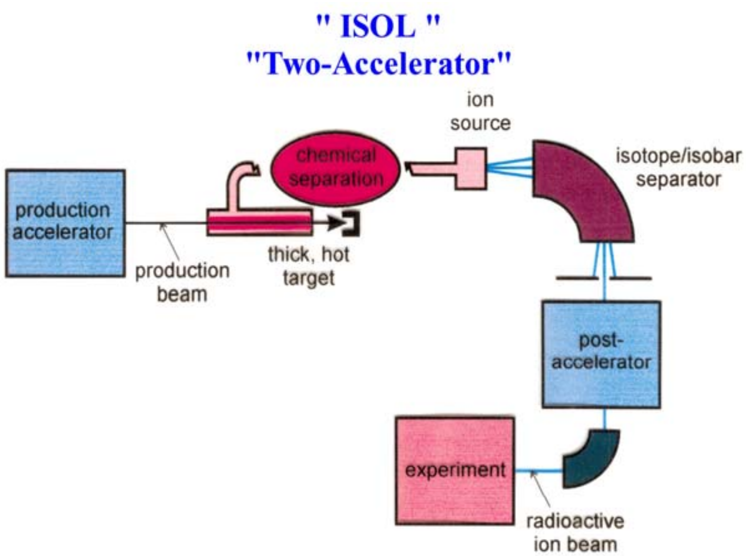


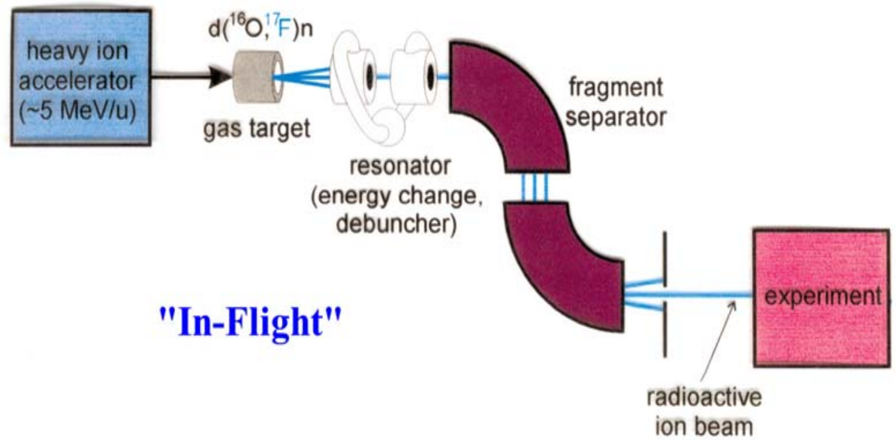
Radioactive beams comprised 17% of running time in FY06

Radioactive beam

Enriched material

Beam Production Methods





+ "Atlas-quality" beams

(beam spot, divergence, timing)

- For long half-lives only

Examples: ^{56}Ni, ^{56}Co, ^{44}Ti, ^{18}F

+ for short half-lives

- Beam spot typically 5 mm

Energy resolution ~ 0.5-1%

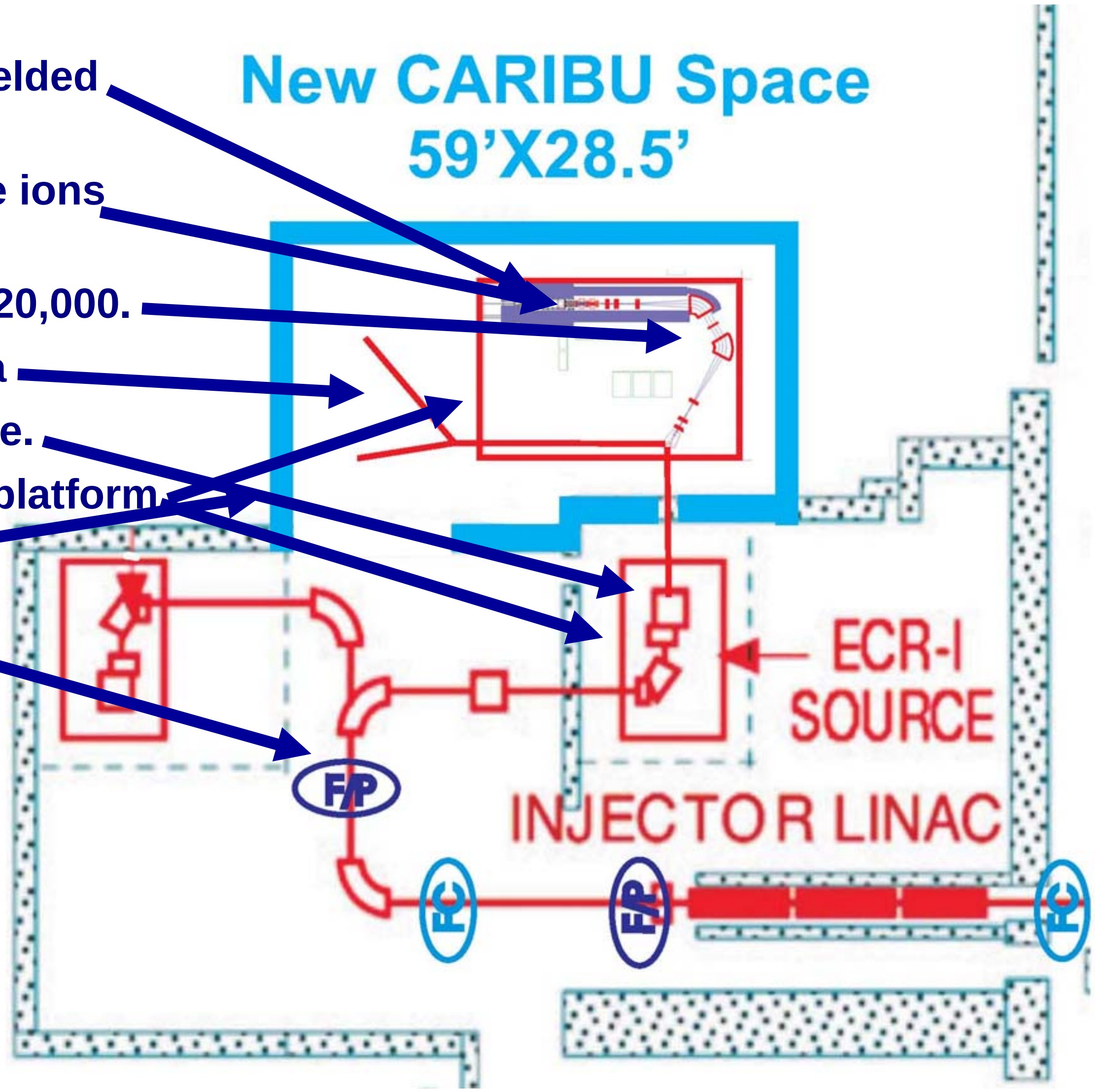
Examples: ^{6}He, ^{8}Li, ^{8}B, … ^{37}K

ATLAS Radioactive Beam Production - Demonstrated

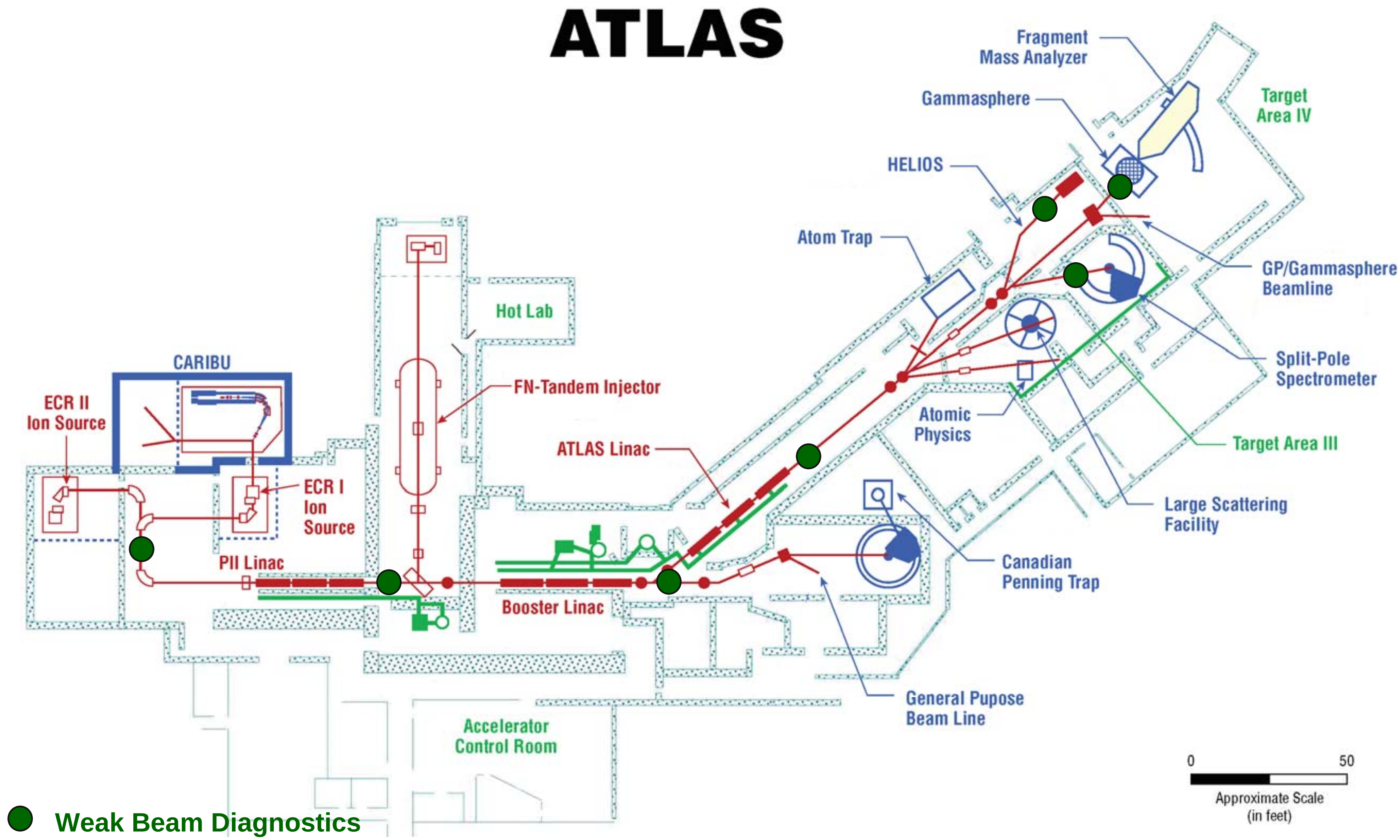
Ion	Reaction	Intens. #/s/pnA	Open Angle	Prod. Energy	Max. Rate , #/s
^{6}He	d(^{7}Li,^{6}He)^{3}He	150	19°	75 (MeV)	1 x 10^{4}
^{8}Li	d(^{7}Li,^{8}Li)p	2000	11°	71	1.5 x 10^{5}
^{8}B	^{3}He(^{6}Li,^{8}B)n	10	13°	27	
^{11}C	p(^{11}B,^{11}C)n	2300	4.5°	105	2 x 10^{5}
^{12}B	D(^{11}B,^{12}B)p	~2500			
^{12}N	^{3}He(^{10}B,^{12}N)n	<25	9.5°	73/100	
^{14}O	p(^{14}N,^{14}O)n	1200	2.9°	170	
^{16}N	d(^{15}N,^{16}N)p	30000	5.4°	70	3 x 10^{6}
^{17}F	d(^{16}O,^{17}F)n p(^{17}O,^{17}F)n	20000 20000	4.5° 1.7°	~90	2 x 10^{6}
^{19}Ne	p(^{19}F,^{19}Ne)n				
^{20}Na	^{3}He(^{19}F,^{20}Na)2n	~1		148	
^{21}Na	d(^{20}Ne,^{21}Na)n p(^{21}Ne,^{21}Na)n	4000 8000	4.0° 2.6°	113 113	2 x 10^{6}
^{25}Al	d(^{24}Mg,^{25}Al)n p(^{25}Mg,^{25}Al)n	1000 2000	3.7° 2.2°	204 180	
^{27}Si	p(^{27}Al,^{27}Si)n				
^{37}K	d(^{36}Ar,^{37}K)n	1200	2.2°	280	
^{18}F	Two-accel.				6 x 10^{6}
^{44}Ti	Two-accel.				2 x 10^{6}
^{56}Ni ^{56}Co	Two-accel.				5 x 10^{4} 2 x 10^{5}

^{252}Cf Fission Source System

- 1 Ci ^{252}Cf fission source in shielded cask.
- Gas catcher/RFQ to thermalize ions and create beam.
- Isobar separator with δm/m:1/20,000.
- Un-accelerated beam trap area
- ECR charge breeder ion source.
- Mounted on HV (up to 200kV) platform
- New ~1600 ft^2 building.
- Weak beam diagnostics.



Layout for ^{252}Cf fission source system at ATLAS



The CARIBU (CAlifornium Rare Ion Breeder Upgrade) Project

Californium Source Characteristics

- CARIBU will use fission fragments from a 1 Ci source of ^{252}Cf.
- Start with two weaker sources – ~3 mCi and ~70 mCi
- ^{252}Cf, produced at the High Flux Reactor at Oak Ridge, will be electroplated by ORNL as an open source on a polished SS plate. Similar sources are in use at ATLAS & INEL.
- Funding constraints jeopardize the continued production of Cf at ORNL.
- Alternative Russian supplier will use a painting technique.
- Source is sealed in a welded double container in a DOT certified cask.
- To minimize flaking & energy spread, the thickness of the deposit is kept to a practical minimum.
- ^{252}Cf has a fairly short lifetime of 2.645 yrs, so source thickness is small.
    - *1 Ci of ^{252}Cf is 1.9 mg; over an ~2x6 cm ellipse area. This yields a density of ~150 mg/cm^2*

The CARIBU (CAlifornium Rare Ion Breeder Upgrade) Project

- *The current funding situation for Cf production in the U.S. leaves the CARIBU project with grave uncertainties regarding the project's viability if the U.S. ceases to produce Cf. We are negotiating with a Russian supplier for our initial 1 Ci source, but even if we are able to obtain the first source, it is not certain that this will be able to continue. The current level of Cf production, I am told, may not be sufficient to provide the world's needs.*

Isotopes used for calibration and other purposes

- ^{54}Mn
- ^{56}Co, ^{57}Co, ^{60}Co
- ^{65}Zn
- ^{85}Sr
- ^{88}Y
- ^{111}In
- ^{113}Sn
- ^{137}Cs
- ^{139}Ce, ^{141}Ce
- ^{152}Eu
- ^{182}Ta
- ^{203}Hg
- ^{207}Bi
- ^{225}Ra
- ^{228}Th, ^{229}Th
- ^{233}U, ^{238}U
- ^{243}Am
- ^{248}Cm