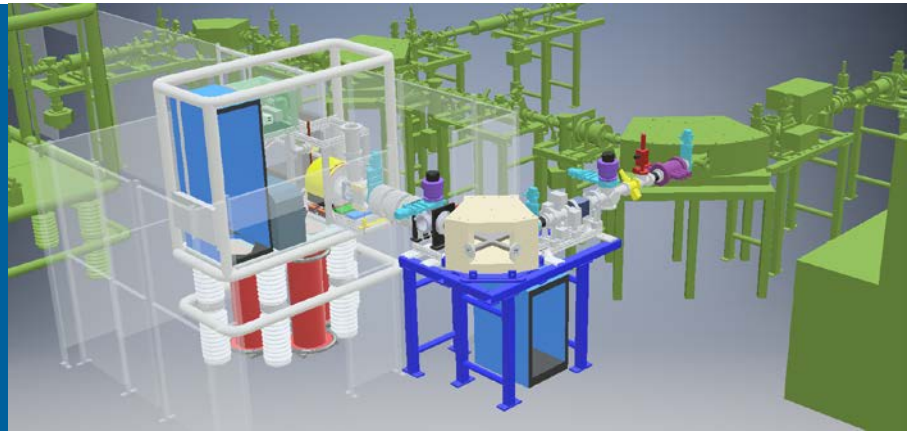
24TH INTERNATIONAL WORKSHOP
ON ECR ION SOURCES

Argonne NATIONAL LABORATORY

ECR3
PREPARATION FOR C-14 ION BEAMS AT ATLAS



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WEZZO03
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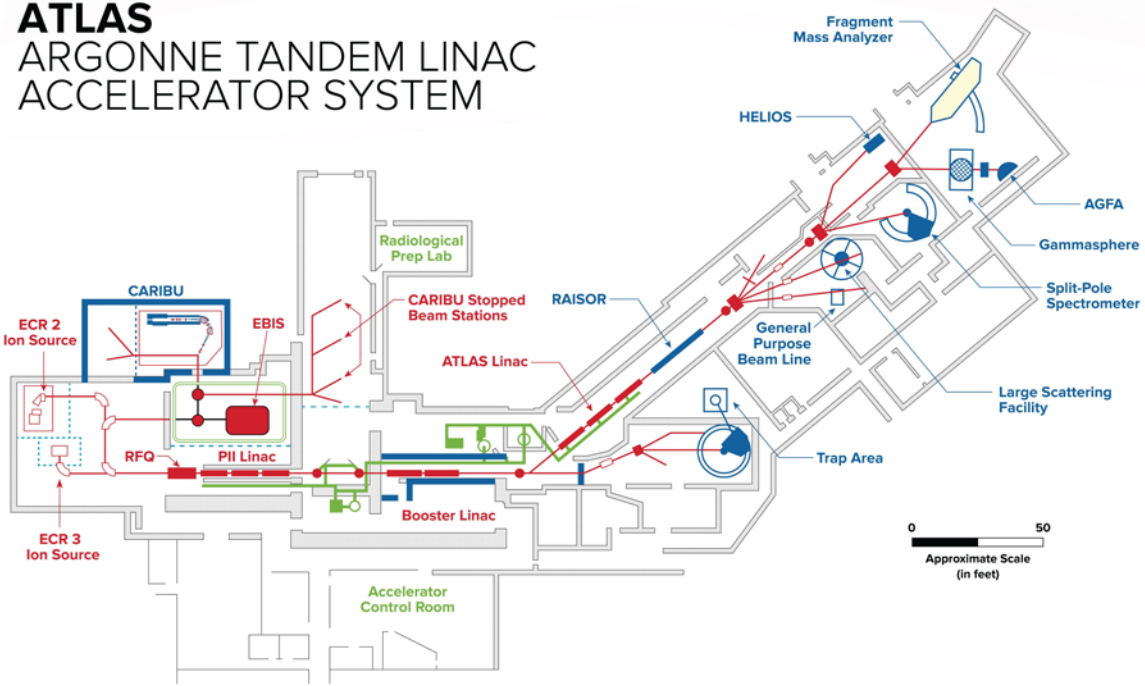
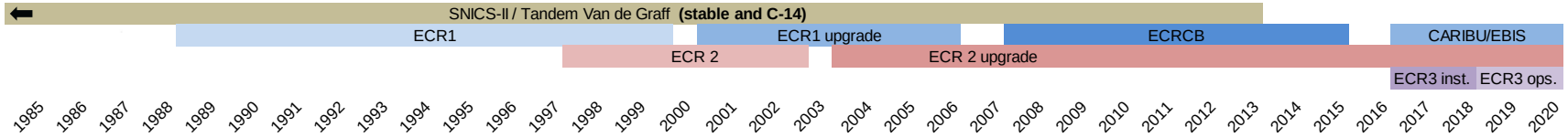
ATLAS
ARGONNE TANDEM LINAC ACCELERATOR SYSTEM



- 24 / 7 operation
- >5000 hours/year on target
- DOE National User Facility
- 2018 operations
  - 80% Stable ECR2
  - 20% CARIBU/EBIS
- 3 accelerating sections, stripping avail. PII, Booster
- Max. energy 17 MeV/u

https://www.anl.gov/atlas/about-atlas

Beam Operation Timeline

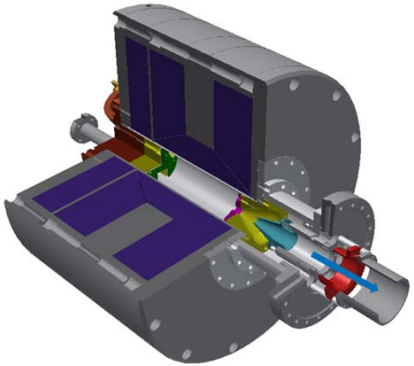


ECR3 INSTALLATION

BIE100 ECR ion source*

- Fulfill two needs:
  - Production of C-14 after 7 year hiatus
  - 2nd source of stable beams

- All permanent magnets
- Small footprint
- Majority of parts re-used
- Capable of 2nd frequency
  - 12.75-14.5 GHz



ECR3 Specifications	
$B_{inj}/B_{min}/B_{ext}$	1.27 / 0.42 / 0.65 T
B_{rad}	1.0 T
PC dimensions	d = 6.4 cm / L = 17.5 cm
TWTA	11-13 GHz/300 W
Source HV	≤ 15 kV
Platform HV	≤ 200 kV

* D. Z. Xie, RSI Vol. 73, No. 2 [DOI; 10.1063/1.1429320]

ECR3 C-14 PLANNING

Carbon-14 experiment requirements:

- Energy 210 MeV
- Intensity 100 pnA at target
- Beam contamination C-14:N-14 ≥ 4:1

ATLAS facility goal:

- Consumption rate as low as possible
  - Reduce radioactive contamination
  - Reduce cost

ECR3 ENERGY VERIFICATION

C-14 experiment requirement: Energy 210 MeV

- Used in-house energy prediction application
- Determined 3 linac configurations that will yield required energy

Source	PII Stripping			Maximum
	Energy		Fraction	Energy
q	[MeV]	q		[MeV]
3+	25.7	3+	-	122.2
3+	**25.7**	**6+**	**0.4**	**210.8**
4+	27.9	4+	-	156.3
4+	**27.9**	**6+**	**0.4**	**212.3**
5+		5+	-	186.4
6+	**30.6**	**6+**	**-**	**214.3**

ECR3 INTENSITY VERIFICATION

C-14 experiment requirement: Intensity 100 pnA at target

- Calculate source intensity required with
  - 20% transmission to target
  - 40% stripping efficiency

Source		Transmission	Target	
q	I [pnA]	[%]	q	I [pnA]
3+	**1250**	8	6+	100
4+	**1250**	8	6+	100
6+	**500**	20	6+	100

- Beam tests with C-13 ethylene gas
  - C-12
    - m/q conflicts 3+,6+
    - Competing background carbon
  - Limited gas and RF input (100W)
    - lens sparking

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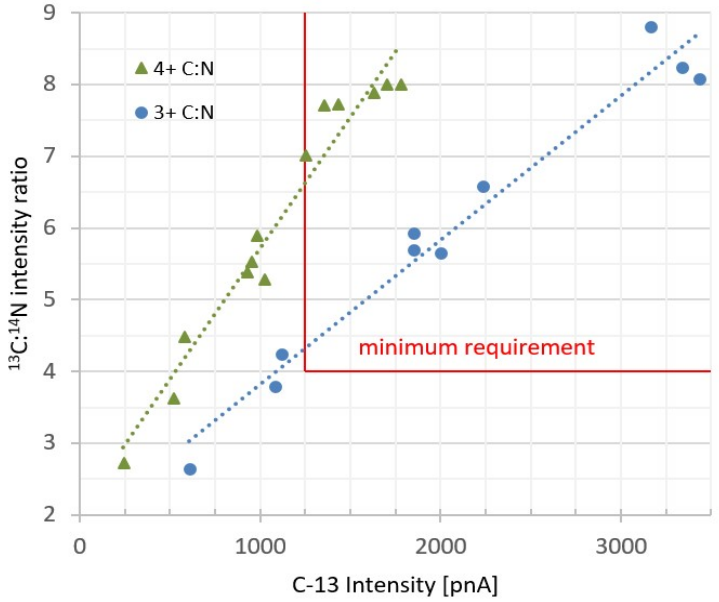
	Required Source	Achieved Source
q	I [pnA]	I [pnA]
3+	1250	8333
4+	1250	5000
5+	--	610
6+	500	13

ECR3 NITROGEN CONTAMINATION

C-14 experiment requirement: C:N ≥ 4:1

- Measured ^{13}C:^{14}N ratio to predict ^{14}C:^{14}N
- Foil stripping fraction into 6+ favors N over C
  - Chart C:N is corrected (20% lower)
- Helium support favors N over C
  - Results do not use a support gas
- Ratio/intensity improve with more ethylene input

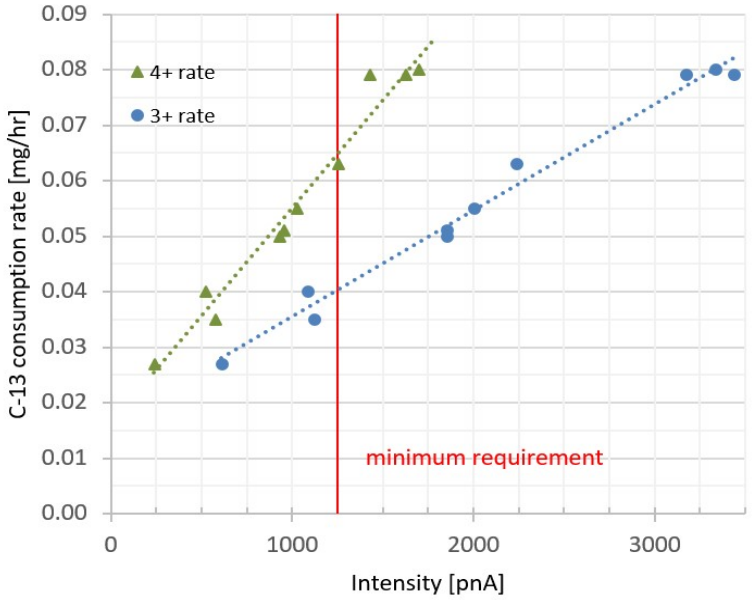


ECR3 C-14 CONSUMPTION RATE

ATLAS facility goal: as low as achievable

- Maintain experiment requirements
- Minimize radioactive contamination
- Lower cost to the facility

- 4+ rate is ~50% higher than 4+ at the required intensity



SUMMARY

- **ECR3 has been installed and commissioned at ATLAS**
- **ECR3 will provide flexibility to ATLAS and C-14 ion beams**
- **ECR3 at ATLAS will meet all C-14 experiment requirements**

Thank you for your attention.