Argonne NATIONAL LABORATORY

ATLAS User Group Meeting
April 8, 2006

ATLAS Facility Status: Operations

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ATLAS Operations Manager

Presentation Outline

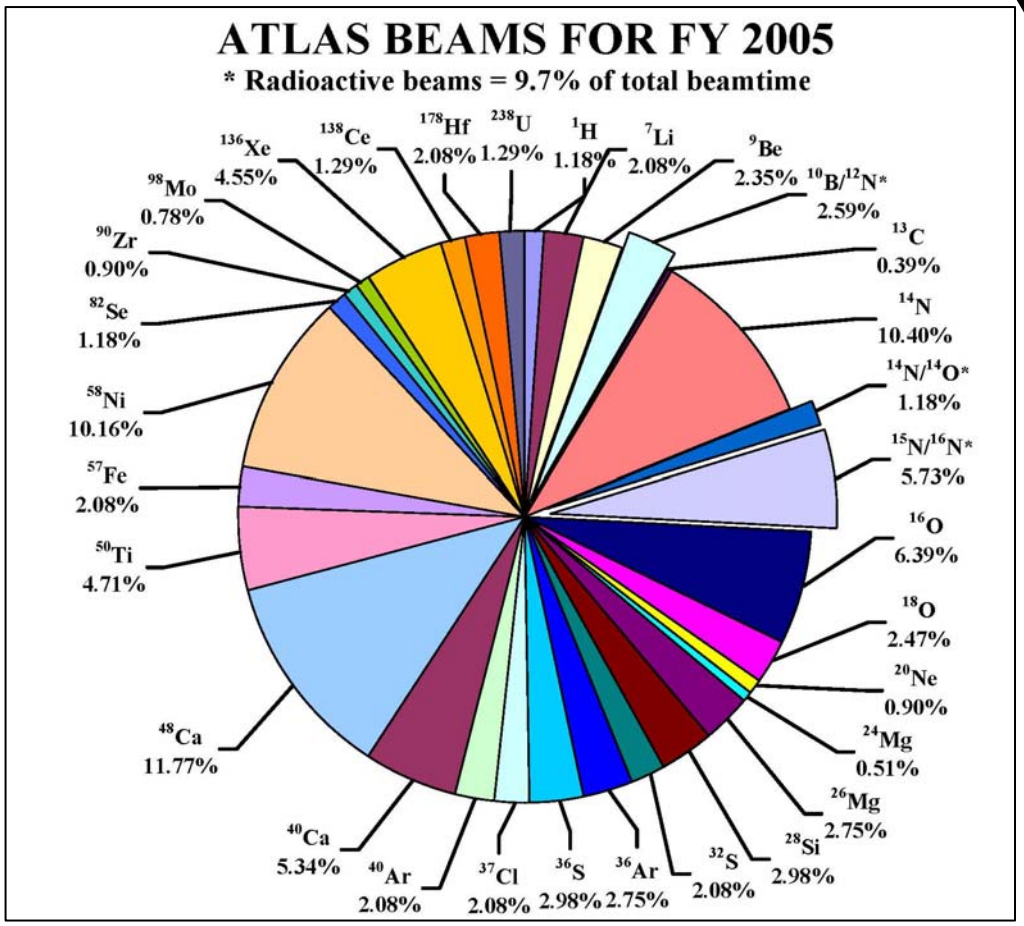
- Facility Performance
- Operations staffing and budget
- Components upgrade and improvements
- Energy upgrade AIP project
- CARIBU and ATLAS during construction and startup

ATLAS Performance

Beams Provided

Variety and beam properties of beams driven by the experimental program.

- **2-3 new beam each year.**
- **Push to higher beam current**
  - **^{50}Ti beam: 200 pnA on target**
  - **^{48}Ca beam: 130 pnA on target**
- **Medium mass has been recent focus**



31 different isotopes

***9.7% beam time for exotic beams**

ATLAS Performance

Operating Statistics

Machine Operation	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005
Scheduled Research Hours	5496	5576	4586	5500	5623	4783
Research Hours (on Target)	5384	5619	4311	5468	5512	4594
Accelerator Devel. Hours	76	97	105	22	47	92
Total R & D Hours	**5460**	**5716**	**4416**	**5490**	**5559**	**4686**
Scheduled Maintenance	597	465	665	333	437	424
Experimental Downtime	296	300	242	256	230	267
Availability (%)	94.9	95.5	95.1	96.1	96.4	95.2
Num. of Experiments	51	42	37	46	41	43

Recent budget constraints have forced a reduction in running time

- **7-day operation resumed from April, 2003 to May, 2004**

- **Since June 2004, ATLAS has operated on a 5.3-day schedule, with a few 7-day runs scheduled when that improves efficiency for particular experiments.**

ATLAS Operations Staff Status

Since the last Users Workshop in 2004, the ATLAS Operations staff has decreased by 2 persons, but staff has been stable for past year.

President's FY07 budget makes staff recovery possible.

Group	FTE
Electronics	2
Cryogenics	2
Operations	6
Vac/Tandem/Utilities	2
ECR Ion Sources	2
Control Computers	2
Safety	0.3
Secretarial	1
Management	2
Total	19.3

President's Budget for FY07 is Encouraging

- **Secure Reliable Operations**
  - Add additional two operators to allow return to flexible 5/7 day operation. (Full 7-day operation must await completion of new operator training, ~6 month period)
  - 5600 operating hours possible in FY07 with this proposed budget
- **Additional M&S so equipment funds can be used primarily for capability improvements**
- **Additional equipment and AIP funds for major initiatives**
- **Address continuing operating and experimental support areas that the user program need**

ATLAS Facility: Tandem Injector

Tandem continues to be valuable for:

- **Light-ion (A ≤ 50) stable beams.**
  - Higher energy than Positive Ion Injector for A<30.
  - Adequate beam currents for most experiments.
- **Long-lived, near-to-stability radioactive ions.**
  - Recent ^{44}Ti run showed the benefits of the 2003 replacement of corona system with resistors.
    - ✓No timing feedback for beam stabilization required
    - ✓New Generating Volt Meter (GVM) bread-boarded electronics improved voltage stability.
    - ✓Intensity increase of ~3X to about $2X10^6$ /s

ATLAS Facility: Positive Ion Injector

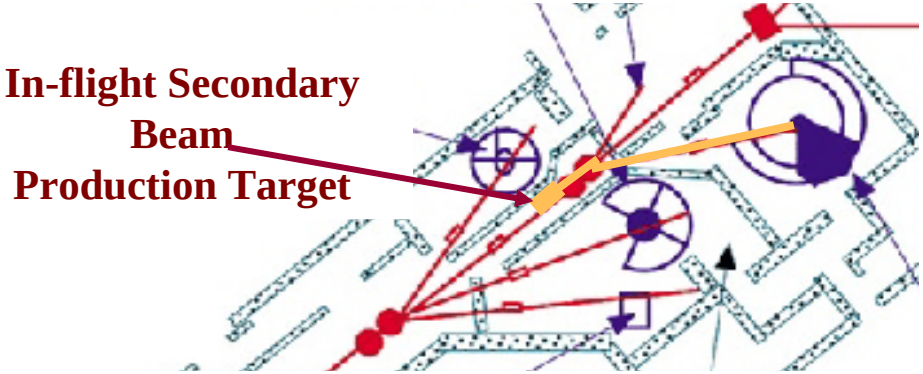
ECR Source Performance/Activity

- ECR-II Hexapole cooling problems fixed with a second design of source 'plasma' chamber
- Continued demand for higher beam current (50-200 pnA)
  - RIB production
    - In-flight program (^{15}N: 150 pnA, ^{7}Li: >60 pnA)
    - Trap experiments (typically ~50 pnA)
  - Super-heavy elements studies
  - Accelerator Mass Spectroscopy (^{39}Ar)
  - High K-Isomer Search ^{48}Ca: 150 pnA
- New Induction Oven
  - Temperatures of up to 1900 C possible
  - ^{50}Ti beam of up to 200 pnA

ATLAS FACILITY:
In-flight Radioactive Beam Program

Complements programs at other labs:
Beams or energies not available elsewhere

- **In-flight production beams**
  - Inverse kinematics
  - Production of wide variety of beams
- **17 radioactive beam species developed since 1994**
  - Most recent additions to stable are: ^{10}C and ^{12}B



ATLAS Radioactive Beam Production

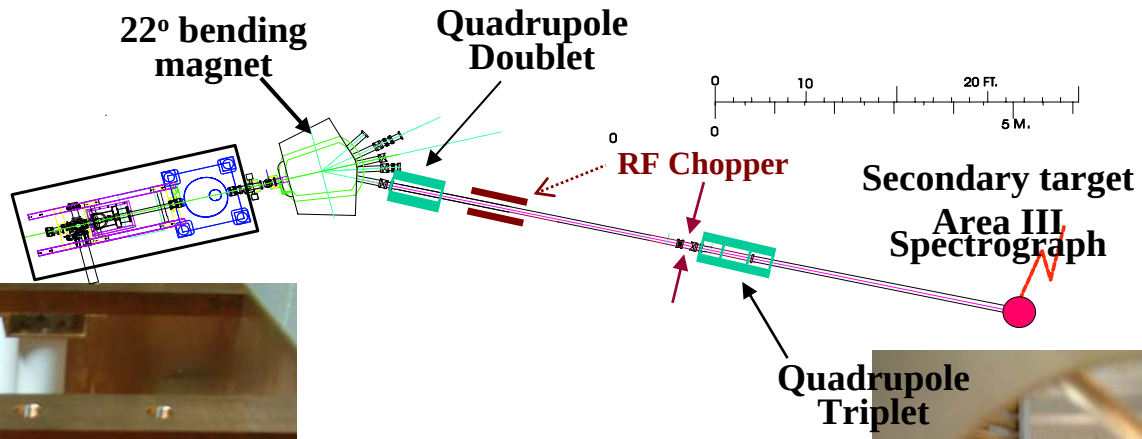
17 radioactive beam species developed since 1994

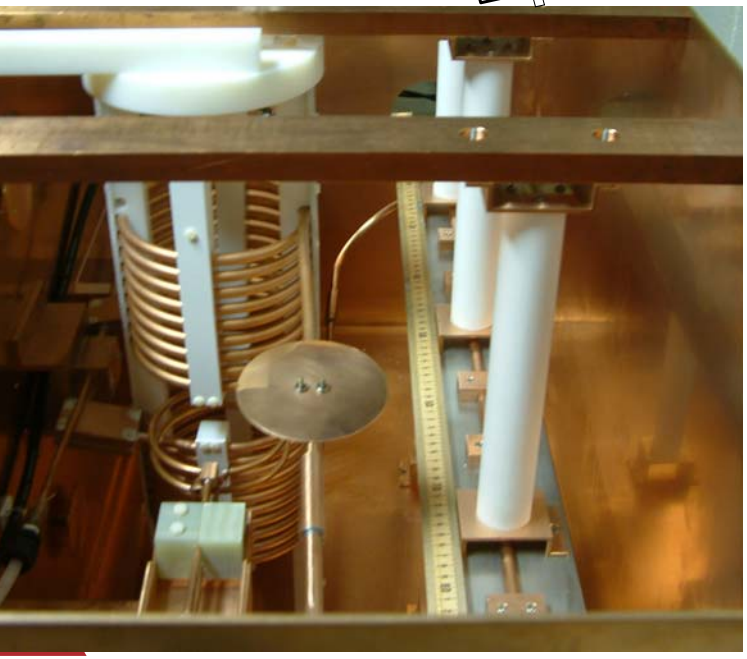
Ion	Reaction	Intens. #/s/pnA	Open Angle	Prod. Energy	Max. Rate , #/s
^{6}He	d(^{7}Li,^{6}He)^{3}He	150	19°	75 (MeV)	1 x 10^{4}
^{8}Li	d(^{7}Li,^{8}Li)p	1200	11°	71	1 x 10^{5}
^{8}B	^{3}He(^{6}Li,^{8}B)n	10	13°	27	
^{12}B	d(^{11}B,^{12}B)p	15000		112	
^{10}C	p(^{10}B,^{10}C)n	530		97	
^{11}C	p(^{11}B,^{11}C)n	2300	4.5^{o}	105	2 x 10^{5}
^{14}O	p(^{14}N,^{14}O)n	1200	2.9^{o}	170	
^{16}N	d(^{15}N,^{16}N)p	30000	5.4^{o}	70	6 x 10^{6}
^{17}F	d(^{16}O,^{17}F)n p(^{17}O,^{17}F)n	20000 20000	4.5^{o} 1.7^{o}	~90	2 x 10^{6}
^{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^{o} 2.6^{o}	113 113	2 x 10^{6}
^{25}Al	d(^{24}Mg,^{25}Al)n p(^{25}Mg,^{25}Al)n	1000 2000	3.7^{o} 2.2^{o}	204 180	
^{37}K	d(^{36}Ar,^{37}K)n	1200	2.2^{o}	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}

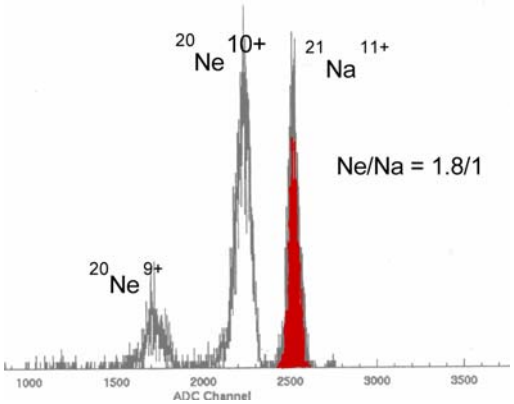
In-flight Radioactive Beam Program:
New RF chopper to remove primary beam tails

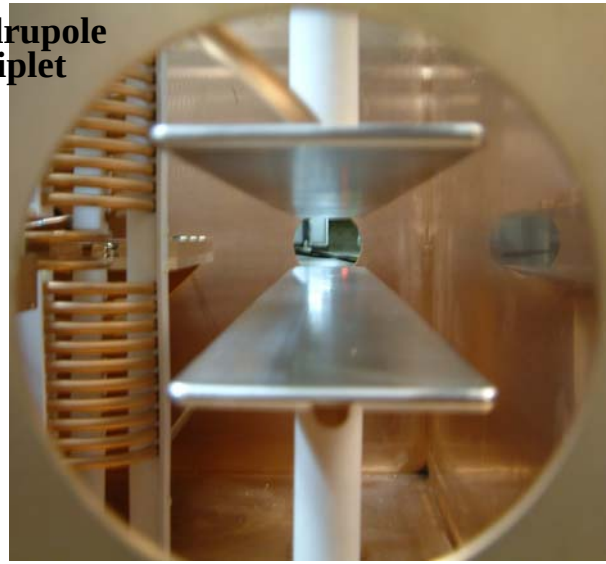
Development determined by manpower and available existing funds

- Chopper plates, resonant circuit and RF box constructed
- Tested to over 50kV, exceeding specification
- Vacuum chamber design complete, but may not have funds to complete until FY07.







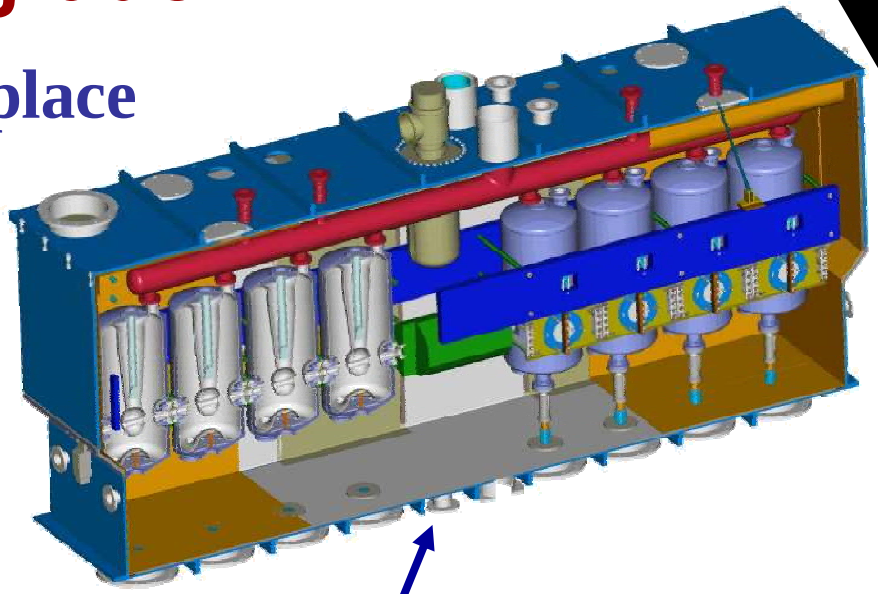


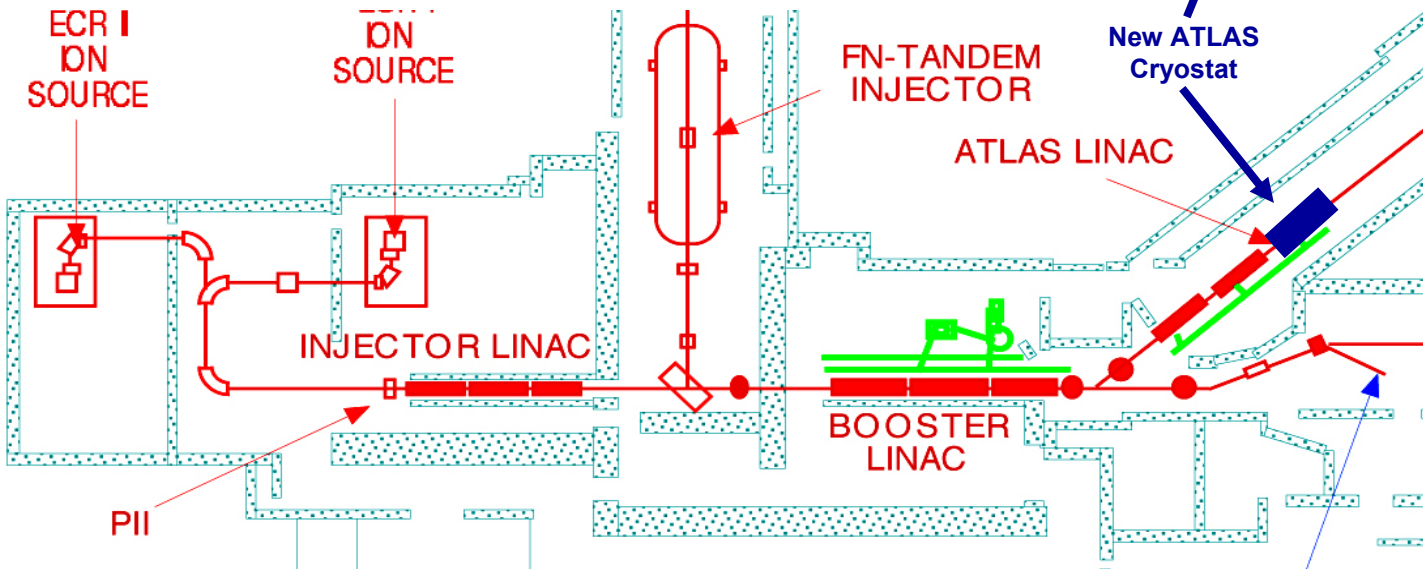
ATLAS AIP Energy Upgrade

ATLAS Energy Upgrade will replace the last ATLAS cryostat with:

New RIA-style cryostat containing
New RIA-class resonators:

- **ß=0.14 quarter-wave resonator**
- **ß=0.26 half-wave resonator**





ATLAS Energy Upgrade

Complete Upgrade Project will consist of:

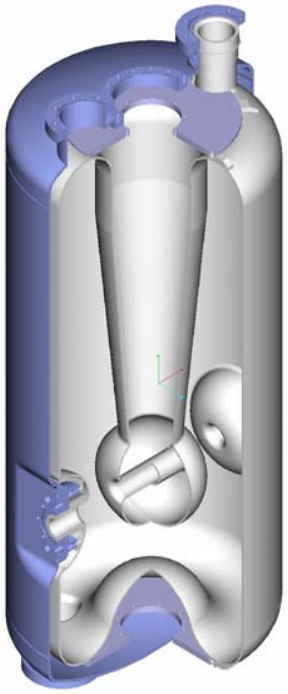
- 7 ß=0.14 Quarter-wave resonators
- 1 ß=0.26 Half-wave resonator

Expected performance improvement from Energy Upgrade

Single cryostat will increase the maximum beam energy by ≥ 25% for all beams.

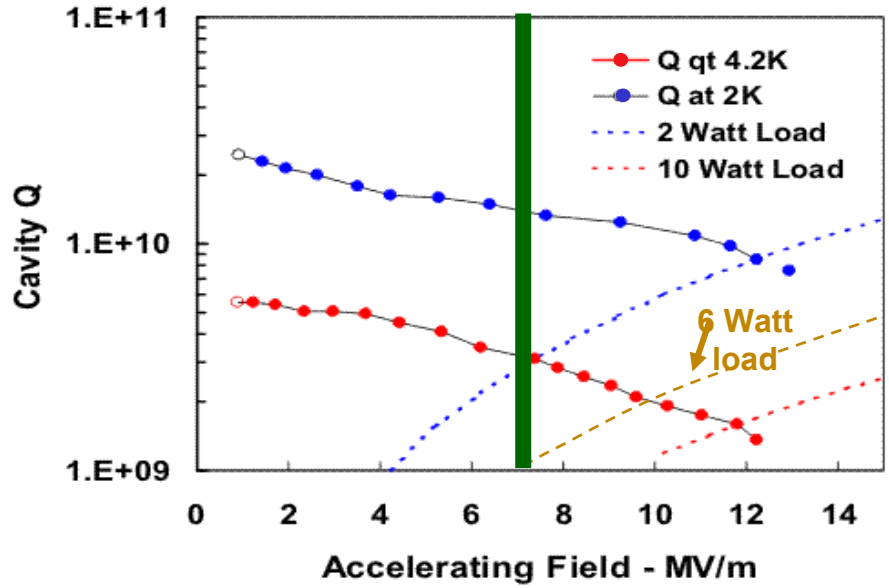
	Current ATLAS		ATLAS Upgrade	
A	No Strip	Strip	No Strip	Strip
1	24.08	24.08	38.50	38.50
16	12.98	15.66	18.50	21.48
40	12.37	13.35	17.49	19.91
58	9.94	11.79	13.49	17.87
78	9.49	11.19	12.78	16.71
132	7.96	9.33	10.37	13.38
197	6.65	7.89	8.37	10.94
238	6.36	7.39	7.94	10.04

ATLAS Energy Upgrade



- One ß= 0.14 quarter-wave resonator prototype complete
- One ß= 0.26 half-wave resonator prototype complete
- Remaining six resonators under construction
  - >50% complete

QWR 109 Parameters		
Frequency	109.125	MHz
Geometric Beta	0.144	v/c
Active Length	25	cm
QRs	40	ohm
Epeak/Eacc	3.2	
Bpeak @1MV/m	58.3	
RF Energy/Eacc^2	0.1662	Joule



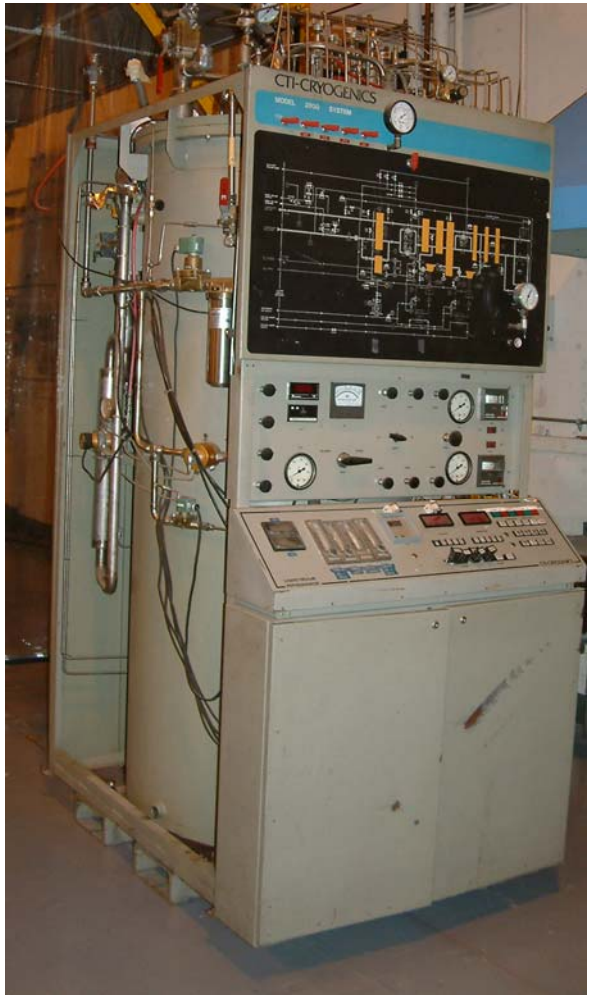
ATLAS Upgrade Cryomodule

- Cryostat assembly completed
- Initial cool down & offline tests took place in December, 2005

ATLAS Refrigeration Upgrade

- **Replace existing 1630 cold box with LLNL surplus 2800 cold box**
  - Increase of >100 watts of cooling capacity
- **Needed for full use of new Energy Upgrade Resonators**
- **Will require 6 week shutdown to implement**
  - Ready for shutdown in late September
  - Exact schedule to be negotiated

+>100 Watts



CARIBU and ATLAS

CARIBU will provide an exciting new array of RIBs far from stability.

- **First beam is scheduled for January, 2009**
  - Plans call for sufficient weak-beam diagnostics to deliver beams to four target stations.
- **Impact on ATLAS operations: minimal until commissioning begins**
  - ECR-I charge breeding studies will have priority for ECR-I
  - Some schedule conflicts possible
- **During commissioning and early operation**
  - Anticipate 10% reduction in scheduled beam time due to commissioning
  - Beams from tandem and ECR-II for stable beam program
  - Length of CARIBU experiments will be longer than for stable beams

Summary

The mission for the ATLAS … is to enable research of the highest quality by its users and staff, … with the associated responsibility of research and development in accelerator science and in the techniques that are required to accomplish its scientific goals.

- **New Capabilities**
  - Increased energy range (Energy upgrade project)
  - Improved In-flight RIB performance (RF sweeper project)
  - CARIBU project will provide first beams in early 2009
  - Increased beam currents (Improved ECR performance)
- **Funding issues have limited operating hours for a number of years**
  - FY07 President's budget is very encouraging
  - Return to 5/7-day mixed operation contingent on actual budget
- **Suggestions for new capabilities or program emphasis are welcome**

Chopper Voltage Required for some RIB Beams

RIB Beam	RIB Energy	Primary Beam	Primary Energy	RIB Velocity	δTOF (ns)	Peak Voltage*
$^{16}N^{7+}$	60 MeV	$^{15}N^{7+}$	64.0 MeV	0.090c	29	11 kV
$^{16}N^{7+}$	60	$^{15}N^{6+}$	47.0	0.089c	43	8.7
$^{37}K^{19+}$	280	$^{36}Ar^{18+}$	258.3	0.127c	9	45
$^{37}K^{19+}$	280	$^{36}Ar^{17+}$	230.4	0.127c	28	16
$^{21}Na^{11+}$	113	$^{20}Ne^{10+}$	98.1	0.107c	18	16
$^{21}Na^{11+}$	113	$^{20}Ne^{9+}$	79.4	0.107c	63	14
$^{8}B^{5+}$	35	$^{6}Li^{3+}$	16.8	0.097c	107	7.9
$^{8}B^{5+}$	35	$^{6}Li^{3+}$	7.5	0.097c	374	4.9
$^{6}He^{2+}$	80	$^{6}Li^{2+}$	68.6	0.169c	41	35

*Assumes: 1m long plates, 2 m drift, 5 cm gap, and 1.5 cm deflection

ATLAS Energy Upgrade Status

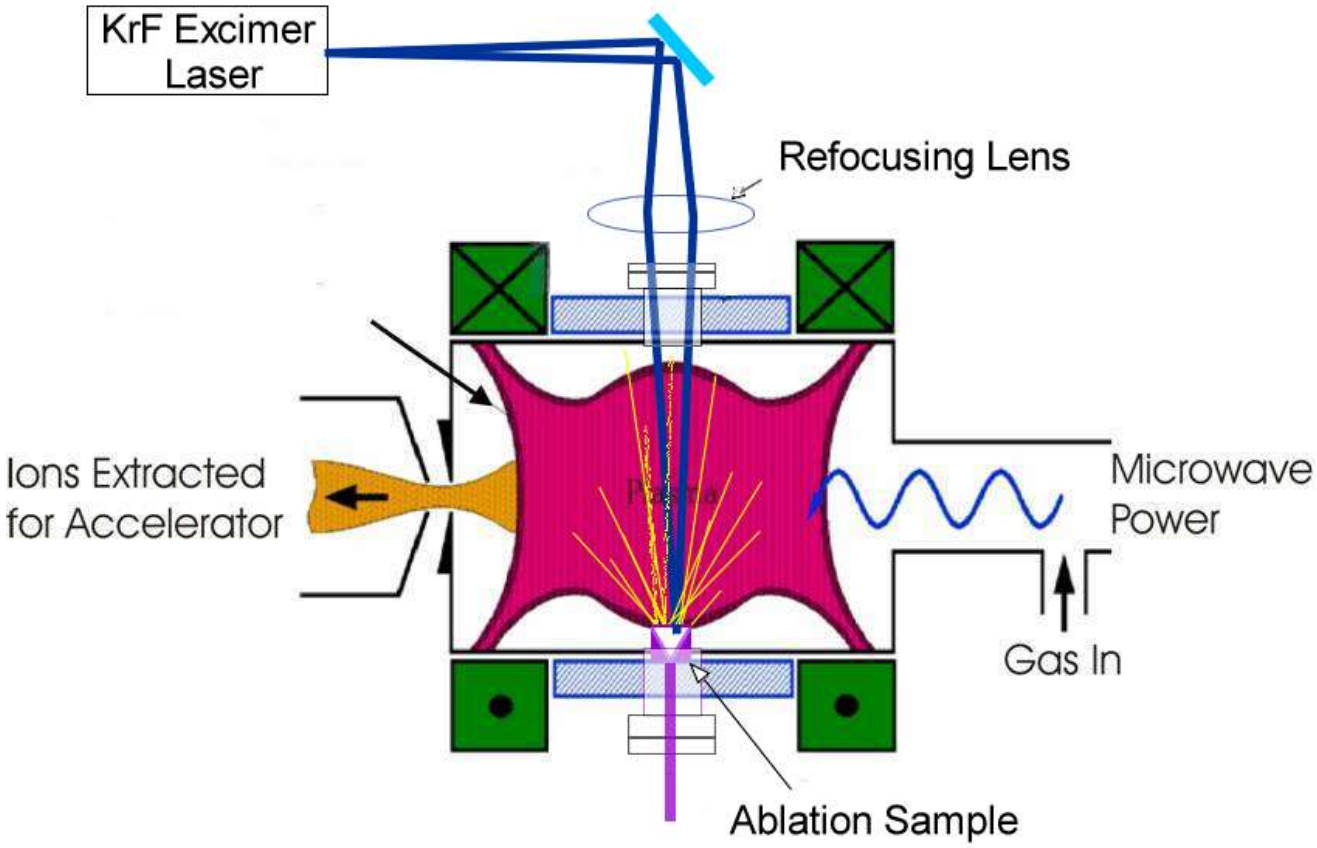
- Cryostat Assembly completed
- Initial cool down & offline tests: December, 2005

ß=0.16 λ/4 resonator

ß=0.26 λ/2 resonator

ATLAS Beams

Laser Solid Material Ablation into ECR Source

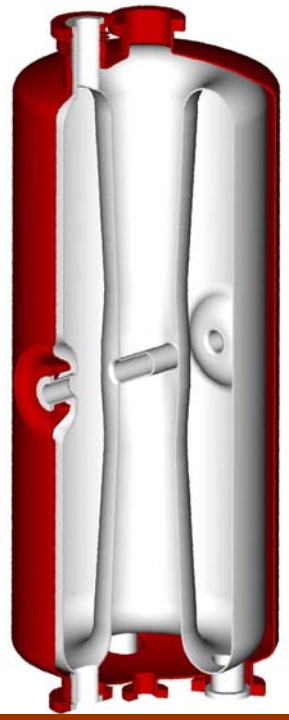


ATLAS Beams

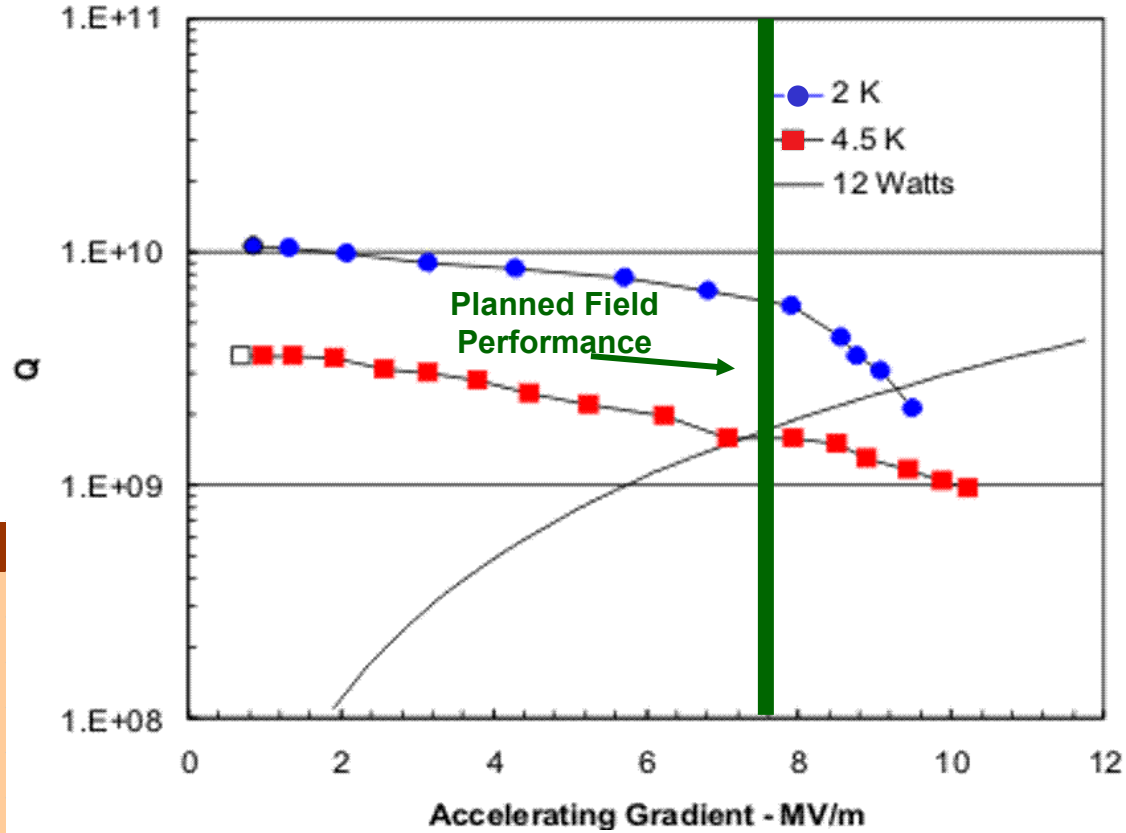
ECR Source Solid Material Improvement Project

- Present techniques
  - Ovens, sputtering material into plasma
  - Low efficiency
  - Sputter technique coupled to plasma configuration
- New Induction Oven
  - Temperatures of up to 1900 C possible
  - ^{50}Ti beam of up to 200 pnA

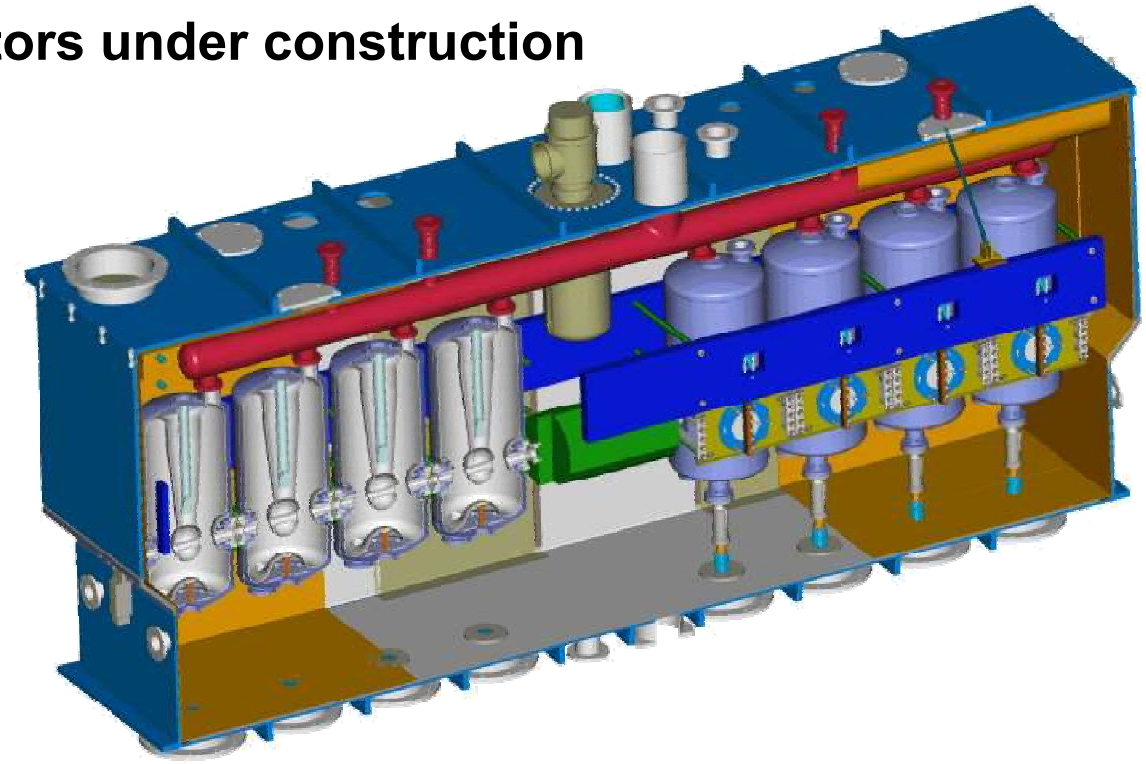
ATLAS Energy Upgrade



Initial Test of Prototype 170 MHz HWR Cavity for RIA and ATLAS



HWR 170 Parameters		
Frequency	170	MHz
Geometric Beta	0.26	v/c
Active Length	30	cm
QRs	57.4	ohm
Epeak/Eacc	2.9	
Bpeak@ 1 MV/m	78	
RF Energy/Eacc^2	0.338	Joule

ATLAS Energy Upgrade Status

- **One ß = 0.14 quarter-wave resonator prototype complete**
- **One ß = 0.26 half-wave resonator prototype complete**
- **Cryostat basic assembly complete**
- **Remaining six resonators under construction**
  - >50% complete