

# Cryogenic Improvements for the ATLAS Energy Upgrade

Cryogenic Operations Workshop May 9-11, 2006

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#### Argonne National Laboratory

A U.S. Department of Energy Office of Science Laboratory Operated by The University of Chicago



- ATLAS Overview
- Cryogenic System Staged Construction
- Energy Upgrade
- Refrigerator Installation Project
- Expected Benefits
- Questions





### **ATLAS Facility Overview**







## Split Ring Type Superconducting RF Cavities

ELIUM

INE-

RANSFER

- 47 Total
- 12 Cryostats
  - 7 Accelerating, 6 cavities each
  - 5 Bunchers, 1 cavity each





INSTRUMENTATION AND

RF LEADS

END VIEW OF LINAC CRYOSTAT

OUTER

VACUUM

LIQUID NITROGEN

HEAT SHIELDS-

COOLED

#### **Original LHe Flow Schematic**

В

- Model 1400 installed 1978
- 1400 replaced by 1630 in 1980
- Series arrangement
- Staged construction
- Cryostat heat exchangers
- Supply line undersized

А



Return pressure maintained by dewar heater

> Booster Secondary





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#### **ATLAS Section Dedicated 1985**

- Added 300 watt CTI model 2800
- Increased supply line size
- Need for cross-connect
- Higher pressure in Booster

- Dewar level control
  - Requires ~30 watts excess
  - Susceptible to load changes







#### Positive Ion Injector (PII) Cryostats and Cavities 1992



- 3 Cryostats 6 Cavities Each
- Gravity fed









#### **Current ATLAS LHe Flow Schematic**









# ATLAS Energy Upgrade



#### 2800 Installation







#### 2800 Center Test

- Last operated in late 90's
- Test the repair of shipment damage/modification
- 80 K trap differential pressure
- Control system operation
- Capacity check
- Equipment
  - Existing spare compressors
  - RDT Transfer line
  - 250 Liter portable dewar w/heater







### 2800 Damage







#### **2800 West Flow Schematic**





D		Task Name	Duration	Start	1 '06 Oct 8 '06 Oct 15 '06 Oct 22 '06 Oct 29 '06
	0				M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F
1		Cryogenic System Shutdown	5.5 days	Mon 10/2/06	
2		Shut down 1630	1 day	Mon 10/2/06	
3		Empty Cryostats	2 days	Mon 10/2/06	
4		Empty distribution lines	0.5 days	Wed 10/4/06	
5		Empty J, K and L Dewar	1 day	Wed 10/4/06	
6		Shutdown refrigerators	1 day	Thu 10/5/06	
7		Vent/purge distribution lines	0.5 days	Fri 10/6/06	
8		Vent vacuum spaces	0.5 days	Mon 10/9/06	
9		Warm gas tubing	7 days	Tue 10/3/06	
10		Compressor/refrigerator interconnects	5 days	Tue 10/3/06	Pipefitters
11		Interference installation	2 days	Tue 10/10/06	Pipefitters
12		Cut out cold line interference	1 day	Mon 10/9/06	Central Shops
13		Booster secondary vacuum break	2 days	Mon 10/9/06	
14		Cut in and 9 welds	1.5 days	Mon 10/9/06	Central Shops
15		Leak check	0.5 days	Tue 10/10/06	Cryo Group
16		T-TT jumper	1 day	Tue 10/10/06	Central Shops
17		Leak check T-TT jumper	0.5 days	Wed 10/11/06	Cryo Group
18		Cut out warm gas interference	0.5 days	Tue 10/3/06	Стуо Group
19		Pump out PII and ATLAS Distribution Vacuum	0.5 days	Wed 10/11/06	📕 Тсуо Group
20		Place 2800 into position	0.5 days	Tue 10/10/06	Cryo Group
21		Mount valve box	1 day	Wed 10/11/06	Central Shops
22		Electrical Connections	6.5 days	Tue 10/3/06	
23		Install components and conduit/romex	3 days	Tue 10/3/06	Electricians
24		Make connections	0.5 days	Wed 10/11/06	Electricians
25		Modify Booster feed line	4 days	Wed 10/11/06	Central Shops
26		Booster feed/Valve box interconnect	2.5 days	Tue 10/17/06	
27		Helium supply butt weld x2	1 day	Tue 10/17/06	Central Shops
28		Leak Check	0.5 days	Wed 10/18/06	
29		Helium return cuff x2	2 hrs	Thu 10/19/06	Central Shops
30		Leak Check	0.5 days	Thu 10/19/06	
31		Vacuum jacket cuff x2	2 hrs	Thu 10/19/06	Central Shops
32		WE #1 in and out/ Valve box interconnect	2 days	Fri 10/20/06	
33		Helium tube butt welds x4	1 day	Fri 10/20/06	Central Shops
34		Leak check	0.5 days	Mon 10/23/06	
35		Vacuum cuff install x4	0.5 days	Mon 10/23/06	
36		Booster secondary/Valve box interconnect	2 days	Tue 10/24/06	
37		Helium tube butt welds x3	1 day	Tue 10/24/06	
38		Leak check	0.5 days	Wed 10/25/06	Schodulo Summarv 🔖
39		Vacuum cuff install x3	0.5 days	Wed 10/25/06	
40		Ref. in and out/ Valve box interconnect	1.5 days	Thu 10/26/06	1 Wook shut down
41		Helium tube butt welds x2	0.5 days	Thu 10/26/06	- I WEEK SIIUL OOWII
42		Leak check	0.5 days	Thu 10/26/06	- 2 Wook installation
43		Vacuum jacket cuff x2	0.5 days	Fri 10/27/06	- S WEEN IIIS Calla Contral Shops
44		Pump out booster dist. Vacuum space	0.5 days	Thu 10/26/06	-1 Wook startun
45		Leak check booster dist. Vacuum space	1 day	Thu 10/26/06	
46		Purge all helium spaces	1 day	Thu 10/26/06	
47	1	Start all LN2	0.5 days	Thu 10/26/06	
48		Start 2800 East and 1630	1 day	Thu 10/26/06	
49		Cool PII and ATLAS	5 days	Fri 10/27/06	
50		Start 2800 Center	0.5 days	Fri 10/27/06	
51		Cool Booster	4 days	Mon 10/30/06	

### **Benefits**

- Provide capacity for new cryostat
- Add stability and decrease operating costs
  - Increase operating margin ~10%
  - Abandon dewar level control
    - Half of the cryo group call-ins
  - 1630 is highest maintenance item
    - ~20% of cryogenic budget/yr
    - Shut down every 4-6 months as opposed to 18 months
- Easier to shutdown 2800 East
- Run 2-3 cryostats with 2800 East down
- Vacuum break





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