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ARIEL electron Target Module Services List

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History of Changes

Release Number	Date	Description of Changes	Author(s)
D1	2014-12-05	Draft	P. Bricault; W. Paley
1	2015-03-02	Added assumptions section and system architecture.	P. Bricault; W. Paley
2	2015-10-14	Changed from 60 to 75kV (design), target heater power from 15 kW to 12 kW; tube heater current from 500A,5kW to 800A, 7kW; added Oven Heaters 1-4 (80A, 1kW each); added Oven return 5 (320A, 4kW); added extraction electrode 2; increase coolant from 2 to 4 tubes; increased gas supply from 1 to 2 tubes & specified 12mm; Added 6 conductors for limit switches.	P. Bricault; A. Gottberg; W. Paley
3	2017-08-21	Authors, reviewers, approver and distribution: P. Bricault, W. Paley removed from author list. A. Gottberg removed from author list, added as the approver. T. Day Goodacre, C. Babcock added to author list. R Dawson, T. Hruskvec, A. Messenberg, G. Minor removed as reviewers. M. Marchetto added as a reviewer. N. Khan, K, Chen, B. Kade, M. Kettle and F. Maldonado added to the distribution list. 1. Background Changed to ensure agreement with current concept. 2. Purpose Scope widened from "only target vessel" to the "target module". Services to facilitate future upgrades are now considered. 3. Assumptions Assumptions split between HV and ground. Minor rewording. Second pair of coolant lines on HV have been added. Provision for IG-LIS added. Provision for negative ion sources has been added. Concept change to use only a ground electrode has been added. The use of X/Y steering plates have been removed. The steering function of the quadrupoles has been included. The vacuum is now assumed to	T. Day Goodacre C. Babcock

		be measured at the beamline exit of the target vessel (previously "at the target vessel"). Extracted ion beam no-longer described as "heavy". Clarification added for vessel venting as all gate valves will not be closed. Three gate valves reduced to two. The discussion of the quick disconnect for the liquid converter and the gate valves on the vacuum tank were removed. Operation at 60 kV added. 4. HV services list "Oven heaters" renamed as "mass marker ovens". The fourth mass marker oven renamed as mass marker return. Extraction electrode 1 (10000 V) has been removed. Extraction electrode 2 renamed to "extraction electrode". Note added to extraction electrode: "this is included for future flexibility". Oven return 5 has been removed. Mass marker use and return possibility clarified. Target common return has been added (capable of up to 1000 A) and the functionality clarified. Maximum target and ion source heating current increased to 2400 A and 1000 A respectively. Voltage specification added to the target, ion source, mass marker ovens and the FEBIAD coil. Anode drain current increased from 1 A to 2 A. Coolant notes changed (meets HV envelope at HV bridge, pipe details defined). Number of thermocouple conductors doubled (two are required for each). FEBIAD coil current reduced to 40 A. Position switches renamed to clarify they are to monitor the target landing. Gate valve on HV added. Rewording of notes. Target coupling actuation added. Converter coupling actuation added. Limit switches added to verify the coupling of the driver beam line to the target, the target to the target station and target landing. Cooling for copper block (γ-dump) added. 5. Ground potential services list Ground services split between target station and the service space. X/Y deflectors removed, the quadrupole duplet will now be used for steering in addition to focusing. Collimator removed. Coolant at ground potential removed. Now only a single gate valve is included in the ground services list.	

		Capacitance manometers added. Extraction electrode added to both of the ground potential services lists. Actuation for gate valve to RIB clarified as via compressed air. Compressed air manifold added.	

Keywords: AETE, P353, ARIEL target station, AETE services list

Distribution List:

Authors, reviewers, approvers, C. Ballard, I. Bylinskii, K, Chen, R. Dawson, E. Guetre, T. Hruskovec, D. Jackson, B. Kade, M. Kettle, N. Khan, R. Laxdal, F. Maldonado, F. Mammarella, A. Messenberg, G. Minor, A. Perera, B. Richert, D. Rowbotham.

1 Background

The primary function of the Advanced Rare IsotopE Laboratory (ARIEL) is to produce and deliver radioactive ion beams to experiments. Two Target Stations are planned: ARIEL Proton Target West (APTW) and ARIEL Electron Target East (AETE). The function of the AETE Target Station is to enable the impinging of an electron driver beam to produce exotic isotopes and to facilitate their extraction, ionization and acceleration into a radioactive ion beam.

2 Purpose

This note specifies the AETE target module services. This document will serve as the definitive working list of services for the purpose of designing Target Station subsystems such as service chases and the quick disconnect mechanism.

3 Assumptions

The services are defined based on the target vessel architecture illustrated in Appendix A. The relevant assumptions about the equipment in the Target Vessel (i.e. target enclosure) are listed here.

3.1 Target module HV common

3.1.1 Design requirements

The ARIEL target modules will be capable of operating between 12 kV and 60 kV. In order to ensure reliable operation, the system is being designed to the specifications of a system capable of operating at 75 kV, this corresponds to distances of >225 mm between maintainable surfaces and >300 mm between surfaces that cannot be easily maintained.

3.1.2 Components referenced to target HV common

- Two pairs of supply and return coolant lines will deliver the high active (low conductivity) coolant to high voltage biased equipment via supply and return manifolds.
- The coolant supply/return temperatures will be measured externally from the module (at ground potential) and are therefore not included in this list.
- The target and hot cavity ion source/cathode will be heated by resistive heating and the impinging driver beam.
- The following ion source functionality will be supported:
    - ALIS (ARIEL Laser Ion Source)
    - IG-LIS (Ion Guide-Laser Ion Source)
    - FEBIAD (Forced Electron Beam Induced Arc Discharge)
    - Surface Ion Source
    - Negative Ion Source

- The AETE will not have ECR ion source functionality.
- While not included in the current design, there will be the provision for a pre-extraction electrode.
- Dedicated common voltage supplies are required at high voltage.
- The temperature may be measured at up to 9 locations on components held at high voltage bias.
- One gate valve will be incorporated onto the target vessel.

3.2 Components referenced to target ground

- Dedicated common voltage supplies are required at ground voltage.
- Ion extraction from the ion source will be accomplished by a grounded extraction electrode.
- The vacuum pressure will be measured at the target station.
- There will be the capability to vent the Target Vessel with an inert gas, while preserving the vacuum down-stream of the target module.
- The inert gas supply control valves will be located on top of the target module.
- The extracted ion beam will be focused and steered with an electrostatic quadrupole duplet mounted in the target station.
- A gate valve will be installed at the exit of the target module.

4 75 kV Services List

The values in these lists are the maximum required voltages or currents to be delivered to the target vessels. Depending on the service, it may be that the maximum current and voltage may not be required simultaneously.

*these values are based on simulations and may vary depending on the results of ongoing tests

	Service		Conductors at target	U [V]	I [A]	Notes
60 kV Bias Plane	Target Heater	Power	2	10*	2400*	The power could be provided by multiple conductors in the building chase.
	Ion Source Heater	Power	2	8*	1000*	The power could be provided by multiple conductors in the building chase.
	Mass marker oven 1	Power	1	8	80	The oven heaters are supplied by independent current inlets, one of the conductors will be used as a common return. In the case where the full current will need to be applied to two ovens, the other two conductors will be used as individual returns.
	Mass marker oven 2	Power	1	8	80	
	Mass marker oven 3	Power	1	8	80	
	Mass marker return	Power	1	8	80	
	Target common return	Power	1		1000	Only one connection is required, this will be a return for the FEBIAD magnet and under certain configurations the ion source heating current.
	FEBIAD Coil	Current	1	100	20	Based on the ISOLDE design, with additional current delivery potentially possible at ARIEL due enhanced water cooling.
	Extraction Electrode	Voltage	1	20000	5.00E-03	This is included for future flexibility, a 1 kV electron catcher may be required should a negative ion source be used.
	60 kV Common		1		5.00E-02	The voltage is the reference voltage for the bias. This voltage could be supplied through the inner enclosure of the high voltage chase.
	Anode		1	500	2	
	IG-LIS	Repeller	2	150	5	Second conductor added for redundancy. Signals via 9-pin connections.
		DC gradient	2	150	5	Second conductor added for redundancy. Signals via 9-pin connections.
		Exit Electrode	2	150	5	Second conductor added for redundancy. Signals via 9-pin connections.
		RF	8	± 150	5	1.5MHz – 4 twisted pairs. Signals via 9-pin connections.
	Thermocouples (pairs)	Heat Shield	4			The number of conductors listed refers to the number of thermocouples, each consisting of a pair of conductors. i.e. the 2 thermocouples for heat shield consists of 2 pairs = 4 conductors. Heat shield = 2x type K, Converter = 3x type K, 1x type C, FEBIAD coil = 1x type K, Target = 2x type C. Signals via 9-pin connections.
		Converter	8			
		FEBIAD coil	2			

		Target	4			
	Coolant	Supply	2 (pipes)			The latest point the cooling water will meet the high voltage envelope is at the input of the HV bridge. The water should not run through the building chase. The pipes for the converter cooling will be either 1/2" or 3/4" in diameter and made from stainless steel. The pipes for the target base plate cooling will be 1/2" and made from stainless steel.
		Return	2 (pipes)			
	Gas		2 (pipes)			The gas pipes are 10 mm stainless steel tubes. One will be used for the FEBAID buffer gas, the other for the creation of molecular ion beams (using gases such as CF_4 or SF_6).
	Target gate valve/front end shutter	Actuation	1 (rod)			Drive delivered from the top of the target module.
		Limit switch	2			A single limit switch will be used to verify the valve is closed. One of the three limit switch connections will be connected to HV common (no signal cable required).
	Target coupling	Compressed air	2 (tubes)			Compressed air delivered via the ground services chase.
	Converter coupling	Compressed air	2 (tubes)			Compressed air delivered via the ground services chase.
	Target landing position switches	Limit switches x3	6			One of the three limit switch connections will be connected to HV common (no signal cable required).

5 Ground Services List

	Service		Conductor	U [V]	I [A]	Notes
0V Ground Plane (target station)	Quad Lens	Voltage	8	5000	5.00E-03	Used both for steering and focussing the ion beam.
	Gate Valve to RIB Actuation & Position	Actuation	1 (rod)			One of the three limit switch connections will be connected to HV common (no signal cable required).
		Limit switch x1	2			
	Ground electrode position	Limit switch x1	3			A single limit switch will be used to verify the extraction electrode has been retracted.
		Actuation	1 (rod)			Drive delivered from the top of the target module.
	Target coupling limit switches	Limit switches x2	4			One of the three limit switch connections will be connected to ground (no signal cable required).
	Target coupling potentiometer		2			
	Converter coupling limit switches	Limit switches x2	4			One of the three limit switch connections will be connected to ground (no signal cable required).
	Converter coupling potentiometer		2			
	Cold cathode ion gauge	Voltage and signal	1	5000	5E-4	The services for the ion gauge are assumed to be delivered via a single connection.
	Argon vent/roughing		1 (pipe)			A single 18 mm steel pipe will be used.
	Chassis		1	1E-02	5.00E-03	

6. Service space ground services list

	Service		Conductor	U [V]	I [A]	Notes
0V Ground Plane (service space)	Target vessel gate valve/front end shutter actuation & position	Actuation signal	TBD	TBD	TBD	The rod driven by this device will pass through the target module. A single cable is assumed for the motor.
		Limit switch x2	4			One of the three limit switch connections will be connected to ground (no signal cable required).
	Front end shutter actuation & position	Actuation signal	TBD	TBD	TBD	
		Limit switch x2	4			One of the three limit switch connections will be connected to ground (no signal cable required).
	Venting/roughing system	Convectron gauge	1			A single power/signal cable is assumed
		2x Capacitance manometers	2			Required for compatibility with the argon used for venting. A single power/signal cable is assumed
		Valves x3	3	24	0.1	A single power/signal cable (containing three wires) is assumed per valve.
	Ground electrode actuation	Actuation signal	TBD	TBD	TBD	The rod driven by this device will pass through the target module. A single cable is assumed for the motor.
		Potentiometer	2	24	0.1	
		Limit switch x2	6	24	0.1	One of the three limit switch connections will be connected to ground (no signal cable required).
	Compressed air manifold	Compressed air input	1 (tube)			One tube in, five tubes out to the target module ground services chase
		Valves x4	7	24	0.1	A single power/signal cable (containing three wires) is assumed per valve.

Particle Beam
Coolant (HA) water
Pneumatic / gas
Electrical
Mechanical Actuation
High Voltage
Primary Vacuum Envelope
Vacuum Boundary

HV Service Chase
HV Quick Disconnect
HV Feed through/ Bridge

Driver Beamline
Station Driver Beam Gate Valve
e⁻
Photo-fission converter
γ
Beam Dump

Actuation from Service Space
Limit Switches (x2)
Limit Switches (x2)
Potentiometer
Limit Switches (x2)
Feedback

Ion source gas input
Baseplate cooling water
Converter/vessel cup cooling water
Target gas input
Target common return
Thermocouples (x4)
Thermocouples (x5)
60kV bias
Target Landing Limit Switches (x3)

Services:
FEBIAD coil Neg. IS
Anode V IG-LIS RF / V

Target heater
Target
Mass marker ovens
Transfer line
IS heater
Ion Sources:
FEBIAD ALIS
IG-LIS Neg. IS
Extraction Electrode (future)

Target Vessel

Target Station

Limit Switch (x1)

Front End (ground)

Target vessel gate valve
& Front End Shutter
Ground Electrode
Quad Lens
RIB
Module RIB Gate Valve
RIB Beamline

Inert gas supply (vent & pump down)
Ion Gauges

Target Vessel and Front End (HV)

Limit Switch (x1)
Limit Switch (x1)

Limit Switches (x4)
Potentiometer (x2)
Target/Converter Coupling

Ground Potential Module Chase

Chassis Ground
Feedback
Piston Actuation
Gas inlet/outlet

Ground Potential Quick Disconnect

Common pneumatic supply manifold

Valve
CG gauge
Valve
CM gauge