



ASTON IMPACT PRODUCT MANUAL

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1. INTRODUCTION

1.1. About Aston Impact

Aston Impact uses mass spectrometry to quantify the composition of constituents in an analyte by filtering associated ions according to their mass-to-charge ratio (m/z) and measuring their abundance. A mass spectrum, consisting of ion signal vs m/z is generated.

Within its compact platform, Aston Impact, uses high-performance electronics and analytical algorithms to display the mass spectrum and compute compositions in real time without sacrificing response time, sensitivity, resolution, or accuracy.

The result is a highly configurable, quantitative real-time analytical tool which has the versatility to address many applications in industrial and laboratory environments.

The system is accessible by users through a user interface (UI) called AtonLab. AtonLab is a feature rich UI providing ample flexibility to customize the system for a desired application.

AtonLab allows the user to:

- Visualize and control instrument state
- Trigger and visualize data acquisition
- Download and visualize reports
- Configure operating parameters
- Perform instrument calibration
- Run built-in diagnostics

1.2. Intended audience

This document is for the reference of operators who are responsible for setting up and using the Aston Impact product as part of their process.

1.3. Software release notes

Software release notes with new features, resolved issues, known limitations etc. are available at the [Atonarp knowledge base](#)

1.4. Safety guidelines

Users must read the general safety information, potential hazards, and associated warnings for the Aston Impact system. Recommended precautions must be taken to minimize hazards.






WARNING!

All work described in this document must be carried out by persons who have suitable technical training and the necessary experience, or who are working under the supervision of the end-user of the product. Only qualified Atonarp representatives, or Atonarp approved personnel must install and service the equipment.

1.5. Notational conventions

This manual uses the following typographical conventions

Bold Text		Menus, menu options, function names, input fields, option icon names, check boxes, drop-down list, dialog box names, window names, and parameters
WARNING!		Information suggesting possible danger from actions that can cause failures or injuries
CAUTION!		Recommended care to avoid danger, mistakes or failures Provides additional
NOTE		Important information about a topic

1.6. Unit conventions

UNIT NAME	SI UNIT	CONVERSION
Pressure	HectoPascal (hPa)	1 hPa = 0.750 Torr = 133.3 Pa
Current	Ampere (A)	1 A = 10^6 μ A, 10^{12} pA, 10^3 mA
Frequency	Hertz (Hz)	1 Hz = 10^{-6} MHz
Capacitance	Farad (F)	1 F = 10^{12} pF
Temperature	Kelvin	K = 273.15 + °C

* *The following units of mass are interchangeably used in this document and/or Aston Impact software - amu, u, Da, Th.*

1.7. Document support

Any errors, comments, and questions regarding this document can be communicated through techpubs@atonarp.com

1.8. Customer support

When issues are encountered with the operation of Aston Impact, or if there are any queries regarding the product, it is advised to raise a support request at the Atonarp customer portal available at support.atonarp.com. For more information about the portal, see [customer support](#) document.

2. SPECIFICATIONS

This section describes the electrical and environmental specification details of the Aston Impact system.

Electrical specifications

Table 1. Electrical Specifications

VOLTAGE	FREQUENCY	MAX POWER
90 – 240V AC	50/60 Hz	250 W

Table 2. Electrical Connection

VOLTAGE	PLUG
110VAC	3 Prong, Grounded plug
230VAC	European style, 2 prong plug with ground contact

Table 3. Inlet Fuse Electrical Characteristics

Ampere Rating	Percentage of Ampere Rating	150%	275%	400%	1000%
5A	Opening Time	30 min	600ms-10s	150ms-3s	20ms-300ms

2.1. Technical specifications [\(See product brochure for latest\)](#)

PARAMETER	CONDITION	MIN	TYPICAL	MAX	UNITS
Mass Range		2		300	u
Mass Resolution	Full Width at 10% valley for N ₂	0.6	0.8	1	u
Mass Number Stability		0.1	0.1	0.3	u
Sensitivity (FC/SEM)	Nitrogen-equivalent		$5 \times 10^{-6} / 5 \times 10^{-4}$		A/Torr
Minimum Detectable Partial Pressure(FC/SEM)	Nitrogen-equivalent		$10^{-9} / 10^{-11}$		Torr

Limit of detection	Nitrogen-equivalent		<100		ppb
Maximum operating pressure			10^{-3}		Torr
Dwell Time per u		1	40	200	ms
Scan update Rate per u			37		ms
Sampling Pressure Range		1×10^{-5}		1×10^{-3}	Torr
Operating Temperature	80% relative humidity non-condensing	5		35	°C
Emission Current		0.1	0.4	1	mA
Emission Current Accuracy		0.03	0.05	0.1	%
Start-up Time			5		mins
Ion current Stability	Over 24 hrs at constant ambient & pressure		<+/-1		%
Concentration Accuracy			<2		%
Concentration Stability		± 0.5	± 0.5	± 1	%

2.2. Environmental specifications

Table 3. Environmental Specifications

SPECIFICATION	VALUE
Indoor/Outdoor	Indoor controlled environment
Relative Humidity	80%, non-condensing
Altitude	max. 2000 m
Ambient Temperature	5 – 35 °C

2.3. Physical dimensions

Aston Impact dimensions are 218 mm wide, 298 mm long, and 314 mm tall as shown below.



The weight of the Aston impact excluding the cable is 13kg.

If Aston Impact is installed inside a closed enclosure, such as a NEMA enclosure, proper ventilation using a fan to sustain an air temperature inside the enclosure under 35 °C and maintaining at least 25.4 mm clearance around the Aston Impact if necessary.

It is also necessary that the users have easy access to the rear side of the Aston Impact, where the power inlet is located. This is necessary whether the Aston Impact is installed inside an enclosure or not and will allow easy and quick disconnection of power to the unit if necessary.

3. PHYSICAL OVERVIEW

The physical design of Aston Impact, the various connections and their functions are described in this section.

3.1 Rear panel

The figure below shows the rear panel of Aston Impact. For a detailed description of the rear panel interfaces, see the table below. Atonarp recommends that the installation at the user site be performed by either Atonarp personnel or onsite professionals with knowledge of vacuum technology aspects. As a reminder, gasses from process chambers simply pass-through Aston to perform measurements and can be leaked to the ambient atmosphere only in the case of an outward leak at the exhaust port of the Aston pump. To minimize the possibility of outward leaks, it is necessary that the system is regularly checked for leakage by operating it with non-harmful gas and checking for any leak point.



Aston Impact rear panel

Back panel interface description

INTERFACE	DESCRIPTION
Power inlet	Input AC power to the instrument_(100-240VAC/ 5A MAX).
Ethernet	A 10/100/1000 Mbps Ethernet interface is provided for high-speed communications and control. The User interface communicates through this connection.
Ethercat IN	Input port for Ethercat connection
Ethercat OUT	Output port for Ethercat connection
STATUS	LEDs show status of the system (see Table 10)
USB Serial	USB port for troubleshooting through a serial debug interface.
USB - OTG	USB Host or Device (OTG) configurable port. OTG mode is used to program the Aston. Host mode is to connect peripheral devices.

Remote IN/OUT	Serial input/output connection (See Tables 7 and 8)
TMP Purge	Connection to a N ₂ line to protect turbo pump bearings from corrosive gasses.
Valve 1/2	Optional ports for Open/Close control of the sample line and exhaust line
Exhaust	Gas exhaust from the system.
Pneumatic (0.4-0.8Mpa)	Optional port for protecting inlet & outlet gas ports, in case of those pressures are out of our acceptable ranges.

3.1.1 Remote IN (DSUB9 Male)

Table 7. Remote In Pin

PIN. NO	ASSIGNMENT
1	Digital IN (24V) Ch.1
2	Digital IN (24V) Ch.2
3	Digital IN (24V) Ch.3
4	Analog IN (0-10V)
5	24V
6	-
7	-
8	GND
9	-

3.1.2 Remote OUT (DSUB9 Female)

Table 8. Remote OUT Pin

PIN. NO	ASSIGNMENT
1	Analog out (0-5V)
2	Digital OUT (24V) Ch.1
3	Digital OUT (24V) Ch.2
4	Digital OUT (24V) Ch.3
5	24 V (power)
6	GND
7	GND
8	GND
9	GND

3.2 Side panel

Below figure shows the side panel of the Aston Impact system.



Analytes are fed to Aston Impact through the top inlet port on the side panel. The inlet is a ¼" VCR female connector. There is a second inlet port for the Aston Impact that can be used as sample bypass for fast response time of the mass spectrometer.

3.3 System LEDs

Functions of various LEDs on the rear panel Aston Impact are described. (Lighting: Normal Status, Blinking: Error Code, x: Lighting or Off)

There is also an LED on the front panel of Aston that turns blue when the power switch is on, and power is properly supplied to Aston Impact internal components, i.e. the inlet fuse is not broken.



Table 10. Rear panel LED status description

LED 1	LED 2	LED 3	LED 4	DESCRIPTION
Lighting	X	X	X	CB is powered
Lighting	X	Lighting	X	CB to PC(UI) Connection is established

4. SYSTEM COMPONENTS AND OPERATION

The core of Aston Impact is the mass spectrometer (MS). Inside the MS, the analyte is processed in three stages. First, the analyte molecules are ionized in the ion source. The ions are then filtered according to their mass-to-charge (m/z) ratio in a mass filter. After filtering, ions of specific mass are captured in a detector which produces an electric current proportional to the molecule/ion count. The magnitude of the electric current as a function of mass is plotted as the mass spectrum.

4.1. Ion source

Ionization of the analyte takes place in the ion source. Ionization of analyte molecules is done to impart a charge to them so that their motion can be controlled by electric fields. The specific method used to ionize the analyte is called the ionization technique. The ions produced in the ion source are transmitted by the ion optics into a mass filter. The polarity of the potentials applied to the ion source and ion optics determines whether positively charged ions or negatively charged ions are transmitted to the mass filter. Aston Impact uses electron impact ionization technique as described below.

4.1.1 Electron impact ionization

Electric current is used to heat a filament causing it to emit electrons. The ion source has electrodes with adjustable bias voltages to create an electric field (typically -70 V) in which the electrons are accelerated towards the analyte molecules. The high-energy (70 eV for example) electrons collide with the analyte molecules to form molecular ions as well as doubly charged ions and fragments of lower mass-to-charge values.

Electrostatic lenses in the ion source accelerate/decelerate the transmission of ions from the ion source to the mass filter. The lens electrode voltages can be adjusted to control the transmission of ions to the mass filter.

Electron ionization is also useful when the application analytes are not chemically corrosive (for example, not Cl or F halide gasses).

Filaments are typically made of Tungsten Rhenium alloys. Tungsten is adequate for chemically reducing environments (for example, H_2 and SiH_4) but vulnerable to oxidation and hence must not be allowed to be in contact with oxygen. For applications featuring oxidizing atmospheres (H_2O , O_2 etc.), it is advised to use an Yttria coated Iridium filament.

4.2. Mass filter

The mass filter separates ions according to their mass-to-charge ratio (m/z). At any specific electric field, only ions of a selected m/z can pass through the mass filter.

The Aston Impact uses a quadrupole mass filter that consists of four cylindrical rods mounted in a matrix-like pattern in ceramic collar. Ions from the ion source are injected into the space between the quadrupole rods.

Time varying voltages applied to the quadrupole rods creates an oscillating electric field through which ions are transmitted. Ions are separated in the quadrupole based on the stability of their trajectories in this oscillating electric field.

Stable trajectories for ions of specific m/z are achieved by applying specific time varying voltage amplitudes to the quadrupole rods. Ions of other m/z ratios have unstable oscillations which increase in amplitude until they collide with the quadrupole rods and are removed from the ion stream.

Each pair of diagonally opposed rods is electrically shorted. A combination of RF and DC voltages is applied to one pair of rods while the same voltages with opposite polarity are applied to the other pair. The amplitude of the RF voltage determines the mass-to-charge ratio of the ions that pass through the mass filter and reach the detector. The ratio of RF to DC voltage determines the resolution (widths of the peaks).

The filtered ions are focused into the detector. This permits selection of an ion with a specific m/z or allows the user to analyze a range of m/z values by continuously varying the applied RF and DC voltages.

4.3. Detector

The detector is located at the exit of the quadrupole mass filter. It receives the ions that are passed through the mass filter. The detector generates an electronic signal proportional to the number of ions striking it.

The detector records the charge induced when an ion passes by or hits a surface. In a scanning instrument such as the quadrupole, a mass spectrum is generated by scanning RF and DC voltages and recording the ion current at each increment.

Aston Impact uses a Faraday cup (FC) as a detector. The collected charge is converted to an electric current in a capacitive feedback electro-meter circuit. The electric current is proportional to the number of ions colliding with it. Because this current is typically quite small, considerable amplification is necessary to extract a signal.

Optional support for a Secondary Electron Multiplier (SEM) is available. Commercially available miniature SEM enabling dual mode detection is embedded within the sensor. The electron multiplier (EM) has an off-axis structure and a Faraday detector for ion detection. In EM mode, ions emitted from the filter are deflected and multiplied by a series of dynodes.

4.4. Vacuum (Quadrupole) chamber

The ion sources, ion optics, mass filter and the ion detection system are enclosed in a vacuum (quadrupole) chamber. A moderate to high vacuum environment is required to manipulate ions across small distances without colliding with each other or the surfaces of parts inside the vacuum chamber. Operation at high pressure can also damage the instrument sensor.

4.5. Process and pressure measurement and regulation

Aston Impact is connected to a process chamber either directly or via an optional sampling module called Advanced Vacuum Controller (AVC). The AVC regulates the pressure inside Aston Impact's vacuum chamber, despite process pressure excursions. The AVC includes a variable leak valve, inlet, and outlet pressure gauges. It throttles the internal valve to regulate its output pressure which is also Aston Impact's input pressure.

4.6. Quadrupole pressure sensor

An integrated cold cathode gauge is used to measure the pressure inside the quadrupole chamber.

4.6.1 Pressure sensor specification

Table 3. Measuring and pressure value

PARAMETER	SPECIFICATION
Accuracy (N ₂)	Approx. +/-30%: 1x10 up to 1x100hPa Approx. +/-50%: 100 to 100 hPa
Repeatability (N ₂)	Approx. +/- 5%: 1x10 ⁻⁸ up to 100 hPa
Measuring range (air, N ₂)	1x10 ⁻⁹ up to 1000 hPa
Maximum pressure (absolute)	10000 hPa, limited to inert gasses and temperature < 55 °C
Burst pressure (absolute)	> 1300 Pa
Measuring principle	Cold cathode

4.7. Sensor heater

The sensor heater is used to prevent condensation and adsorption of process species on the inner walls of the vacuum chamber and on the sensor.

4.8. Controllers

4.8.1 Main controller

The main controller has the integrated drive electronics required to:

- Drive the filament to produce desired emission
- Generate the DC and RF voltages needed to create electric fields between the sensor electrodes
- Collect data from the ion detector, amplify, and digitize the signal
- Provide computational horsepower needed to run algorithms that post-process the signal
- Run a web application to provide the user interface for instrument configuration, control, and reporting

Aston Impact controller supports different scan types to generate, fragment, and eject ions from the mass filter. The ability to adjust the scan type, and other settings gives flexibility to adapt it to process requirements.

4.9. Pumping system

A differential pumping system consisting of a turbo-molecular pump and a (optional) internal roughing pump is used to maintain a moderate to high vacuum in the vacuum chamber. Split flow turbo molecular pump is clamped to the bottom of the vacuum chamber. The turbo pump is controlled by a pump control unit.

On receiving a signal from Aston Impact controller, the turbo controller initiates the start-up procedure for the turbo pump. During normal operation, the pump controller monitors the turbo pump for significant changes in turbo speed, operating temperature, and load faults. When a fault occurs, the controller will shut off the pump automatically.

5. LEGAL INFORMATION

5.1. Liability

Atonarp assumes no liability and the warranty becomes null and void if the end-user or third parties:

- 5.1.1.** Do not follow the information provided in this document.
- 5.1.2.** Use the product in a non-conforming manner.
- 5.1.3.** Make any kind of interventions (modifications, alterations etc.) on the product.
- 5.1.4.** Use the product with accessories not listed in the product documentation.

5.2. Licenses, trademarks, and copyright

This section describes the licenses for third party software used or associated with this product.

Table 36. Software licenses

PACKAGE	COMMENTS	VERSION	LICENSE TYPE
Iniparser	-	-	MIT
Armadillo	-	-	Mozilla Public License Version 2.0
Libuv	derived out of nodejs	-	BSD
Libwebsockets	statically linked to unmodified version of libwebsockets	-	LGPL
Sqlite	-	-	Public Domain
Nlopt	dynamically linked to operating system provided library	-	a portion of nlopt contains GPL
Curl	dynamically linked to operating system provided library	-	https://github.com/curl/curl/blob/master/COPYING
I2C and SPI driver	-	-	Apache License, Version 2.0
Nodejs	-	-	MIT
npm packages	body-parser	1.15.2	MIT
	cookie-session	1.2.0	MIT
	Express	4.14.0	MIT

	socket.io	1.4.8	MIT
	Multer	1.2.0	MIT
	Jade	1.11.0	MIT
sqlite3	-	3.1.4	BSD
Websocket	-	1.0.24	Apache License, Version 2.0
Angularjs	-	-	MIT
Bootstrap	-	-	MIT

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6. ABBREVIATIONS

A	Amperes (current)
Amu	Atomic Mass Unit
BSD	Berkeley Software Distribution
CLI	Command Line Interface
COMM	Communication Port
CTS	Clear to Send
Da	Dalton
dB	Decibel
DB	Database
DC	Direct current
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
EI	Electron Ionization
EHS	Environmental Health and Safety
eV	Electron volt
GND	Ground
GPL	General Public License
HTTPS	Hypertext Transfer Protocol Secure
Hz	Hertz (frequency)
IP	Internet Protocol
IPv4	Internet Protocol version 4
I2C	Inter Integrated Circuit Communications
JPEG	Joint Photographic Experts Group
JSON	JavaScript Object Notation
LED	Light emitting diode
m/z	Mass to charge
Nmtui	NetworkManager Text User Interface
PC	Personal Computer
PDF	Portable Document Format
pF	Picofarads
PNG	Portable Network Graphics
RF	Radio Frequency
RPM	Revolutions per Minute
RS-232	Recommended Standard no. 232
RTS	Request to Send
RX	Receive
SoC	System on a Chip
SSH	Secure Shell
SSL	Secure Sockets Layer
SVG	Scalable Vector Graphics
Th	Thomson

TLS	Transport layer security
TTL	Transistor-Transistor Logic
TX	Transmit
U	Unified Atomic Mass Unit
USB	Universal Serial Bus
UI	User Interface
URL	Uniform Resource Locator
V	Volts (voltage)
W	Watts (power)

7. QUICK ACCESS TO ASTON IMPACT FILES

Quick Links to Aston Impact Source Files

1	Atonarp knowledge base
2	Aston Impact Windows client application
3	Aston Impact Ubuntu client application

8. GLOSSARY

Ambient Temperature

Ambient temperature is the temperature of the air surrounding a component.

Analyte

Analyte is a substance whose chemical constituents are being identified and measured.

Annotate

Annotate is technique to describe or add additional comments, notes, explanations, or other types of remarks to a plot.

Aston Impact

Aston Impact uses mass spectrometry to quantify the composition of constituents in a gas blend by measuring the mass to charge ratio of the ions generated from the blend.

Aston Impact configuration

Aston Impact configuration sets the mass spectrometer properties.

Aston Impact manager

A middleware layer of the Aston Impact software stack.

Background scan

A background scan measures the contribution of ion leakages and environment to the generated spectrum.

Baud

Baud is a component that determines the speed of communication over a data channel.

Blend

Blend is a mixture of different analyte molecules. Known blends are used for calibrating the Aston Impact.

Calorific value

The amount of energy produced by the complete combustion of a specified quantity of material or fuel.

Compliance

Following certain accepted standards

Dashboard

Dashboard is the primary page for the user to interact with and monitor the Aston Impact.

Detector

Detector is a component in the mass spectrometer which generates an electronic signal proportional to the number of ions striking it.

DHCP server

DHCP server is a network server that automatically assigns an IP addresses and other network configuration parameters to a device on a network so it can

communicate with other IP networks. It relies on the standard protocol known as Dynamic Host Configuration Protocol (DHCP).

Ethernet

A system for connecting computer systems to form a local area network, to transmit the data bits containing any sort of information.

Faraday cup

Faraday cup is a component in the mass spectrometer, also known as [Detector](#).

Filter

Filter is a process which removes or separates unwanted components. The Aston Impact requires one filter at the inlet to keep out undesired contamination.

Initialize

Bring the system into a state ready for data acquisition.

Ion Current

An ion current is the rate of flow of electrical charge associated with the flow of ions into the ion detector (electrometer/collector).

Ion source

Ion source is a component in the mass spectrometer where ionization of the analyte takes place by electron bombardment.

Ionization

Ionization is a technique used in mass spectrometer to ionize the analyte.

Mass Filter

Mass filter separates ions according to their mass-to-charge ratio (m/z).

Mass spectrometer

Mass spectrometer is an analytical technique that ionizes a sample based on their mass-to-charge ratio of the ions generated from the sample.

Molecules

A molecule is an electrically neutral group of two or more atoms held together by chemical bonds. Molecules are distinguished from ions by their lack of electrical charge.

Quadrupole

Quadrupole is a type of mass filter used in mass spectrometry. It consists of four cylindrical rods mounted in a ceramic collar. Every pair of opposing rods is electrically shorted, and a radio frequency (RF) voltage with a DC offset voltage is applied between one pair of rods and the other. The magnitude of the RF voltage determines the mass-to-charge ratio of the ions that pass through the mass filter and reach the detector. The ratio of DC-to-RF voltage determines the resolution (widths of the mass peaks).

RF to DC ratio

Ratio of the RF (AC) voltage to the DC voltage applied to the quadrupoles of a mass filter. The RF-DC ratio determines the resolution (inverse to sensitivity) of the peaks in a mass spectrum.

Scan

Each sequence of processing the ions in the mass filter followed by analysis of the ions in the detector is called a scan.

Scan configuration

Scan configuration provides options to configure the masses scanned, the number of scans run, trade-off between speed and accuracy.

Scan report

Record of all scans performed on the system. This includes system settings, mole fractions, and ion currents for all masses that are scanned.

Spectrum

Distribution of ion currents corresponding to ion fragment masses of interest.

Standby

Put the system in a state not ready for scan so that it can then be shutdown. Also required before certain features in the Aston Impact software can be used.

Workflow

Workflows allow the user to sequence scan events with unique scan properties and controls valves alongside running scans in the sequence.

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