

# TANDETRON ACCELERATOR SYSTEMS

MEDIUM CURRENT, MEDIUM CURRENT PLUS AND HIGH CURRENT

0.1 - 6.0 MV/TV



**T-SHAPE 1.0 - 3.0 MV**

**COAXIAL 4.0 - 6.0 MV**



## HIGH VOLTAGE ENGINEERING

Particle Accelerator Systems for the scientific, educational and industrial research communities





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## Introduction

The HVE Tandetrans are reliable, compact and versatile -state of the art- tandem accelerator systems designed to produce MeV ion beams of virtually all periodic-system elements for material modification and analysis.

The HVE Tandetron accelerators are designed to operate in a normal laboratory environment and fit into a single room laboratory of the type found in normal analytical facilities.

A built-in magnetic suppression system to reduce backstreaming electron energy gain ensures a virtually X-ray radiation free operation.

The clever concept permits straight forward set-up and operation of the system with little operator training required.

A wide range of analyzing/switching magnets, beamlines and end stations is available to suit various applications including:

- Ion Implantation
- Rutherford Backscattering Spectrometry (RBS)
- Particle Induced X-ray Emission (PIXE)
- Elastic Recoil Detection (ERD)
- Nuclear Reaction Analysis (NRA)
- Accelerator Mass Spectrometry (AMS)

A modular design allows customized systems from standard components and makes future system extensions possible with minimal changes and costs.

## Three-in-one concept

The HVE Tandetrans are, unlike other types of tandem accelerators, available in three beam current versions within one basic concept: medium current (MC), medium current plus (MC<sup>+</sup>) and high current (HC).

*This three-in-one concept allows laboratories to start off with a low cost system, for instance a MC-Tandetron initially used for ion beam analysis only and in future to upgrade it at reasonable cost and with minimal changes to a MC<sup>+</sup>- or a HC -Tandetron for (additional) applications which require higher beam currents such as ion implantation.*

Besides these MC, MC<sup>+</sup> and HC Tandetrans HVEE offers a range of Coaxial Tandetrans capable of producing even higher beam currents.



**State of the art HV-power generation**

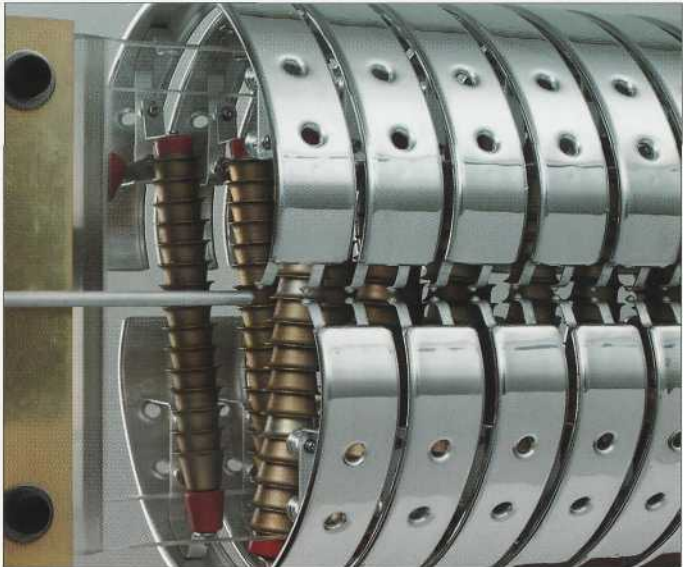
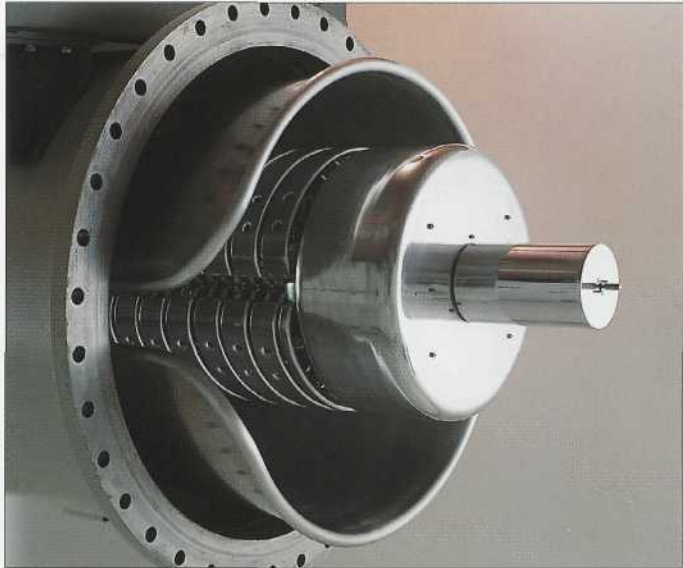
The central feature of the HVE Tandetron concept is a -state of the art- SF6 insulated, parallel fed, capacitively coupled Cockcroft-Walton type High Voltage power supply characterized by high reliability, extreme low noise level, high terminal voltage stability and low terminal voltage ripple.

Because the Tandetron HV power supply is a voltage source rather than a current source corona stabilization, to accomodate differences in beam- and charging-currents, is not required.

A high RF driving frequency, special RC-filtering and feedback circuits eliminate hum, drift and jitter and provide a high terminal voltage stability and low terminal voltage ripple without the need for slit stabilization.

As a result, the beam energy resolution of the Tandetron is superior compared to other types of tandem accelerators.

Moreover, since the Tandetron HV power supply is a purely electronic power supply it has the advantage that it has no moving parts. As a result there are no vibrations, which might result in terminal voltage fluctuations and ripple & stability values and dynamic behaviour are stable over many years of operation whereby maintenance of the components in the pressure tank is seldom, if ever, needed. Many Tandetrons have been in operation for years without ever opening the pressure tank.





### Perfect energy matching

After mass analysis the ion beam is injected into the Tandetron and focussed through the HV terminal stripper by means of a novel (patented) energy matching lens.

The so-called Q-snout lens is located in the entrance of the LE accelerator tube and matches the characteristics of the injected ion beam with the ion optics of the accelerator for the entire terminal voltage range and is capable of transporting high current ion beams without introducing significant changes in beam diameter.

The Q-snout lens eliminates the need for gridded lenses, pre-acceleration stages, HV protection cages and X-ray shielding as required with conventional tandem injection systems and allows automatic focussing.



### Large variety of ions

Three types of ion sources are available of which, depending on the application(s) of the system, any two can be mounted simultaneously on the dual source injector system.

This provides flexibility to produce a large variety of ions and quick change-over from heavy to light ions with a combined implantation-analysis system.

The following types of ion sources are available:

- RF ion source Model SO-173

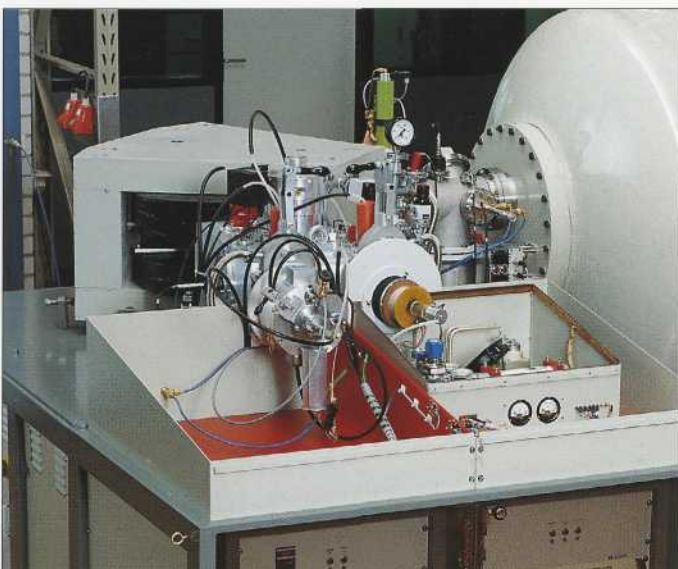
A further development of the Oak Ridge RF ion source specially suited to produce He ions.

- Duoplasmatron ion source Model 358

An upgraded version of the Van Ardenne ion source specially suited to produce H and He ions.

- Negative sputter ion sources Model 860A and C.

HVE versions of the Middleton sputter ion source specially suited to produce ions from a large variety of materials.



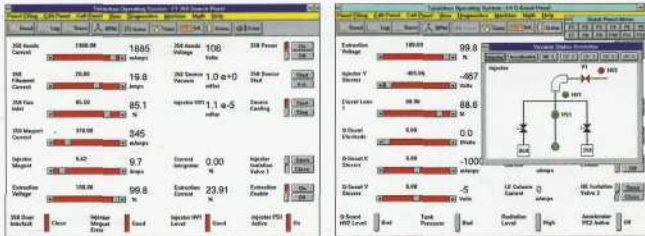
### High resolution Mass analysis

The HVE Tandetron is provided with a very compact -high mass resolution- dual source injection system.

Source selection and mass analysis of the injected ion beam is accomplished by a unique 90° switching/analyzing magnet.

A specially designed (patented) magnet allows two ion beams, originating from two independent sources and injected under a small angle, to be efficiently transported and focussed to a common mass defining slit.

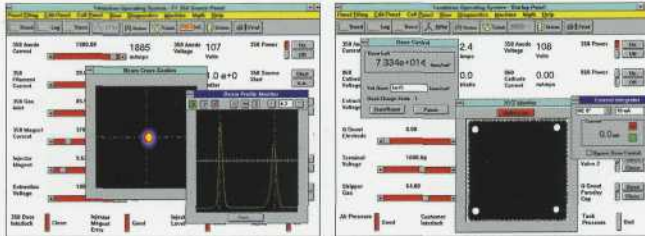
The injection system is able, at maximum injection energy to deflect and analyse all elements in the periodic table with a mass resolution of no less than 1 : 190.



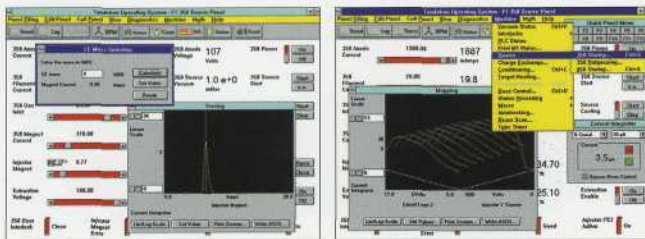
## Full control automation

The HVE Tandetrans use modern automation techniques to achieve maximal use and optimal performance on a day-to-day and month-to-month basis.

A dedicated Microsoft™ based software program, developed in-house at HVE running on an industrial personal computer provides user friendly interfaces and allows automatic start up & shut down and automated tuning, control & monitoring of the entire accelerator system

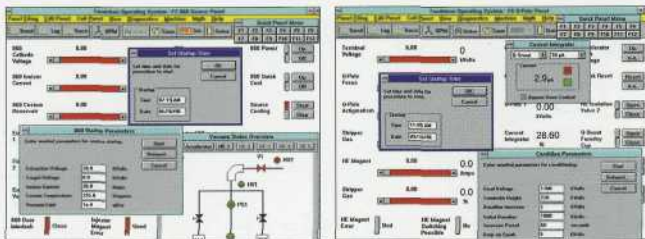


All system parameters can be controlled using a mouse and/or keyboard whereby the actual readings are shown in an interactive sequential format or in a graphic format simultaneously as a function of time without the need for additional conventional control knobs, read outs or oscilloscopes.



## Auto start up and shutdown

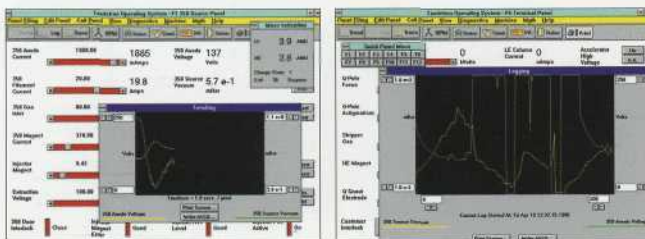
Automatic (unattended) system self start up and shut down allows maximal use of the accelerator system and includes control and monitoring of among others: ion sources, charge exchange canal, vacuum system, terminal voltage conditioning and target heaters.



## Auto tuning

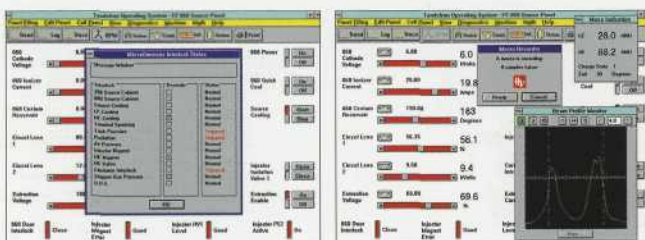
For automated tuning and optimizing of system parameters various subroutines are included such as:

- Automatic setting of magnet currents based on entry of ion mass in AMU
- Direct entry of required dose in ions/cm<sup>2</sup>
- Tracing & Mapping for optimizing of parameters, one respectively two (dependent) parameters simultaneously
- Teach & Playback capability for recall of parameters based on previous runs
- Display on the computer screen of an image of the scanned target area and beam profiles & cross sections at various locations throughout the system.



## Automatic (unattended) operation

Unlike most other accelerators where continuous operator supervision is essential, the HVE Tandetrans are almost completely automated. User pre defined batches of samples can be implanted of analyzed without operator intervention.



## Auto beam tracking

Beam tracking is included for automatic adjustment of Einzellenses, steerers, Q-poles, beam scanners, electrostatic deflectors, magnets, etc when changing the beam energy. Moreover automatic beam energy stepping is available for automated thick layer implants and for automated nuclear reaction and resonance scattering analysis.

## SPECIFICATIONS

Model No.	4110			4117			4120			4130			4140			4150			4160						
	MC	MC*	HC	MC	MC*	HC	MC	MC*	HC	MC	MC*	HC	MC	MC*	HC	MC	MC*	HC	MC	MC*	HC				
Beam current version*																									
Terminal voltage range	0.1 - 1.0			0.1 - 1.7			0.1 - 2.0			0.2 - 3.0			0.2 - 4.0			0.3 - 5.0			0.3 - 6.0						
Terminal voltage stability																									
· standard system (GVM)**	150			200			200			300			400			500			600						
· with slit stabilisation***	30			30			30			30			30			30			30						
Terminal voltage ripple**																									
· standard system	100			100			100			200			300			400			500						
· with de-rippling kit	25			25			25			30			40			50			60						
X-ray level****	<2			<2			<2			<2			<2			<2			<2						
Beam currents*****																									
· Ion source Model 860A																									
	<sup>11</sup> B	2+	10	15	15	2+	10	20	20	3+	10	20	20	3+	5	20	20	3+	5	15	15	3+	4	10	10
	<sup>16</sup> O	2+	25	50	80	2+	25	40	80	3+	25	50	100	3+	20	40	100	4+	15	30	100	4+	15	30	80
	<sup>28</sup> Si	2+	35	50	100	2+	40	50	140	3+	40	50	150	3+	20	40	125	4+	15	30	125	4+	15	30	100
	<sup>31</sup> P	2+	15	25	25	2+	15	35	35	3+	15	35	35	3+	10	40	40	4+	10	30	35	4+	10	30	30
	<sup>58</sup> Ni	2+	3	6	6	2+	5	10	10	2+	5	10	10	3+	3	8	8	3+	3	10	10	4+	3	8	8
	<sup>63</sup> Cu	2+	5	10	10	2+	5	15	15	2+	5	15	15	2+	3	10	10	3+	3	10	10	3+	3	8	8
	<sup>197</sup> Au	1+	10	50	50	2+	20	50	60	2+	20	50	60	2+	10	40	40	2+	8	30	40	3+	10	25	35
· Ion source Model 358																									
	<sup>1</sup> H	1+	5	20	20	1+	5	25	25	1+	5	25	25	1+	4	25	25	1+	4	20	20	1+	3	15	15
	<sup>4</sup> He	2+	0,5	1	1	2+	1	2	2	2+	1	2	2	2+	0,7	2	2	2+	0,7	1,5	1,5	2+	0,5	1	1
· Ion source Model 173																									
	<sup>4</sup> He	2+	0,2	0,5	0,5	2+	0,5	1	1	2+	0,5	1	1	2+	0,3	1	1	2+	0,3	0,8	0,8	2+	0,3	0,5	0,5

\* Medium current plus (MC\*) version is a medium current (MC) version equipped with a (optional) stripper gas re-circulation pump.

\*\* High current (HC) version is a medium current plus (MC\*) version equipped with a (optional) high current power supply.

\*\*\* measured over one hour, after one hour of warming up, at 75% of maximum terminal voltage.

\*\*\*\* measured over one hour, after one hour of warming up, at the exit of a HVVEE 90° 1500mm radius analyzing magnet, by means of the <sup>7</sup>Li(p,n) reaction at 1.881MeV.

\*\*\*\*\* measured at 1mtr from the tankwall, running a 1µA He beam at maximum terminal voltage.

\*\*\*\*\* measured at maximum terminal voltage in a Faraday cup after a HVVEE high energy switching magnet.

High Voltage Engineering Europa B.V. reserves the right to change specifications and features without prior notice, unless part of a quotation or order.

