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RHODOTRON

The New High-Power / High-Energy Electron Accelerator for Industry

ION BEAM APPLICATIONS

Customer Requirements

- 10 MeV for sterilization of medical devices
- 10 MeV for effective penetration of chords of thick wall tubing
- 150 - 200 kW for sufficient throughput rates to ensure competitive edge
- High scan rate to ensure uniform dosing at fast line speeds
- High reliability and availability
- High power conversion from electrical to radiant energy
- High precision in current settings
- Flexibility in scan widths
- Integration support with then yet to be defined material handling systems

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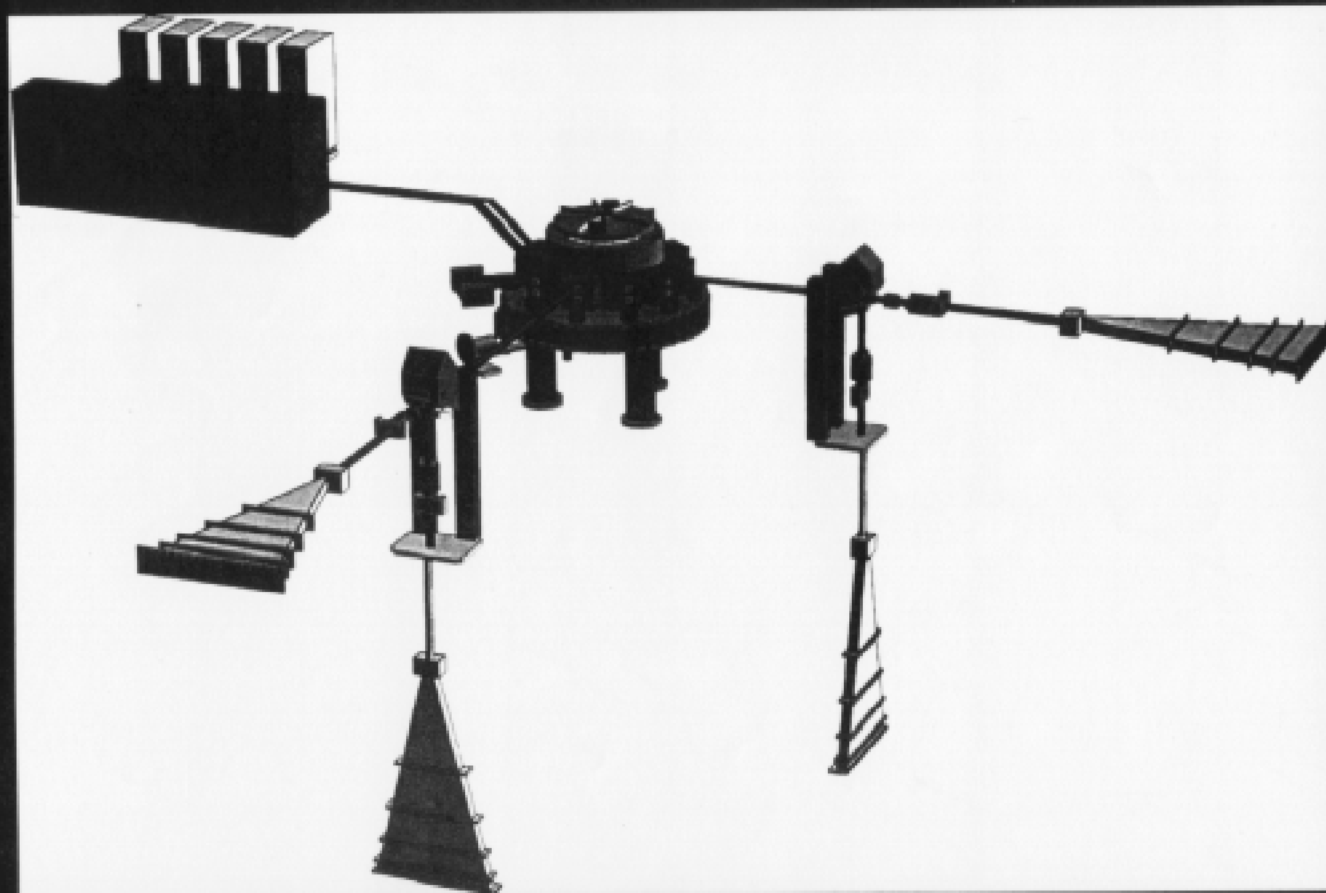
MULTI-BEAM / DUAL VOLTAGE SCHEMATIC

RHODOTRON



ION BEAM APPLICATIONS

HIGH POWER AT HIGH VOLTAGE

WHILE AWAITING MORE POWERFUL MACHINES, THE DEVELOPMENT OF MARKETS AT 10 MEV HAVE LAGGED THOSE OF LOWER MEVs.

IN SOME CASES, SOLUTIONS AT LOWER VOLTAGES WERE SOUGHT..

...IN OTHER CASES, DEVELOPMENTS WERE POSTPONED

WITH BEAM POWERS AND ELECTRICAL EFFICIENCIES NOW RIVALLING THOSE OF DC SYSTEMS, INDUSTRY MUST RE-EXAMINE THEIR OPTIONS AT VOLTAGES BETWEEN 5 AND 10 MEV.

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AT HIGHER MEV:

Minimization of max/min ratios

Treatment of thicker, denser and irregular profiles

Avoidance of "end-range" deposition of electrons likely to cause pinholes or discharge artifacts in non-conducting materials

Facilitate material handling, especially with bulk loaded and fluidized bed products, or when double sided processing can be avoided

Better process tolerance to profile variations

Greater X-Ray conversion efficiency

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Example: Formed Polymer Parts

Large max/min ratios can adversely affect end product properties as not all polymer blends have wide and tolerant dose windows.

Intra-product variations in crosslink, gel content, expansion properties. etc., can complicate post irradiation treamtents and performance, especially in heat-shrink stress prone applications.

Higher voltages can minimize dose ratios in thicker and more complexly shaped parts and profiles, especially if single sided irradiation is possible.

Higher powers combined with higher voltages can make such irradiation treatments both technologically and economically desirable.

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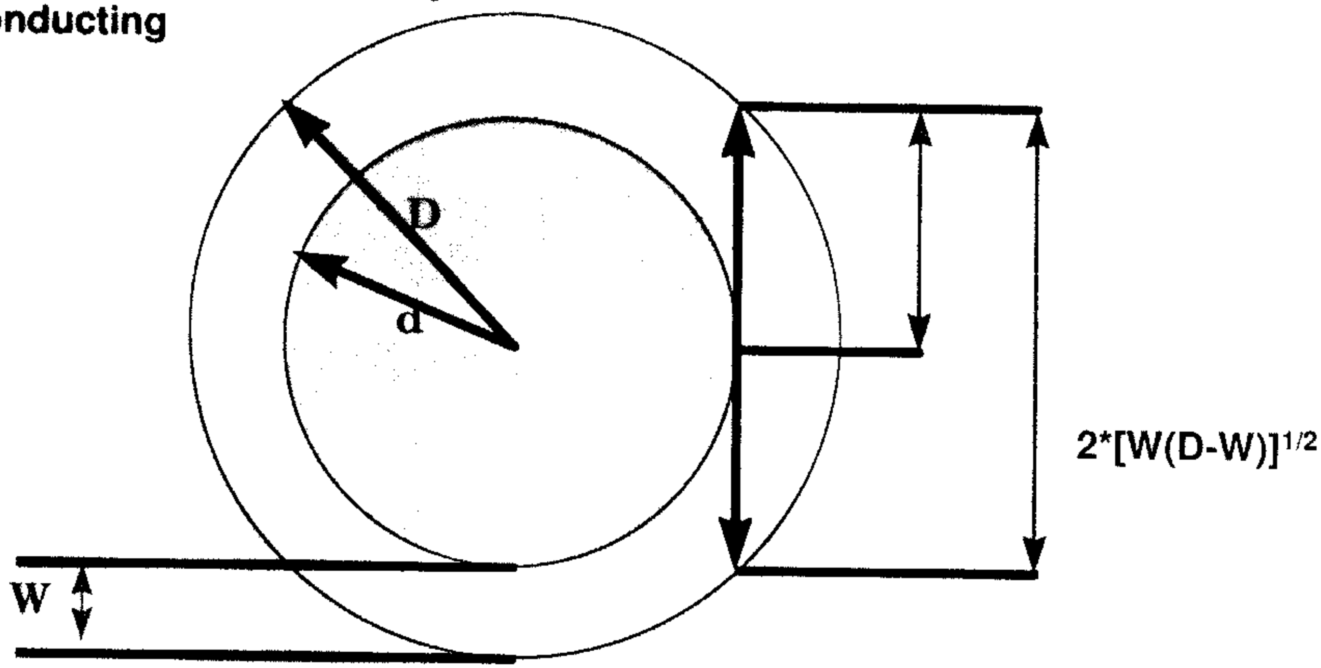
Example: Thick Wall Tubing

Irradiation techniques to "half-chord" thicknesses can lead to "pinholes", especially in non-conducting materials



At 10 MeV, "full chord" thicknesses of approximately 5.5 gm/cm^2 are treatable without risk of pinholes or discharge

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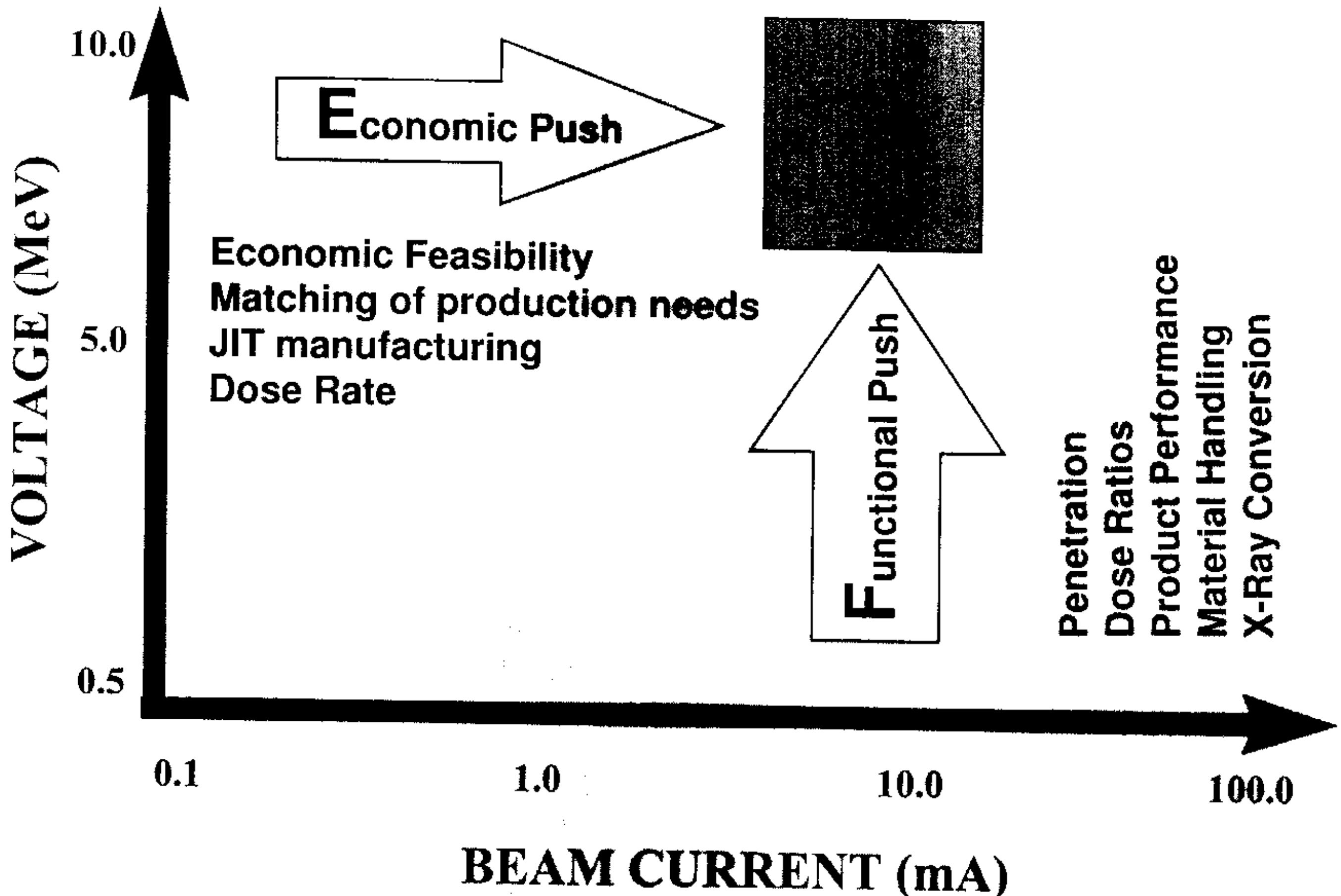
HIGH VOLTAGE-POWER MARKETS



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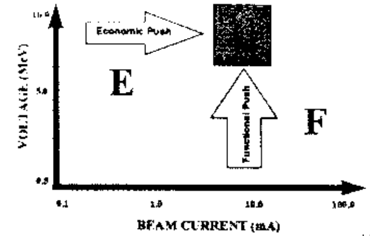
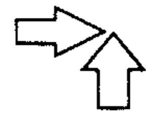
HIGH VOLTAGE-POWER MARKET DRIVING FORCES

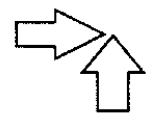


PULP DEPOLYMERIZATION
(RAYON, VISCOSE)



HEAVY WALL TUBING AND PIPE
(HOT WATER, WASTE, ANTI-CORROSIVE)

THICK, FORMED, THERMOPLASTICS
(AUTOMOTIVE, CONSTRUCTION MATERIALS)



HEAT SHRINK PARTS
(VARIOUS)

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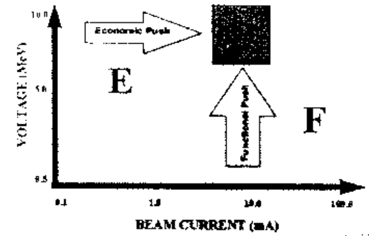
HIGH VOLTAGE-POWER MARKET DRIVING FORCES



CURING OF ADVANCED COMPOSITES
(AEROSPACE, AUTOMOTIVE)

FOOD IRRADIATION WITH ELECTRONS
(GRAINS, FEEDSTOCK, SPICES, ETC.)

FOOD IRRADIATION WITH X-RAYS
(VARIOUS)

IN-LINE STERILIZATION
(DENSE, HIGH-VOLUME MANUFACTURING)

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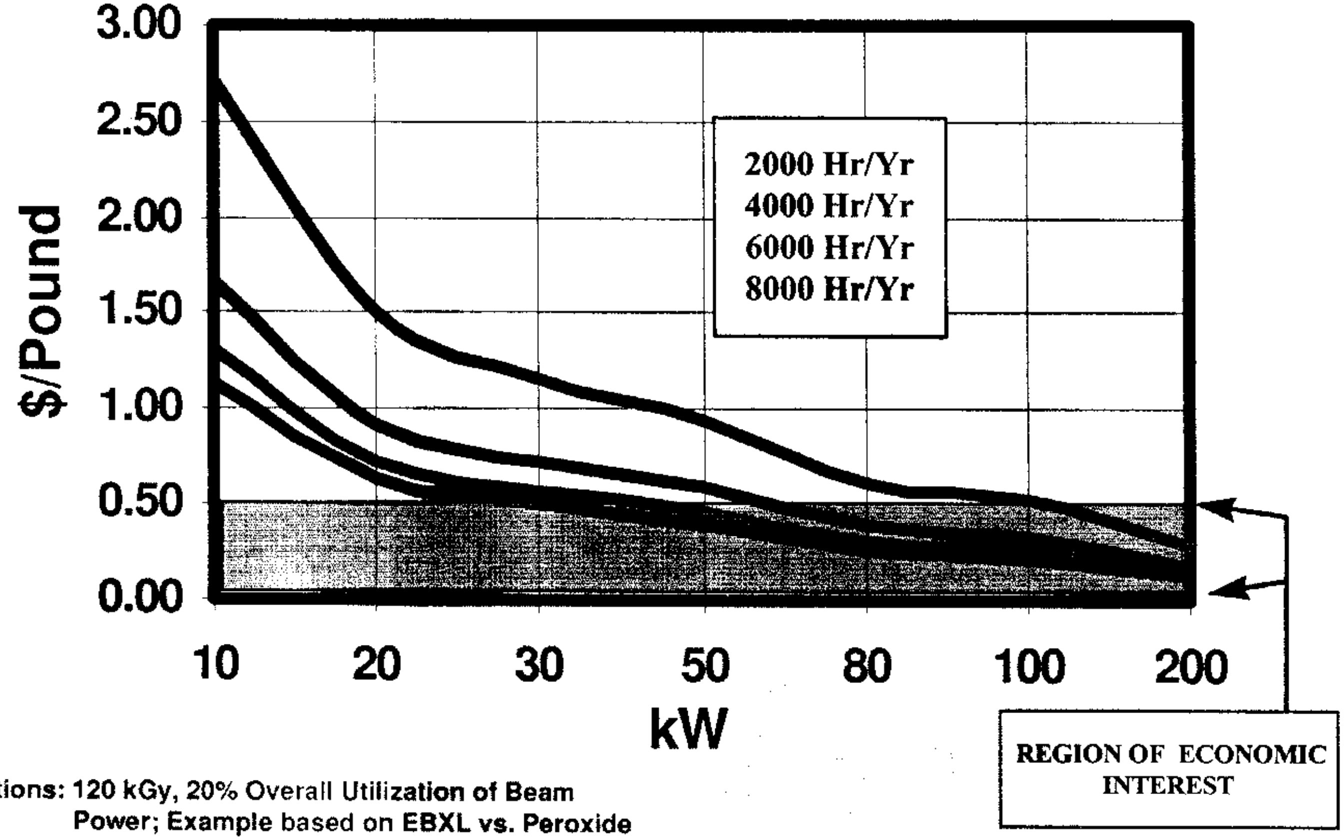
EB CROSSLINKING OF POLYMER PARTS: COSTS AT 10 MEV



Assumptions: 120 kGy, 20% Overall Utilization of Beam Power; Example based on EBXL vs. Peroxide Crosslinking of HPDE

$ USA (1997)

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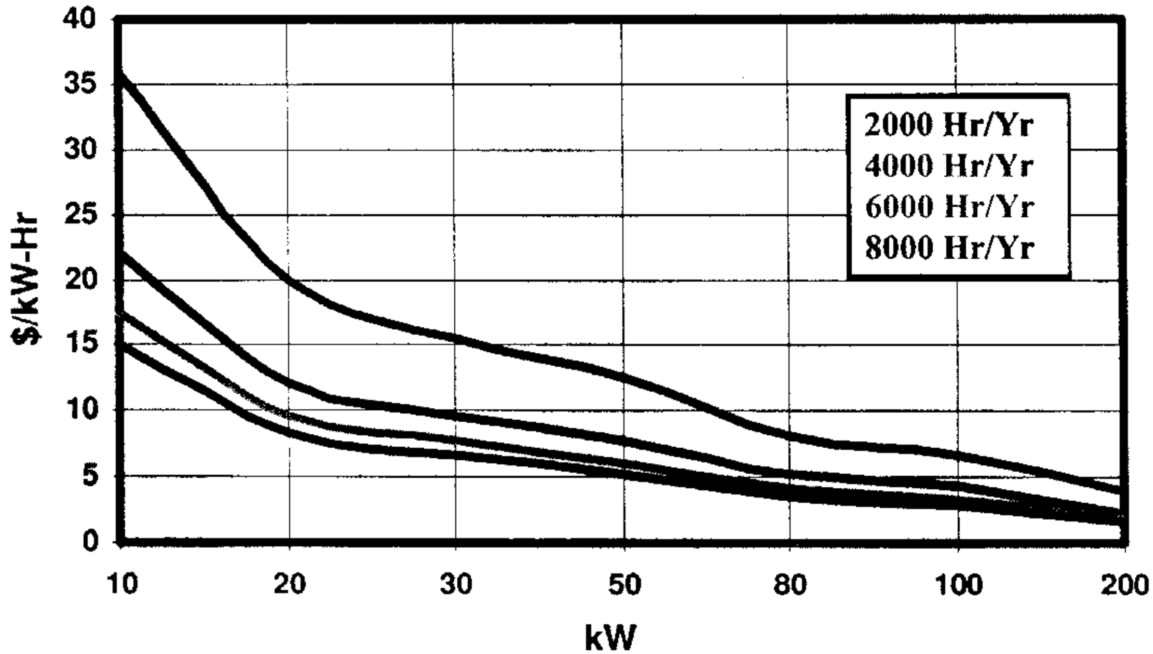
10 MEV ELECTRON BEAM FACILITY OPERATING COSTS (in $/kW-Hr of Beam)



Includes: Depreciation at 10% pa, Maintenance, Electricity at $0.1/kWH, Direct Labour, Basic Administration and Overheads

$ USA (1997)

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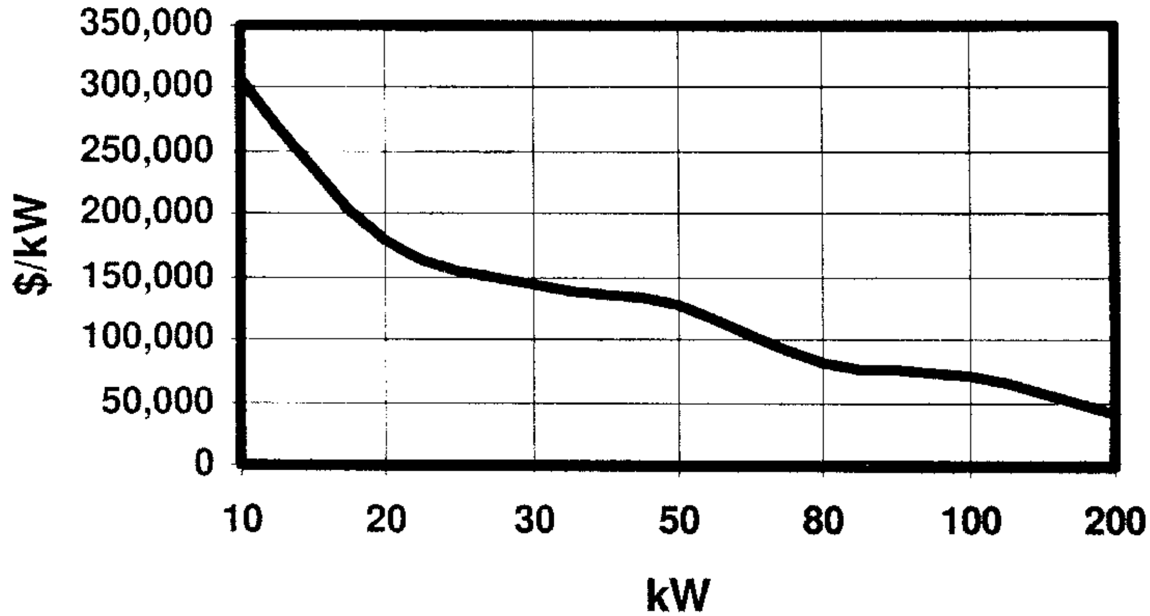
10 MEV ELECTRON BEAM FACILITY CAPITAL OUTLAY (in $/kW)



Includes: Accelerator, Shielding, Safety and Ventilation
Conveyance, Secondary Cooling, Engineering
Installation, and Commissioning

$ USA (1997)

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AT HIGHER BEAM CURRENTS:

- Increased volumetric, mass, and area throughput rates
- Rapidly increasing economies of scale
- Improved "plug to beam" electrical efficiency (CW - Rhodotron)
- Ability to integrate production to on-line processes
- Surge capacity and enhanced flexibility in production modes and operational philosophies

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3 IBA RHODOTRON MODELS:

	TT100	TT200	TT300
Energy (MeV)	1-10	1-10	1-10
Power (kW)	1-35	1-80	1-150
Design Value (kW)	45	100	200
Full (cavity) Dia. (m)	1.60(1.05)	3.00(2.00)	3.00(2.00)
Full (cavity) Height (m)	1.75(0.75)	2.40(1.80)	2.40(1.80)
Weight (T)	2.5	11	11
MeV/pass	0.833	1.0	1.0
Number of passes	12	10	10
Stand-by kW used	<15	<15	<15
Full beam kW used	<180	<260	<350

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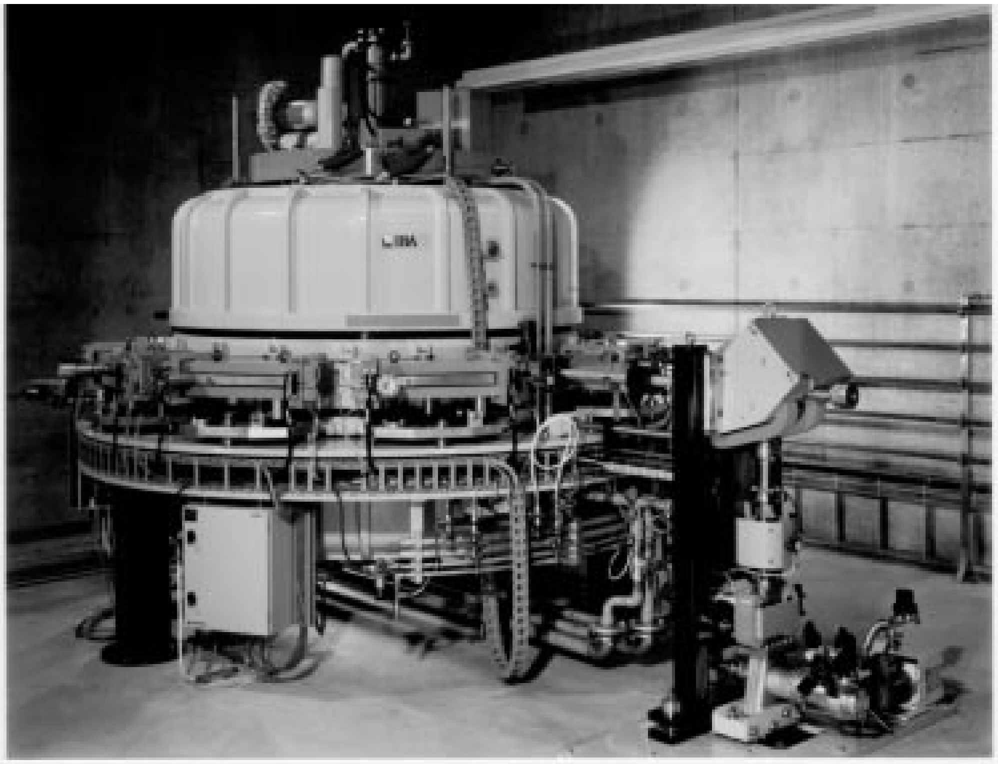
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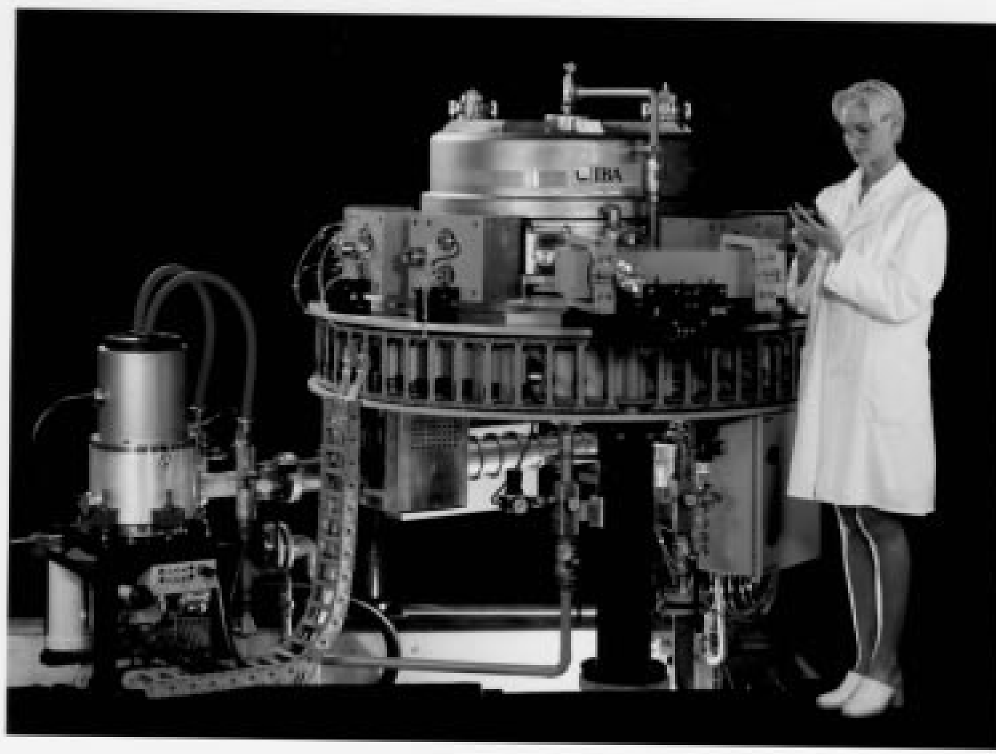
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ADVANTAGES OF THE RHODOTRON OPERATIONS

- Daily startup cycle is only 3 minutes
- High electrical efficiency
- Low standby power consumption
- Wide operating temperature range
- Beam can follow product handling system
- Reserve power
- Compact design lowers shielding costs
- Flexible and easy to integrate/validate PLC
- "InTouch" PC control interface

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ADVANTAGES OF THE RHODOTRON MAINTENANCE

- ✓ All consumable parts on outside of cavity
- ✓ Fast "plug and play" replacement of parts
- ✓ Built-in preventive maintenance scheduling
- ✓ Windows based trouble-shooting screens
- ✓ Single, large, easy access acceleration cavity
- ✓ Inexpensive, long-life tetrode amplifier
- ✓ IBA modem diagnostics
- ✓ More than 90% of all maintenance by user
- ✓ Customized service/maintenance plans

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History of the Rhodotron

1989:	Design proposed by Pottier from the French Atomic Energy Agency (CEA)
1990:	First prototype by CEA, at 3.5 MeV and average power of 20 kW
1991:	IBA/CEA collaboration gave IBA exclusive rights to industrialize the Rhodotron
1991-1994	First industrial unit designed: 5 & 10 MeV with CW power up to 100 kW
1995:	First sale of a Rhodotron (Studer)
1995:	Smaller Rhodotron developed (10 MeV, 35 kW), approximately 1/8 the size
1996:	Installation of the Studer Rhodotron
Present:	Six Rhodotrons sold, with additional sales in 1996 pending

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OPERATING PRINCIPLE OF THE IBA RHODOTRON

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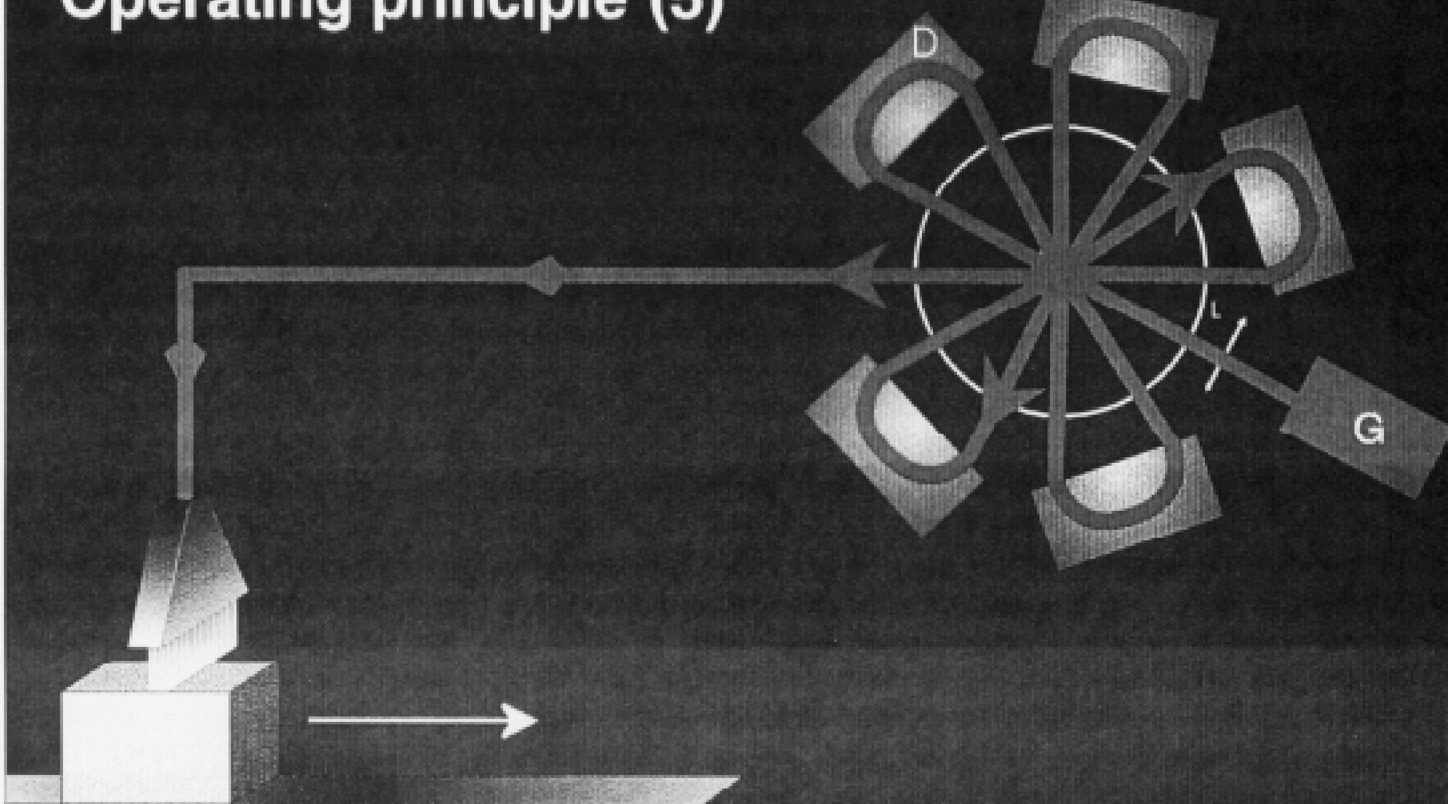
IBA RHODOTRON

Operating principle (5)



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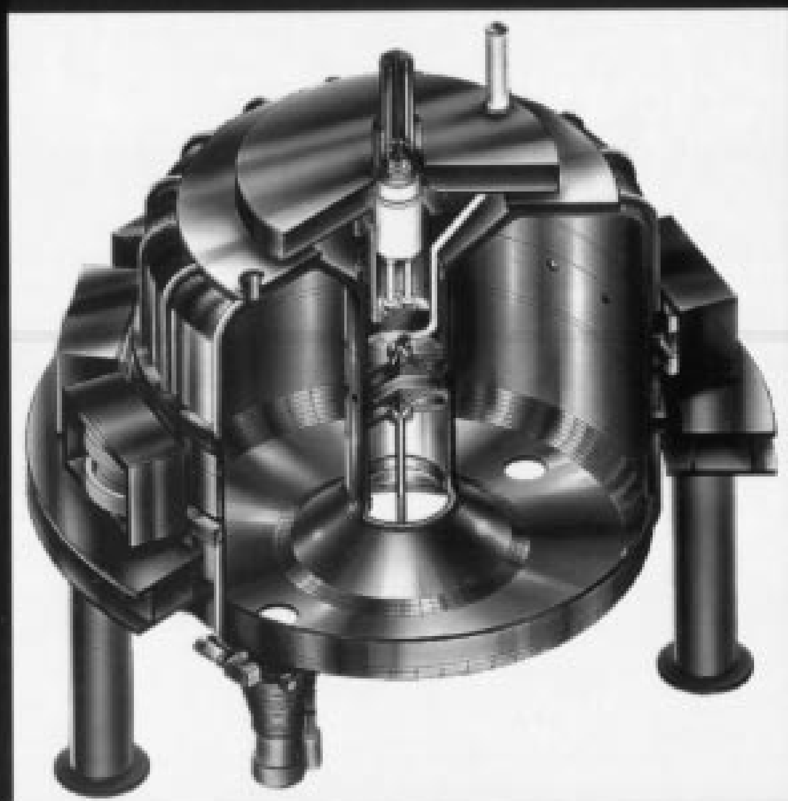
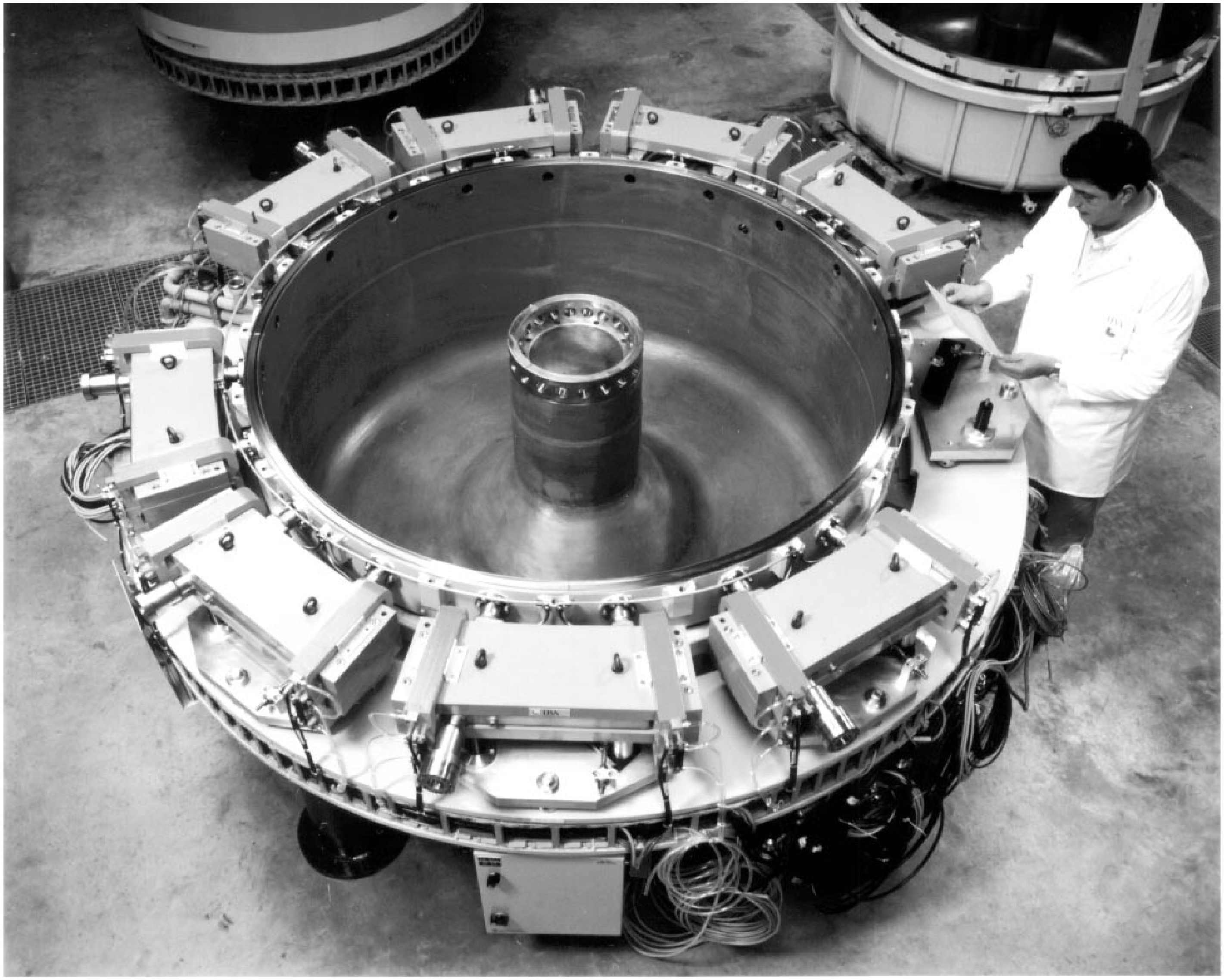
Cut-Away View

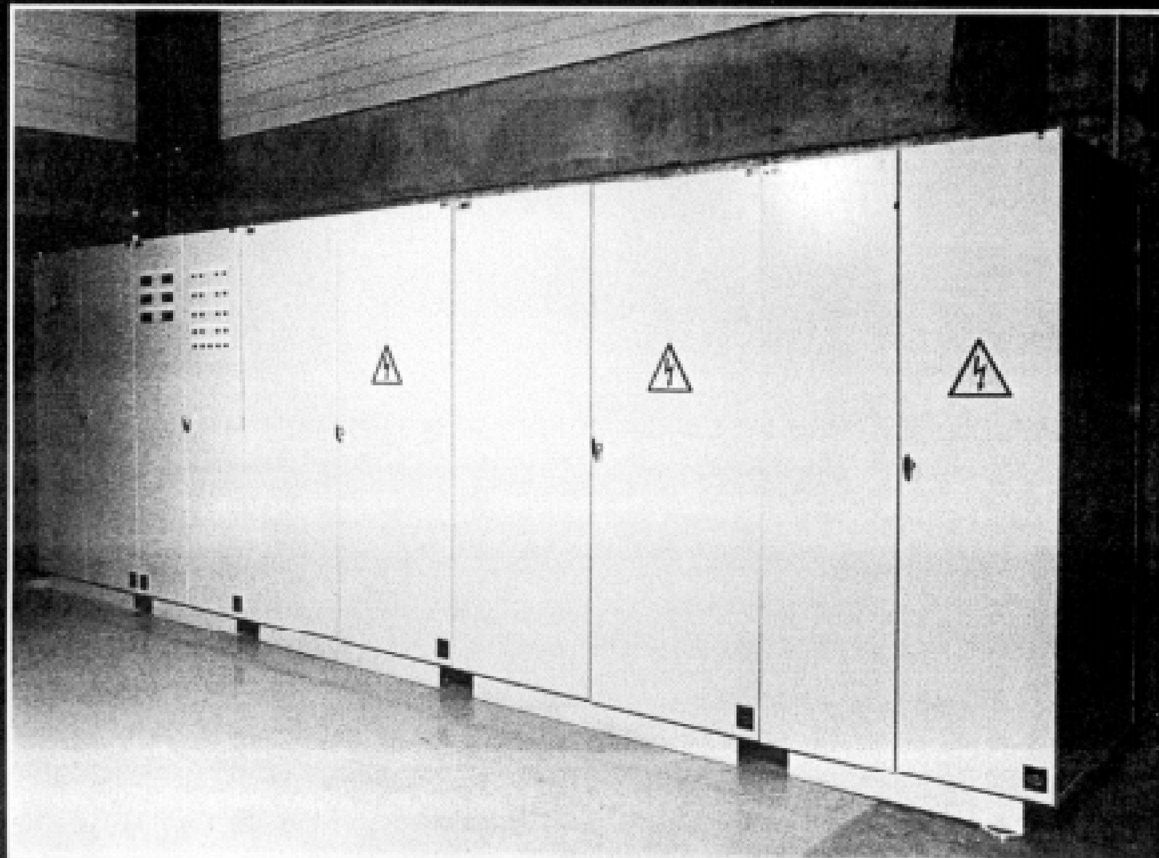
RHODOTRON



ION BEAM APPLICATIONS



IBA Power Supply Cabinets



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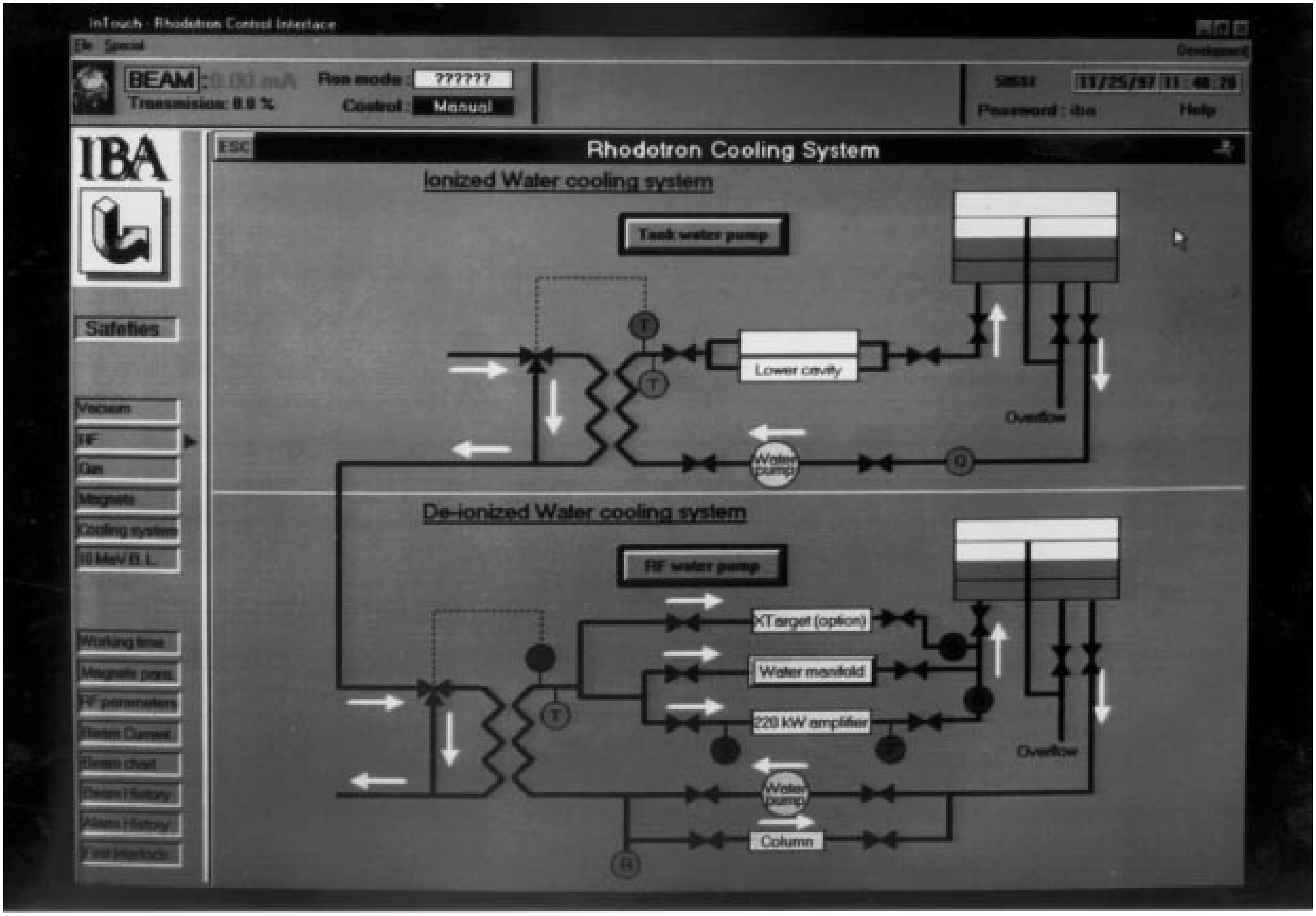
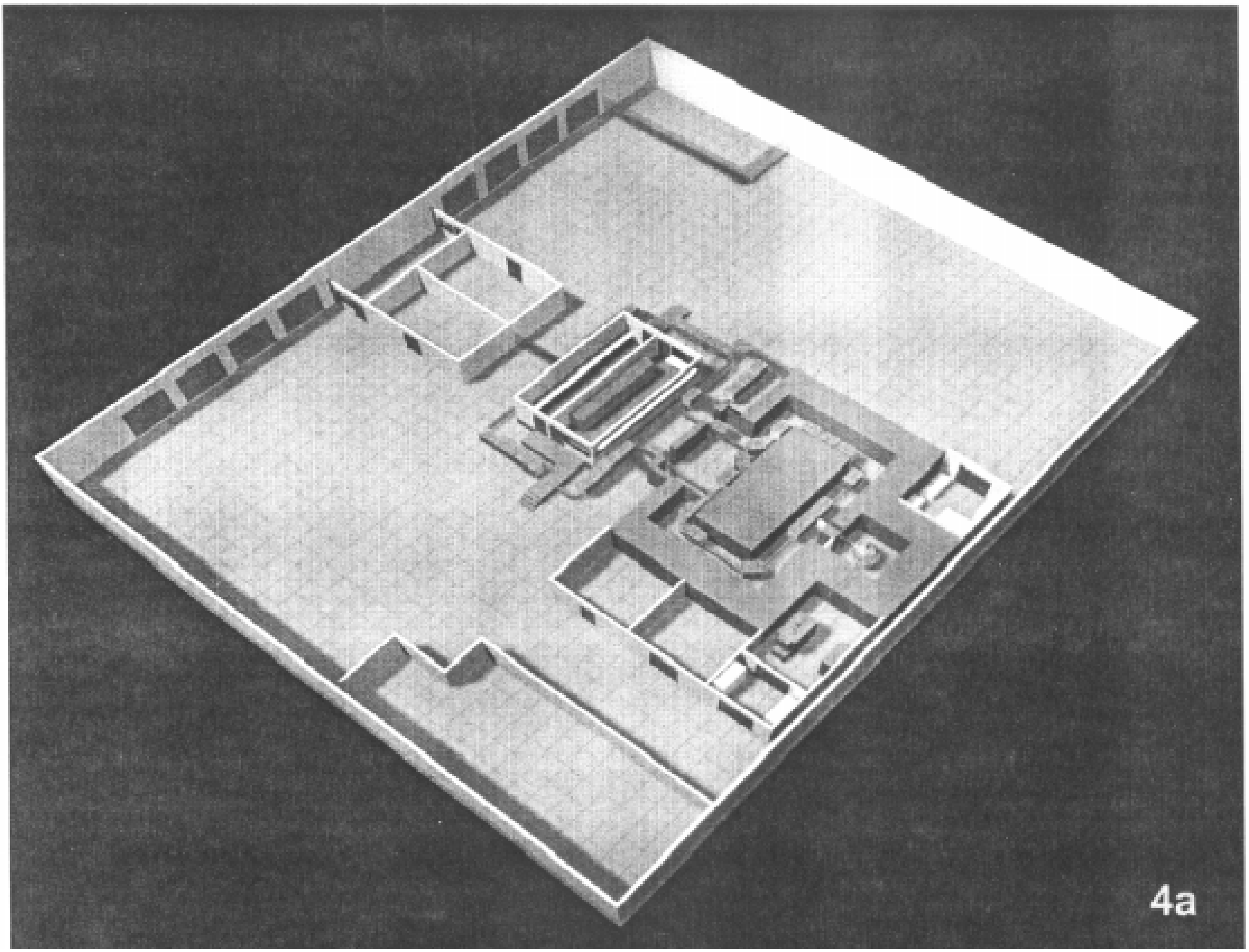

InTouch - Rhodotron Control Interface
BEAM
Run mode : ??????
Control : Manual
Transmission: 0.0 %
Password : iba
Help
IBA
Safeties
Vacuum
Gun
Magnets
Cooling system
ESC
Rhodotron Cooling System
Ionized Water cooling system
Tank water pump
Lower cavity
Overflow
Water pump
De-ionized Water cooling system
RF water pump
Target (option)
Water manifold
220 kW amplifier
Column
Overflow



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