

PERKIN ELMER

**Performance,
Engineering,
and
Environmental
Specifications**

**PHI 5400
ESCA System**

Specifications are subject to change without prior notice.

PHI Model 5400 ESCA Systems

ESCA SENSITIVITY (Ag 3d_{5/2} PEAK, DUAL ANODE X-RAY SOURCE)

Specified performance is obtained with a single Mg anode operating at 26.7 mA and 15 kV (400 W) on a sample of clean silver. Performance for a selected aperture size will meet or exceed the curve defined by the following values. The sensitivity is defined as the counts per second in the data channel for the Ag 3d_{5/2} peak intensity. The FWHM of the Ag 3d_{5/2} peak is measured following a subtraction of background intensity linearly interpolated between the background intensity at binding energies 12 eV above and below the silver Ag 3d_{5/2} peak.

ANALYSIS AREA

The analysis area is selected by an externally adjustable 4 position aperture plate and computer controlled analyzer lens voltages. For the three small area apertures, the analysis area diameter is defined as the distance between the points at which the Ag 3d_{5/2} signal amplitude is 16% and 84% of the maximum value as a silver-coated knife edge is translated across the analysis area in a direction perpendicular to the input lens axis. The area specification applies to all analyzer pass energies below 90 eV.

† LARGE AREA, SMALL SOLID ANGLE ANALYSIS

Resolution FWHM (eV)	Single Channel Detector Peak Sensitivity (CPS)	Position Sensitive Detector Peak Sensitivity (CPS)
1.00	300,000	870,000
0.86	150,000	330,000
0.80	50,000	100,000

† SMALL AREA, LARGE SOLID ANGLE ANALYSIS

Size of Analysis Area	Resolution FWHM (eV)	Single Channel Detector Peak Sensitivity (CPS)	Position Sensitive Detector Peak Sensitivity (CPS)
1 x 3.5 mm	1.00	300,000	1,000,000
1 x 3.5 mm	0.80	40,000	100,000
1.1 mm dia.	1.40	300,000	1,000,000
1.1 mm dia.	1.00	150,000	500,000
1.1 mm dia.	0.80	25,000	50,000
0.6 mm dia.	1.40	90,000	350,000
0.6 mm dia.	1.00	45,000	175,000
0.6 mm dia.	0.80	7,000	20,000
0.2 mm dia.	1.40	6,000	20,000
0.2 mm dia.	1.00	3,000	10,000
0.2 mm dia.	0.80	500	2,000

† Specifications indicate minimum guaranteed performance. System will meet or exceed stated specifications. Items marked with a dagger (†) will be demonstrated at customer site. Specifications are subject to change without notice.

† MODEL 10-360 SPHERICAL CAPACITOR ANALYZER WITH OMNI-FOCUS™ II SMALL AREA LENS, LARGE SOLID ANGLE ANALYSIS AND OPTIONAL MODEL 10-410 TOROIDAL MONOCHROMATOR WITH MODEL 10-550 X-RAY SOURCE

Analysis Area*	Resolution FWHM (eV)	Single Channel Detector Sensitivity (CPS)	Position Sensitive Detector Sensitivity (CPS)
1 x 3.5 mm slit	≤ 0.52	30,000	90,000
1 x 3.5 mm slit	≤ 0.60	45,000	135,000
1.0 mm dia.	≤ 0.50	25,000	75,000
1.0 mm dia.	≤ 0.60	40,000	120,000
0.6 mm dia.	≤ 0.50	12,000	36,000
0.6 mm dia.	≤ 0.60	20,000	60,000
0.2 mm dia.	≤ 0.48	1,500	4,500
0.2 mm dia.	≤ 0.60	3,000	9,000

*Typical (not guaranteed) signal to background ratio with PSD at 1 x 3.5 mm is ≥ 160:1 measuring the background at 7 eV lower binding energy than Ag 3d5/2 signal intensity.

PRECISION ENERGY ANALYZER, MODEL 10-360

Type Spherical Capacitor Analyzer (SCA).
 Mean Diameter 279.4 mm (11.00 in).
 Lens Omni-Focus™ 7-element.
 Input Slit 4 x 10 mm.
 Detector Single Channel: Channeltron electron multiplier with amplifier/discriminator.
 Position Sensitive Detector (optional).

ANALYZER ELECTRONICS, MODEL 80-365

Energy
 Scan Range 0 to 4800 eV for ESCA; 0 to 3200 eV for optional ISS.
 Resolution 25 meV minimum step size.
 Pass Energy (Fixed Analyzer Transmission Mode)
 Range 0 to 200 eV.
 Resolution 25 meV.
 Resolution (Fixed Retarding Ratio Mode)
 Range 0.25 to 1.2%.
 Multiplier
 Input Bias 0 to ± 200 V.
 Multiplier Voltage 0 to +3000 V.
 Polarity Dual polarity.

DUAL ANODE X-RAY SOURCE, MODEL 04-548

Energy Range Variable; 4 kV to 15 kV.
 Anode Dual anode design.
 Anode Material Side 1-Mg, Side 2-Al, Mg, Cu, Si, Zr, Au, Ag or Ti optional.
 Power 750 W total power (15 kV, 50 mA);
 maximum 400 W during single anode operation.
 Single or simultaneous dual anode operation with independent computer control of individual anode power.

Anode Selection	Switch selectable: computer controlled or manual switch select.
Source Cooling	Recirculating heat exchanger with deionizer cools anodes and housing; position up to 7.6 m (25 ft) from system.
Coolant	Deionized water.
Safety Interlocks	High voltage, coolant flow rate and vacuum sensors.

X-RAY MONOCHROMATOR, MODEL 10-410 (OPTIONAL)

The x-ray monochromator is a 500 mm Rowland Circle quartz crystal monochromator compatible with the test chamber and uses the Model 10-550 X-ray Source with an aluminum anode.

Crystals	Quartz (100) crystals on a toroidal substrate.
Alignment	5 degrees of freedom: X tilt, Y tilt, focus, x-ray source linear motion and tilt.
Electronics	X-ray controller is capable of continuous operation at 300 W on a single anode.
Energy Range	Variable, 4 keV to 15 keV.
Anode Material	Aluminum.
Power	300 W (15 kV, 20 mA) recommended continuous power.
Source Cooling	Recirculating heat exchanger with deionizer cools anode and housing. Position up to 7.6 m (25 ft) from system.
Coolant	Deionized water.
Safety Interlocks	High voltage, coolant flow rate and vacuum sensors.

SPECIMEN HANDLING SYSTEM, MODEL 10-323

The specimen handling system consists of the specimen manipulator, specimen introduction attachment, and various stage modules and specimen holders.

Sample Capacity	Single sample stage (standard); eight sample stage (optional).
Sample Holder	Accepts Model 190 Flat Specimen Holders, Model 191 Recessed Specimen Holders, and/or Model 193 Faraday Cup.
Z-Axis Sample Translation	
Orientation	Single motion along Z (vertical) axis.
Range	± 0.5 cm.
Resolution	± 10 μm.
Y & X Sample Translation (optional)	
Range	± 1.0 cm.
Resolution	± 20 μm.
Sample Tilt (optional)	
Range	± 50°.
Resolution	± 1°.
Manual Control	Model 176 Tilt Module.
Automatic Control (optional)	Model 170 Motorized Rotary Feedthru and Model 71-205 Digital Motor Control operated by the computer system.

SAMPLE ADVANCE (OPTIONAL: USED ON EIGHT SAMPLE HOLDER)

Range	360° continuous; two rotations per sample advance.
Manual Control	Rotary feedthru module.
Automatic Control (optional)	Model 172 Motorized Rotary Feedthru and Model 71-205 Digital Motor Control operated by the computer system.
Electrical Connections	2 BNC connectors provided for target and ion current. A 10-pin feedthru is provided with six pins wired for the sample heater.

FLAT SPECIMEN HOLDERS, MODELS 190 AND 190M

Holder Size 2.54 cm (1.0 in) diameter with two hold-down clips.
Sample Size Clips hold sample 1.27 cm wide x 2.54 cm long.
Material
Model 190 Stainless steel.
Model 190M Molybdenum.

RECESSED SPECIMEN HOLDERS, MODELS 191 AND 191M

Holder Size 2.54 cm (1.0 in) diameter with two hold-down clips.
Recess holds sample 1.0 cm wide x 2 cm long x 0.5 cm thick.
Material
Model 191 Stainless steel.
Model 191M Molybdenum.

FARADAY CUP, MODEL 193

Aperture Size 0.254 mm (0.010 in) diameter aperture.
Measurement Faraday cup connected to ion current connector on 10-323.

COOLING MODULES (OPTIONAL);

MODEL 196 SINGLE SPECIMEN AND MODEL 198 EIGHT SPECIMEN

Cooling Internal thermal conductor connected to Model 6, external cryogenic dewar.
Compatibility Attaches to Model 10-323 Specimen Manipulator.
Cools specimen holder at analysis position.
Temperatures Ambient to < -100°C.

SINGLE SAMPLE HEATING MODULE AND CONTROL, MODEL 175 (OPTIONAL)

Temperature Range Ambient to 600°C.
Temperature Stability ± 1°C.
Electrical Connections Heater (2), Thermocouple (2).

SPECIMEN INTRODUCTION ATTACHMENT, MODEL 04-727

Specimen Holder Holds one Model 190, 190M, 191, or 191M Specimen Holder with attached specimens or one Model 193 Faraday Cup.
Entry Mechanism Load hatch to put specimen holder on transfer fork. Pumping controlled by the Auto Valve Control.
Specimen Transfer Holders are manually transferred to Model 10-323 Specimen Manipulator
Introduction Time Less than 3 minutes from air to analysis position for non-outgassing samples.
Controls Automatic (Standard): Pump-down and up-to-air sequencing provided by Auto Valve Control and pneumatic valves.
Pumping Turbo molecular pump, 50 l/sec air-cooled, with 1.5 m³/hour backing pump.
Base Pressure < 10⁻⁴ Pa (10⁻⁶ Torr) with turbo molecular pump.

MULTIPLE SAMPLE EVACUATION CARROUSEL, MODEL 02-700 (OPTIONAL)

Allows transfer of 8 specimens with only one pump down of the specimen introduction attachment.

VACUUM TRANSFER VESSEL, MODEL 04-110 (OPTIONAL)

Specimen Holder	Holds one Model 190, 190M, 191, or 191M Specimen Holder with attached specimens.
Vacuum Vessel Seal	O-ring sealed platform.
Open/Close Control	Top knob; 16 turns CCW lowers platform to accept specimen holder.
Vacuum Vessel/Intro Seal	Vacuum vessel seals onto Model 04-727 Specimen Introduction Attachment hatch opening.
Entry Mechanism/Specimen Transfer	Vacuum vessel platform opens inside specimen introduction attachment and specimen transfers to probe fork.
Vessel Pumping	Mini CF flange 1.91 cm (0.75 in) OD with port for mounting optional 2 l/sec ion pump and control, or other pump.

SAMPLE FRACTURE ATTACHMENT, MODEL 04-535 (OPTIONAL)

Must be used with Model 04-747 Linear Transport

Sample Mounts	Special fracture mount accepts notched, cylindrical sample.
Fracture Mode	Plunger-actuated lever for shear fracture.

ANALYSIS CHAMBER (refer to chamber drawing, p. 11)

Type	Stainless steel; copper gaskets.
Rough Pumping	
Type	50 l/sec air-cooled turbomolecular pump.
Range	Ambient to 10^{-3} Pa (10^{-5} Torr).
Gauging	Thermocouple gauge in introduction chamber.
UHV Pumping	
Type	120 l/sec differential ion pump with Ti sublimator and optional cryopanel; 2000 l/sec cryopump optional.
Range	10^{-3} to 10^{-8} Pa (10^{-5} to 10^{-10} Torr).
Gauging	Nude thermionic ionization gauge in analysis chamber.
*Guaranteed Base Pressure	6.7×10^{-8} Pa (5×10^{-10} Torr) following bakeout and using Ti sublimator (using 120 l/sec ion pump).
Vacuum Interlock	Electrical power to analysis electronics disabled when preset vacuum level is reached (set point is adjustable).
System Bakeout	Analysis chamber and installed optics bakeable.
Ovens	Heating elements integral to instrument console and ion pump; fabric shroud for analysis chamber.
Temperature	Greater than 100°C but less than 200°C (less than 150°C with optional monochromator).
Control	Automatic bakeout timer.

ION BEAM SPUTTER ETCHING GUN, MODEL 04-300

Source Type	Electron impact.
Beam Voltage	200 V to 4 kV.
Maximum Beam Current	$> 5 \mu\text{A}$ at 4 kV.
Beam Current Density	$> 800 \mu\text{A}/\text{cm}^2$ at 4 kV.
Beam Deflection	
Mechanical	± 4 mm in X, Y directions via integral port aligner.
Electrical Raster	Independent X, Y rastering; maximum 10 mm by 10 mm centered on static beam position.
Gas	Argon (other noble gases available).
Gas Inlet	Leak valve (feedback regulated thermal leak valve optional).
Pressure Differential	Less than 1.3×10^{-5} Pa (1×10^{-7} Torr) with optional differential pumping.
Faraday Cup (optional)	250 μm diameter aperture; measures ion current density.

COMPUTER SYSTEM

The system electronic architecture uses distributed microprocessors controlled by a central host computer, linked with the IEEE-488 General Purpose Instrument Bus. The host computer can be either a Concurrent 7000 Series Computer or an Apollo® Domain® Series Personal Workstation™ computer.

System Description - Apollo® host computer

The software runs on the 32-bit Apollo® Domain® Series Personal Workstation™ computer under a combination of the AT&T System V UNIX® and Apollo's AEGIS™ operating systems, using the C programming language.

Command input is via 10 softkeys, which may be picked directly or by using the mouse or trackball. In addition to the standard PHI settings, up to four sets of user-defined settings can be saved and recalled to allow the user interface to be customized for four individual users. The user can assign names to the HOME BANKS (a grouping of commands) and assign which commands appear at each location within each HOME BANK. Within the HOME BANKS and COMMAND BANKS, keyboard type-ahead has been included to allow very fast input by the user. The mouse or trackball can also be used to pick parameters within the menus.

An Ethernet® interface is included with each Apollo computer provided by PHI. Also included are utilities which allow access to data files by other PHI-Apollo systems on the network, and which provide sharing of the plotter and printer peripherals on the network.

System Description - Concurrent Series 7000 host computer

The software runs on the Concurrent 7000 Series computers under the Idris™ operating system, using the C programming language. Command input is via function keys 24 "hard" fixed function keys, 8 "soft" programmable function keys.

Software Versions

Version 2.0 software is available with the Standard or Enhanced options. The Enhanced option is required with the position sensitive detector or with automated stage controls. Version 3.0 software, with advanced curve-fitting algorithms and Autopeak ID is only available on the Apollo® computer.

SOFTWARE SPECIFICATIONS (VERSION 2.0 AND 3.0 ESCA SOFTWARE)

I. System Setup

Status Line Display

- Technique (ESCA, ISS)
- Time of Day, Date
- X-ray Source (Anode material, On, Off)
- Ion Gun (On, Off, Gas Pressure)
- Neutralizer (On, Off)
- Time remaining for sputtering
- Acquiring Message

Hardware Configuration

- Stage Select (single or 8-sample)
- Neutralizer Control Select
- X-ray Source (Dual Anode, Monochromator)
- ‡Stage tilt (Auto, Manual)
- ‡Stage index (Auto, Manual)
- Plotter (HP7475A, HP7750A)
- Floppy disk (Yes, No)
- DIG reading

Ion Gun Menu

- Ion Energy
- Grid Energy
- Sputter Time
- ‡Beam Voltage (On, Off)

Analyzer/Detector Parameters

- Detector (Single Channel, Position Sensitive†)
- Input Lens (Standard, Extended, Omni-I, Omni-II§)
- Lens-to-Sample Distance (Extended Lens)
- Analysis Mode (Large, Small)
- ISS Scattering Angle
- Aperture Sensitivity Selection

Energy Resolution Menu (ESCA, ISS)

- Selection Mode (Survey, Utility, High Resolution)
- Pass Energy
- eV/Step
- Time/Step

Color Selection Menu

- Data Display and Axis Colors (16 selectable)

Electron Multiplier Supply (Counts vs voltage display)

Acquisition Default Menu

- Sputter Mode (Alternating, Continuous)
- X-ray on during Sputtering
- Baseline Endpoint Calculation

- Type (Smooth, Average), Number of Points

Element Table

- Element Name, Transition Type
- Acquisition Window
- Analysis Window

- Peak Energy
- Sensitivity Factors
- Alignment (ESCA, ISS)
- X-ray Control
 - Photon Energy
 - X-ray Power
 - Manual or Automated On/Off Control
 - Standard or Monochromator X-ray Selection

II. Data Acquisition

User may begin to acquire immediately assuming previous settings, or may go into the setup routine.

- Previous, New, File or up to 4 User Defined Acquisition Parameter Menu Settings
- Survey (ESCA, ISS)
- Multiplex (ESCA, ISS)
 - Up to 20 Energy Regions Selectable
- Profile (ESCA, ISS)
 - Up to 20 Energy Regions Selectable
 - Continuous or Alternating Sputtering
 - Save Every Nth Cycle
- Angle Dependent Depth Profile (ESCA)
 - Up to 12 Take-Off Angles
 - Up to 20 Energy Regions Selectable
- Cycle Stop Acquisition
- Sweep Stop Acquisition
- Abort Acquisition
- More (Allows user to take more data, and add to a completed survey, multiplex or profile data file)
- Suspend/Resume Ability
- User Savable Settings:
 - For survey, multiplex, profile and angle dependent profile modes.

III. Graphics Data Massage and Display

User defined message soft key banks allow the operator to customize the location of message soft keys to place the functions used most often in the most convenient keyboard location. (Customization is only available with the Apollo[®] computer option.)

- Smooth (3-25 point Savitzky-Golay convolution; cubic-quadric)
- Differentiation (3-25 point Savitzky-Golay convolution)

- Expand With Either Numeric or Graphic Input Cursor (Readout Binding Energy and Intensity)
- Edit Data
- Annotation

- User Labeling
 - Label Axis with Message Operator Used
- Display Add to Superimpose Curves
- Add/Subtract Spectra
- Montage Display
- Baseline Subtraction (Linear or Integral)
- Shift of Binding Energy Axis
- Curve Fit
 - Gaussian
 - Lorentzian
 - Gaussian/Lorentzian mixed
 - §Asymmetric line shapes
 - §Doublet fitting
 - §Multiplet fitting
- Deconvolution
- X-ray Satellite Peak Subtraction
- Profile Redefine (of profile after acquisition)
- Save Messaged Data
- Hard Copy Data Output
 - HP LaserJet Plus™ Printer Output
 - HP 7475A 6 Pen Plotter (user-defined plot sizes)
 - HP 7550A 8 Pen Plotter (user-defined plot sizes)

IV. System Level Functions

- Directory Utilities
 - Listing
 - Delete
 - Copy
 - Search
 - Move
 - Create
 - Rename
- Auto File Naming
- Foreground/Background Operation
- Display of Valid Parameter Entry Range
- Data Transmit
 - Network Interface
 - RS 232 Terminal Emulator (Option)
 - Kermit Protocol
 - IBM[®] Formatted Floppy Disks (Option)

V. AutoChem

- Atomic Concentration
 - User settings
 - User-modifiable sensitivity tables
 - AC's from surveys
 - AC profile conversion
 - Pre-selected acquisition limits
 - Profile redefine
 - Baseline redefine
 - Area under a curve
- §Automatic Peak Identification
 - User-modifiable S/N selection
 - Turn elements On/Off
 - Automatic peak labeling
- Chemical State Identification Table
 - User-selectable energy range
 - Element selection
 - Transition selection
 - Chemical assignment with binding energy
 - Literature reference

Element Table (XPS, AES)

- Element Name, Transition Type
- Acquisition Window
- Analysis Window
- Peak Energy
- Sensitivity Factors

AutoCom

- Automated Command Sequence
- Sequencing ability
- Looping ability
- User-defined sequences
- Up to 40 sequences in user-named files

Sensitivity Factor Selection

- Input lens, magnification
- X-ray source position (standard, monochromator)

‡Requires Enhanced V2.0 or V3.0 Software

§Requires V3.0 Software

ENVIRONMENTAL REQUIREMENTS

- Magnetic Fields Less than 2 μ T (20 mG) peak-to-peak.
- Relative Humidity Less than 70%.
- Temperature 20°C \pm 5°C.
- Heat Dissipation 2344 W (8,000 BTU) under typical operating conditions.
3600 W (12,200 BTU) additional heat during system bakeout.

UTILITY REQUIREMENTS

- Electrical 200-240 V AC, 50-60 Hz, 40 A single phase (to be hard wired by customer).
- Dry Nitrogen 0.279 kg/cm² (4 PSI) maximum.
- Compressed Air 5.6 to 7.0 kg/cm² at 0.17 m³/hr (80 to 100 PSI at 0.1 CFM), pressure regulated.
- Liquid Nitrogen 2 l/hr for cryopanel (optional).

SHIPPING AND INSTALLATION

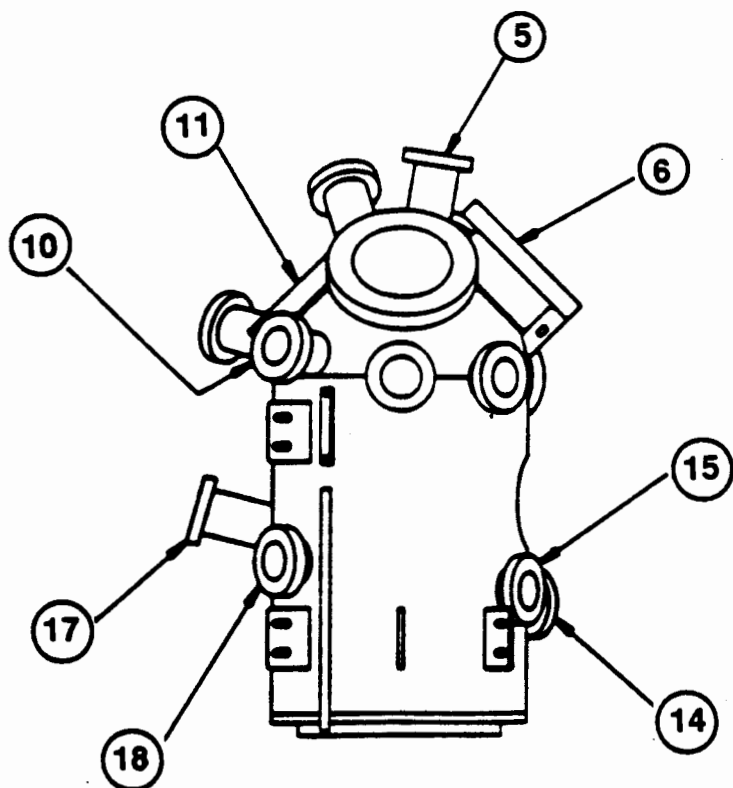
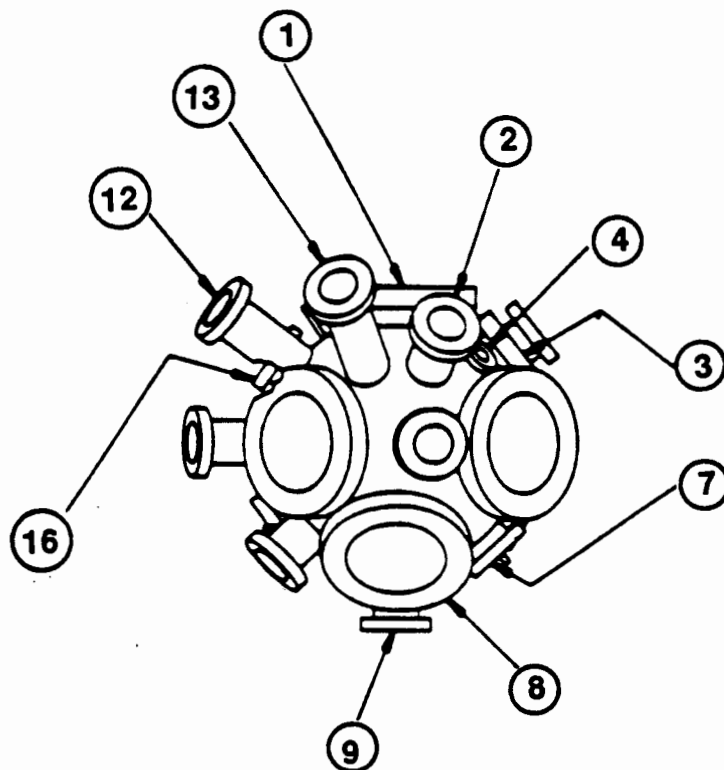
- Shipping Weight Approximately 1360 kg (3000 lbs).
- Shipping Volume Approximately 8.4 m³ (300 ft³).
- Laboratory Entrance 109.2 cm (43 in) width minimum laboratory access.
System can pass through 91.4 cm (36 in) door if analyzer is removed.

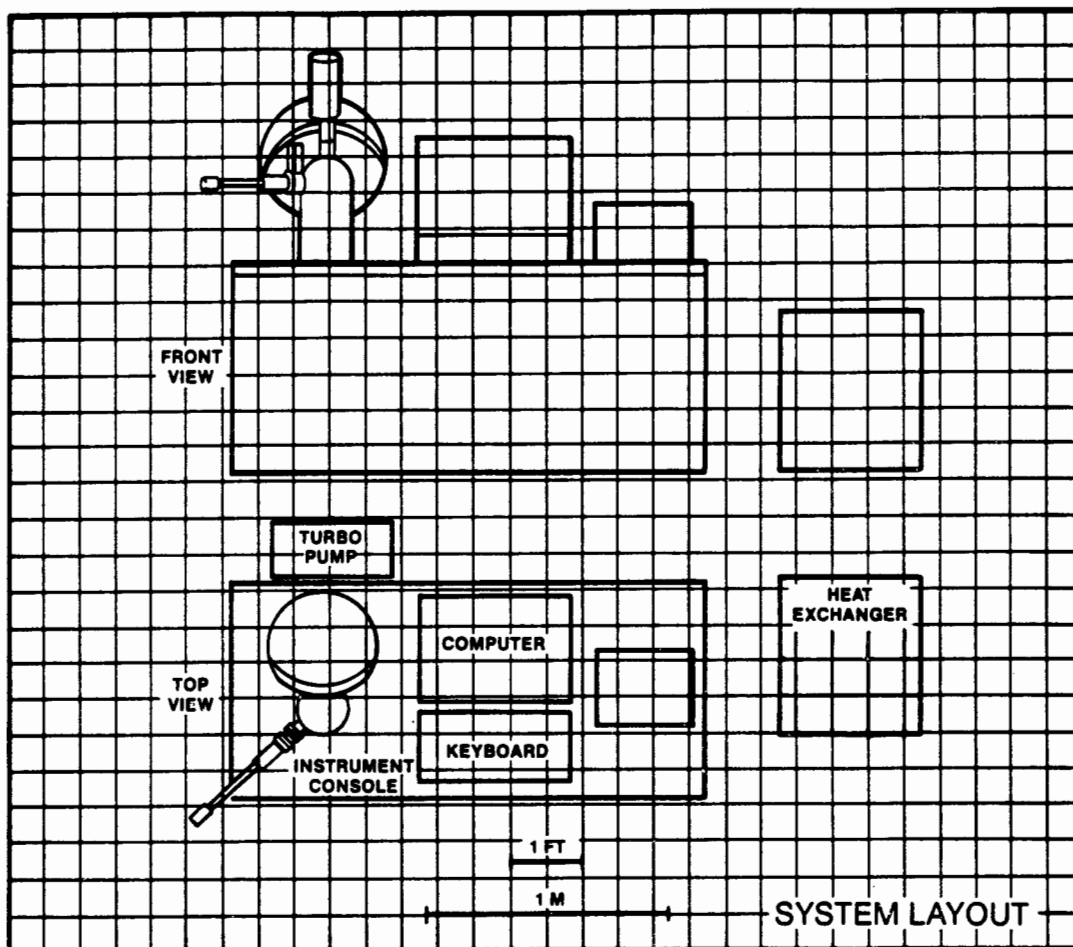
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PORT ASSIGNMENT CHART

Port No.	Flange OD	Flange to Centerline Length	Usage
1	6.0"	6.0"	10-320 Manipulator
2	2.75"	7.68"	Microscope
3	4.5"	6.7"	Viewing Port
4	1.33"	5.8"	Light Source
5	2.75"	9.0"	04-548 X-Ray Source
6	6.0"	6.95"	Monochromator or E-Gun
7	2.75"	6.0"	04-725 Intro
8	6.0"	6.95"	E-Gun or SIMS
9	2.75"	7.5"	2650 RXN Chamber
10	2.75"	7.0"	UPS
11	6.0"	6.75"	10-360 SCA
12	2.75"	9.0"	04-085 Neutralizer
13	2.75"	10.6"	Ion Gun
14	2.75"	7.03"	LN ₂ Dewar
15	2.75"	5.5"	Mono Pumping
16	2.75"	5.88"	Ion Gauge
17	2.75"	6.5"	SCA Pumping
18	2.75"	6.25"	Spare

MODEL 41XT TEST CHAMBER





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Specification sheet part no. 615134 rev A.