1 SCOPE

The purpose of this document is to detail the use of the Varian 350D Ion Implanter. All users are expected to have read and understood this document. It is not a substitute for in-person training on the system and is not sufficient to qualify a user on the system. Failure to follow guidelines in this document may result in loss of privileges.

2 REFERENCE DOCUMENTS AND PEOPLE

- Varian 350D Implant manual
- Ion Implant lecture and video, L.F. Fuller and I.R. Turkman
- Steve Stefanski, Kodak Equipment Engineer
- Scott Blondell, RIT Facilities Manager
- Richard Battaglia, RIT Equipment Engineer

3 DEFINITIONS

3.1 General Description

The Varian 350D Ion Implanter is capable of implanting Boron (B11 or BF2) or Phosphorous (P31) in 4” or 6” wafers with doses of 1E12 to 5E15. Implant energy levels can be adjusted from 10KeV and 200 KeV.

NOTE: The REMOTE ELECTRONICS RACK contains switches and joysticks to adjust the beam setup, focus and steering parameters. The operator can also turn the adjustment dials manually on the MAIN IMPLANTER CONSOLE. Several of the remote switches and motor drives are inoperative and must be adjusted from the main console. This instruction set identifies the exact controls to use to avoid confusion.
4 TOOLS AND MATERIALS

4.1 The Varian 350D Ion Implanter has dedicated Teflon wafer boats for the 4” and 6” end stations. An attached label indicating “VARIAN 350D” identifies them.

5 SAFETY PRECAUTIONS

5.1 Refer to the following MSDS sheets:
   - Boron Trifluoride
   - Phosphine/Hydrogen
   - Argon
   - Fomblin Vacuum Pump Fluid

5.2 The following stored energies are present in this tool and represent potential hazards to operators and service personnel:
   - High voltage DC supplies
   - High voltage: 208VAC 3 phase
   - Line voltage: 120 VAC
   - Compressed Air: 80-100 psi
   - Compressed Nitrogen: 20 psi
   - Pressurized Water Cooling Lines: 40-60 psi

5.3 The following represent physical hazards:
   - Pneumatic Cylinders
   - Wafer Pick Arms
   - Robotic End Station Cassette Handlers
   - Load Lock Components

5.4 The following represent potential health hazards:
   - Source pressurized gases
   - Contaminated sources and source components
   - Vacuum pump fluids
6 INSTRUCTIONS

6.1 System Start Up

6.1.0 Activate the card swipe interlock by logging in at CARD SWIPE ACCESS 3 located in cleanroom hallway. Panel 7 POWER key switch is interlocked.

6.1.05 Verify that NITROGEN for the Varian 350 Implanter is turned ON at the NITROGEN MANIFOLD 2765 located in Service Chase 2765. The manifold regulator gauge should read 20 psi. The gauge on Implanter located below the endstation controller should read approx. 9 psi.

* NOTE – Turn ON the Appropriate END STATION MOTOR POWER SWITCH located on the ENDSTATION OPERATOR CONTROL PANEL.

Switches are a lift and select style. Do not force them if they do not move.

6.1.1 Check the levels of the three VACUUM GAUGE CONTROLLERS located on panels 3, 5 and 8. All should read <1E-6 Torr on the LOG scale.

6.1.2 Use the POWER key to turn ON the POWER switch (left side of panel 7 - remote rack).

6.1.3 Remove POWER key from panel 7. Return the MODE key to panel 6.

6.1.4 Use the MODE key to select the SET UP mode (right side of panel 6 – remote rack).

6.1.6 Select ES 1 for 6” or ES 2 for 4” (End station 1 or 2) on the BEAM FOCUS AND SCAN portion of panel 6.

6.1.7 Press the TERM ON button (left side of panel 7). Ensure that gauges behind the viewing window inside the HIGH VOLTAGE TERMINAL illuminate.
6.1.8 Turn on the VIEWING WINDOW LIGHT to fully illuminate the meters inside the HIGH VOLTAGE TERMINAL.

6.1.9 Set the BEAM MONITOR to I/X (panel 2).

6.2 Beam Set Up

6.2.1 Ensure that ALL dopant gases are OFF – the B, P and CAR ON lights are OFF. If any buttons are lit, press them once to turn OFF that gas function.

6.2.2 For a source warm-up, select the desired gas by pressing the B(oron) or P(hosphorous) button (panel 7 – DOPANT).

6.2.3 Verify the SOURCE VACUUM pressure is in the range of 5 E-6 Torr to 5 E-5 Torr, as indicated by the GREEN markers (panel 5). If the vacuum needs to be adjusted, turn the NITROGEN gas adjust pot located on PANEL 11 CW to increase vacuum or CCW to decrease the source vacuum.

6.2.4 Verify that the ARC-VOLTS meter visible through the TERMINAL VIEWING WINDOW is reading between 60-110 volts (gas dependent). B~110V  P~60V

6.2.5 Verify that the FILAMENT-AMPS meter visible through the VIEWING WINDOW is approx. 0 amps.

6.2.6 Verify that the EXTRACTION VOLTS meter visible through the VIEWING WINDOW is approx. 33KeV.

6.2.6 Adjust the SOURCE MAGNET dial on PANEL 11 to approx 200.

6.2.7 Set the ARC manual dial to 050 (PANEL 11).

6.2.8 Slowly increase the FILAMENT dial on PANEL 11 while observing the FILAMENT-AMPS meter through the VIEWING WINDOW. As you approach 200 AMPS check the ARC-AMPS meter for any
deflection from its zero position. This indicates plasma has been ignited.

NOTE: If NO ARC AMPS are indicated then decrease the FILAMENT current to 50 AMPS and increase the SOURCE MAGNET dial to 400. Slowly increase the FILAMENT current again, while observing the ARC-AMPS meter. This procedure will need to be repeated until the plasma is created, as indicated by an ARC-AMPS reading. If necessary, decrease the FILAMENT to 50 AMPS, increasing the SOURCE MAGNET by another 200 and then increase the FILAMENT current towards 150 AMPS. If no plasma is established after several attempts, contact a Technician for guidance (Rich @ 478.3834 or Scott @ 738.4073).

6.2.9 Pause at the point of ARC-AMPS deflection to allow the source to stabilize for 60 seconds.

6.2.10 Adjust the ARC dial to give approx. 0.1-0.3 AMPS on the ARC-AMPS meter in the VIEWING WINDOW. Allow the source to stabilize at these settings for 5 minutes.

6.2.11 Readjust the ARC dial on panel 11 to give approx. 0.2-0.5 ARC-AMPS. Stable plasma is more desirable than a specific arc current.

6.2.12 Turn ON the high voltage (If Needed) by depressing the HV button located on the left side of panel 7.

6.2.13 Turn up the black BEAM ENERGY ADJUST KNOB located on the right side of PANEL 13, located just above the countertop. Watch PANEL 6 for ENERGY readout in KeV.

6.2.14 Turn ON the chart recorder LINE POWER and SERVO power. Load chart paper and turn ON the CHART HOLD. Uncap the recorder pen.

6.2.15 Locate the desired species peak by monitoring the chart recorder for peaks while adjusting the ANALYZER dial on panel 11:
B11 ~ 290  
P31 ~ 485  
BF2 ~ 625  
F ~ 385

It may be beneficial to plot the entire spectrum to verify the correct peak.

6.2.16 Adjust the ANALYZER dial slightly in both directions to obtain the peak beam current as displayed on the panel 4 DOSE PROCESSOR meter. Select the appropriate scale to display the current. Monitor the chart recorder during this step to stay on the correct peak.

6.2.17 Adjust the SOURCE STEERING joystick on panel 7 in both X directions to maximize the beam current on the panel 4 DOSE PROCESSOR meter. The Y-axis is disabled.

6.2.18 While observing the M image on the panel 2 scope, adjust the focus and center the beam using the TRIM, BALANCE and OFFSET-SHIFT pots on panel 12. Make adjustments for I/X and I/Y (select on panel 2).

6.2.19 On the BEAM SCAN CONTROLLER (panel 10) adjust the H AMP and V AMP pots for proper tail lengths on the I/X and I/Y M’s. Adjust the V STEER pot for Y centering.

6.2.20 Set the desired implant dose on the panel 4 DOSE PROCESSOR.

6.2.21 Select the scanned implant area by choosing the desired end station:
   - ES # 1 for 6” wafers = 196 cm2
   - ES # 2 for 4” wafers = 91.5 cm2

6.2.23 Switch to X/Y on the Beam Monitor Display (panel 2). This value closely represents the actual implant current.

6.2.24 Calculate the implant time and adjust the PANEL 11 ARC pot or SOURCE MAGNET pot as necessary to yield an implant time > 20 seconds.
Time=(Dose x Area x q) / I  where:
area = 91.5 cm$^2$ for 4” or 196 cm$^2$ for 6”
q=1.6E-19

NOTE: On the computer desktop double-click on the Beam Current Calculator shortcut and enter the Dose, Area, and Desired Beam Current to calculate the Implant Time.

6.3 Doing the Implant

* NOTE – Verify the appropriate END STATION MOTOR POWER SWITCH located on the ENDSTATION OPERATOR CONTROL PANEL has been turned ON as per step 6.1.05.

6.3.1 Load the wafers in the marked Teflon cassette provided. DO NOT use any other cassette.

6.3.2 Standard orientation is wafers with flats up, device side facing into the Implanter, starting in the boat location and slot closest to the operator.

6.3.3 On the End Station Operator Control Panel, set the number of wafers to 00 on the thumb wheels.

6.3.4 Set Implanter mode to IMPLANT (key switch on panel 6).

6.3.5 Set the end station to ES2 for 4” or ES1 for 6” wafers (IMPLANT MODE controls on right side of panel 6).

6.3.6 Press the appropriate START button on the END STATION controller.

* NOTE – It is strongly recommended that the “ABORT” button be used in the event of a wafer mishandle event. DO NOT continue with a START command. THIS MAY BREAK YOUR WAFER AND/OR DAMAGE THE TOOL. Contact a technician to troubleshoot the problem.

6.3.7 The implanter will look at all 25 wafer slots and return to the LOAD position and an alarm will sound indicating lot completion. On the End Station Operator Control Panel, push the COMP-MUTE and then the ERROR-CLEAR buttons.
6.3.8 **ERROR 21** - If the **DOSE PROCESSOR** returns an **ERROR 21** after pressing the **START** button, this is an indication that the beam current is too high for the dose you have selected. In order to ensure a uniform implant the dose processor calculates the implant time (T) before starting the actual implant. If \( T < \sim 15 \) seconds, it will cause an error. Go to **SETUP**, lower the beam current, return to **IMPLANT** and press **START** on the **ENDSTATION**.

6.4 **Shut Down/ Standby**

* NOTE – Turn OFF the appropriate **ENDSTATION MOTOR POWER SWITCH** located on the **ENDSTATION OPERATOR CONTROL PANEL**.

6.4.1 Set the Key switch to **SET UP mode** (**panel 6**).

6.4.2 On **Panel 2**, switch the **Beam Monitor** to **I/X**.

6.4.3 Set the **SOURCE STEERING** (**panel 7**) to maximize current displayed on the **BEAM CURRENT** meter (**panel 4**).

6.4.3 Turn down the **Beam Energy Adjust** knob located on **panel 13** to < 35 KeV as shown on **panel 6**.

6.4.4 Turn down **FILAMENT** dial to Zero (**panel 11**).

   Check meter in viewing window to make sure it is as close to zero as possible. Dial at zero won’t always get meter to zero.

6.4.6 Set **ARC** to **050** on dial (**panel 11**).

6.4.7 Turn **OFF** the Dopant Gas button on remote electronics rack (**panel 7**).

6.4.8 Turn **OFF** the High Voltage (**HV OFF** (**panel 7**).

6.4.9 Turn **OFF** the Terminal Voltage (**TERM OFF** (**panel 7**).

6.4.10 Turn **OFF** the **POWER** key button by pushing in the button (**panel 7**).
6.4.11 Turn OFF the VIEWING WINDOW LIGHT on the HIGH VOLTAGE TERMINAL.

6.4.12 Turn OFF Varian nitrogen on N2 Manifold 2765 located in chase 2765.

6.4.13 Turn OFF End Station Motor on the End Station Operator Control Panel.

6.4.14 Deactivate the Card Swipe Interlock by logging off at CARD SWIPE ACCESS 3.

6.5 Errors During Run

6.5.1 Consult the Error Code chart posted on the Implanter for corrective action and contact a technician.
7 ATTACHMENTS

REVISION RECORD

<table>
<thead>
<tr>
<th>Summary of Changes</th>
<th>Originator</th>
<th>Rev/Date</th>
</tr>
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<tbody>
<tr>
<td>Original Issue</td>
<td>R. Battaglia</td>
<td>A - 12/13/02</td>
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<tr>
<td>Updated all instructions</td>
<td>Scott Blondell</td>
<td>B - 03/17/03</td>
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<tr>
<td>Added N2 instructions and ERROR CODES</td>
<td>Scott Blondell</td>
<td>C - 03/24/03</td>
</tr>
<tr>
<td>Updated all instructions</td>
<td>Scott Blondell</td>
<td>D - 08/07/07</td>
</tr>
<tr>
<td>Updated last page to include Recorder shut off</td>
<td>Mike M.</td>
<td>E – 6/25/07</td>
</tr>
<tr>
<td>Updated instructions using written edits from Rev E.</td>
<td>Kelly Johnson</td>
<td>F – 10/19/10</td>
</tr>
<tr>
<td>Updated all instructions; eliminated N2 carrier gas warmup.</td>
<td>Scott Blondell</td>
<td>G – 11/08/11</td>
</tr>
<tr>
<td>Updated all instructions using written edits in Rev G</td>
<td>R. Battaglia</td>
<td>H – 12/16/2016</td>
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