

Hercules® Viewers Handbook

HercViewer HercLotViewer

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Imprint

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1. Equipment and measurement device coupling

Please note:

- Without data coupling: Several lots with different recipes will be saved in one data file.
 - Individual recipes can only be identified by their process time.
 - It is necessary to create a common data base in the Fab.
- **Important:** The goal is to have plasma data and logistical data in one data base so that the logistical data refer to the plasma data.
- The time stamp in the Hercules® data set the start time (plasma on) of the process. This value is based on the local time zone and the date settings.



2. Performance of HercViewer and HercLotViewers

- Analysis of plasma data (electron density, electron collision rate, peak/dc bias voltage, sheath thickness, harmonics of current and its phase) for etch and deposition processes:
 - 3 axes for 2 parameters and process length
- Comparison of plasma data of several etch tools and Hercules® systems (e.g., chamber matching)
- Data analysis and compression by statistical methods
- Plasma parameters can be saved in ASCII-format (Excel import).
- Chamber_ID is created by connection of Tool_ID and chamber identifier.
- Plotting over wafer number or wafer start time
- Step wise analysis possible
- HercViewer:
 - Quasi on-line process control (comparison with reference wafer), e.g., conditioning
 - Time resolved presentation of plasma data



3. HercViewer

3.1. Short guide

3.2. Open / save data file (file format: hpl and hdx)

3.3. Graphic parameter presentation

3.4. Further presentation options

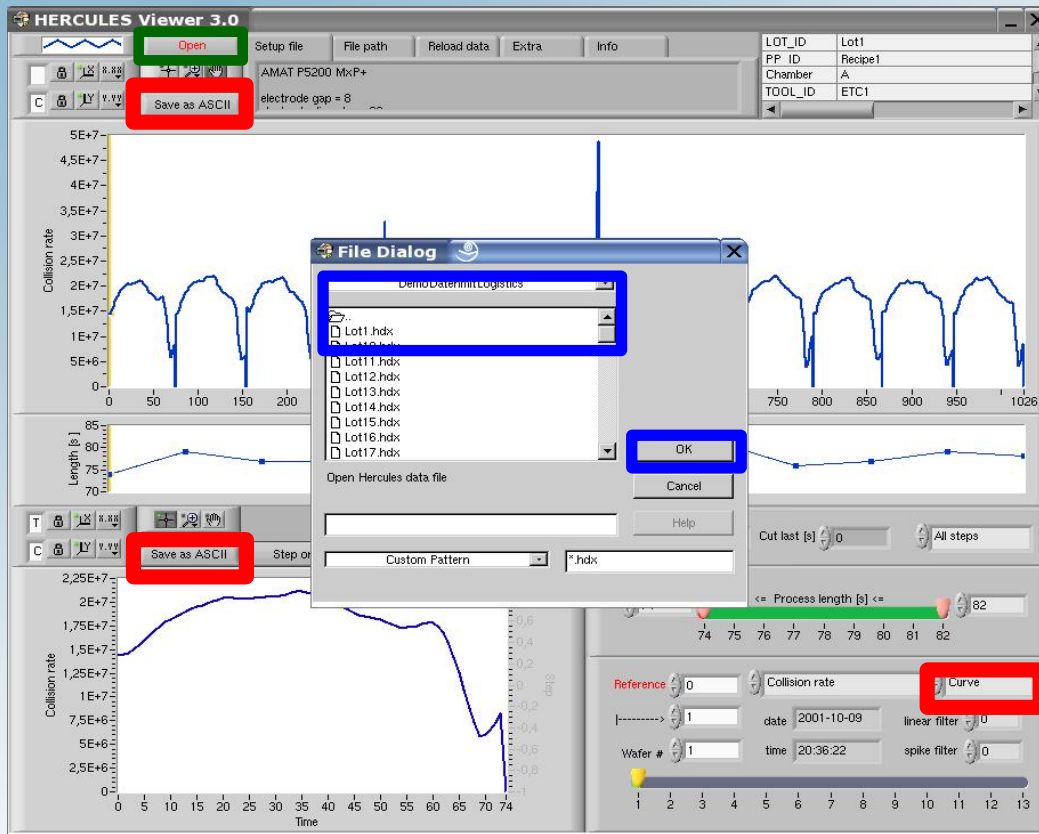


3.1. Short guide

- Logistical data available (CommServer connected):
 - Files according the lot and recipe
 - Step-wise analysis of plasma processes (selection of step number)
 - Display of step numbers in time resolved plot
- Logistical data not available (recipe known):
 - Data are saved as day files (chamber-wise).
 - Selection of recipes, e.g., dry clean or etch process, by defining a process length range (Process lengths shown in a separate window.)
 - Selection of distinct process parts by cutting their first and last seconds (semi step-wise analysis)



3.2. Open/save data file (file format: hpl and hdx)

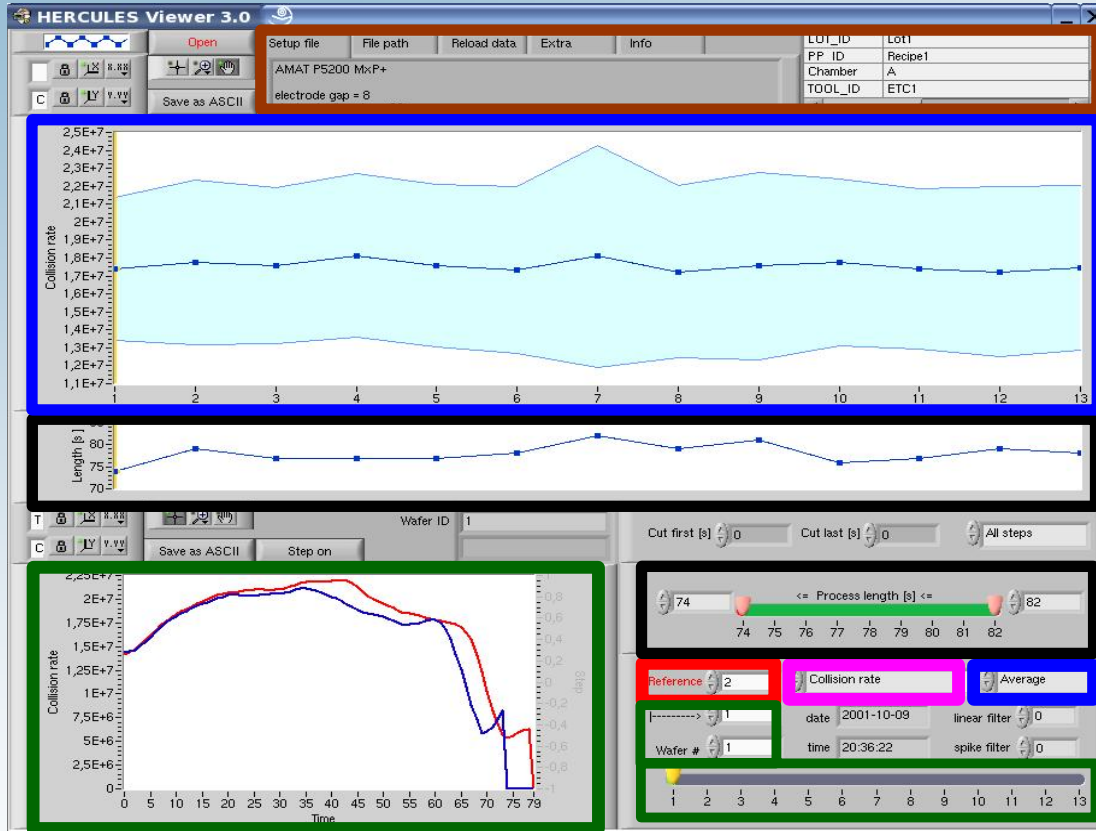


- Click 'open' to open the file dialog
- Selects the directory and the data file (LotID or date) and click OK
- Saves all, selected or time resolved data in an ASCII-file
 - Mode 'curve': Saves all wafers time-resolved in 1 column for each wafer!

- The plasma parameters are saved in the hpl-file, whereas the logistical data are stored in the hdx-file.
- Only the hdx-data files are shown in the open window. The HercViewer loads the hpl-data file automatically.



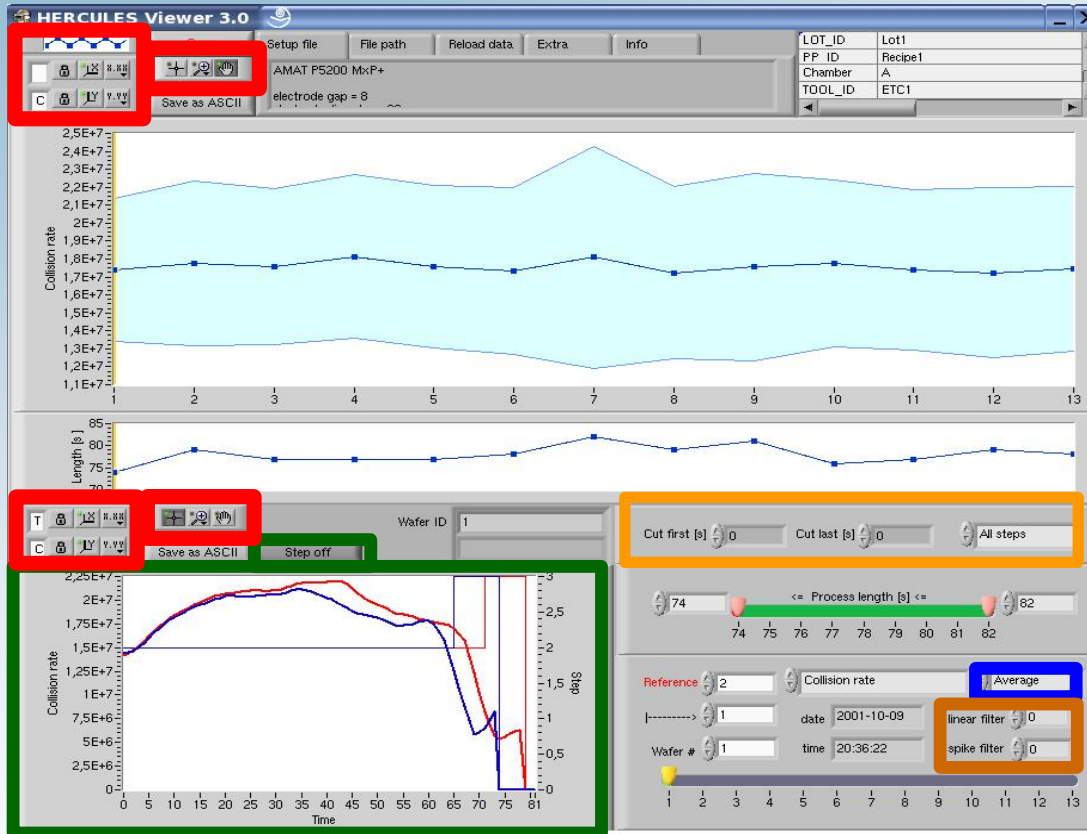
3.3. Graphical parameter presentation



- Mean and standard deviation for each wafer (mode: Average)
- Process lengths: Display and selection of recipes to be analyzed
- Time resolved plasma parameter for selected wafer(s) and the selected reference wafer
- Logistics and further infos
- Selection of plasma parameter



3.4. Further presentation options



- Selection of mode: Curve, Average or Standard deviation
- Presentation of a single step by selection or by cutting the first/last seconds
- Filter to remove spikes and smooth of curves
- The step information, step number refers to right y-axis
- Several options for formatting graphics



4. HercLotViewer

- 4.1. Short guide
- 4.2. Open and selection of directories
- 4.3. Data selection (logistical parameters)
- 4.4. Pre-selection of process lengths and steps
- 4.5. Data visualization
- 4.6. Plot modification
- 4.7. Chamber and recipe comparison
- 4.8. Comparison of time resolved data

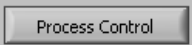


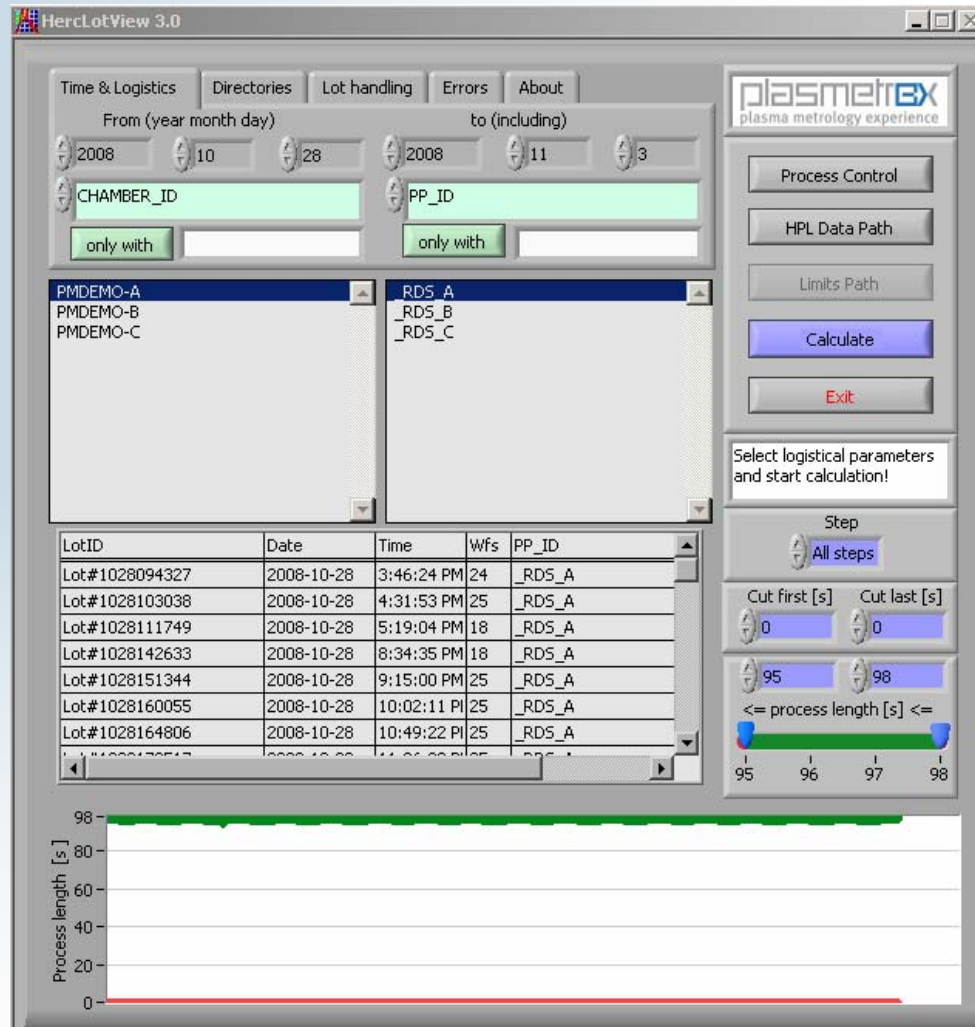
4.1. Short guide

- If logistical data are available (CommServer connected), the following are possible:
 - Pre-selection of recipes (logistical parameter: PP_ID)
 - Selection of LOT_ID, TOOL_ID, CHAMBER_ID, File
 - Selection by parts of LOT_ID, TOOL_ID, CHAMBER_ID, File
 - Step wise analysis of plasma processes (selection of step number)
 - Comparisons of chambers and recipes
- If logistical data are not available (recipe known); it is necessary to:
 - Pre-select recipes, e.g., dry clean or etch process, by defining a process length range (saves computing time)
 - Select special process parts by cutting the first and last seconds (semi step-wise analysis)
- Visualization of time resolved plasma parameters:
 - Time resolved plasma data are shown for the complete process.
 - The diagram shows the time resolved curve and the corresponding wafer ID.

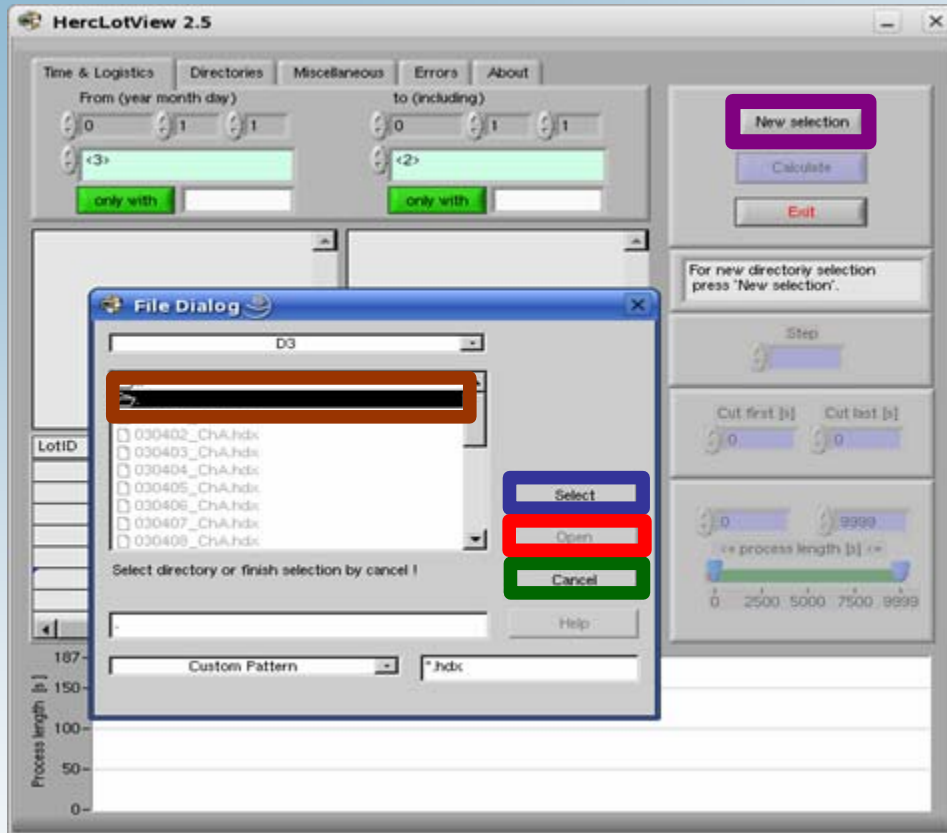


Additional Features from Version 3.0

- The HercLotViewer from Version 3.0 and higher provides additional features for process control  which are used for the configuration of the SAPC server.
- These features are active if the SAPC server was ordered.



4.2. Open and selection of directories



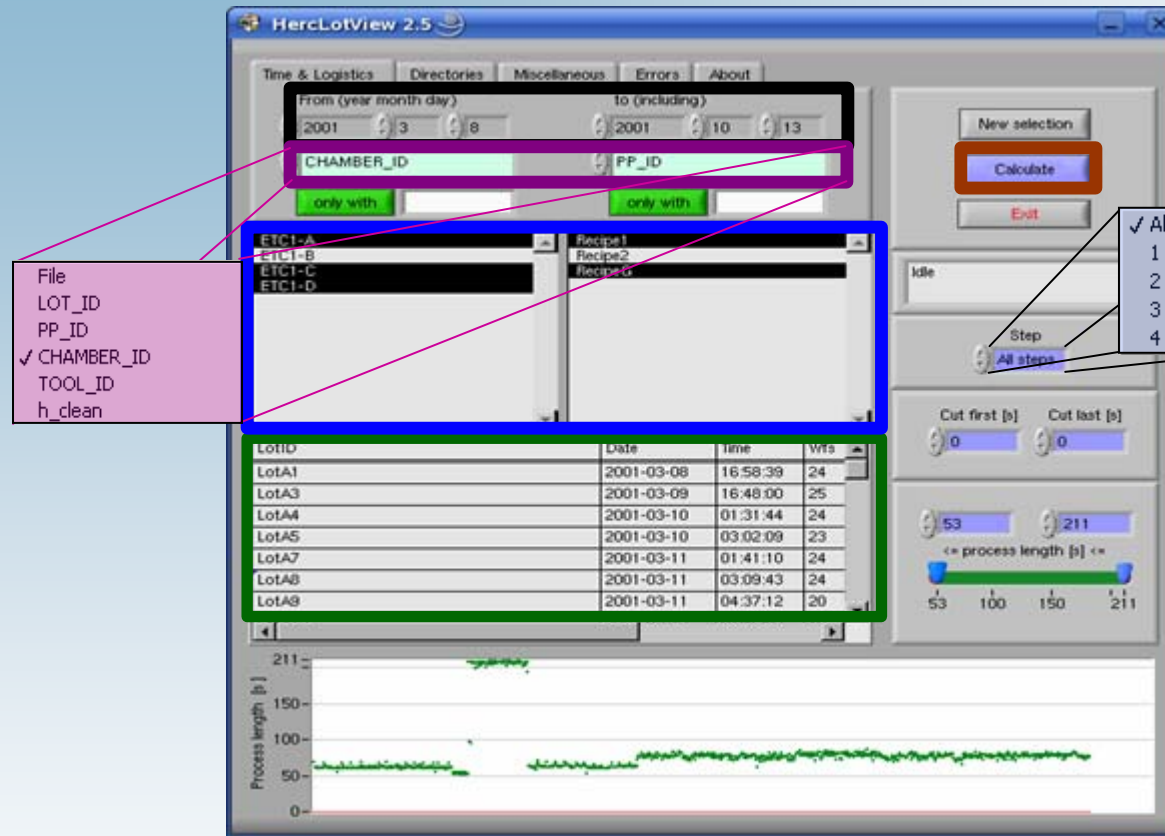
- Click on 'New selection' to open the file dialog
- Select directory (in Windows this directory must be opened before)
- To select this directory please click 'Select'
- The data files in the LotViewer are loaded by clicking the button 'Cancel'.
- The button 'Open' has no function here!

Please note:

The selection of further directories is possible by repetition of step 2 and 3.



4.3. Data selection (logistical parameters)



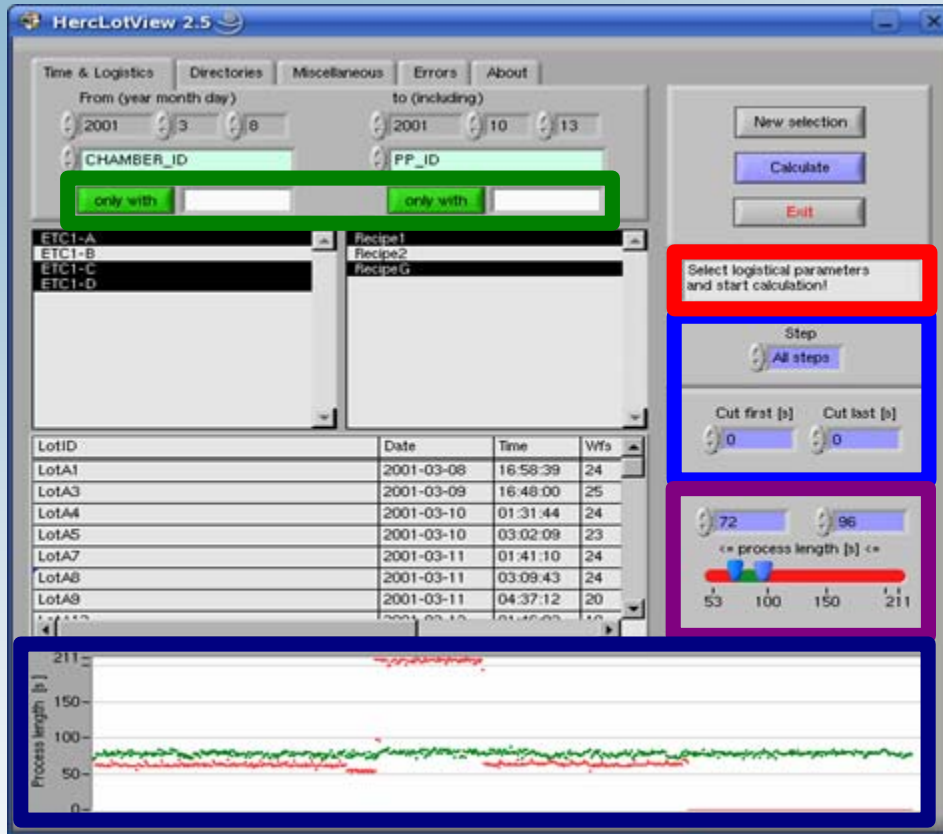
- Select type of logistics
- Chose logistical data parameter 1 and 2, multiple selection by Ctrl-key + left mouse possible (in Linux: Ctrl-Alt-keys)
- Select the date interval
- The selected lots or runs are displayed here.
- Start calculation

If the data don't contain the selected parameters no data are shown in the output window.

File: file name
LOT_ID: number of Lot
PP_ID: Recipe
CHAMBER_ID number
TOOL_ID: etch tool



4.4. Pre-selection of process lengths and steps



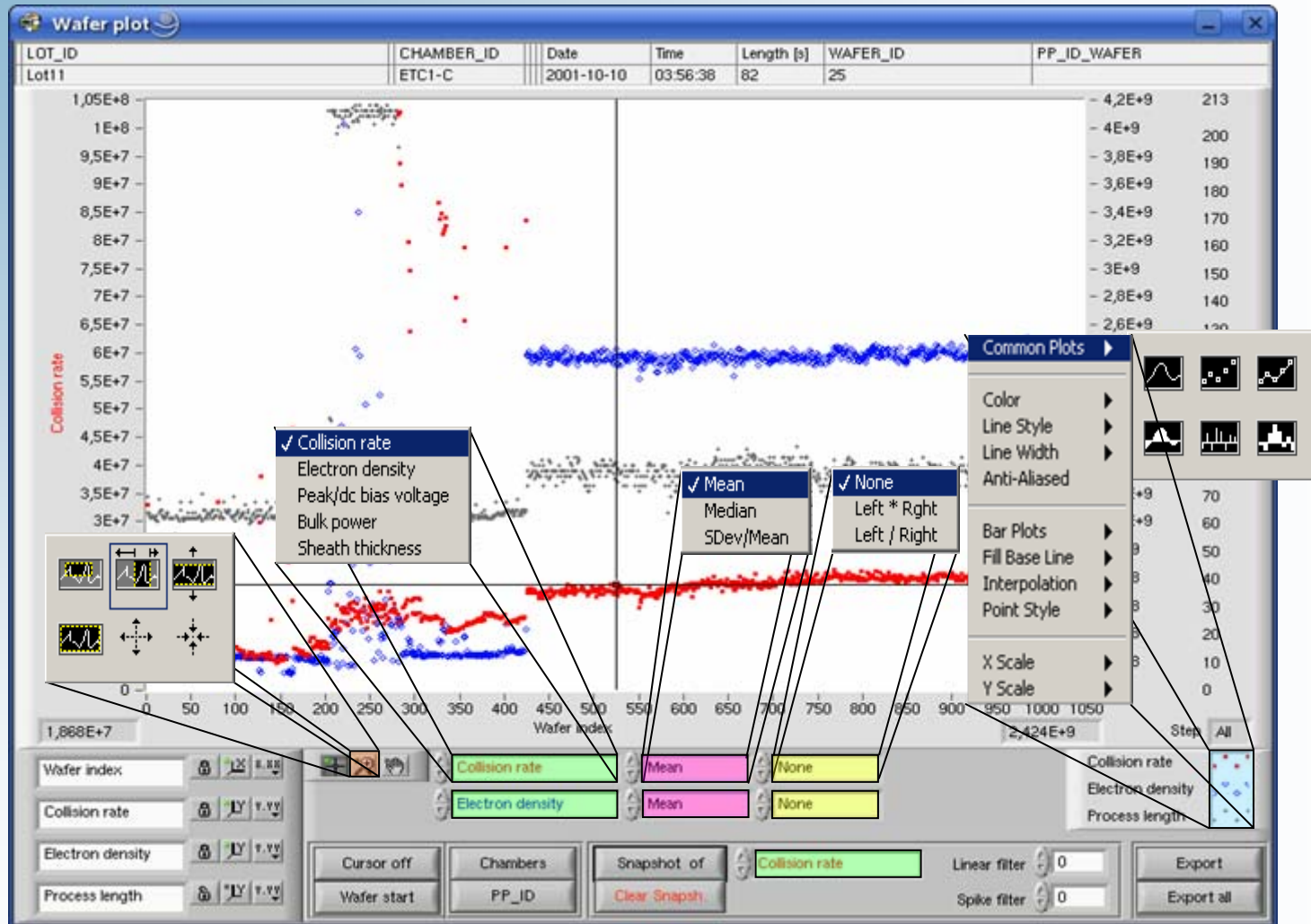
- Choose a range of process lengths by the sliders (blue) or the numerical controls
- The selected wafers appear green, the deselected red.
- Presentation of a single step by selection or by cutting the first/last seconds
- Current operation and advice
- Additional selection criteria concerning: Lot ID, PP ID, File name, tool ID ...

Current selection: Processes of recipes 1, 3; process length 72 s – 96 s; chamber A, C and D

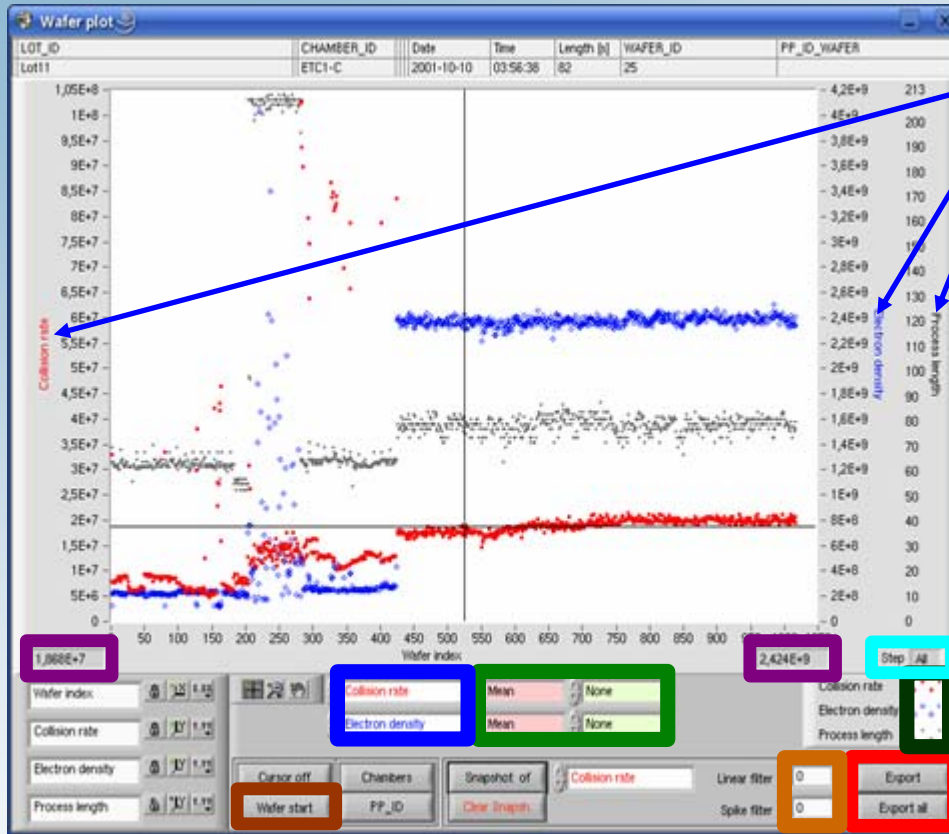
Move the mouse arrow over a button to get an explanation



4.5.1. Data visualization (menus)



4.5.2. Data visualization (description)

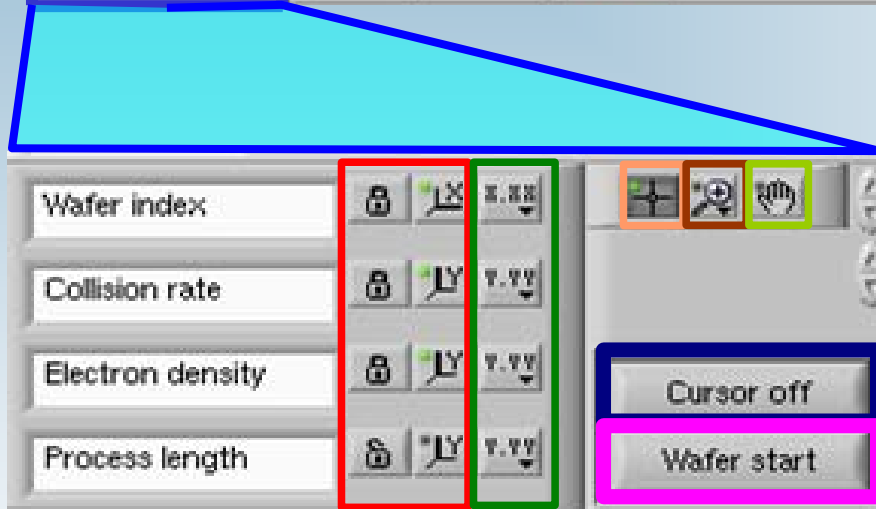


- 2 parameters and the process length are shown as selected below.
- Selection: Wafer number or start time.
- Export all (=original) or selected data in an ASCII-file.
- Mathematical and statistical operations
- Several options for formatting symbols
- Filter to smoothing and remove spikes
- The chosen step of the displayed values is shown.

Mean, median or standard deviation of the cursor-marked wafer of chosen step or complete process is shown. This value is independent of the mathematical operation!



4.6. Plot modification



Change scaling:

- Auto scaling: on/off
- Format of scaling → for each axis
- Activates cursor (cross-hair moveable with arrow keys)
- Zoom
- Activates manual scrolling
- Cursor: on/off for presentation
- X-axis wafer No. or start time

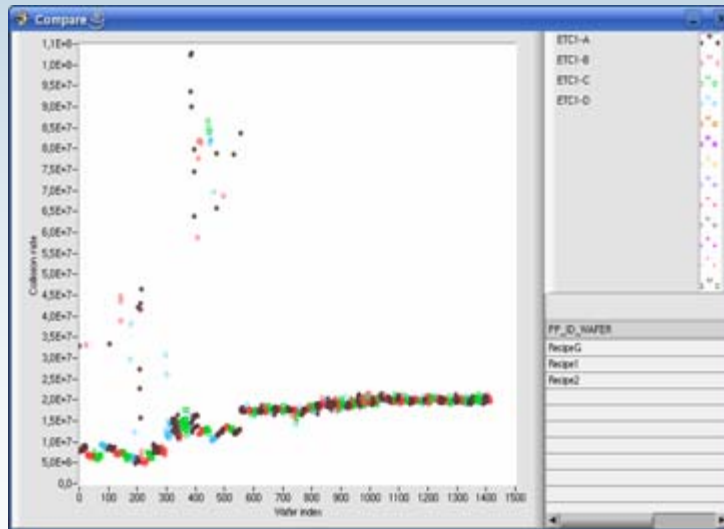


4.7. Chamber and recipe comparison



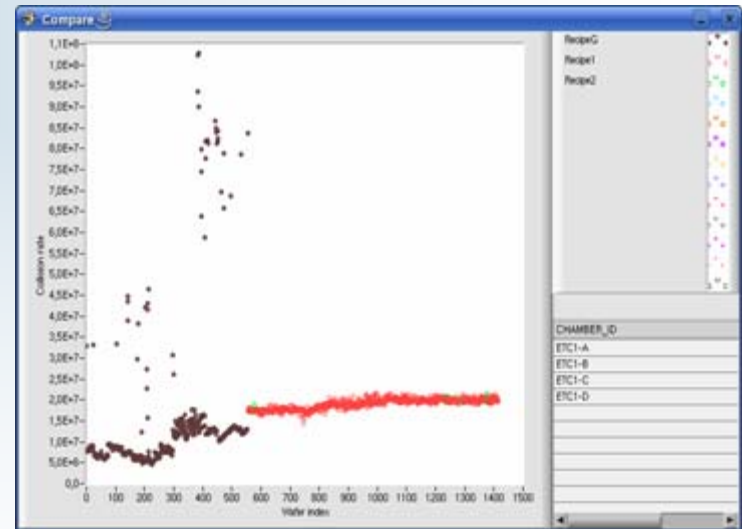
Chamber comparison:

- Symbols for chambers used
- List of recipes used



Recipe comparison:

- Symbols for recipes used
- List of chambers used



1st selected parameter with chosen attributes is shown.

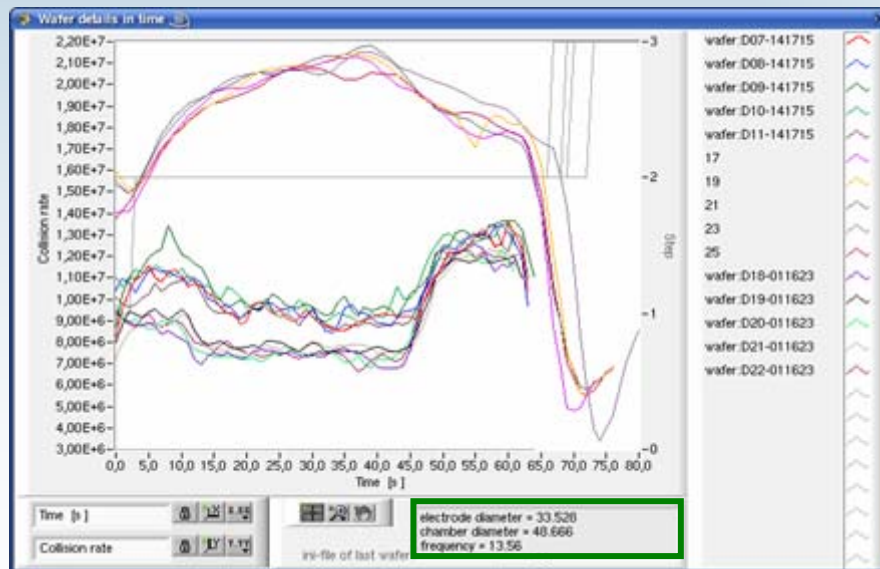


4.8. Comparison of time resolved data



Both the bottom 'Snapshot of' and the Enter key open the diagram 'wafer details in time' and shows the plasma parameter of the wafer marked by the cursor. Move the cursor with the mouse or use the arrow key.

The displayed parameter can be changed by choosing another one.



Find here the Herc.ini file of the last drawn wafer.
Activate it with mouse and scroll using arrow keys.

Attention!

For snapshot by pushing the Enter key the wafer plot window has to be activated.



5. Appendix

- 5.1. Mean and Median dependencies of plasma parameters
- 5.2. Dependencies of plasma parameters
- 5.3. Electron density
- 5.4. Collision rate



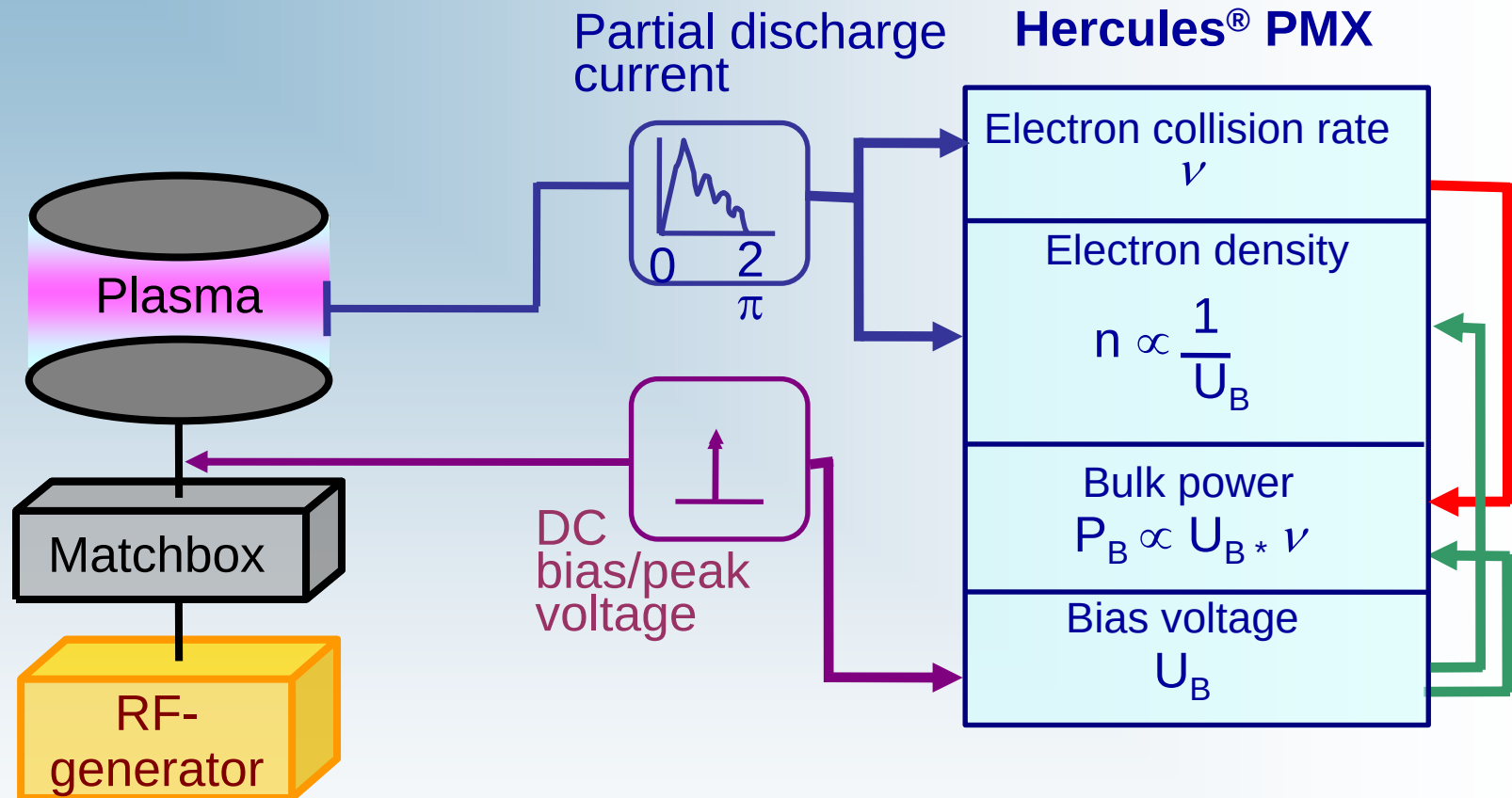
5.1. Mean and Median

Statistical moment	Advantage	Disadvantage	Example1 Values: 1,2,3,4,50000	Example2 Values: 1,1,1,1,1,9,9,9,9
Mean	All values have the same influence on the mean.	A very high value can dominate the mean.	Mean = 10002	Mean = 4,6
Median	Large values can not dominate the median.	In case of strong variations in the process step do not use the median.	Median = 3	Median = 1

The median use only for step-wise analyzes!



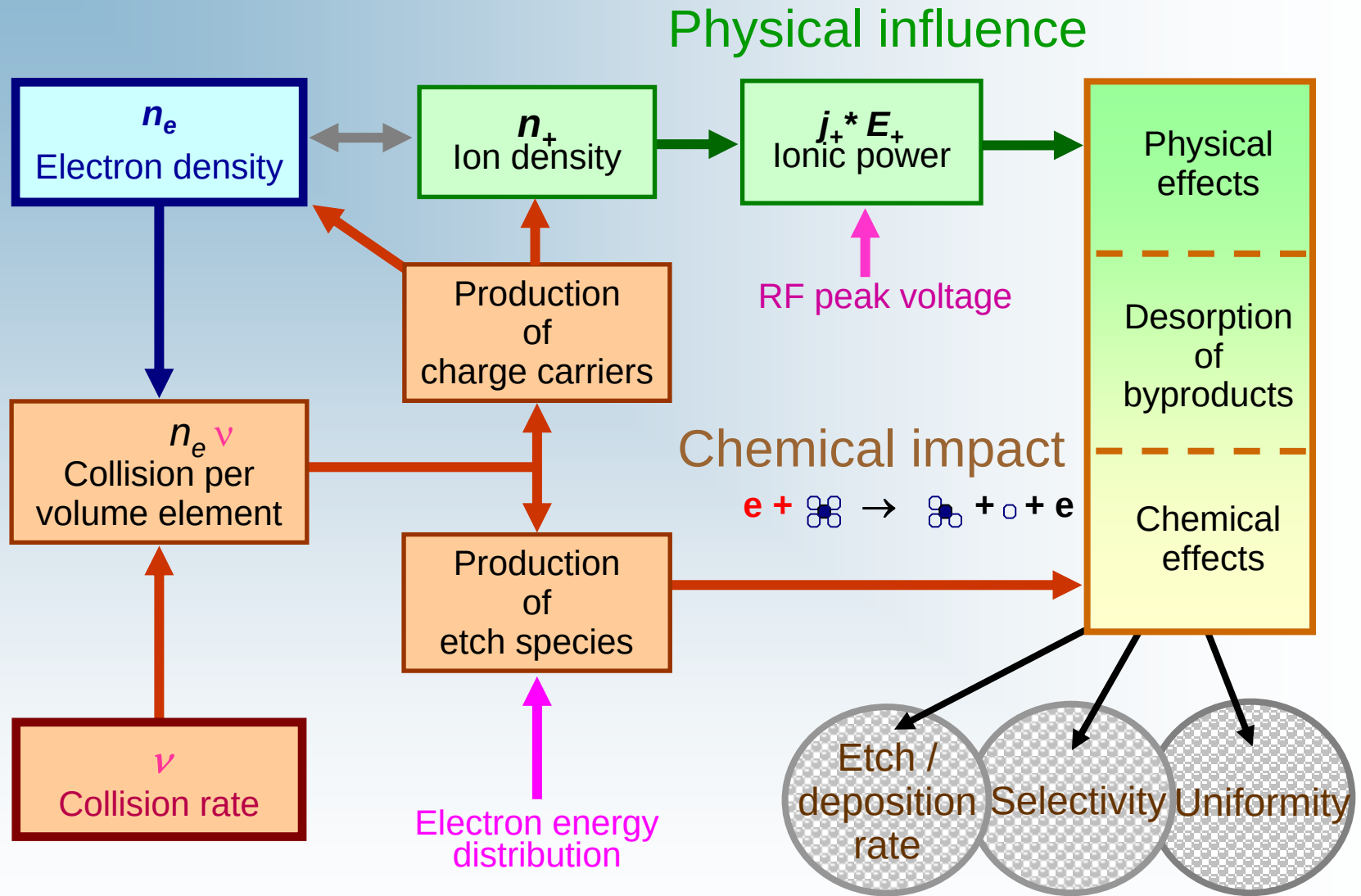
5.2. Dependencies of plasma parameters



The explanation of plasma parameters
please see next pages!



5.3. Electron density



5.4. Collision rate

- Depends on power and pressure (recipe)
- Depends on gas mixture (recipe)
- Impact of electrons on chemistry
- Feedback from chemistry via cross sections and relative concentration of species

Stochastic heating (sheath)

Density of neutrals

Collision cross-section

Relative concentration

low medium large

He

Cl₂

Polymer particle

$$v_{\text{eff}} \approx \frac{1.6}{l} \sqrt{\frac{U_{\text{bias}}}{2\pi m_e}} + \frac{p}{kT_n} \sum_i \frac{p_i}{p} \sigma(\frac{1}{v_e}) v_e$$

v_{eff} : Number of collisions of one electron with neutrals per second

