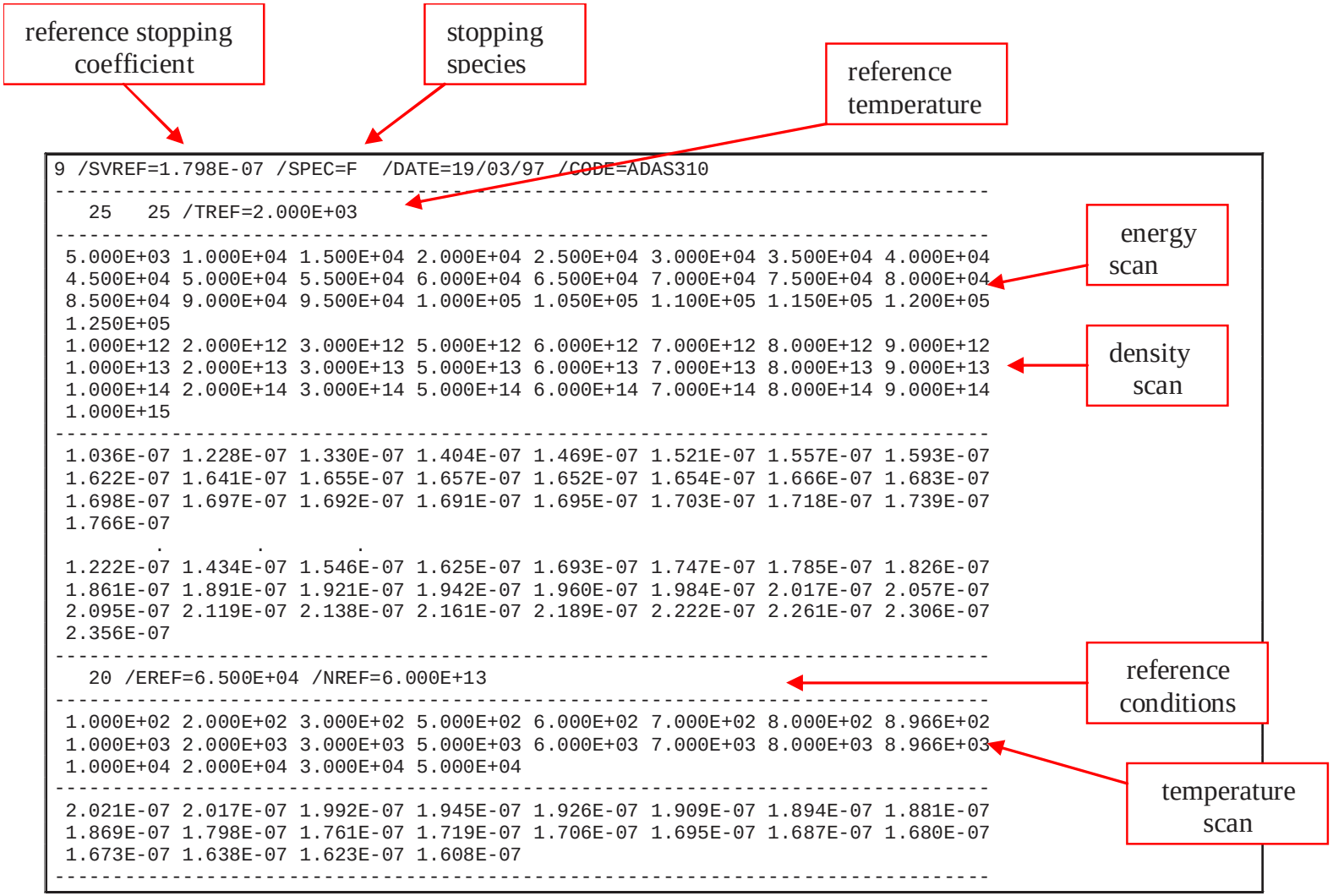
Beam stopping and Beam emission spectroscopy

- Extracting effective beam stopping coefficients or beam emission coefficients using ADAS304.
- Calculating the beam population structure using ADAS310
- Details of beam emission with adas305_get_stark.pro

Interrogating effective beam stopping coefficients

- Datasets of class ADF21 contain effective stopping data as a function of beam and plasma parameters for different plasma species.
- Datasets of class ADF22 contain effective beam emission data as a function of beam and plasma parameters for different plasma species.
- Code ADAS304 interrogates ADF21 or ADF22 data sets to provide coefficients at beam and plasma conditions of your choice.

ADF21 beam stopping coefficients

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 8.500E+04 9.000E+04 9.500E+04 1.000E+05 1.050E+05 1.100E+05 1.150E+05 1.200E+05
 1.250E+05
 1.000E+12 2.000E+12 3.000E+12 5.000E+12 6.000E+12 7.000E+12 8.000E+12 9.000E+12
 1.000E+13 2.000E+13 3.000E+13 5.000E+13 6.000E+13 7.000E+13 8.000E+13 9.000E+13
 1.000E+14 2.000E+14 3.000E+14 5.000E+14 6.000E+14 7.000E+14 8.000E+14 9.000E+14
 1.000E+15
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 1.766E-07
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 1.000E+04 2.000E+04 3.000E+04 5.000E+04
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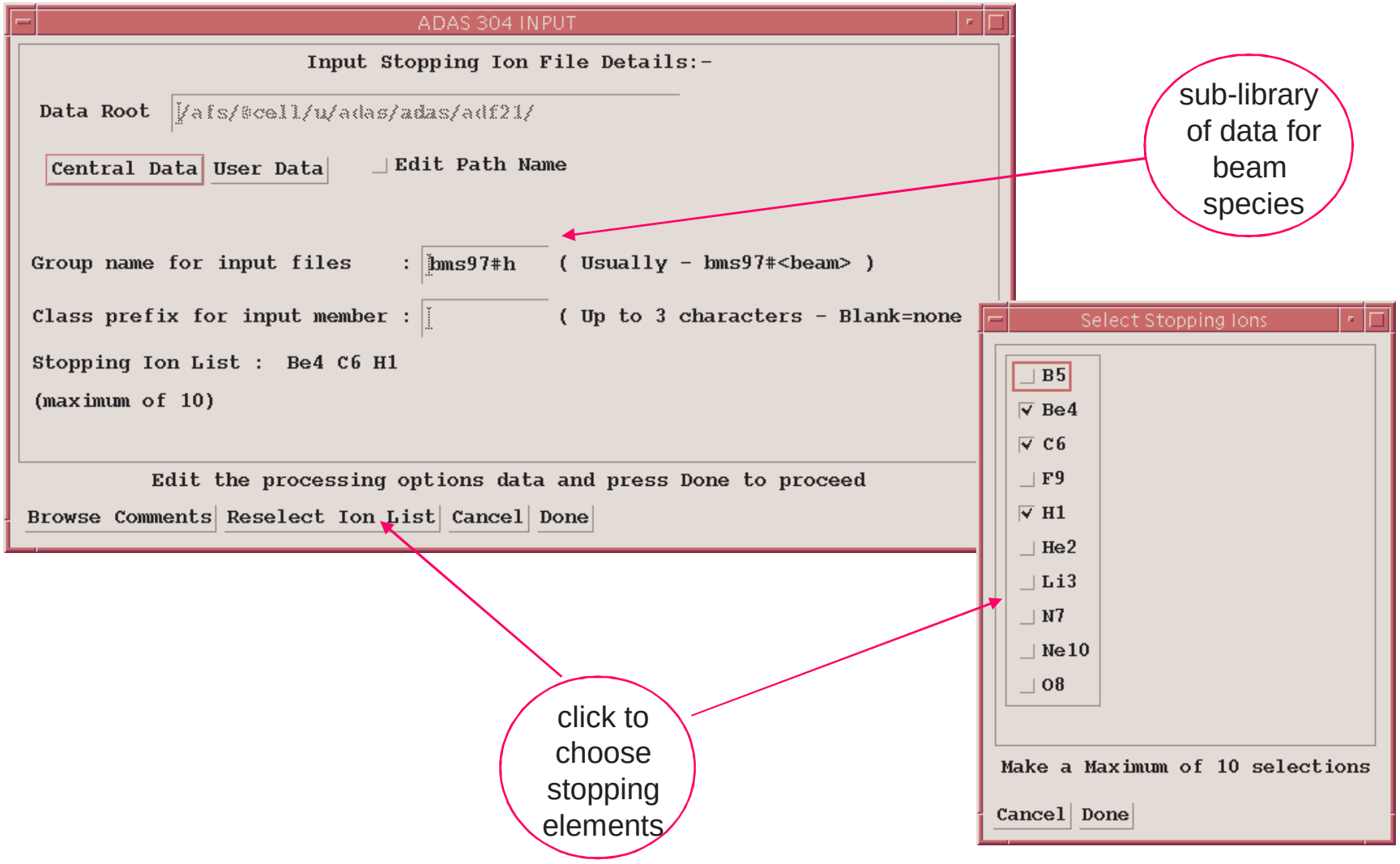
ADAS304 Input



ADAS304 Processing

select type of graph display

specify beam and plasma conditions

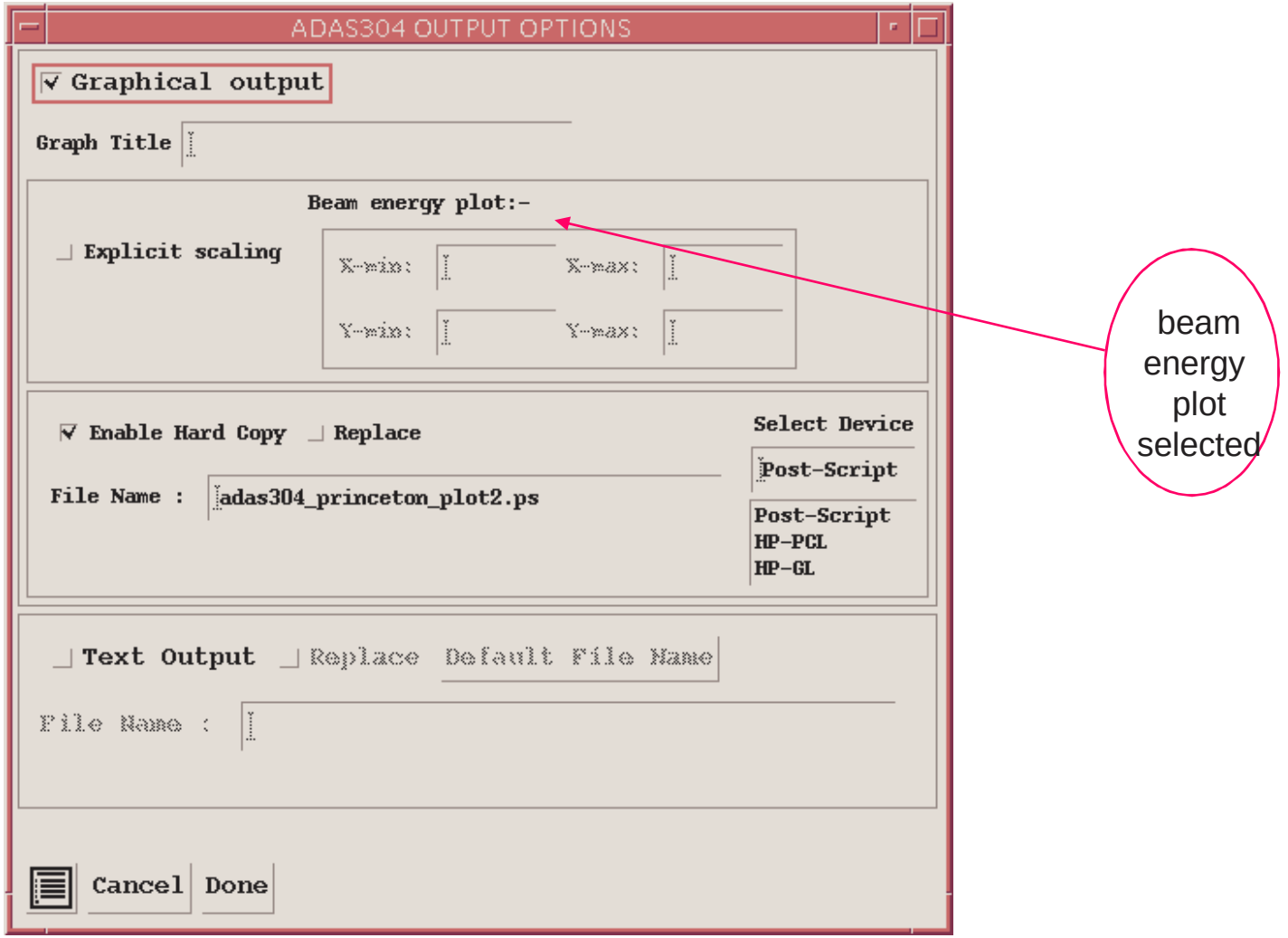
set fractions for each stopping species

Obtaining effective beam stopping or emission coefficients (contd.)

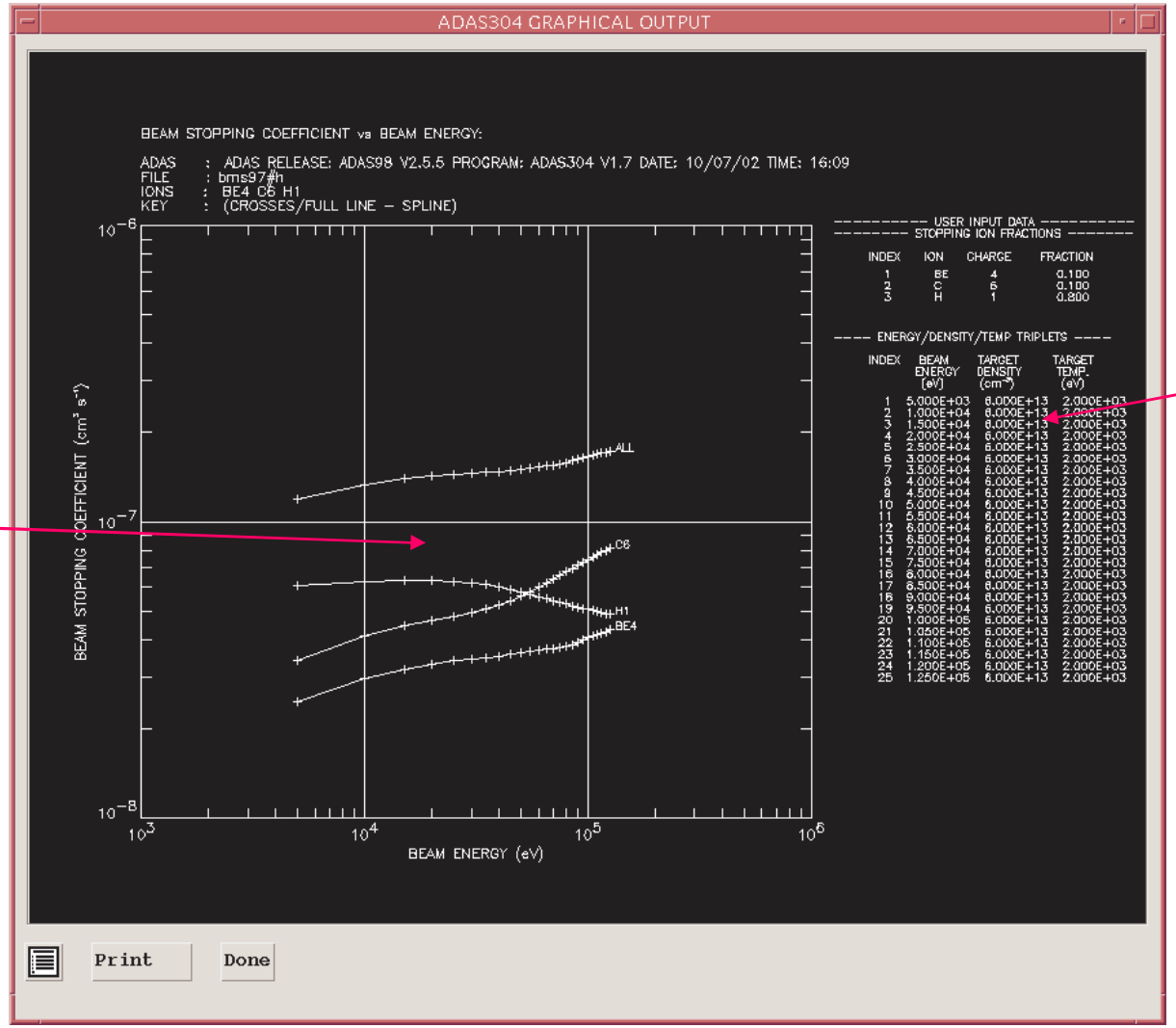
- The composite stopping for a mixed composition plasma is assembled as

$$N_e S_{CR}^{(A)}(E_B, N_I, T_I) \approx \sum_{i=1}^{I} N_{e,i}[S_{CR}^{(i,e)}(E_B, N_I, T_I) + (1/z_{0i}) S_{CR}^{(i,z_0)}(E_B, N_I, T_I)]$$

ADAS304 output



ADAS304 graph



Each contribution to stopping and total

specified conditions

Computing effective beam coefficients

- The first step is the calculation of the full collisional-radiative population structure of the hydrogen beam atoms.
- Code ADAS310 performs these calculations in the bundle-n model.
- It executes these repeatedly for the sets of plasma parameters required to construct tables containing the excited population structure and beam stopping.

Computing effective beam coefficients (contd.)

- The full population structures are archived in ADF26 according to (single) impurity.
- Code ADAS312 post-processes the ADF25 files to extract the beam stooping and beam emission coefficients of choice.
- The output is structured according to the ADF21 (beam stopping) and ADF22 (beam emission) specifications.

Computing effective beam coefficients (contd.)

- File selection
  - » Two input files may be selected.
  - » The first, called the expansion file, gives the pathway for storing condensed collisional-radiative matrices.
  - » The second, charge exchange file, is not important for the beam case. ADAS310 can compute hydrogen populations in the plasma (including CX) as well as beams

ADAS310 Input

beam species

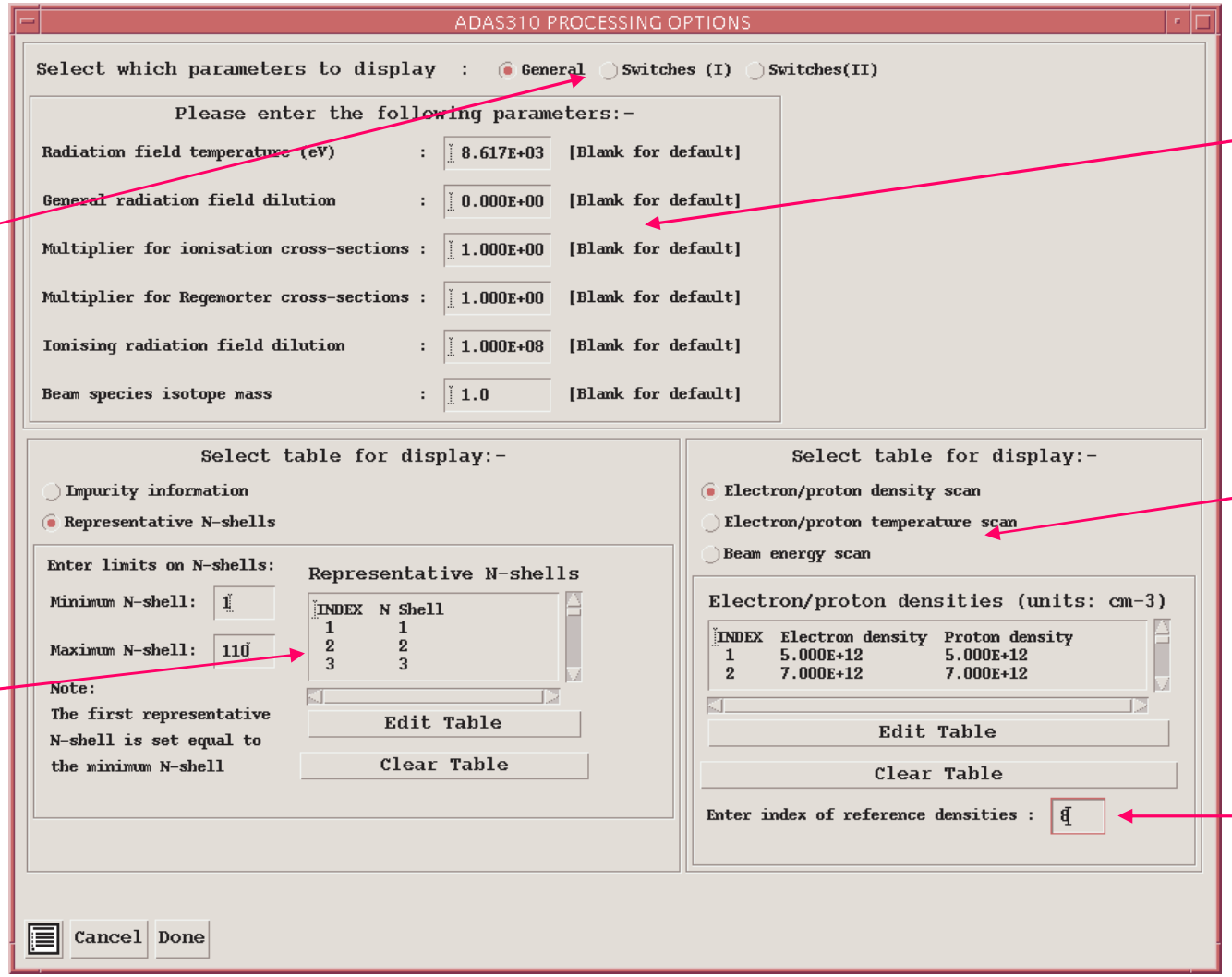
expansion file for high n-shell handling

advanced usage not applicable to simple stopping

Computing effective beam coefficients (contd.)

- Processing options
  - » There are many parameters to specify but most are set with defaults.
  - » The main user data are the impurity specifications and the plasma parameter scans.
  - » ADAS310 can work with mixed impurities but main tabulations are for single impurities which are linearly combined for mixtures at the spectral analysis stage

ADAS310 Processing



three sets of switches - defaults are set

general parameters controlling x-sect. use

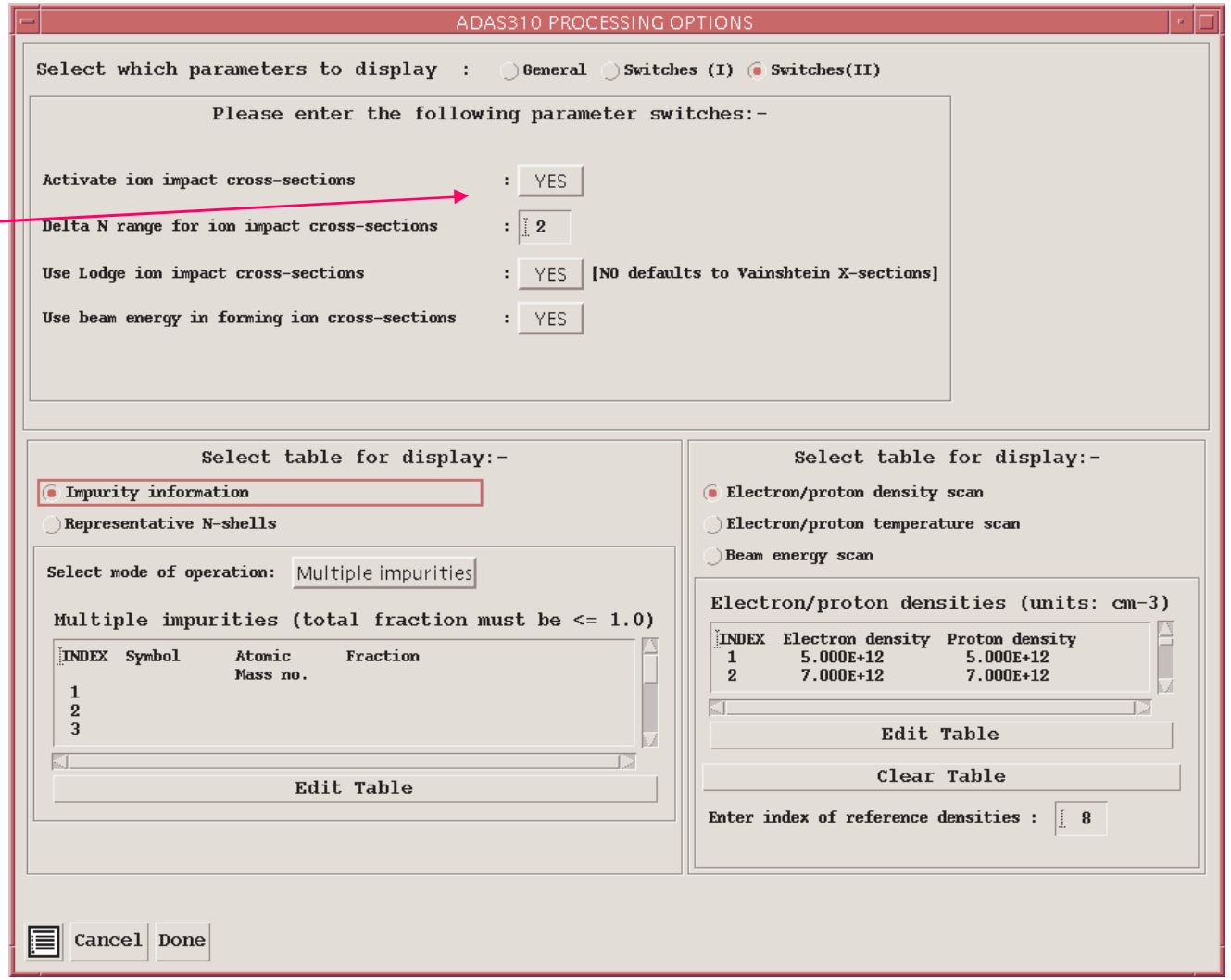
specify scans in key parameters

specify details of bundle-n model for hydrogen

note use of reference conditions

ADAS310 Processing (contd.)

third switch set



Computing effective beam coefficients (contd.)

- Output options
  - » There is no graphical display from ADAS310.
  - » Several pass files are created
  - » The fourth passing file is the population structure (ADF26)
  - » Execution time is longer than most interactive codes.

ADAS310 Output

extended set of passing files for post-processing

Beam emission and the Balmer alpha Stark multiplet structure

- The calculation of local Stark/Zeeman emission feature from H (D/T) beams is accessed via an IDL procedure call *adas305_get_stark.pro* or within FORTRAN by calling the *stark.for* routine in the adas3xx library.

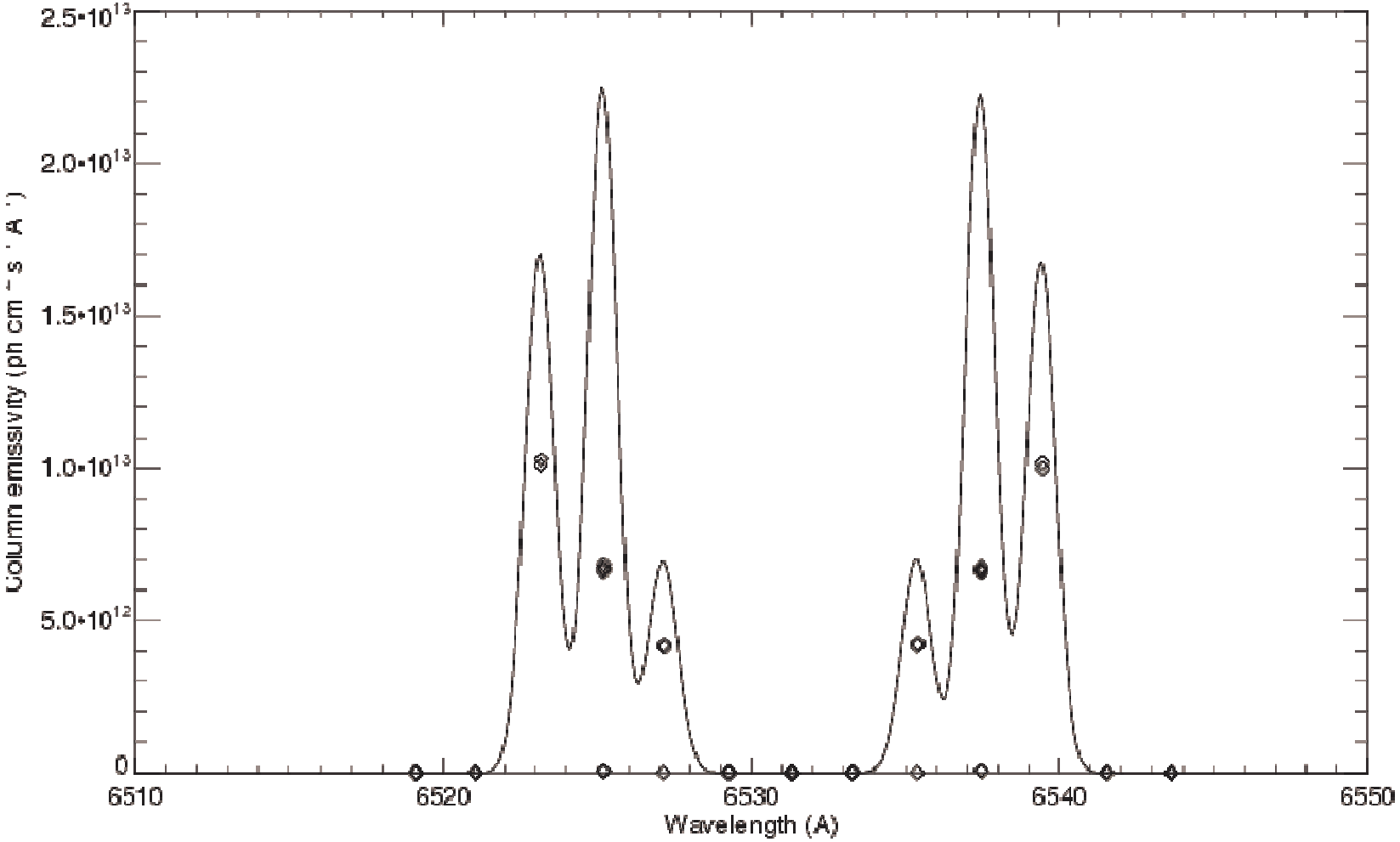
- The beam, plasma, E and B fields and observation orientation must be specified. General geometry specification is defined by direction cosines. The polarisation can be specified by multipliers on the π and σ components.

- The feature is returned as either a collection of component wavelengths and emissivities or a Doppler broadened feature over a specified wavelength range (specify minimum and maximum wavelengths and number of pixels).

adas305_get_stark.pro

```
PRO stark_fig

beam   = {mass : 2.0, energy : 40.0e3, te : 10.0, density : 4.27e9, $
          dc_x : 0.0, dc_y : 0.0, dc_z : 1.0}
plasma = {mass : 2.0, te : 8e3, density : 5.0e13, zeff : 2.0}
bfield = {value : 3.3915, dc_x : 0.788, dc_y : 0.0053, dc_z : 0.6152}
efield = {value : 0.0000, dc_x : 1.000, dc_y : 0.0000, dc_z : 0.0000}
obs    = {dc_x : 0.8701, dc_y : -0.047, dc_z : 0.4905, sigma : 0.00, pi : 1.0}

wave_min = 6510
wave_max = 6550
npix     = 500

adas305_get_stark,  beam           = beam,          $
                    plasma         = plasma,        $
                    bfield         = bfield,        $
                    efield         = efield,        $
                    obs            = obs,           $
                    n_lower        = 2,             $
                    n_upper        = 3,             $
                    wave_comp      = wave_comp,     $
                    emiss_comp     = emiss_comp,    $
                    wave_min       = wave_min,      $
                    wave_max       = wave_max,      $
                    npix           = npix,          $
                    emiss_doppler  = demiss   , /doppler  ; , /nocheck

wave  = adas_vector(low=wave_min,high=wave_max,num=npix, /linear)
dwave = wave[1]-wave[0]

plot, wave, demiss/dwave, $
      xtitle = 'Wavelength (A)', $
      ytitle = 'Column emissivity (ph cm!u-2!n s!u-1!n A!u-1!n)'

plots, wave_comp, emiss_comp, psym=4

END
```

Balmer alpha Stark multiplet



Feature variation

B: 1.4T – 50 T

E: 0.5Mev/amu – 100eV/amu