5. Population and line ratio studies

- Populations
  - » Obtaining the populations of excited states of ions in a plasma
  - » Setting up spectrum lines for study
  - » Displaying temperature & density sensitive line ratios

Obtaining populations

- Datasets of class adf04 contain all the information necessary to evaluate excited populations of an ion. It is called a ‘specific ion file’
- Code ADAS205 computes the populations at temperatures and densities of you choice

Obtaining populations (contd.)

- Start ADAS205 as follows
  - » *Start ADAS*
  - » *Move to ADAS series 2*
  - » *Click button for ADAS205*
- ADAS205 has the standard sequential three screen structure, namely *file selection*, *processing options* & *output options* screens

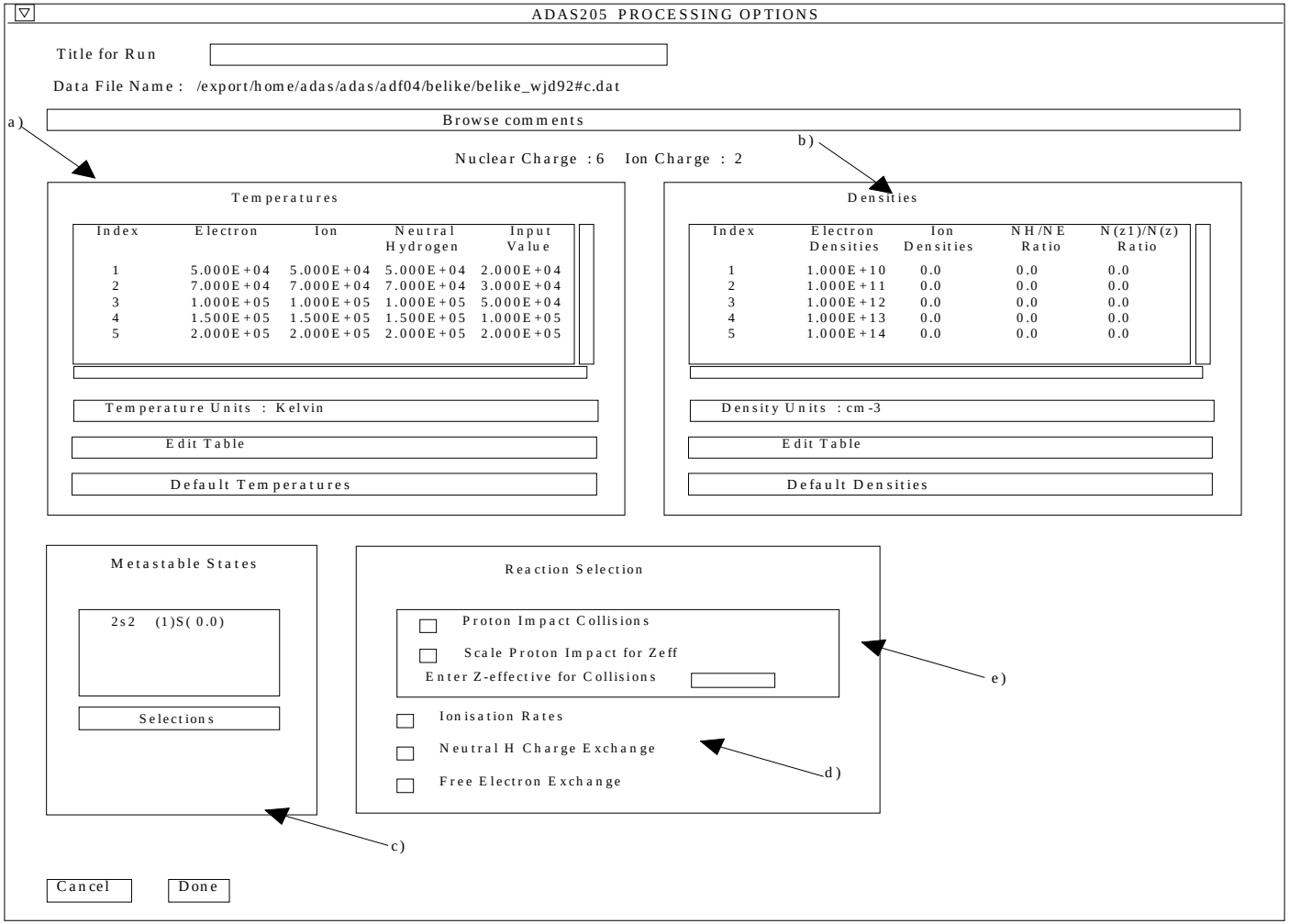
Obtaining populations (contd.)

- File selection
  - » *Path to central ADAS data of the correct class (adf04) is selected by button press.*
  - » *A display screen shows available files which are selected by clicking on them.*
  - » *Files have the .dat extension otherwise they are directories.*
  - » *Done means go to next screen, Cancel means return to the previous screen.*

Obtaining populations (contd.)

- Processing options
  - » *First our choice of temperatures and densities must be entered.*
  - » *The 'Table Editor' widget is activated by button press to allow this.*
  - » *Using the editor takes a little practice.*
- Designation of metastables must be made.

ADAS205 Processing



Obtaining populations (contd.)

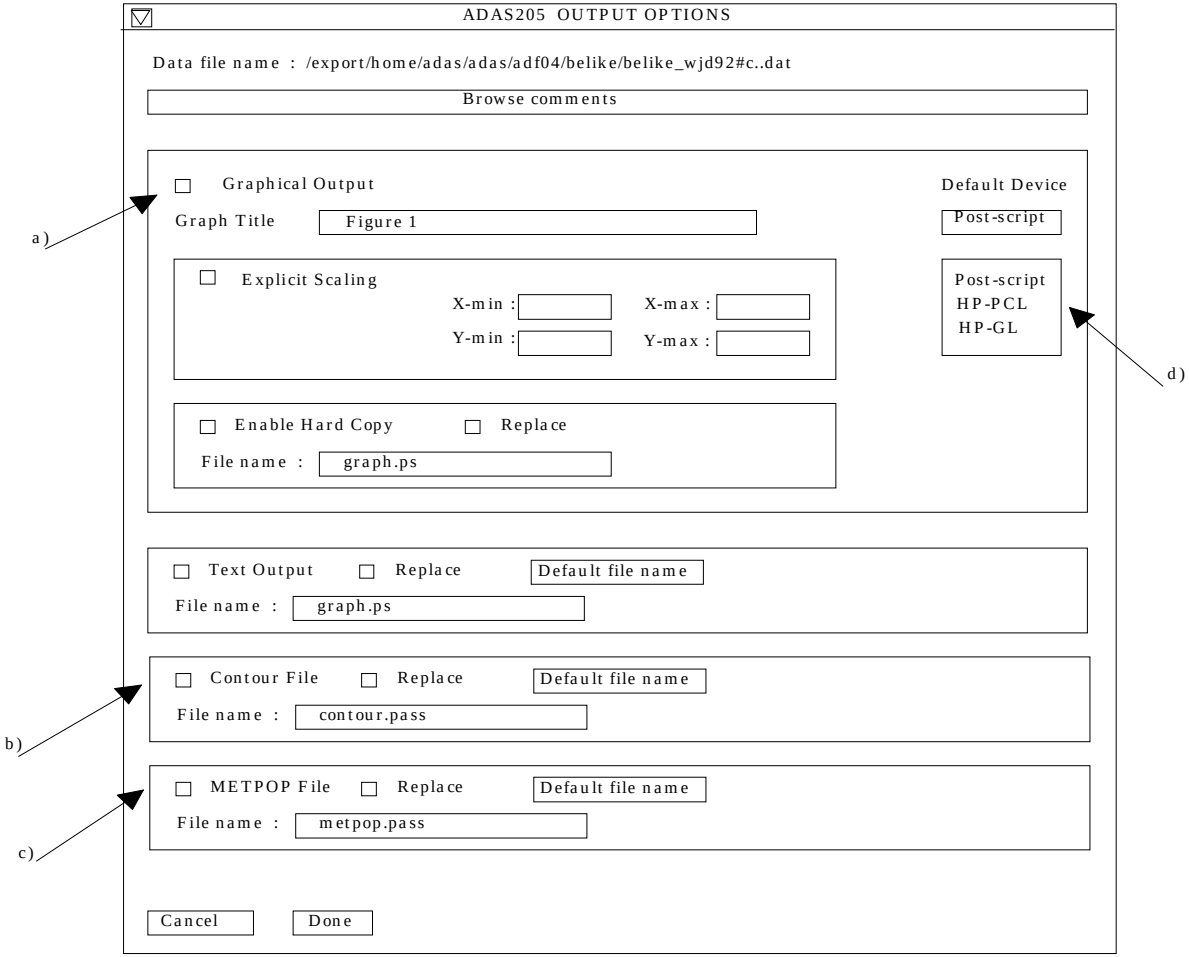
- The program solves for excited level populations in terms of the designated ground and metastables. That is for the F's where

$$N_i = N_e \sum_{\rho=1}^{M} F_{i\rho}(T_e, N_e) N_\rho$$

Obtaining populations (contd.)

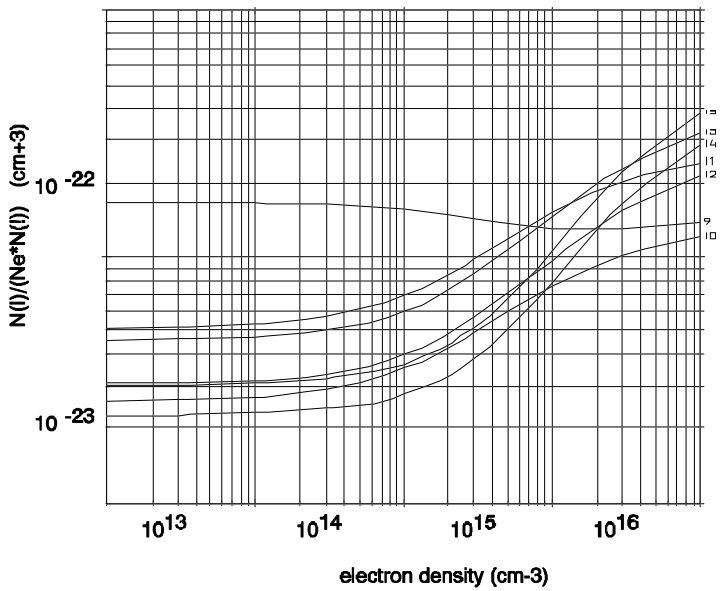
- Output options
  - » *Graphical display of the F's as a function of density is allowed*
  - » *An output file of the F's called the 'contour' pass file cand be generated. This file must be created to allow the next step of looking a line ratios.*

ADAS205 Output



ADAS205 graph

POPULATION DEPENDENCE ON METASTABLES : O+5 ELECTRON TEMP. = 2.00E+01 (EV)
ADAS RELEASE : ADAS91 V1.01 PROGRAM: ADAS205 V1.0 DATE: 26/05/93 TIME: 16:15
GRAPH TITLE : POPULATION GRAPH
INPUT FILE : /JETSHP.COPSM#LI.DATA(SM#O5)



O+5 POPULATIONS

------ LEVEL ASSIGNMENTS ------

INDEX	DESIGNATION	
1	2s1	(2)S(0.5)
2	2p1	(2)P(0.5)
3	2p1	(2)P(1.5)
4	3s1	(2)S(0.5)
5	3p1	(2)P(0.5)
6	3p1	(2)P(1.5)
7	3d1	(2)D(1.5)
8	3d1	(2)D(2.5)
9	4s1	(2)S(0.5)
10	4p1	(2)P(0.5)
11	4p1	(2)P(1.5)
12	4d1	(2)D(1.5)
13	4d1	(2)D(2.5)
14	4f1	(2)F(2.5)
15	4f1	(2)F(3.5)
16	5s1	(2)S(0.5)
17	5p1	(2)P(0.5)
18	5p1	(2)P(1.5)
19	5d1	(2)D(1.5)
20	5d1	(2)D(2.5)
21	5f1	(2)F(2.5)
22	5f1	(2)F(3.5)
23	5g1	(2)G(3.5)
24	5g1	(2)G(4.5)

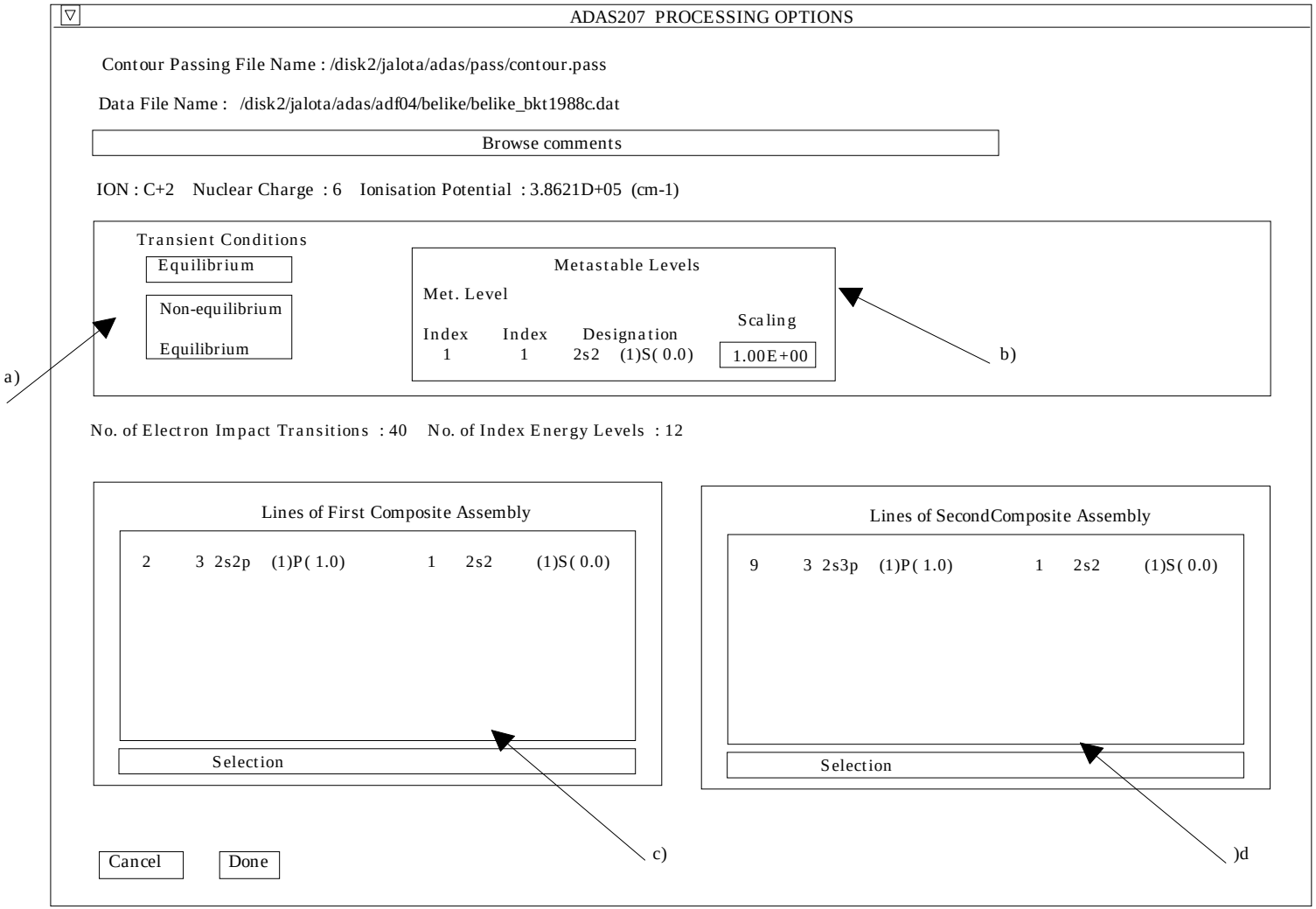
Setting up lines

- Code ADAS207 is the diagnostic analysis program which allows study of line ratios.
- It needs the ‘contour’ pass file of populations. It also fetches the specific ion file which was used in the population calculation.

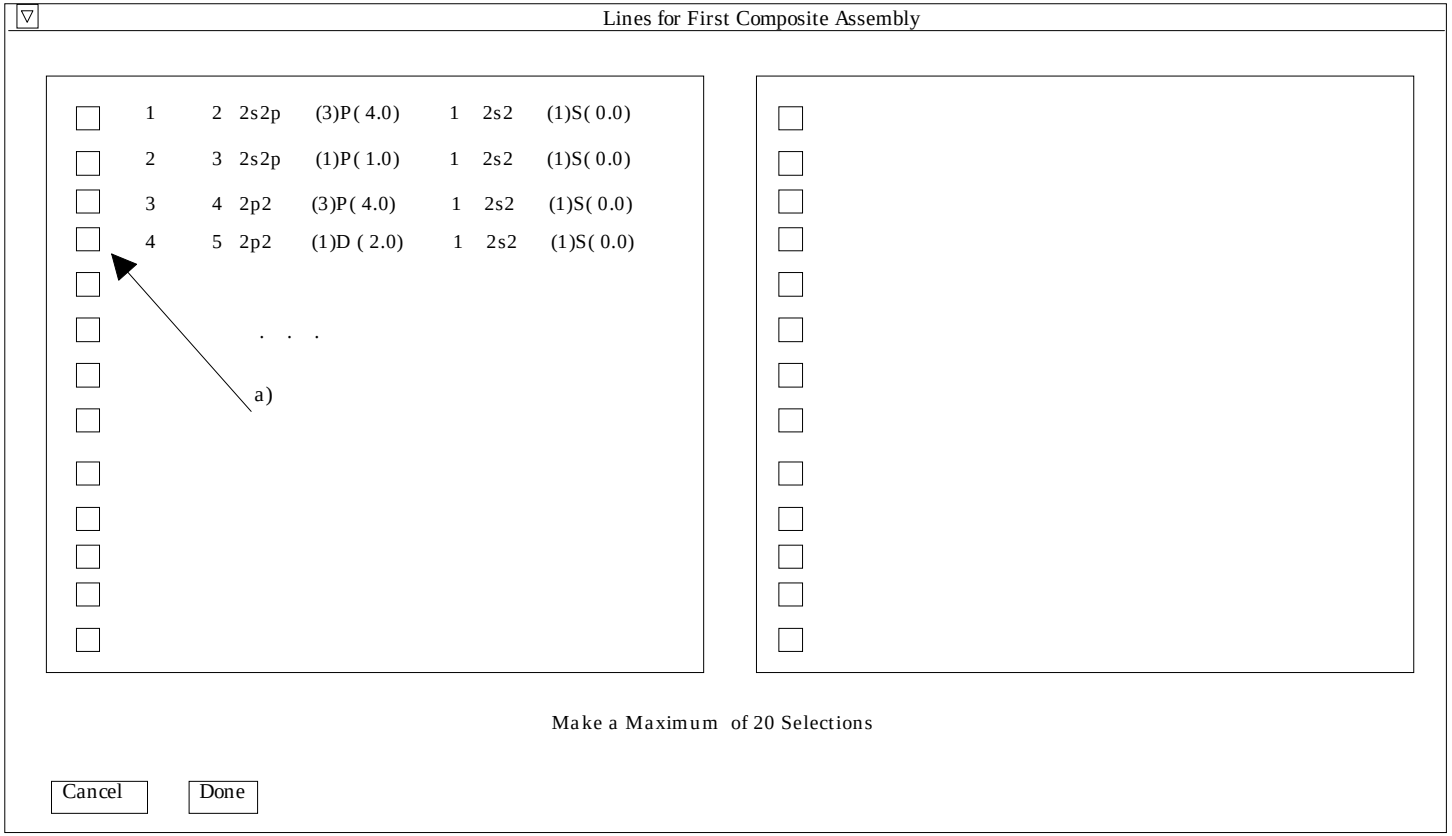
Setting up lines (contd.)

- Processing options
  - » *The first task is setting up the lines. The program in deals with line assemblies.*
  - » *Clicking on the 1st line assembly button gives a display of all the possible lines from which to make a selection.*
  - » *Similarly a 2nd line assembly may be formed. The ratio of these assemblies may be studied as a function of Te and Ne.*

ADAS207 Processing



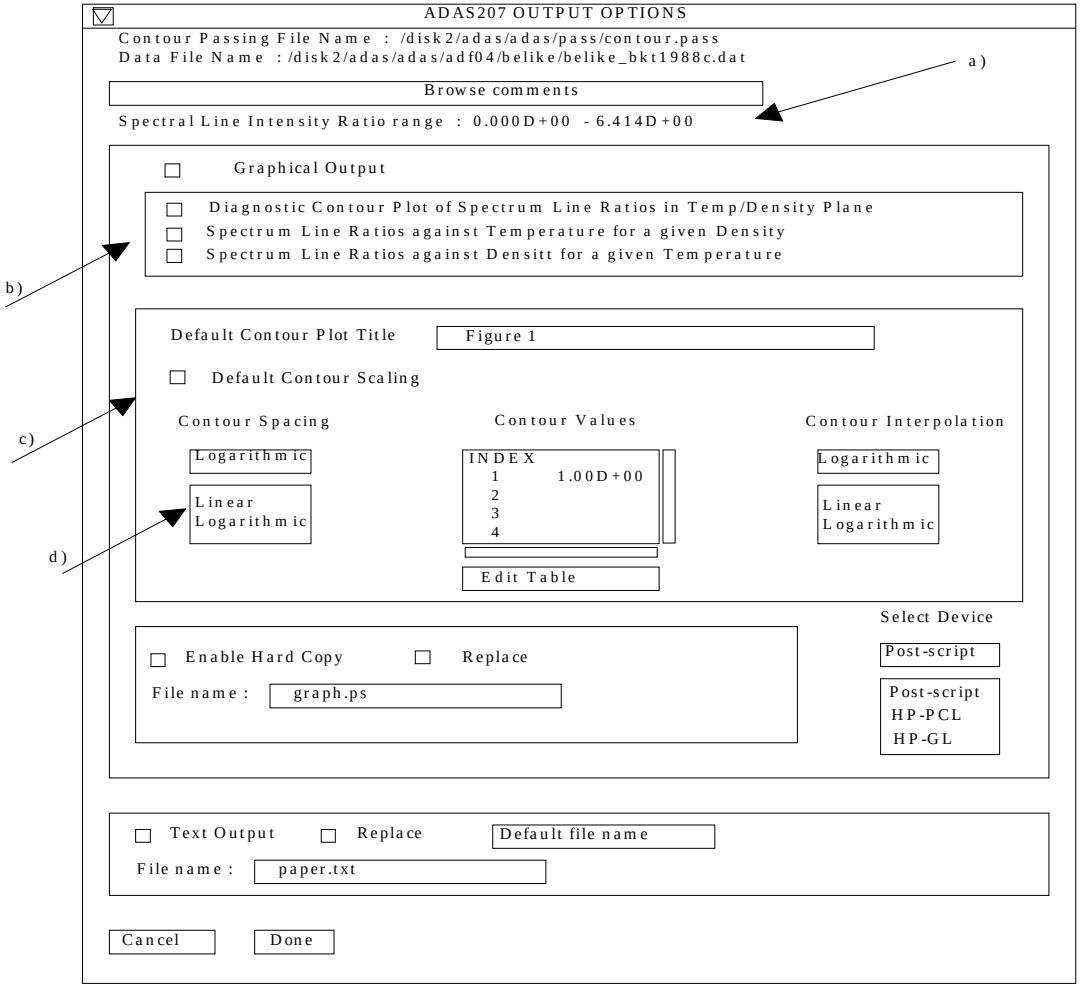
ADAS207 Line assembly



Displaying line ratios

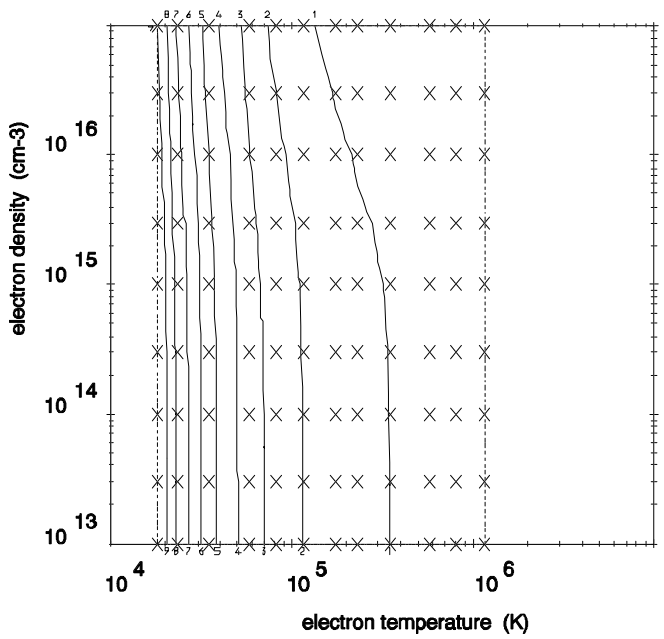
- Output options
  - » The type of display of the ratio of line assemblies may be chosen.
  - » The contour form on the Te/Ne plane seems to be the favourite.
  - » Crosses on the graph mark the tabular points

ADAS207 Output



ADAS207 graph

SPECTRUM-LINE INTENSITY RATIO ON TEMP/DENSITY PLANE - DIAG. CONTOUR PLOT: ION - O+5
ADAS RELEASE : ADAS91 V1.01 PROGRAM: ADAS207 V1.0 DATE: 26/05/93 TIME: 16:49
GRAPH TITLE : LINE RATIO CONTOUR GRAPH
COPASE FILE : /JETSHP.COPSM#LI.DATA(SM#05)



** LOGARITHMIC INTERPOLATED CONTOURS **

------- CONTOUR VALUES -------

INDEX	SPECTRUM LINE RATIO
1	1.9940D+02
2	2.6123D+04
3	3.4224D+06
4	4.4837D+08
5	5.8741D+10
6	7.6957D+12
7	1.0082D+15
8	1.3209D+17
9	1.7305D+19

------- FIRST LINE GROUP: TRANSITIONS -------

INDEX	-- UPPER LEVEL --		-- LOWER LEVEL --	
1	2p	2P 0.5	- 2s	2S 0.5

----- SECOND LINE GROUP: TRANSITIONS -----

INDEX	-- UPPER LEVEL --		-- LOWER LEVEL --	
1	3d	2D 1.5	- 2p	2P 0.5

--------- METASTABLE MULTIPLIERS -------

INDEX	--- DESIGNATION ---		SCALING FACTOR
1	2s	(2)S(0.5)	1.000D+00