5. Ionisation and emission, part I

- Ionisation
  - » Studying the temperature and density dependent ionisation balance in more detail
  - » Analysing the make-up of G(Te,Ne) emission functions
  - » Setting up a personal collection of G(Te,Ne)

Ionisation and emission, part I (contd.)

- The ionisation balance is often a weakness in the theoretical input.
- Code ADAS405 is provided for examining and contrasting ionisation balances as a function of Te and Ne.
- It has also capability for examining radiated power and the ingredients of G(Te(h),Ne(h)) functions

Ionisation and emission, part I (contd.)

- Improved precision and study of ionisation balance necessitates consideration of the following issues:
  - » *Relaxation time constants*
  - » *Metastable populations*
  - » *Density dependence*
- Only an introduction is possible here

Ionisation and emission, part I (contd.)

- The ingredients are stored in central adas data classes *adf11* and *adf15*
  - » adf11 contains collisional- radiative coefficients (acd, scd, plt,prb etc.) stored by year number and element.
  - » They may be stage to stage or metastable resolved and are density dependent
  - » adf15 contains emissivity coefficients (pec) (density dependent & metastable resolved)

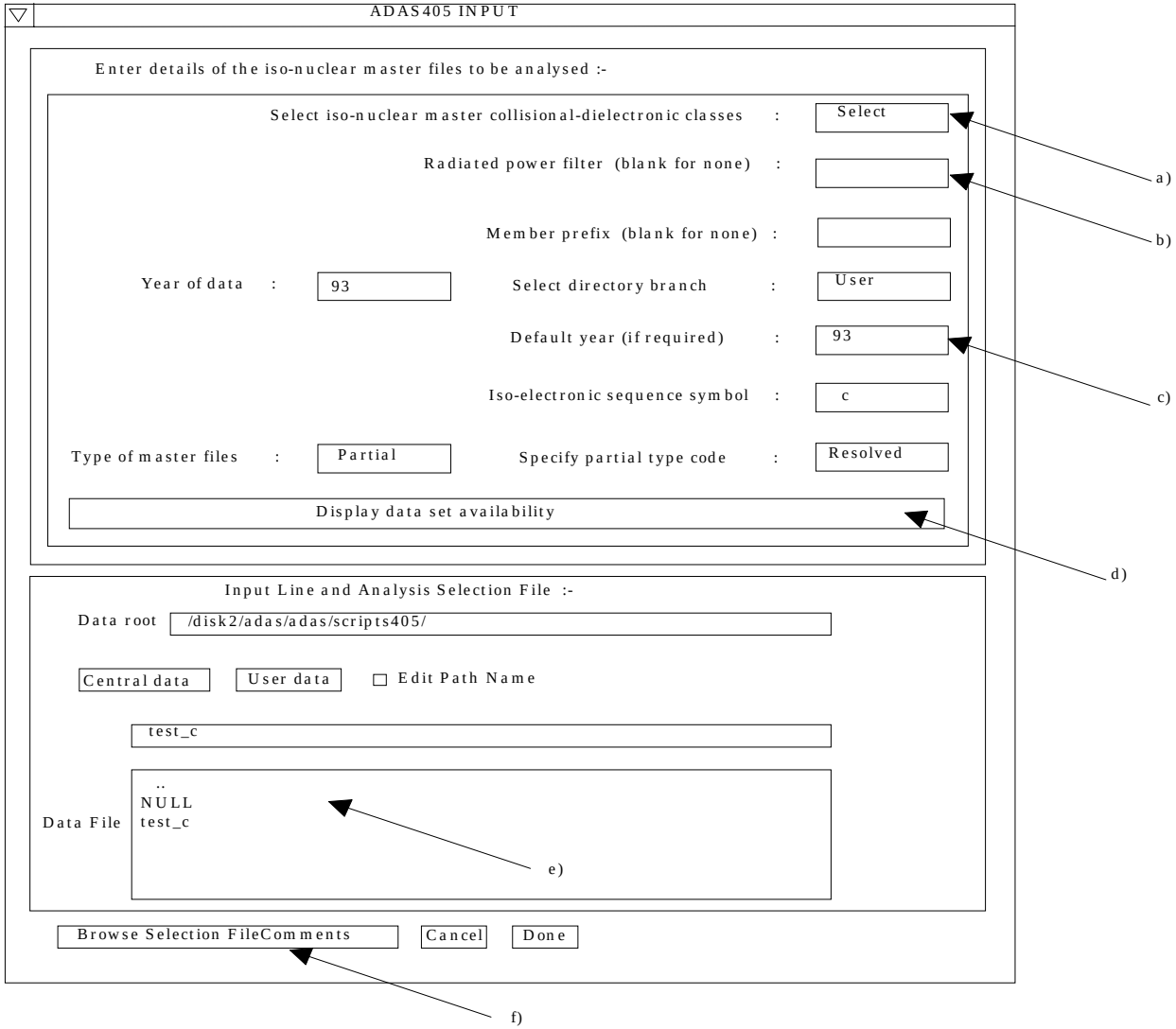
Ionisation and emission, part I (contd.)

- Start ADAS405 as follows
  - » *Move to ADAS series 4*
  - » *Click button for ADAS405*
- ADAS405 has the standard sequential three screen structure, namely *file selection*, *processing options* & *output options* screens

Ionisation and emission, part I (contd.)

- File selection
  - » *This is more complex than usual. The top part selects the adf11 data for an element.*
  - » *The lower part identifies a 'script' file for an element*
  - » *The script file spells out the way each line emission function is to be assembled from pec parts (excitation parts, different metastables, recombination parts etc)*

ADAS405 Input



ADAS405 Input (contd.)

Class selection and file availability :-

Class	Year	Element	Member Prefix	Power Filter	Type	USER DATA Selected	USER DATA Availability	DEFAULT DATA (93) Used	DEFAULT DATA (93) Available
acd	93	c			Rpartial	YES	YES	no	YES
scd	93	c			Rpartial	YES	YES	no	YES
ccd	93	c			Rpartial	no	no	no	no
prb	93	c			Rpartial	YES	YES	no	YES
prc	93	c			Rpartial	no	no	no	no
qcd	93	c			Rpartial	YES	YES	no	YES
xcd	93	c			Rpartial	YES	YES	no	YES
plt	93	c			Rpartial	YES	YES	no	YES

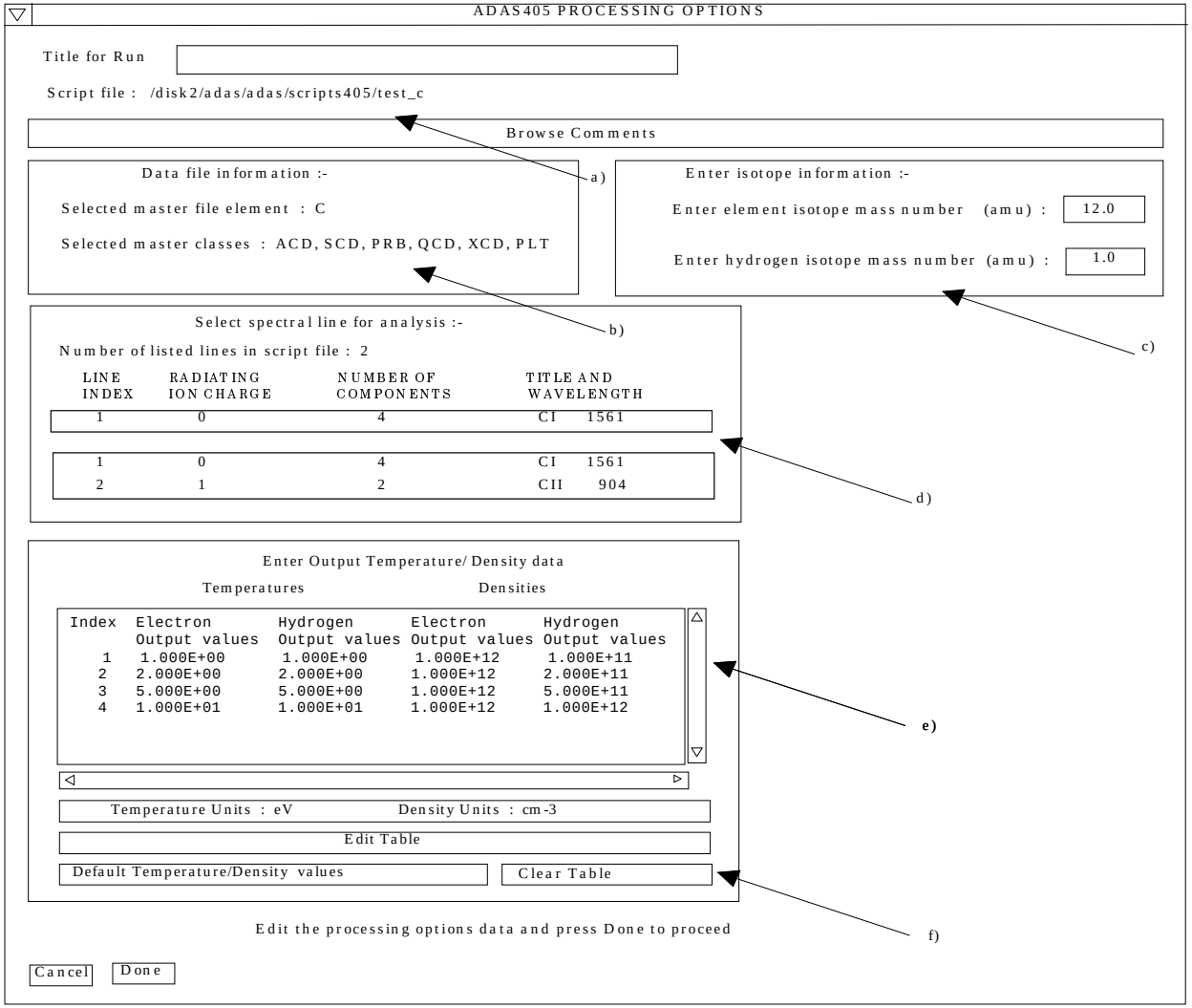
All requested files available from user data sets.

OK

Ionisation and emission, part I (contd.)

- Processing options
  - » Temperatures and densities are entered for a model atmosphere.
  - » A choice may be made of which script line to display.

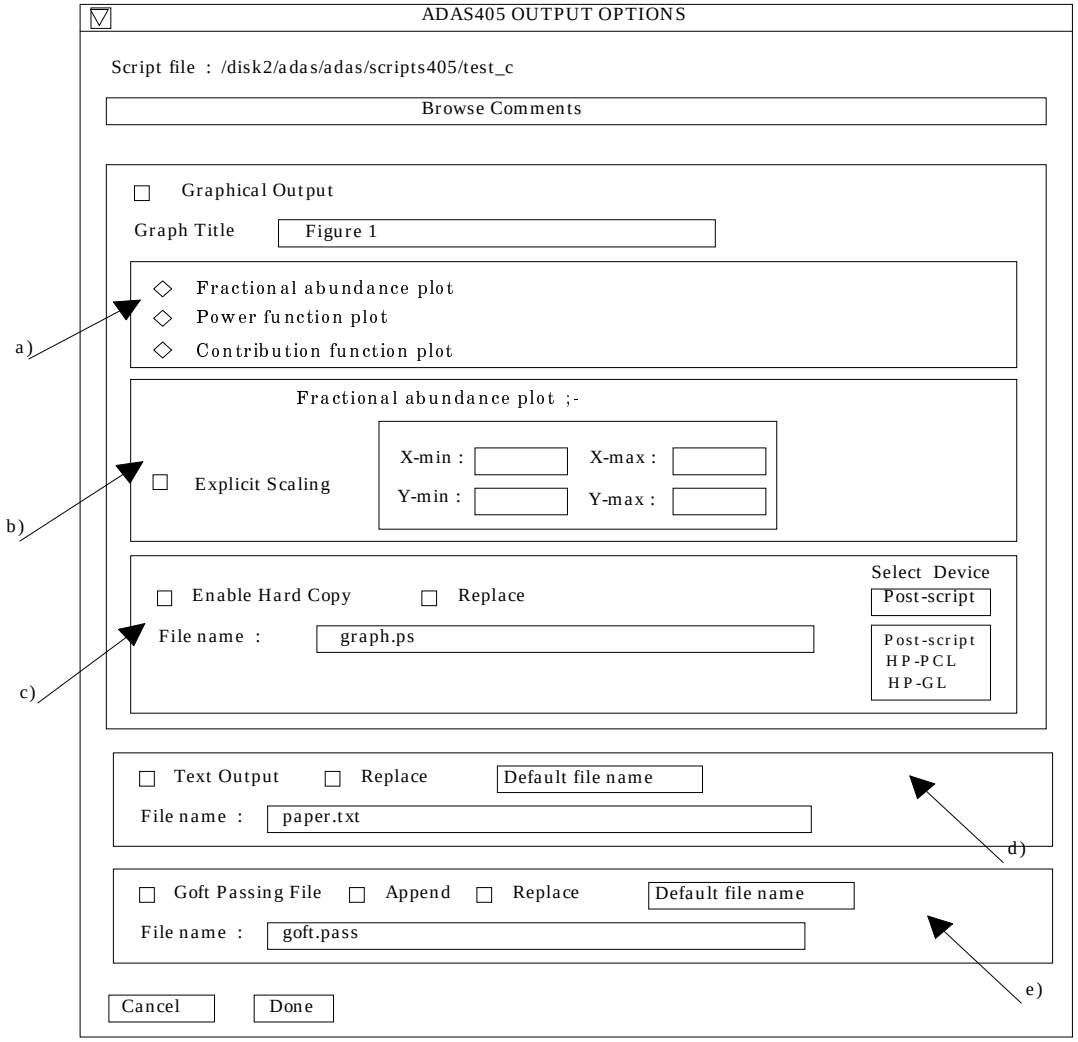
ADAS405 Processing



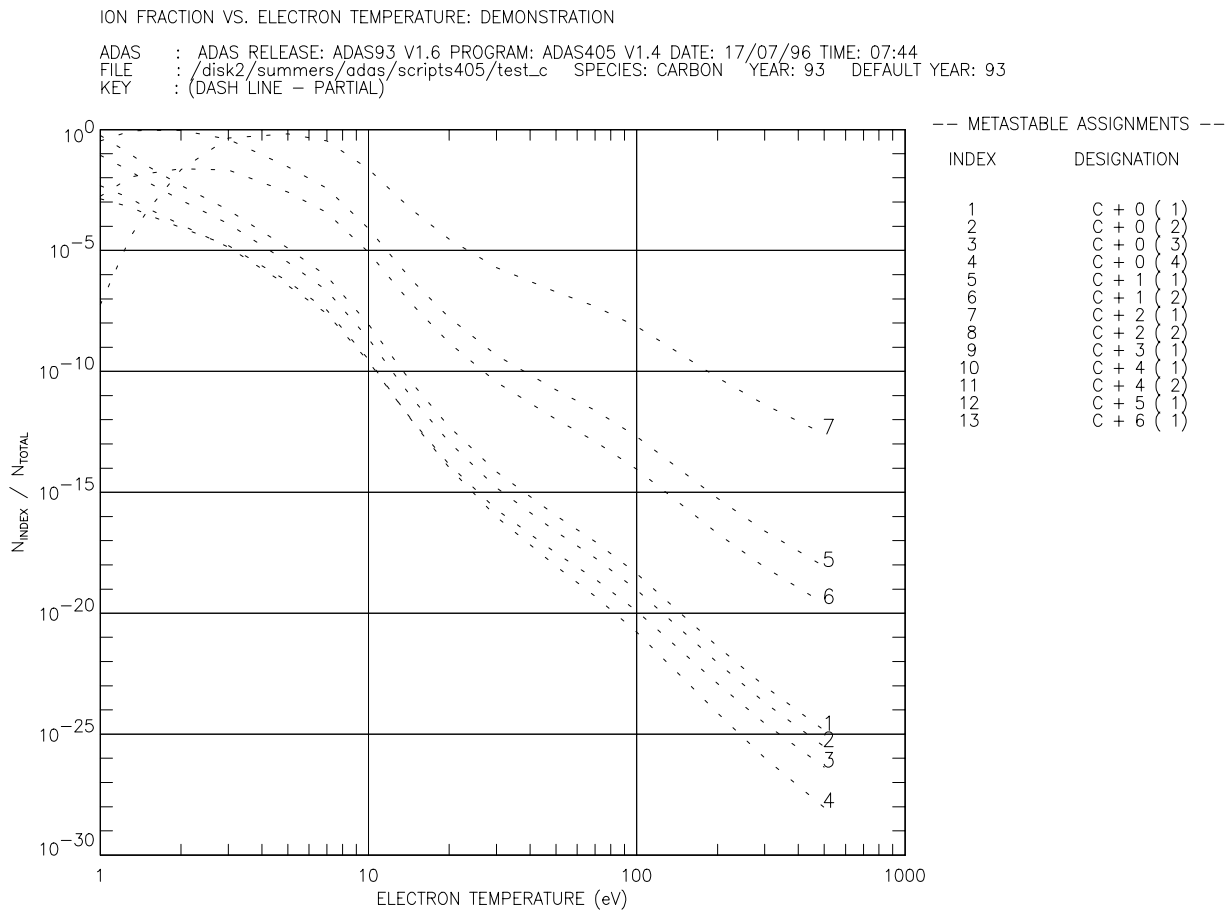
Ionisation and emission, part I (contd.)

- Output options
  - » *Graphing of the ionisation balance, the radiated power functions or the chosen emission function may be selected.*
  - » *An output file of the G(Te(h), Ne(h)) functions identified in the script file may be produced.*

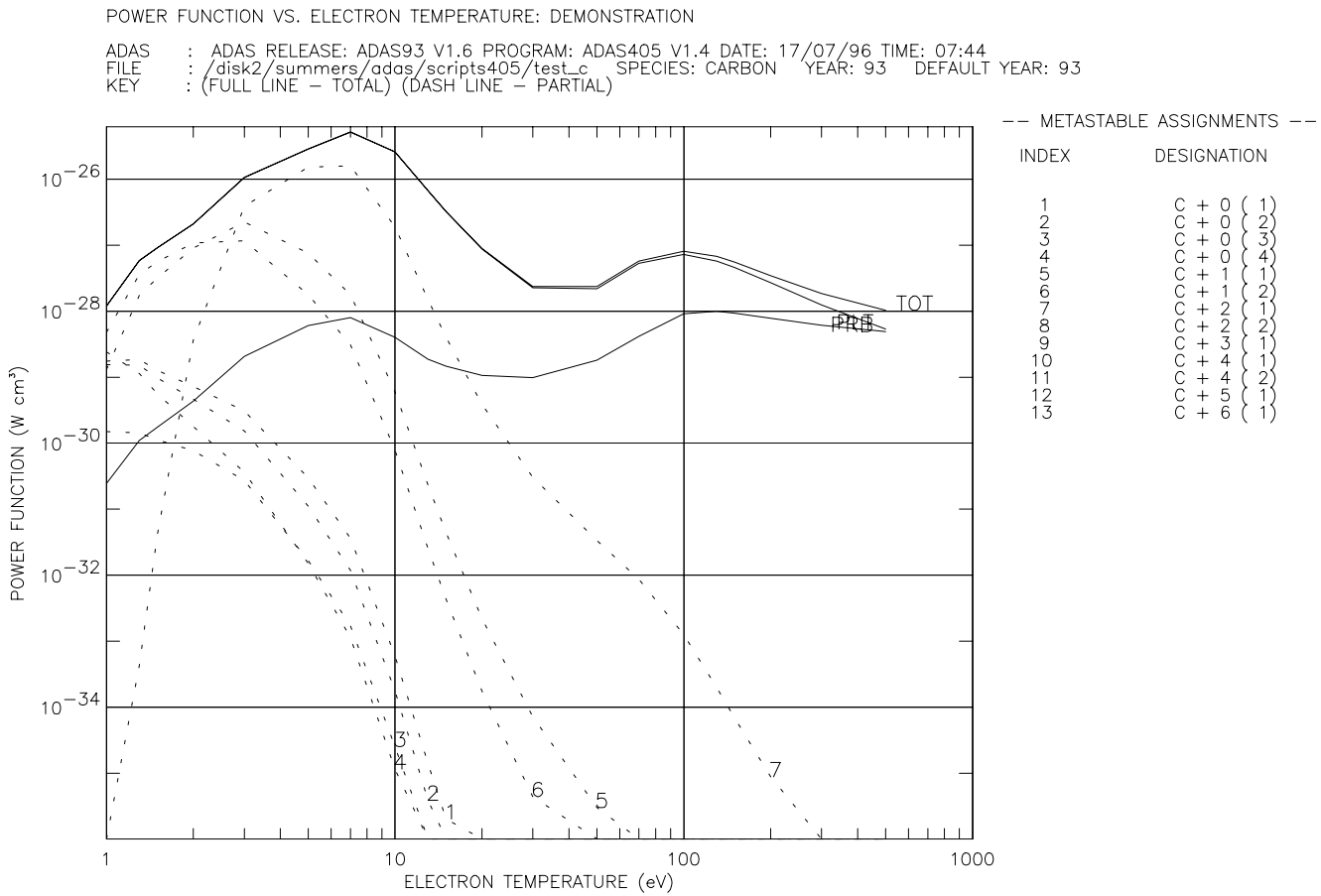
ADAS405 Output



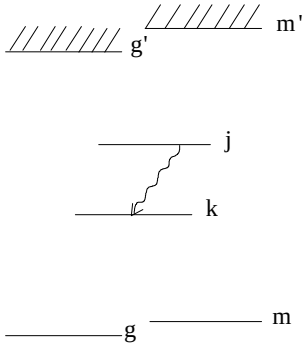
ADAS405 graph

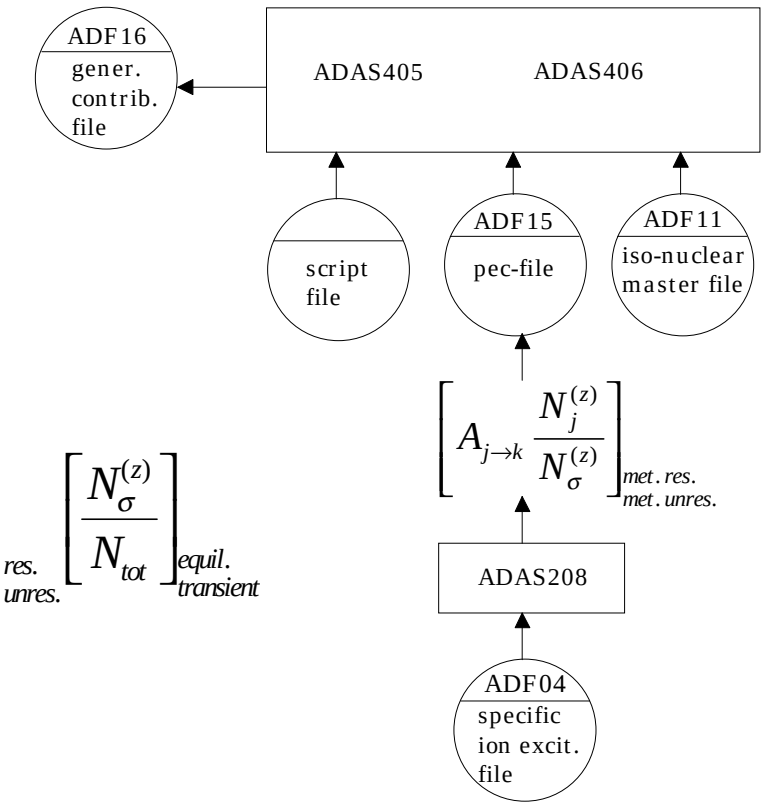


ADAS405 graph



G(Te, Ne) functions





$$G(T_e, N_e) = \sum_{\sigma} \left[A_{j \to k} \frac{N_j^{(z)}}{N_\sigma^{(z)}} \right]_{\substack{met.\,res.\\ met.\,unres.}} \left[\frac{N_\sigma^{(z)}}{N_{tot}} \right]_{\substack{equil.\\ transient}}$$

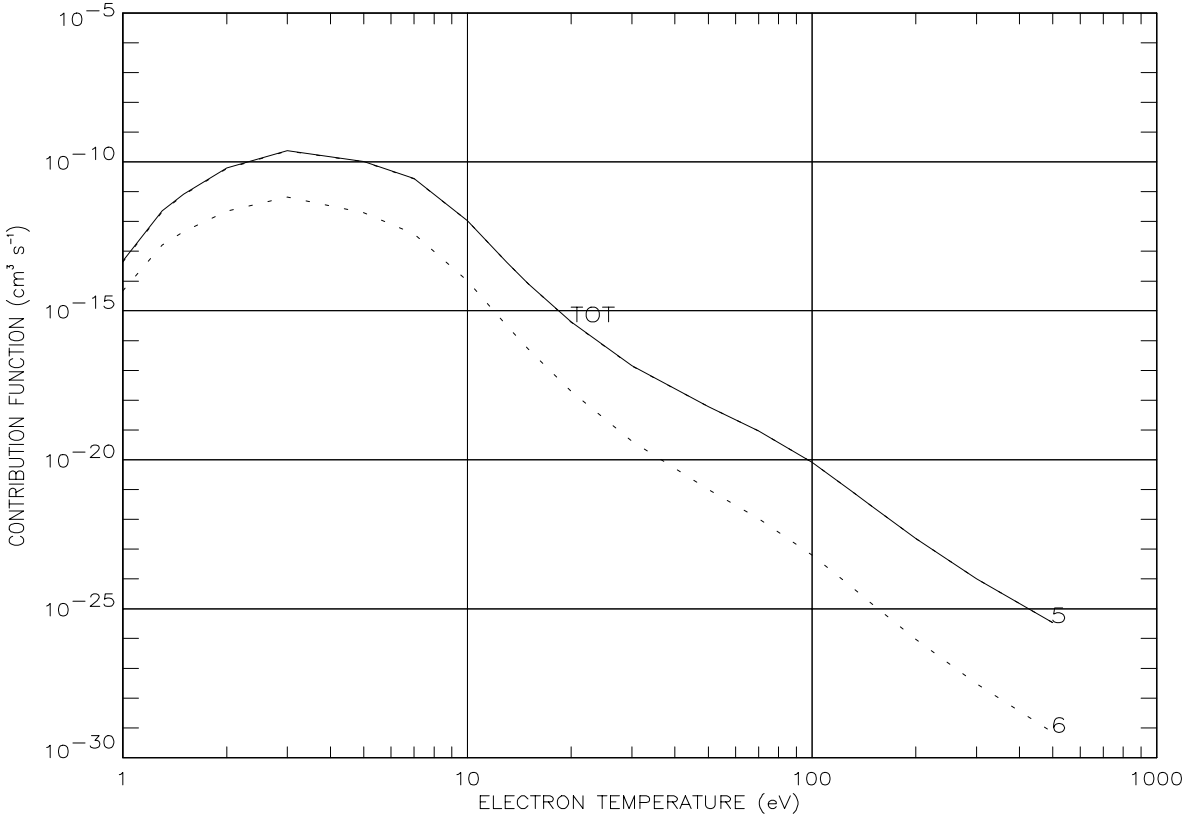
G(Te,Ne) functions (contd.)

- Two-dimensional G(Te,Ne) functions and line ratios from different ionisation stages are beyond the scope of this first tutorial.
  - » *Codes ADAS208 and ADAS409 will provide a full capability*

ADAS405 graph

CONTRIBUTION FUNCTION VS. ELECTRON TEMPERATURE: DEMONSTRATION

ADAS : ADAS RELEASE: ADAS93 V1.6 PROGRAM: ADAS405 V1.3 DATE: 11/07/96 TIME: 16:53
FILE : /disk2/summers/adas/scripts405/test_c SPECIES: CARBON YEAR: 93 DEFAULT YEAR: 93
KEY : (FULL LINE – TOTAL) (DASH LINE – PARTIAL)



-- METASTABLE ASSIGNMENTS --

INDEX	DESIGNATION
5	C + 1 (1)
6	C + 1 (2)

-- SPECTRUM LINE SPECIFICATION --

TITLE = CII 904A
SELECT NO. = 2
COMPONENTS = 2

-- COMPONENT PARAMETERS --

IC	IZ	IM	IP	IF	INDX
1	1	1	3E	2	5
2	1	2	25E	2	6

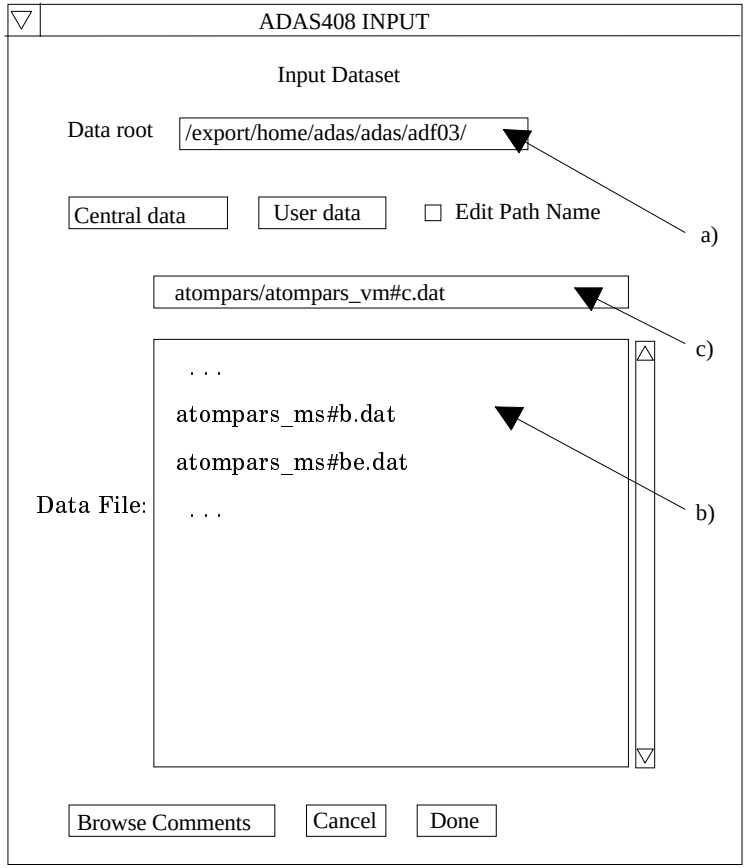
Ionisation and emission, part I (contd.)

- The most basic ADAS calculation of stage to stage ADF11 datasets for an element uses codes ADAS407 and ADAS408.
- ADAS407 processes mass produced ADF04 files for an element, extracting approximate form parameters (ADF03).
- ADAS408 uses ADF03 parameters to generate the ADF11 datasets.

Ionisation and emission, part I (contd.)

- File selection
  - » *This is a simple selection of an atomic parameter file of type ADF03 for an element.*
  - » *Martin O'Mullane ('mm') is our expert on producing these for heavy elements.*
  - » *Data sets with the code 'vm' (Van Maanen) come from the original JET baseline production.*

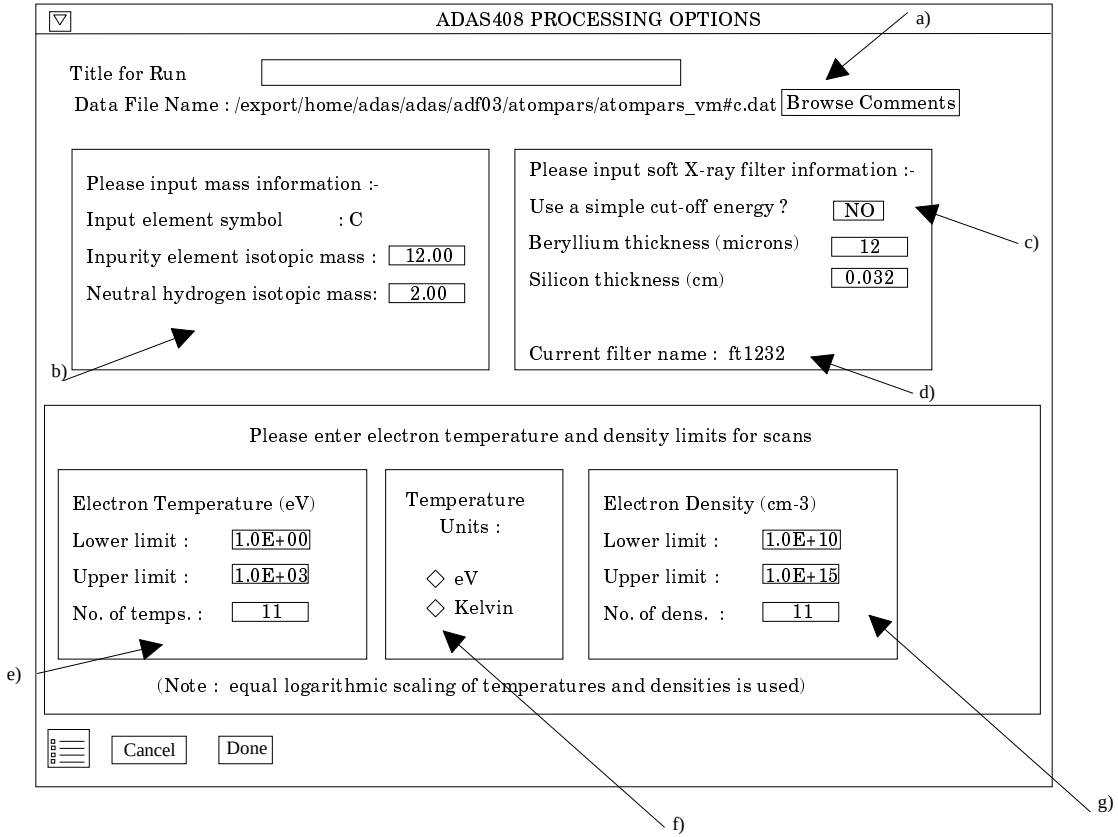
ADAS408 Input



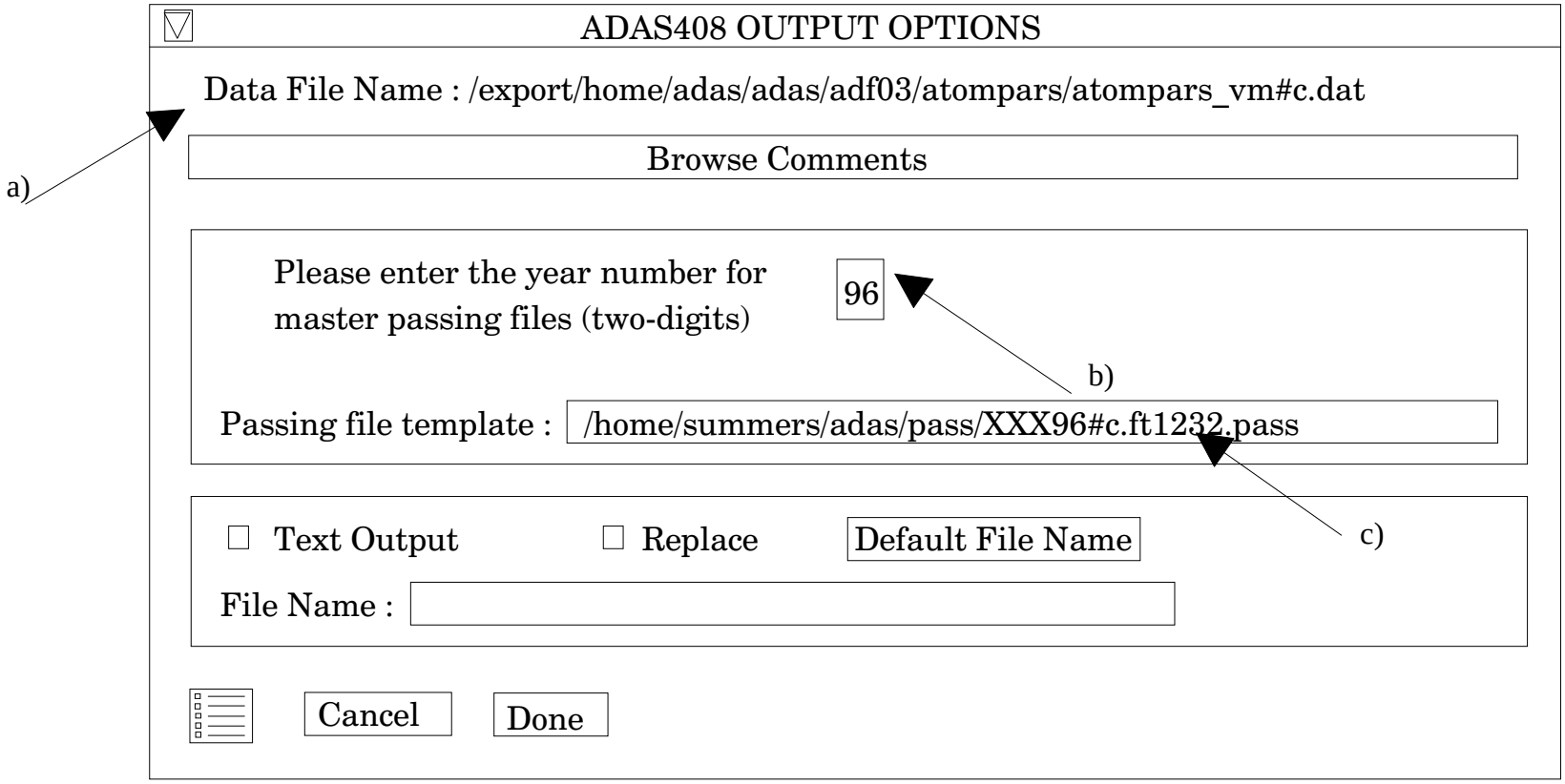
Ionisation and emission, part I (contd.)

- Processing options
  - » *Te and Ne ranges must be set up. ADAS408 forces an equally spaced logarithmic grid.*
  - » *Radiated power coeffts. produced include line power ('plt') and recom./Brems. power ('prb'). The effect of filter can be imposed.*
  - » *Simple cut-off or Be/Si filters are allowed. The output file naming includes the filter spec.*

ADAS408 Processing



Ionisation and emission, part I (contd.)

- Output options
  - » *ADF11 data are stored by ‘year number’.*
  - » *A year number tends to be used for an approximation (eg. baseline unresolved ‘89’ ; advanced resolved ‘93’,’96’)*
  - » *ADAS consortium members are also allocated decades (Garching ‘10’, JET ‘20’)*
  - » *A template file naming is built from the year number and the power filter.*

ADAS408 Output