INMS Analysis Library

David A. Gell

734.763.6221 (voice)   734.615.9723 (fax)

gellda@umich.edu

INMS Tutorial

- Handouts
  - User’s Guide for the INMS Analysis Library
  - Presentation
- Outline
  - Installation
  - Obtaining Data
  - Background
    - Purpose
    - Level 1A File Formats
    - Data Structures
  - Reading & Selecting Data
  - Display
  - Data Manipulation
- Online help is included in library: inms_analysis_help.html

INMS Analysis Tutorial
Installation

- Requirements:
  - IDL v6.0 or later
  - X-server for interactive display
  - Virtual frame buffer for batch operations
- Installation
  - download gziped archive from ION “analysis -> File system”
  - Install the software in desired installation location

    cd the/installation/directory

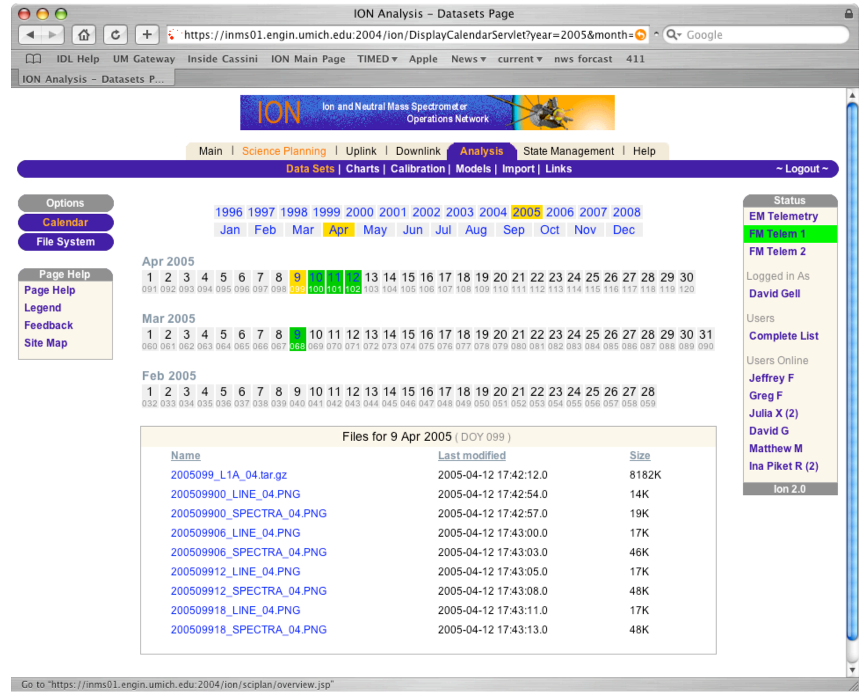
    gunzip *yyyyddd*-inmsAnalysis.tar.gz

    tar -xvf *yyyyddd*-inmsAnalysis.tar
- Test the software
  - download data from the TA encounter
  - Start IDL and execute inms_test routine

    IDL> .RUN INMS_TEST
  - Compare images to INMS_TEST_RESULTS.PS

INMS Analysis Tutorial
Obtaining Data

- Navigate to “Data Analysis”
- Select year, month, and day on calendar
- Click on archive file link to download
- Move archive file to a convenient location and expand



INNMS Analysis Software Tutorial

- INMS Analysis Software
  - Is a library of IDL procedures and functions
  - Is a toolkit, not an application
- Provides tools to access, select, manipulate and display Level 1A data
  - access: inms_get_data, inms_read_cal
  - selection: inms_get_spectra, inms_get_series, inms_grid_spectra
  - manipulation inms_compute_summed_spectra inms_compute_mean_spectra, inms_subtract_background inms_spectra_calculation, inms_deconvolve
  - display: inms_plot_mt_spectra,inms_plot_mt_line inms_plot_series, inms_plot_histogram, inms_plot_mass_history, inms_plot_stacked_spectra inms_plot_cal
  - utility inms_prepare_plot, inms_close_windows, inms_query_l1a, inms_saturn_latitude,inms_saturn_wlongitude and more

INMS Analysis Tutorial
Background - Level 1 A file format

- The analysis software reads and processes Level 1 A data
- Level 1 A data consists of a header (PDS compliant label) and spreadsheet data in separate files.
- Each row in the spreadsheet corresponds to an IP
- Data items (columns) consist of ancillary data, geometric data, instrument configuration data, and counts
- Contents are described in “0025V18-L1aProdDef.xls” available on ION and in “L1A_STRUCT_04.FMT” included with the data downloads.

name	description	type	units	range	format	notes, questions, concerns
sclk	spacecraft clock time	string			C24	instant at the start of the IP.
uttime	time of measurement expressed in msec since midnight UTC	int	ms	0 ≤ x ≤ 86400000	I8	
target	name of target body	string		<blank> Saturn titan, ...	C26	<blank> when INMS is not the prime instrument. Information to come from an "event table" containing the time intervals assigned to each target.
time_ca	time since closest approach	int	ms	$\lvert x \rvert \le$ 86400000	I8	time to the closest approach, negative prior to CA positive afterwards. Only included within 24 hr (86400000 ms) of CA
targ_pos_x	position of the target body in the IAU Saturn reference frame	real	km	$\lvert x \rvert \le 10^7$	F9.0	Values present only within 3600 s of closest approach, otherwise no entry. Format is sufficient to contain position of target out to 100 Saturn Radii (6,000,000 km) with a precision of 1 km
targ_pos_y	position of the target body in the IAU Saturn reference frame	real	km	$\lvert x \rvert \le 10^7$	F9.0	
targ_pos_z	position of the target body in the IAU Saturn reference frame	real	km	$\lvert x \rvert \le 10^7$	F9.0	
source	ion source used for this measurement	string		csn osi osnb osnt esm	C4	csn closed source (1) osi open source ion (3) osnb open source neutral beam (2) osnt open source neutral thermal (0) esm energy scan mode
data_reliabity	Value is non-zero if there is the possibility of data corruption due to instrument configuration transitions	int		x≥0	I4	For inclusion in Version 2. value is set to a non-zero value during scans in which an instrument transitions may cause data quality concerns. These transitions include filament on-off transitions, filament warm up period, scan table transitions and others
table_set_id	table set ID number	string			C8	Table set identifier, consisting of a table set number and a revision number separated by dash: TTTT-rrr
coadd_cnt	specifies the number of IPs added together. A value of 1 indicates no coadding	int		1 ≤ x ≤ 255	I3	
osp_fil_1_status	Filament 1 status	string		off low high	C6	reports whether the filament is off, on and if on, the electron energy
oss_fil_2_status	Filament 2 status					
csp_fil_3_status	Filament 3 status					
css_fil_4_status	Filament 4 status					
seq_table	sequence table number	int		1≤x≤64	I2	
cyc_num	The cycle index for this sequence	int		1≤x≤31	I2	
cyc_table	cycle table number	int		1≤x≤64	I2	Specifies which tables from the table set are in use during this scan
scan_num	scan number	int		1≤x≤31	I2	
trap_table	trap table number	int		1≤x≤31	I2	
sw_table	switching table number	int		1≤x≤31	I2	
mass_table	mass table number	int		1≤x≤96	I2	
focus_table	focus table number	int		1≤x≤31	I2	
da_table	D/A table number	int		1≤x≤16	I2	
velocity_comp	compensation velocity used in on-board computation of lens and deflector voltages	real	km s^{-1}	0≤ x <50	F6.3	For "energy scan" measurements, the dac values are computed on the ground. The compensation velocity is not used in this case. In Version 2 will add a method to determine the compensation velocity in these cases.
ipnum	integration period number	int		1 ≤ x ≤ 68	I2	
mass_per_charge	mass	real	Da/z	0.125 ≤ x ≤ 99	F6.3	
os_lens2	open source lens 2 voltage	real	V	$\lvert x \rvert$<10.	F6.2	
os_lens1	open source lens 1 voltage	real	V	$\lvert x \rvert$<10.	F6.2	
os_lens4	open source lens 4 voltage	real	V	$\lvert x \rvert$<62.	F6.2	
os_lens3	open source lens 3 voltage	real	V	$\lvert x \rvert$<62.	F6.2	
qp_lens2	quadrapole 2 switching lens voltages	real	V	$\lvert x \rvert$<200.	F7.3	
qp_lens1	quadrapole 1 switching lens voltages	real	V	$\lvert x \rvert$<200.	F7.3	
qp_lens4	quadrapole 4 switching lens voltages	real	V	$\lvert x \rvert$<200.	F7.3	
qp_lens3	quadrapole 3 switching lens voltages	real	V	$\lvert x \rvert$<200.	F7.3	
qp_bias	Quadrapole Bias voltage	real	V	$\lvert x \rvert$<200.	F7.3	

name	description	type	units	range	format	notes, questions, concerns
ion_defl2	ION Deflector 2 voltage	real	V	$\|x\|<62.$	F6.2	
ion_defl1	ION Deflector 1 voltage	real	V	$\|x\|<62.$	F6.2	
ion_defl4	ION Deflector 4 voltage	real	V	$\|x\|<62.$	F6.2	
ion_defl3	ION Deflector 3 voltage	real	V	$\|x\|<62.$	F6.2	
top_plate	top plate lens voltage	real	V	$\|x\|<30.$	F6.2	
p_energy	Particle Energy	real	eV		F7.3	Back computed from OTS, using mass and velocity from tables and performed in the scaled integer arithmetic used by the flight code.
alt_t	altitude above the surface of the named target body	real	km	$\|x\| \le 10^5$	F9.2	
view_dir_t_x view_dir_t_y view_dir_t_z	components of the unit vector in the direction of the INMS aperture outward normal .	real		$\|x\| \le 1$	F9.6	
sc_pos_t_x	x component of spacecraft position wrt the named target	real	km	$\|x\| \le 10^5$	F9.2	
sc_pos_t_y	y component of spacecraft position wrt the named target	real	km	$\|x\| \le 10^5$	F9.2	
sc_pos_t_z	z component of spacecraft position wrt the named target	real	km	$\|x\| \le 10^5$	F9.2	
sc_vel_t_x	x component of spacecraft velocity wrt the named target	real	km s^{-1}	$\|x\| \le 100$	F7.3	Values present only within 3600 s of closest approach, otherwise no entry.
sc_vel_t_y	y component of spacecraft velocity wrt the named target	real	km s^{-1}	$\|x\| \le 100$	F7.3	Given relative to named coordinate frame listed above. The frame will be the IAU frame for the specific target. Format for altitude and position is sufficient to contain values to
sc_vel_t_z	z component of spacecraft velocity wrt the named target	real	km s^{-1}	$\|x\| \le 100$	F7.3	
sc_vel_t_scx	spacecraft frame x component of spacecraft velocity wrt the named target	real	km s^{-1}	$\|x\| \le 100$	F7.3	
sc_vel_t_scy	spacecraft frame y component of spacecraft velocity wrt the named target	real	km s^{-1}	$\|x\| \le 100$	F7.3	
sc_vel_t_scz	spacecraft frame z component of spacecraft velocity wrt the named target	real	km s^{-1}	$\|x\| \le 100$	F7.3	
lst_t	local solar time at the sub-spacecraft point on the target body	real	hours	$0 \le x \le 24$	F6.3	
sza_t	solar zenith angle at the sub-spacecraft point on the target body	real	deg	$0 \le x \le 180.$	F7.3	Values describe the position of the sun with respect to the spacecraft and the target body. Values must be computed with the aberration corrections applied.
ss_long_t	longitude of the sub-solar point on the target body on the target body	real	deg	$0 \le x \le 360.$	F6.2	
distance_s	distance between spacecraft and center of Saturn	real	km	$\|x\| \le 10^7$	F9.0	
view_dir_s_x view_dir_s_y view_dir_s_z	components of the unit vector in the direction of the INMS aperture outward normal	real		$\|x\| \le 1$	F9.6	
sc_pos_s_x	x component of spacecraft position	real	km	$\|x\| \le 10^7$	F9.0	given relative to the IAU Saturn frame. Format for altitude and position is sufficient to contain position of spacecraft out to 100 Saturn Radii (6,000,000 km) with a precision of 1 km
sc_pos_s_y	y component of spacecraft position	real	km	$\|x\| \le 10^7$	F9.0	
sc_pos_s_z	z component of spacecraft position	real	km	$\|x\| \le 10^7$	F9.0	
sc_vel_s_x	x component of spacecraft velocity	real	km s^{-1}	$\|x\| \le 100$	F7.3	
sc_vel_s_y	y component of spacecraft velocity	real	km s^{-1}	$\|x\| \le 100$	F7.3	
sc_vel_s_z	z component of spacecraft velocity	real	km s^{-1}	$\|x\| \le 100$	F7.3	
lst_s	local solar time at the sub-spacecraft point on Saturn	real	hours	$0 \le x \le 24$	F6.3	
sza_s	solar zenith angle at the sub-spacecraft point on Saturn	real	deg	$0 \le x \le 180.$	F7.3	Values describe the position of the sun with respect to the spacecraft and Saturn. Values must be computed with the aberration corrections applied.
ss_long_s	longitude of the sub-solar point on the target body on Saturn	real	deg	$0 \le x \le 360.$	F6.2	
sc_att_angle_ra	right ascension of spacecraft z axis	real	rad	$0 \le x \le 2\pi$	F9.6	The transformation matrix, T which transforms the a vector expressed in the J2000 frame to the spacecraft body frame is given by
sc_att_angle_dec	declination of spacecraft z axis	real	rad	$-\pi/2 \le x \le \pi/2$	F9.6	
sc_att_angle_tw	rotation of spaceraft about z axis	real	rad	$0 \le x \le 2\pi$	F9.6	T = [TW]3 [90 - DEC]2 [RA]3
c1counts	high sensitivity counts	int		$0 \le x \le 10^6$	I6	total counts.
c2counts	low sensitivity counts	int		$0 \le x \le 10^6$	I6	total counts.

INMS Analysis Tutorial
Background - Data Structures

- IDL structures are aggregates of elements
  - Each component, a field, has a name (tag name)
  - Each component may be a scalar, an array, or a structure
- Arrays of structures are permitted (and useful)
- A structure field is referenced as structure.tag for example
  xSpect.anC1counts[3]
  axL1Adata[1325].mass
- To determine the fields in a structure use the IDL command
  help,/structure, *xStructure*

- Notational Conventions used in IDL programs

numbers	n*Name*
strings	s*Name*
structures	x*Name*
arrays	an*Name*, as*Name*, ax*Name*

INMS Analysis Tutorial
INMS Data Structures

- Level 1 A data is collected in a axL1A data structure array
  - One array element (xL1A structure) for each IP
  - Each field in the L1A data file is contained in a field in the xL1A structure
  - Each field in the structure is named identically to the field in the file (these names do not comply with the "Hungarian Notation" convention)
- Spectral data is collected in a axSpect data structure array
  - One array element (xSpect) for each spectra
  - Fields in the xSpect structure contain arrays of masses, counts, samples, standard deviation and ancillary data
- Calibration data is collected in a axCal data structure array
  - One array element (xCal) for each species, source, filament and electron beam energy
  - Fields contain dissociation pattern and sensitivity

INMS Analysis Tutorial
Reading Data

- inms_get_data
  - Reads one or more L1A files and produces a L1A structure
  - Files may be specified by name, time range or through a selection dialog
  - Data files may be located in any directory or folder
  - Obtains meta-data
- inms_read_cal
  - Reads a calibration summary spreadsheet file and produces a calibration summary structure
  - Calibration summary structure is used by several manipulation routines.

Reading Data
inms_get_data

- The simplest way to invoke the routine
```
inms_get_data, axL1A
```
A file selection dialog is presented from which one or more files may be specified for reading
- Files may also be specified by name or by UTC time range
```
inms_get_data,axL1A,
    trange=['2004-183T00:00:00','2004-184T23:59:59'],
    path='path/to/data/files'
inms_get_data, axL1A, files=['file1.CSV','file2.dat'],
   path='path/to/data/files'
```
- The data directory organization is specified by the *yeardir* or *doydir* keywords
- Files may be specified by a list
Default location for files is the current working directory

Reading Data
inms_get_data

- Meta-data is collected by inms_get_data consists of
  - Names of the files read
  - Axis labels
- Accessor routines are provided:

  inms_l1a_files_read - function returning an array of strings
  inms_l1a_labels - function returning an array of strings
- Example

```
inms_get_data, axData              ;; reads data
asFiles=inms_l1a_files_read()      ;; gets a list of files
```

- Additional summary information is returned by inms_query_l1a

table_set_id	coadd_cnt
seq_table	cyc_table
mass_table	velocity_comp

INMS Analysis Tutorial
Selecting Data

- Subsets of data may be extracted using inms_get_series
  - Operates on a L1A structure and produces a L1A structure
  - Data is selected based on keyword-value pairs
- Spectra may be formed using inms_get_spectra or inms_grid_spectra
  - Each operates on a L1A structure and produces a Spectra structure
  - Spectra are specified by mass table, source and co-add count
  - Spectra structures include ancillary data and arrays of counts, standard deviation, and sample size in IPs
- Selection criteria are specified by a simple syntax used by all selector routines.

Selecting Data
Specifying Criteria

- Selection criteria are specified as keyword-value pairs
  - keywords are names of L1A structure fields
  - values may be scalars, two element vectors, multi-element vectors
- Selection criteria are specified as a keyword-value pair
  - Values may be a scalar value, a two element array, or a multi-element array
    - scalars values require the variable equal the value
    - two element arrays specify the range of value
    - multi-element arrays specify a list of values
- If multiple criteria are supplied, the selected L1A record meets all criteria

Selecting Data
Specifying Criteria

Example Criteria

target='titan'	selects all data records with 'titan' as target string comparisons are case-insensitive
cyc_table=10	selects all data records collected while cycle table 10 is executing
alt_t=[1200.,1400.]	selects all data between 1200 and 1400 km altitude
mass_table=[12,13,14]	selects records from 3 mass tables
mass_table=[1,1,15]	selects records from 2 mass tables

Resolving ambiguity

mass, mass_table are ambiguous according to idl. Adorn one or the other with a leading underscore: _mass.

Selecting Data
inms_get_series

- inms_get_series extracts data which meets user specified criteria.

```
inms_get_series,axData,axSeries,
        uttime=[43200000, 4680000],
        coadd_cnt=1,
        mass=28.
```

- The result is an array of Level 1A data structures which contain matching data

Selecting Data
inms_get_spectra

- inms_get_spectra forms spectra from Level 1A data

```
inms_get_spectra, axData, axSpectra,
        massTableID=[15,16],
        source='osn', coadd_cnt=1, ...
```

- A spectra is formed by aggregating a series of integrations, beginning at the first IP of the first mass table specified to the last IP of the last mass table specified
- A particular mass bin may be the result of accumulating several IPs
- The output structure contains time, a list of mass tables, a list of masses and for each mass, the counts, error ($N^{1/2}$) and number of samples.
- Additional selection criteria may be specified in the same way as inms_get_series

Selecting Data
inms_grid_spectra

- inms_grid_spectra forms spectra from L1A data

  inms_grid_spectra, axL1A, axSpectra,
  masstableid=[15,16], source=‘osn’,
  stride=15, span=90, order=2

- Algorithm

  Data is interpolated onto a uniform time grid, with one point every *stride* seconds. The data point is formed by fitting a span of *span* seconds centered at a time of interest to a polynomial. That polynomial is evaluated at the time point. This is effectively a low-pass filter.

- The spectra at a particular time consists of the reconstructed counts for all masses included in the selected mass tables.

Break

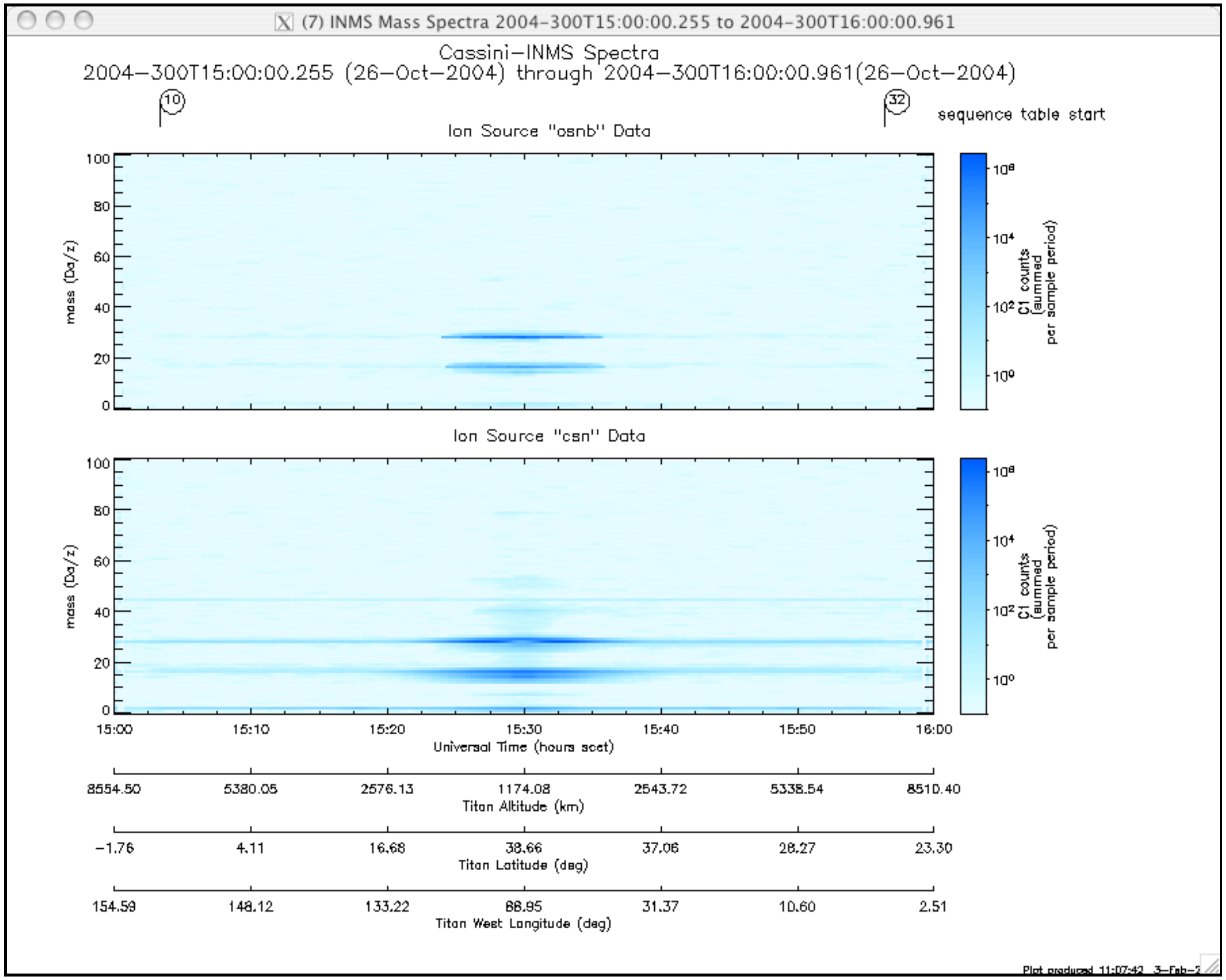
INMS Analysis Tutorial
Data Display

- Plotting L1A data
  - inms_plot_mt_spectra — mass-time spectra
  - inms_plot_mt_line — mass histories
  - inms_plot_series — time series plots of L1A data
- Plotting spectra data
  - inms_plot_histogram — single spectra
  - inms_plot_stacked_spectra — mass-time spectra
  - inms_plot_mass_history — mass history
- Supporting routines
  - inms_prepare_plot — sets plotting environment and device
  - inms_close_windows — closes all open windows
  - inms_make_window — creates a new X window
  - sprl_colorplot — plots a function of two variables
  - sprl_load_colors — loads color tables
  - sprl_find_colors — returns color number or index

INMS Analysis Tutorial
Level 1A Plots

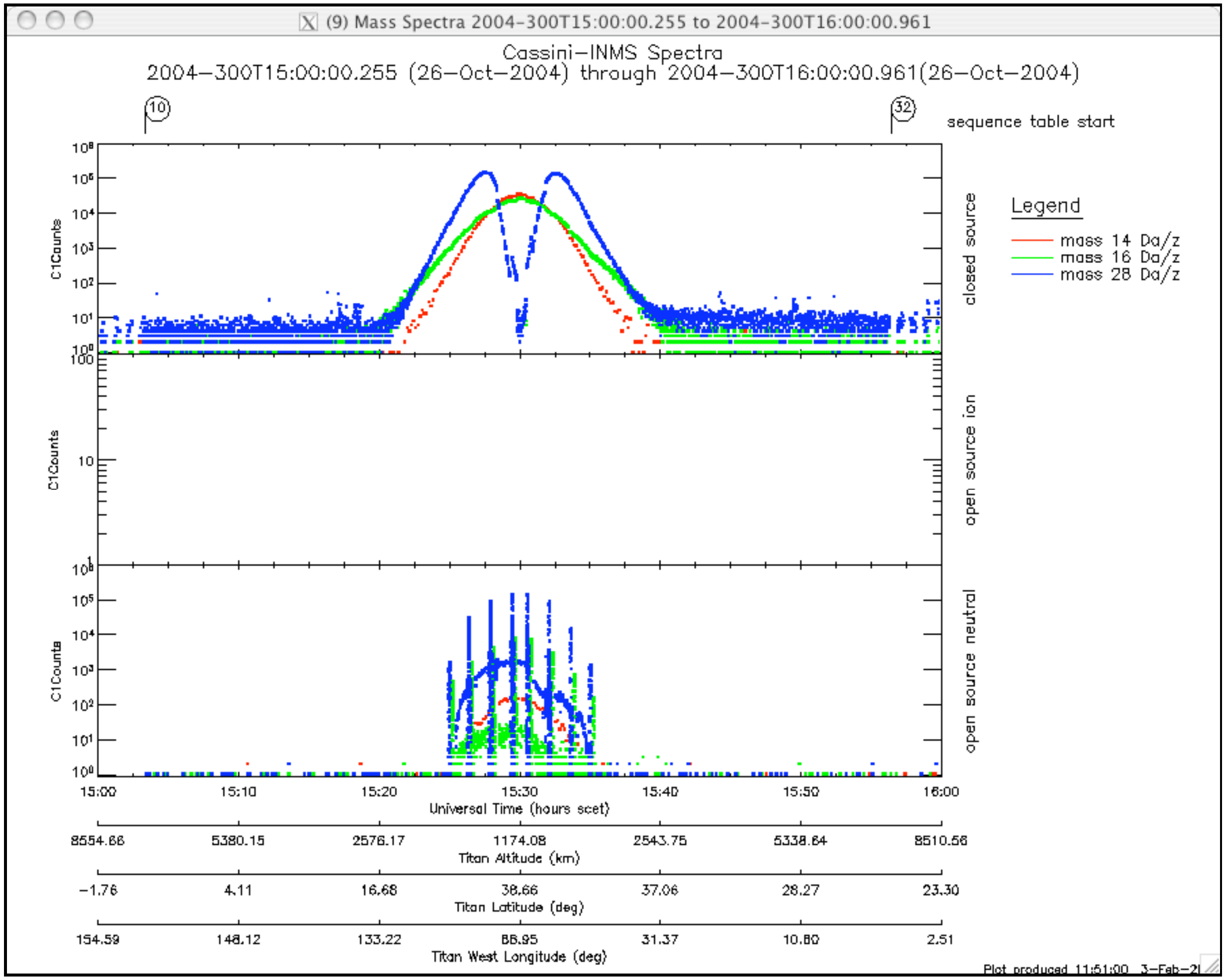
- inms_plot_mt_spectra produces plots showing counts as a function of time and mass
  - modes (ion source) are indicated by color bar
  - optional multi-panel plots with one panel per mode
  - sequence table starting points are flagged
  - optional auxiliary axes, altitude, latitude and longitude
- inms_plot_mt_line produces plots showing count rate as a function of time for specified masses
  - one panel displayed for each mode
  - sequence table starting points are flagged
  - optional auxiliary axes , altitude, latitude and longitude
- inms_plot_series produces time series plots of any L1A quantity
  - discrete items are plotted as color bars
  - continuous items as time plots
  - each plot must contain at least one continuous time - known bug

Level 1A Plots
inms_plot_mt_spectra



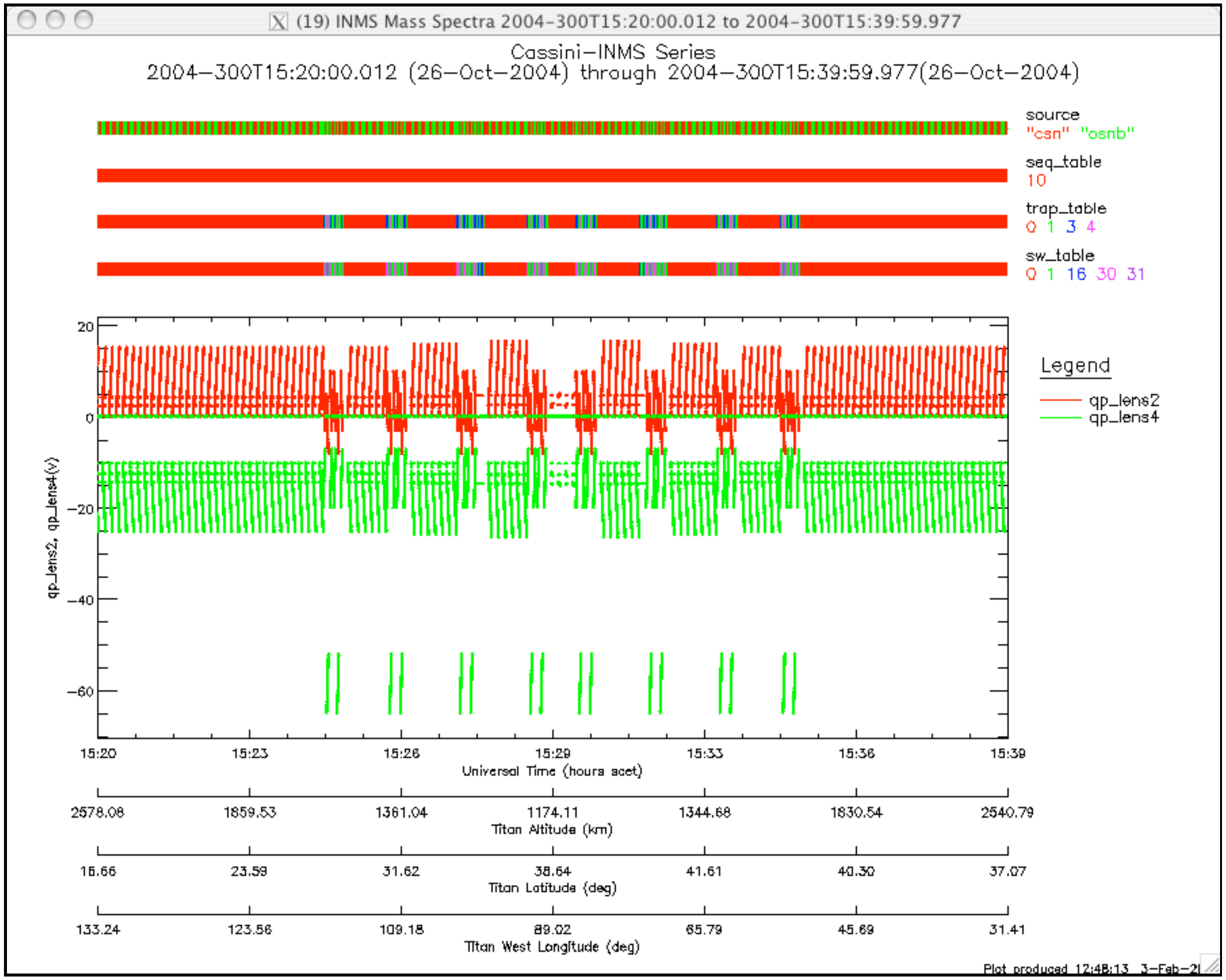
IDL> inms_plot_mt_spectra,axData, /target, source=['csn','osnb']

Level 1A Plots
inms_plot_mt_line



IDL> inms_plot_mt_line,axData,[14,16,28],/target

Level 1A Plots
inms_plot_series

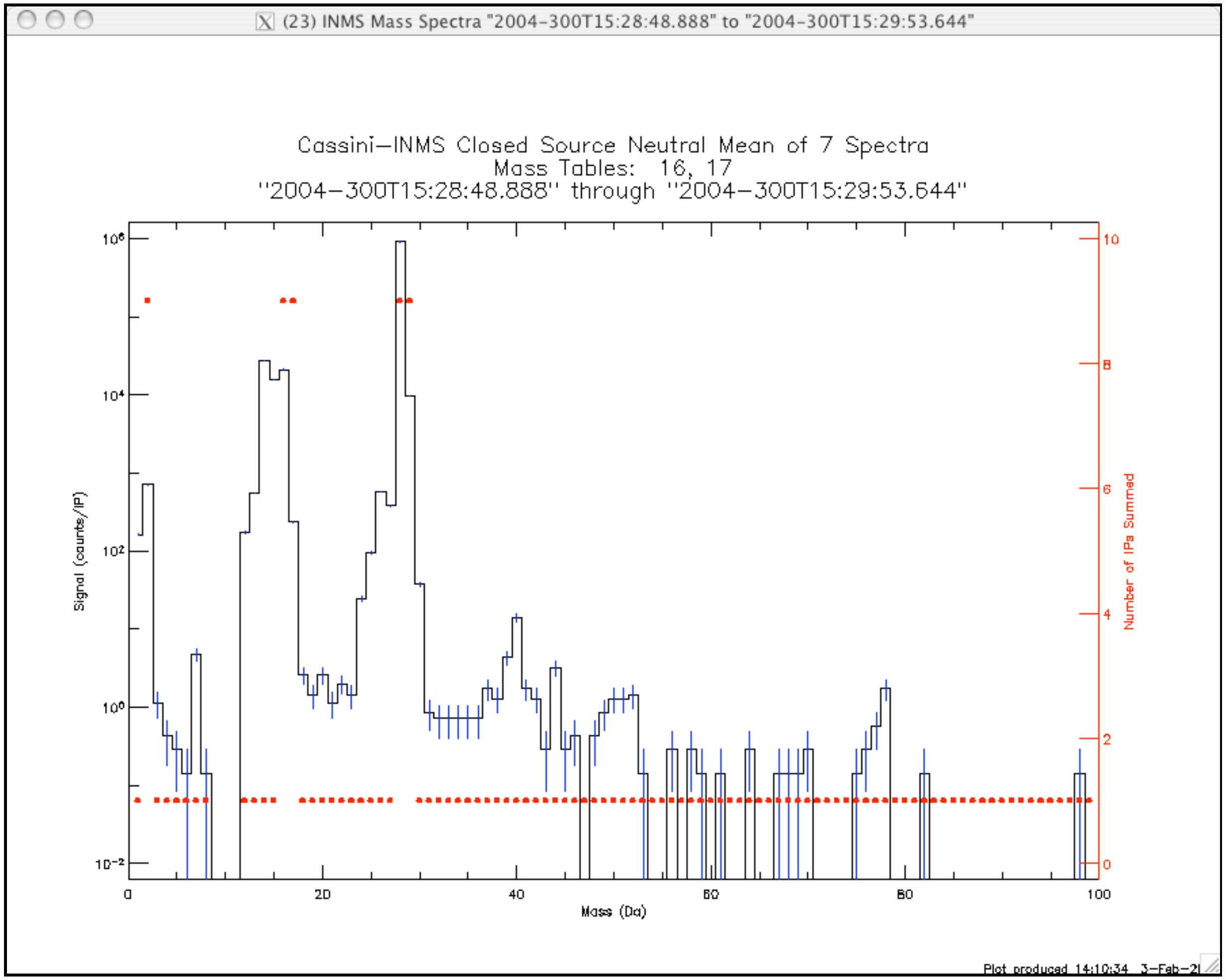


IDL> inms_plot_series,axData,$
    [‘source’,’qp_lens2’,’qp_lens4’,’seq_table’,’trap_table’,’sw_table’]$,/aux,/target

INMS Analysis Tutorial
Spectra Plots

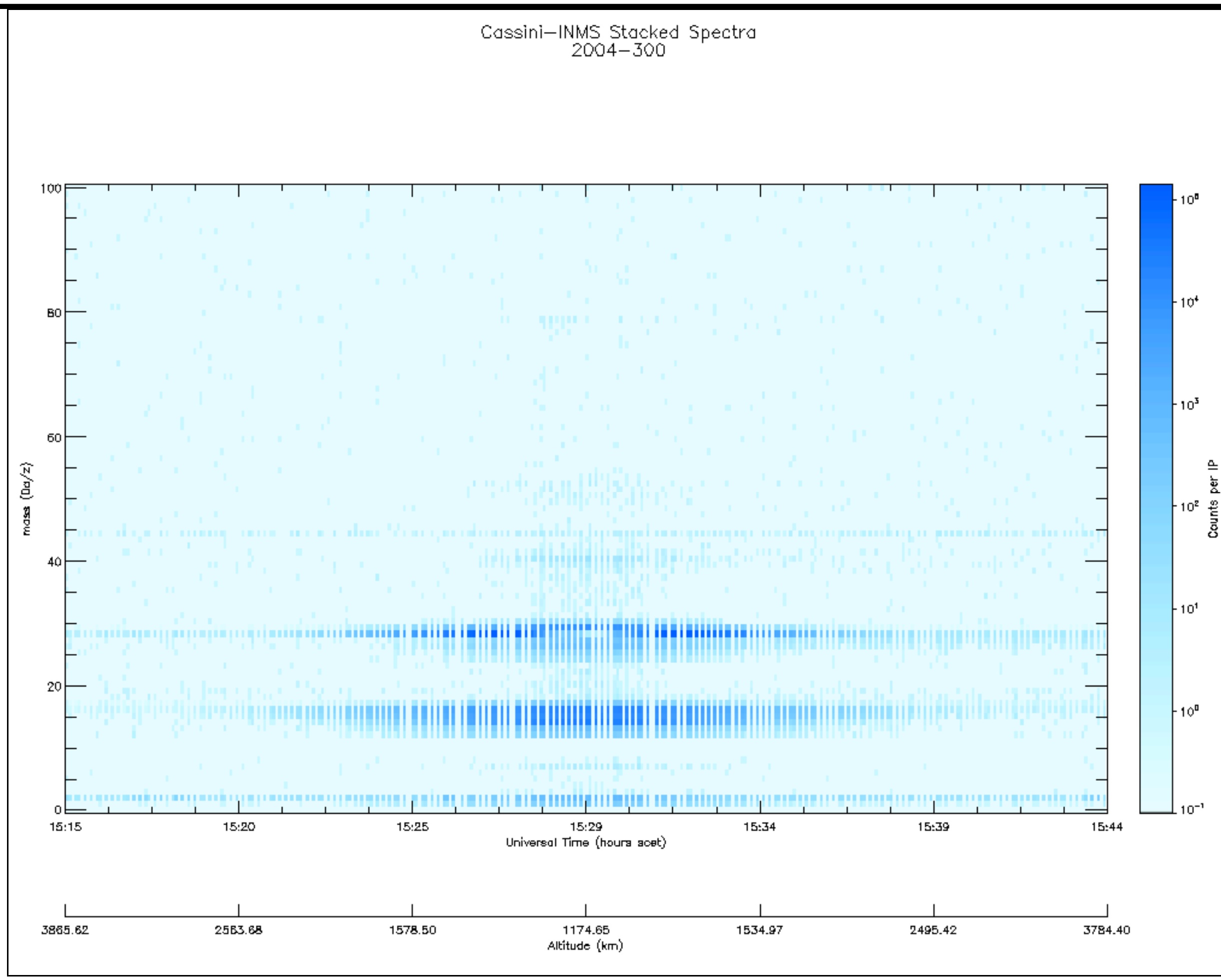
- inms_plot_histogram plots the counts in each mass bin
  - Counts are plotted on logarithmically
  - Error bars may be added
  - Counter 1 plotted by default, /c2 switch plots counter 2
  - Saturated counter 1 values may be replaced by scaled counter 2
- inms_plot_stacked_spectra plots the counts as a function of time and mass
  - Select C1 or C2 to display
  - Auxiliary altitude above the target scale shown
  - Accepts keywords defined for sprl_colorplot to control format
- inms_plot_mass_history plots a time series of one or more masses
  - Select C1 or C2 to display
  - Accepts keywords defined by IDL plot procedure to control format

Spectra Plots
inms_plot_histogram



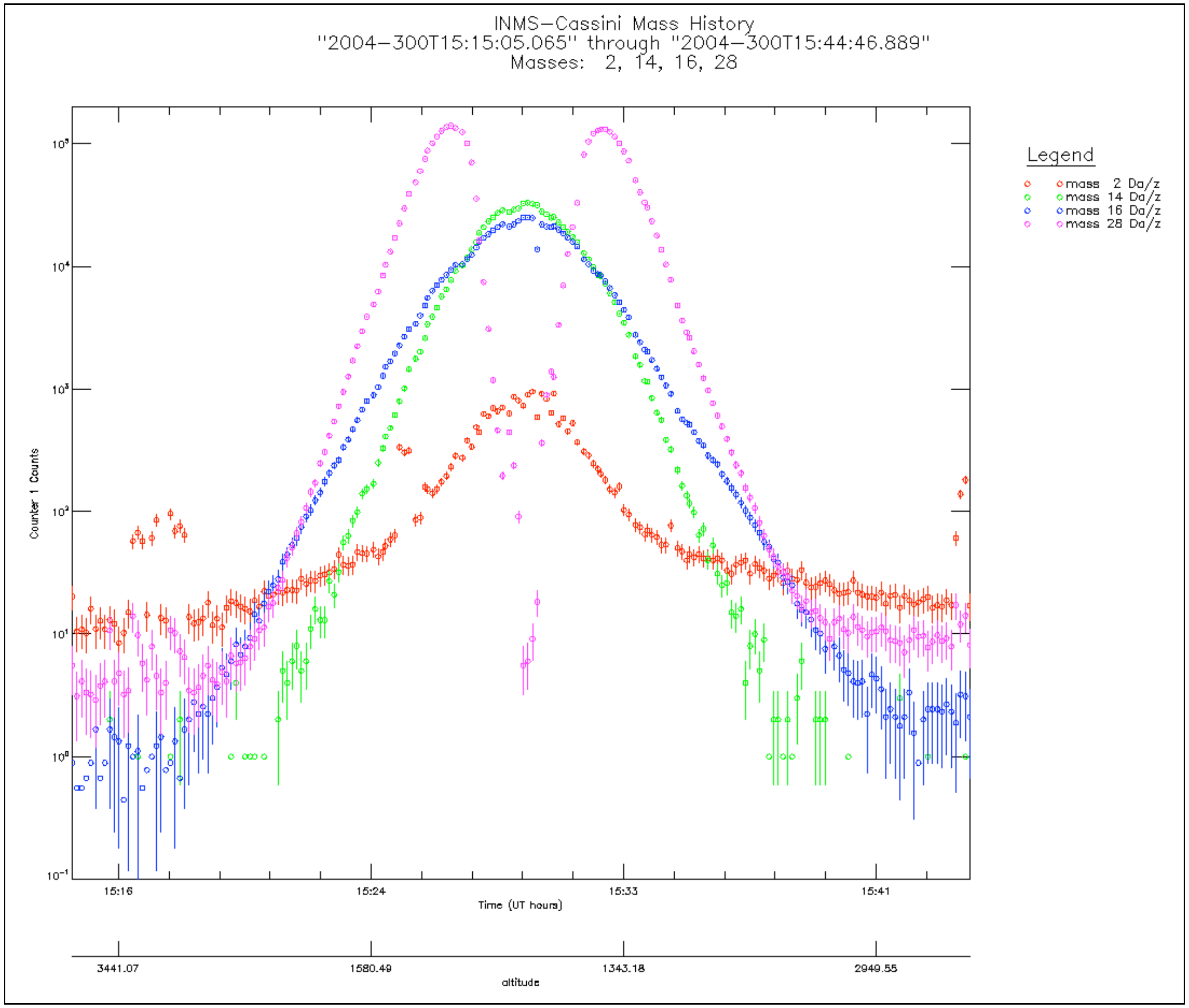
IDL> inms_plot_histogram, xMean,/err,yrange=[1.0,1e6]

Spectra Plots
inms_plot_stacked_spectra



IDL> inms_plot_stacked_spectra, axSpectra

Spectra Plots
inms_plot_mass_history



IDL> inms_plot_mass_history, axSpectra,[2,14,16,28], /ylog, yrange=[0.1,2E5], ystyle=1, /errorbar

Supporting Display Routines

- inms_prepare_plot sets and initializes the plot device

  inms_prepare_plot, init="*device*" {, /black | /white}
  {,/publication} {, resolution=[*hh,vv*} {,/portrait}
  {,path="*dir/path*"} {, file="*filename*"}

  - device may be
    - X - Xwindow device
    - IMAGE - creates a PNG file — file restricted to one plot
    - PS creates a postscript file — file may contain multiple plots
    - NULL disables display
  - Allows the file name and destination directory to be specified
- inms_prepare_plot also closes plot files

  inms_prepare_plot, {/done | spool}

INMS Analysis Tutorial
Supporting Display Routines

- Using inms_prepare_plot
  - Call with init keyword and optional keywords as desired
  - Create one plot if device is IMAGE
  - Create one or more plots if device is PS
  - Call with /done or /spool keyword to complete graphics file

```
inms_prepare_plot, init='ps', file='TAspectra'
for nI=0,10 do inms_plot_histogram, axSpectra[nI],/errorbar
inms_prepare_plot,/spool
```

- It is not necessary to call inms_prepare_plot when plotting to the default device (xWindow)
  - Default color table may not be desirable, on some machines it is grey scale
  - Calling inms_prepare_plot,init='x' insures correct color table and character sizes.

INMS Analysis Tutorial
Supporting Display Routines

- sprl_colorplot creates a plot of a function of two variables.
- command syntax:

sprl_colorplot, *anZ* {, *anXin*} {, *anYin*}
{, zrange=[*zmin,zmax*]} {,ztitle='*title for scale*'}
{, /logsw} {, /xwrap}, {, /ywrap} {, /noerase}
{, /contour} {,smooth=n | smooth=[*hs,vs*]} {, missing=*n*}
{, region=[*x0,z0,x1,y1*]} {, margins=[*lt,lo,rt,up*]}
{, gutter=n},
{*keyword expressions accepted by plot and contour*}

- Any keyword defined for sprl_colorplot may be passed through inms_plot_mt_spectra and inms_plot_stacked_spectra to control the plot format
- Especially useful are /logsw, zrange, and smooth

INMS Analysis Tools
Supporting Display Routines

- sprl_load_colors controls the color table.
- Command syntax is:

    sprl_load_colors, /divergent | categorical | sequential{=blue|red|spectrum}

- Three classes of color tables are available
    - divergent - best for data showing deviation from mean
    - sequential - best for one-sided data (like our spectra)
    - categorical - best for discrete variables

Supporting Display Routines

- inms_close_windows
  - closes all open windows

- inms_make_window
  - procedure used by all routines to create and title an X window
  - may be used interactively to create window for ad-hoc plots

INMS Analysis Tutorial
Data Manipulation

- inms_spectra_calculations
  - Operates on spectra, adds subtracts, multiplies or divides one spectra by another or by a scalar
  - Determines Standard Deviation of result
- inms_compute_mean_spectra
  - Computes the average spectra from an array of spectra structures
  - Counts are weighted by standard deviation
- inms_compute_summed_spectra
  - Computes the total counts in each mass bin from an array of spectra structures
  - Computes standard deviation as $N^{1/2}$.

INMS Analysis Tutorial
Data Manipulation

- inms_compute_density
  - simplified retrieval of N_2 and CH_4 abundance
  - used by inms_density_file to prepare inputs to Virginie's analysis
- inms_deconvolve
  - Linear least squares retrieval of multiple species from a spectra
  - species to consider an input.
  - Determines abundance, mole-fraction and isotopic ratios
- inms_saturn_wlongitude
  inms_saturn_latitude
  - Compute the longitude and planetocentric latitude of the spacecraft in the IAU Saturn frame

```
;
; program retrieve_densities
;
; PURPOSE: compute the densities for the TA encounter
;
; USEAGE:  .run retrieve_densities
;
; CHANGES:
; 29-Dec-2004  DAG initial coding
;=====================================================
;
;; read calibration data
if n_elements(axCal) eq 0 then begin
    inms_read_cal, axCal
endif
;;
;; form background
if n_elements(xBackground) eq 0 then begin
  inms_get_data, axL1aBack, /doydir, $
      path='~/Desktop/inmsData', $
      trange=['2004-264T19:00:00','2004-264T20:59:59']
  inms_get_spectra, axL1aBack,axSpBack,source='csn', $
      masstableid=[16, 17]
  inms_compute_mean_spectra, axSpBack, xMean, /poisson
  xBack0 = inms_spectra_calculations(xMean, 0.2922, $
      /multiply)
endif

xBackground = xBack0  ;; save unadjusted background
xBackground.anC1counts = $
        (xBackground.anC1counts gt 0.03) $
        * xBackground.anC1counts

if n_elements(axData) eq 0 then begin
  ;;
  ;; data is not yet read
  ;; locate data file and read
  inms_get_data, axData, /doydir, $
     path='~/Desktop/inmsData', $
     trange=['2004-300T15:20:00','2004-300T15:40:00']
endif

inms_get_spectra, axData, axSpectra, source='csn', $
                  masstableid=[16, 17], $
                  uttime=[0l, 55810432L], $
                  alt_t=[1100, 1230]

inms_compute_mean_spectra, axSpectra, xSpectra0, $
            /poisson
xSpectra = $
     inms_subtract_background(xSpectra0, xBackground)

sIn = 'n2 n2(iso) ch4 ch4(iso) h2 ar ar(iso) ‘$
      + ‘c2h2 c2h4 c2h6 c3h4 c3h8 c4h2 c6h6 c3hn’
asSpecies = strsplit(sIn, ' ,', /extract)

inms_deconvolve, axDens, $
                 axRatios, $
                 xSpectra0, $
                 axCal, $
                 c2Factor=6727., $
                 species=asSpecies, $
                 chisqr = nChiSqr, $
                 /plot
print, 'nominal ratio - 6727'
print, 'reduced Chi square: ',  nChiSqr
print, 'species', 'alt', 'Density', $
       'Sigma Dens', 'MoleFrac', 'Sigma MF',$
       'nsing', $
       format='(A10,A8,5A12)'

print,axDens,format='(A10,f8.2,5E12.4)'
print
print, 'species', 'alt', 'I-Ratio', 'Sigma I-Ratio', $
       format='(A10,A8,2A12)'
print, axRatios, format='(A10,F8.2,2E12.4)'
end
```

INNMS Analysis Tutorial
QUESTIONS?