ALMA Offline Requirements - All Priorities (1, 2, & 3)

Test 1: AIPS++ Glish: single field interferometry, *only priority 1 requirements graded*
Test 2: AIPS++ Glish: small mosaics, *only priority 1 requirements graded*
Test 3: AIPS++ Glish: combining single-dish and mosaic synthesis images,*only priority 1 requirements graded*
Test 4: CASApy: Single BL interferometry, commissioning support,*only priority 1 requirements graded*
User Focus group: user interface working group input, *no grades*
Test 5: CASApy: **1)** single dish reduction & imaging &**2)** synthesis regression testing, *priority 1 & 2 requirements graded*

Grades: **A** = adequate, **E** = enhancement desired, **I** = inadequate, **U** = unable to evaluate
For grades with **(P)** attached, the requirement could only be partially tested.

	Req.			1st Audit	Test 1	Test 2	Test 3	Test 4	Test 5	Test 5	Comments
Sect.	No.	Priority	Requirement description	Grade	Grade	Grade	Grade	Grade	SD	synth	
1.1			**General Rqmts & relation to the Pipeline**								
1.1	R1	1	An offline data processing pkg must fulfill the rqmts in this document	A							
1.1	R2	1	All std obs modes supported by ALMA must be processable by the pkg.	U							
1.1	R3	1	Pkg shall be installable at users inst and available at ALMA centers	U	**A**	**A**	**A**		**x**	**x**	
1.1	R4	1	Pkg performance shall be benchmarked and meet ALMA rqmts	U			**A(P)**			**x**	
1.1	R5	2	Functionality available in pipeline should also be in the offline package	U							
1.2			**Operational Issues**								
1.2	R1	1	Installation of pkg shall be easy	A	**A**	**A/E**	**A/E**		**x**	**x**	
1.2	R2		Error reporting & handling shall be user-understandable & non-destructive:								
1.2	R2.1	1	Error reporting messages shall be written for end users, not programmers.	I	**I**	**I**	**I**		**x**	**x**	
1.2	R2.2	1	Must be provision for job ctrl (interupt & abort)	A	**I**	**I**	**I**		**x**	**x**	
1.2	R2.3	2	Error handling shall be non-destructive (no corrupted data), fail gracefully	I					**x**	**x**	
1.2	*R2.4*	*3*	*Code traceback of execution errors shall be available*	A							
1.2	R3.1	1	Logging of commands and user inputs shall be provided	I	**A/E**	**A/E**	**A/E**		**x**	**x**	
1.2	R3.2	1	Logging of tool results shall be provided (errors, files written, timing)	A	**A/E**	**A/E**	**A/E**		**x**	**x**	
1.2	R3.3	2	Logging of output such as summaries of results shall be provided	A					**x**	**x**	
1.2	R3.4	2	The session log shall be readable by the user (e.g. text file, not binary)	A					**x**	**x**	
1.2	*R3.5*	*3*	*Session logs shall be executable by package UI, reproducing the session*	I							
1.2	R4	1	There shall be comprehensive handling of multi users/tasking	A					**x**		
1.2	R5	1	There shall be support for the pkg (bug fixes done according to priority)	U	**A**	**A**	**A**		**x**	**x**	
1.2	R6	1	Improvements & updates based on user feedback shall be done	A	**A**	**A**	**A**		**x**	**x**	
1.2	R7	2	Backward compatability of core functions should not be broken w.out reason	U						**x**	
1.2	R8	2	Source code for astronomical routines shall be available to the user	A							
1.2	R9	2	User installation of package not restricted by expensive or licenses	A						**x**	
1.2	R10	2	Provision for development and incorporation of user-supplied code possible.	A							
1.2	R11	2	Successive stages of call, correction, flagging should not destroy data.	A						**x**	
2.1			**General User Interface Rqmts**								
2.1	R1.1	1	A command line interface (CLI) shall be provided	A	**A**	**A**	**A**		**x**	**x**	
2.1	R1.2	1	A GUI shall be provided - GUI actions shall be scripted	A							
2.1	R2	1	The user shall be able to run host operating system commands (ls, rm)	A	**A/E**	**A**	**A**		**x**	**x**	
2.1	R3	1	Multi-tasking for all interfaces shall be available where appropriate	A					**x**	**x**	
2.2			**Graphical User Interface (GUI)**								
2.2	R1.1	1	GUI window updating must be fast (less than 0.1s)	U							
2.2	R1.2	1	Windows shall not take up excessive screen space (<=800x800 pixels)	I							
2.2	R1.3	2	Be able to choose cascading windows or re-use single window for new ops	I							
2.2	R1.4	2	Must be easy & robust to move and resize all windows	A							
2.2	*R1.5*	*3*	*There shall be a master control GUI for process control*	A/E							
2.2	R2	1	It must be easy to run GUIs remotely	A							
2.2	R3	2	GUIs should be easy to learn how to use	A/E							
2.2	R4	2	GUIs should be available for reduction of all standard ALMA obs modes	U							
2.2	R5	2	GUI look & feel should be uniform throughout the package	A							
2.2	R6		GUI features for beginner modes shall include:								
2.2	R6.1	2	built in help facility with access to novice-oriented help doc	A							

2.2	R6.2	2	Sensible defaulting of values for parameters, with guidance for user choice	A/E							
2.2	R6.3	2	Integrated functionaly built around common data analysis tasks	I							
2.2	*R7*	*3*	*It shall be easy for users to develop & include custom GUIs in the package*	A							
2.3	R2		**Command Line Interface (CLI)**								
2.3	R1	1	Command files for batch CLI processing shall be possible	A	**A**	**A**	**A**		**x**	**x**	
2.3	R2	1	The CLI shall have command-line recall & editing w/ name completion	A/E	**A/E**	**A/E**	**A/E**		**x**	**x**	
2.3	R3	1	All GUI functionality must be available in CLI mode	A							
2.3	R4	2	CLI use easy over low-speed modem lines or network, with ASCII emulation	A							
2.3	R5	3	Desirable to have CLI mode menu to edit input parms	Missing					**x**	**x**	
2.4			**Interface programming, parameter passing & feedback**								
2.4	R1.1	1	The UI must have variable assignment & evaluation	A						**x**	
2.4	R1.2	1	The UI must have array handling	A						**x**	
2.4	R1.3	1	The UI must have conditional statements	A			**A**			**x**	
2.4	R1.4	1	The UI must have control loops	A			**A**			**x**	
2.4	R1.5	1	The UI must have string manipulation	A						**x**	
2.4	R1.6	1	The UI must have user-defined functions & procedures w/ arguments	A						**x**	
2.4	R1.7	1	The UI must have process control, interrupts, error handling	A						**x**	
2.4	R1.8	1	The UI must have std mathematical operations & functions	A						**x**	
2.4	R1.9	2	The UI must have efficient special vector and matric operations	A							
2.4	R1.10	2	The UI must have user-defined data structures	A							
2.4	R2	1	Commands executed will be logged with provision to re-execute	A					**x**	**x**	
2.4	R3	1	Input parm. & syntax checking shall be done when a function is called	I					**x**	**x**	
2.4	R4	2	Parms should be passable between applications, global vars not the default	A					**x**	**x**	
2.4	R5	2	Vars shall be named consistently and clearly using astronomical terms	I					**x**	**x**	
2.4	R6		Parameter inputs to tools shall be stored for later recall:						**x**	**x**	
2.4	R6.1	2	Save inputs on closure and reinstate on next instance of tool	A					**x**	**x**	
2.4	*R6.2*	*3*	*Be able to save/recall state of parms for entire package & individual tools*	I							
2.5			**Documentation & Help Facility**								
2.5	R1.1	1	User cookbooks with extensive examples shall be available	I	**A**	**A/E**	**A/E**		**x**	**x**	
2.5	R1.2	1	Application help & ref manual (w/ all fctn & tool inputs) shall be available	I	**A/E**	**A/E**	**A/E**		**x**	**x**	
2.5	R1.3	1	On-line help, FAQs, e-mail contact info shall be available	A	**A**	**A**	**A**		**x**	**x**	
2.5	R1.4	1	Release history, bug reports/tracking, patch descriptions shall be available	I	**A**	**A**	**A**		**x**	**x**	
2.5	R1.5	2	Programmer references and guides shall be available	I							
2.5	R1.6	2	Data format descriptions shall be available	A					**x**	**x**	
2.5	R1.7	2	Algorithm descriptions shall be available	A/E					**x**	**x**	
2.5	*R1.8*	*3*	*news letters, e-mail exploders, notes series shall be available*	A							
2.5	R2	1	Documentation must be up-to-date & complete for all parts of the pkg.	I	**I**	**I**	**I**				
2.5	R3.1	1	Help mtls shall be available in std document print format (pdf, postscript)	I	**A/E**	**A/E**	**A/E**		**x**	**x**	
2.5	R3.2	2	Help mtls shall be available in printer-friendly versions of HTML pages	A					**x**	**x**	
2.5	*R3.3*	*3*	*Help mtls shall be available in popular proprietary formats (MS-Word)*	Missing							
2.5	R4	2	Help shall be context-sensitive where relevant, includes GUI fly-over banners	A					**x(P)**	**x(P)**	evaluate only whether help is context-sensitive
2.5	R5	2	GUIs: help directs browser to web page. CLI: in-line text based help	A/E					**x(P)**	**x(P)**	Evaluate only CLI in-line text-based help
2.5	R6	2	Full search capability must be built into documentation library	A					**x**	**x**	
3.1			**Data Handling - General Data Requirements**								
3.1	R1		The pkg must support data taken in any std ALMA hdw modes	A							
3.1	R2.1	1	The pkg should handle program header info	A	**A/E**	**A**	**A**		**x**	**x**	
3.1	R2.2	1	The pkg should handle obs status info (and schedules)	A							
3.1	R2.3	1	The pkg should handle field info	A	**A**	**A**	**A**		**x**	**x**	
3.1	R2.4.1	1	The pkg should handle SD&Interf. data organized by position	A	**A**	**A(P)**	**A(P)**		**x**	**x**	
3.1	R2.4.2	1	The pkg should handle SD&Interf. data organized by subreflector state	A							
3.1	R2.4.3	1	The pkg should handle SD&Interf. data organized by polarization products	A	**A**	**A(P)**	**A(P)**		**x**	**x**	
3.1	R2.4.4	1	The pkg should handle SD&Interf. data organized by spectral channels	A	**A**	**A(P)**	**A(P)**		**x**	**x**	
3.1	R2.4.5	1	The pkg should handle SD&Interf. data organized by frequency bands	A	**A/E**	**A(P)**	**A(P)**		**x**	**x**	
3.1	R2.4.6	1	The pkg should handle SD&Interf. data organized by Ifs	A	**A**	**A(P)**	**A(P)**		**x**	**x**	
3.1	R2.4.7	1	The pkg should handle SD&Interf. data organized by subarrays (incl. ACA)	A	**A**	**A(P)**					
3.1	R2.5.1	1	The pkg should handle cross-correlations (including 12m array x ACA)	A	**A**	**A(P)**	**A(P)**			**x**	
3.1	R2.5.2	1	The pkg should handle auto-correlations	A							
3.1	R2.5.3	1	The pkg should handle uncorrected &/or on-line WVR corrected data	A							
3.1	R2.5.4	1	The pkg should handle phase-array data (if chosen by user)	A							

3.1	R2.6	1	The pkg should handle total power from antennas in SD mode	A					x		
3.1	R2.7	1	The pkg should handle weights &/or data uncertainties	A	**A/E**	**A**	**A**		x	x	
3.1	R2.8.1	1	The pkg should handle OTF scanning mode	A					x		
3.1	R2.8.2	1	The pkg should handle subreflector switching mode	A							
3.1	R2.8.3	1	The pkg should handle frequency switching mode	A							
3.1	R2.9	1	The pkg should handle flagging data or masks	A	**A**	**A**			x	x	
3.1	R2.10	1	The pkg should handle diagnostic data & errors	A	**I**	**I**					
3.1	R2.11.1	1	The pkg should handle bandpass calibration data	A	**A**	**A**			x	x	
3.1	R2.11.2	1	The pkg should handle source flux density cal data	A	**A**	**A**			x	x	
3.1	R2.11.3	1	The pkg should handle antenna polarization leakage cal data	A							
3.1	R2.12.1	1	The pkg should handle gain tables	A	**A**	**A**				x	
3.1	R2.12.2	1	The pkg should handle flux bootstraps	A	**A/E**	**A/E**			x	x	
3.1	R2.13	1	The pkg should handle images &/or models produced from data	A	**A**	**A**	**A**		x	x	
3.1	R2.14	1	The pkg should handle processing history	A	**A**	**A**	**A**		x	x	
3.1	R3.1	1	The user should be able to select srcnames, etc (w/ wildcarding)	I					x	x	
3.1	R3.2	1	The user should be able to select mosaic or scanning pointing centers	A		**U**			x	x	
3.1	R3.3	1	The user should be able to select polarization products or channels	A	**A**	**A**	**A**		x	x	
3.1	R3.4	1	The user should be able to select bands (e.g. frequency bands, lfs)	A	**A**	**A**	**A**		x	x	
3.1	R3.5	1	The user should be able to select spectral channels	A	**A/E**	**A/E**	**A**		x	x	
3.1	R3.6	1	The user should be able to select frequency-switched data	A							
3.1	R3.7	1	The user should be able to select interferometer subarrays	A							
3.1	R3.8	1	The user should be able to select interf. WVR-corrected/uncorrected BLs	A							
3.1	R3.9	1	The user should be able to select ACA subarrays	new							
3.1	R4	1	Multiple pointing centers for mosaics must be supported	A		**A**	**A**		x	x	
3.1	R5	1	Image transformation to desired Stokes parameters must be provided	A							
3.1	R6	1	Averaging of data over time, bands and spectral channels shall be possible.	I	**I**	**I**	**I**		x	x	
3.1	R7	1	Data taken in arbitrary scanning patterns must be dealt with	A							
3.1	R8.1	1	Universial Time (UT) shall be supported	A	**A**	**A**	**A**		x	x	
3.1	R8.2	1	Coordinated Universal Time (UTC) shall be supported	A							
3.1	R8.3	1	International Atomic Time (IAT) shall be supported	A							
3.1	R8.4	1	Local sidereal time (LST) shall be supported	A							
3.1	R8.5	1	Greenwich Mean Sidereal Time (GMST) shall be supported	A							
3.1	R8.6	1	Julian date (JD) & Modified Julian Date (MJD) shall be supported	A							
3.1	R8.7	1	Dynamical Times (TDT, TDB) shall be supported	A							
3.1	R9.1	1	Equatorial coordinates (RA,Dec) shall be supported	A	**A**	**A**	**A**		x	x	
3.1	R9.2	1	Ecliptic coords (ELON, ELAT) shall be supported	A							
3.1	R9.3	1	Helioecliptic coords (GLON, GLAT) shall be supported	A							
3.1	R9.4	1	Galactic coords (GLON, GLAT) shall be supported	A							
3.1	R9.5	1	Supergalactic coords (SLON, SLAT) shall be supported	A							
3.1	R9.6	1	Terrestrial coords (Az, El) shall be supported	A							
3.1	R10.1	1	J2000 equinox (and other FK5 equinoxes) shall be supported	A	**A**	**A**	**A**		x	x	
3.1	R10.2	1	B1950 (and other FK4 equinoxes) shall be supported	A	**A**	**A**			x	x	
3.1	R10.3	1	Geocentric apparent place ref frame & coords of date shall be supported	A							
3.1	R10.4	1	Topocentric coords shall be supported	A							
3.1	R10.5	1	International celestial ref system (ICRS) shall be supported	A							
3.1	R11.1	1	Radio velocity definition shall be supported	A	**A**	**A**	**A**		x	x	
3.1	R11.2	1	Optical velocity definition shall be supported	A							
3.1	R11.3	1	Redshift velocity definition shall be supported	A							
3.1	R12.1	1	Std velocity frames shall be supported, including: topocentric	A						x	
3.1	R12.2	1	Std velocity frames shall be supported, including: geocentric	A							
3.1	R12.3	1	Std velocity frames shall be supported, including: barycentric	A							
3.1	R12.4	1	Std velocity frames shall be supported, including: heliocentric	A							
3.1	R12.5	1	Std velocity frames shall be supported, including: kinematic LSR	A						x	
3.1	R12.6	1	Std velocity frames shall be supported, including: dynamic LSR	A							
3.1	R12.7	1	Std velocity frames shall be supported, including: galactocentric	A							
3.1	R12.8	1	Std velocity frames shall be supported, including: local group	Missing							
3.1	R13.1	1	Coords/locations defined w/ respect to topocentric frame shall be supported	A							
3.1	R13.2	1	Coords/locations defined w/ respect to geocentric frame shall be supported	A							
3.1	R14	1	Flagging mask/tables must be maintained with the data during all ops	A	**A**	**A**			x	x	

3.1	R14.1	2	flagging mask/tables shall be transferable to other equivalent data sets	I							
3.1	R15	1	Calib & ancillary monitoring data in ALMA format must be preserved	U							
3.1	R16	1	Multiple bit depths (16/32bits) & compressed data must be transparent	U							
3.1	R17	1	Processing history info must be maintained & exportable (tables & text).	I	**I**	**I**	**A(P)**		**x**	**x**	
3.1	R18	1	Users should be able to change all aspects of the data, including header	A	**A**	**A**	**A**		**x**	**x**	
3.1	R19	1	Pkg should support locking data files: "one writer, multiple readers"	A	**A**	**A**	**A/E**		**x**		
3.1	R20.1	1	Extraction of subsets of data (src,time,subarray) shall be supported	A/E	**A/E**	**A/E**			**x**	**x**	
3.1	R20.2	2	Merging/reinsertion of data subsets (configs, ACA+12m) shall be supported	A/E							
3.1	R20.3	2	Merging & splitting shall be straightforward	I						**x**	
3.1	R20.4	2	Use of merged or split data shall be robust	A						**x**	
3.1	*R20.5*	*3*	*Cal and monitoring data for merged or split data shall be preserved*	I							
3.1	R21	2	Distinctions between single/multi-source, SD, synth data shall be avoided	A					**x**	**x**	
3.1	R22	2	Be able to look at & print header info (scan summaries, ant locations)	A					**x**	**x**	
3.1	*R23*	*3*	*Sorting/indexing to improve performance should be transparent to user*	A							
3.1	*R24*	*3*	*Data compression w/ selectable levels of loss should be available*	I							
3.1	R25		Data selection and handling issues related to single dish processing:								
3.1	R25.1	1	Provide easy mechanism to select single or multiple spectra	new					**x**		
3.1	R25.2	1	Provide easy mechanism to select IFs or polarizations	new					**x**		
3.1	R25.3	1	Be able to easily set range of spectral points for baseline removal, stats	new					**x**		
3.1	R25.4	1	Package identify 'on' & 'off' spectra for sky subtraction	new					**x**		
3.1	R25.5	1	Be able to select sets of sources based on simple regular expression	new					**x**		
3.1	R25.6		Single dish Meta data issues:								
3.1	R25.6.1	1	Header info should be viewable & editable by user (e.g. scale Tsys values)	new					**x**		
3.1	R25.6.2	2	User should be able to add missing header info to one or multiple scans	new							
3.2			**Data Import and Export**								
3.2	R1.1	1	ALMA std archive data format must be fully supported for input (synth+SD)	revised							
3.2	R1.2	1	Other std data formats designated by ALMA shall be supported, including:	U							
3.2	R1.2.1	1	- standard image FITs files	new					**x**	**x**	includes RP FITS
3.2	R1.2.2	1	- uv FITS	new						**x**	
3.2	R1.2.3	2	- Single dish FITs	new							
3.2	*R1.3*	*3*	*Other data formats may be supported with some loss in information content*	A							
3.2	R2	1	Disk & offline data storage must be supported (+ proj list of what's available)	A	**A**	**A**	**A**				
3.2	R3	1	Pkg should efficiently handle datasets larger than main host memory	U							
3.2	R4	2	The ability to drop flagged data on export shall be included	I					**x**	**x**	
3.2	R5	2	Internal data format must not be bloated, no more than 1.5xraw data	I					**x**	**x**	
3.2	R6	2	It must be possible to append single dish spectra to existing output files	new					**x**		
3.2	R7		Coordinate frames and units for single dish data export:								
3.2	R7.1		User should be able to specify reference frame for exporting data, e.g.:	new					**x**		
3.2	R7.1.1	1	Equitorial coordinates J2000 & B1950	new					**x**	**x**	
3.2	R7.1.2	1	Galactic coordinates	new							
3.2	R7.1.3	1	Ecliptic coordinates at an assigned epoch	new							
3.2	R7.2	2	Non-conformist positional frames (e.g.Az-El) should be supported for export	new							
3.2	R7.3		The user should be able to specify the projection for exported data, e.g.:	new							
3.2	R7.3.1	2	Sine projection (SIN)	new							
3.2	R7.3.2	2	Flamsteed (Global sinusoidal, GLS)	new							
3.2	R7.3.3	2	Tangent or gnomonic projection (TAN)	new							
3.2	R7.3.4	2	Stereographic projection	new							
3.2	R7.3.5	2	Equidistant cylindrical projection	new							
3.2	R7.3.6	2	Mercator's projection	new							
3.2	R7.3.7	2	Hammer's projection	new							
3.2	R7.3.8	2	Aitoff's projection	new							
3.2	R7.3.9	2	Homogographic projection	new							
3.2	R7.4	3	Support any coord & projection defined by the World Coord System (WCS)	new							
3.3			**Images and Other Data Products**								
3.3	R1.1	1	Package must support spectra and image slices (1D)	A	**A**	**A**	**A**		**x**	**x**	
3.3	R1.2	1	Package must support planar images (2D)	A	**A**	**A**	**A**		**x**	**x**	
3.3	R1.3	1	Package must support spectral and time cubes (3D)	A	**A**	**A**	**A**		**x(P)**	**x(P)**	Test support of spectral cubes only
3.3	R1.4	2	Package must support higher-dimensional arrays (4D)	A							
3.3	R2.1	1	Point (CLEAN) models must be supported	A	**A**	**A**	**A**			**x**	
3.3	R2.2	1	Pixel (gridded image) models must be supported	A	**A**	**A**	**A**			**x**	

3.3	R2.3	1	Elliptical Gaussian models must be supported	A							
3.3	R2.4	2	Uniform (optically thick) disk models must be supported	A							
3.3	R2.5	2	Optically thin disk models must be supported	Missing							
3.3	*R2.6*	*3*	*Wavelets must be supported*	Missing							
3.3	*R2.7*	*3*	*Pixons must be supported*	I							
3.3	R3	1	Pixel blanking shall be maintained through image processing	A							
3.3	R4		The package shall support all std projectsions, including:								
3.3	R4.1	2	- sine or slant orthographic (SIN)	A							
3.3	R4.2	2	- tangent or gnomonic (TAN)	A							
3.3	R4.3	2	- cylindrical plate caree (CAR)	A							
3.3	R4.4	2	- Mercator (MER)	A							
3.3	R4.5	2	- stereographic (STG)	A							
3.3	R4.6	2	- Hammer-Aitoff (AIT)	A							
3.4			**Foreign Data**								
3.4	R1	2	Be able to process data from other interferometers, SDs if in ALMA format	U					**x**	**x**	
3.4	R2	2	Be able to import FITS images and combine with ALMA data	U					**x(P)**	**x(P)**	test import of FITs images only
3.5			**Interaction with the Archive**								
3.5	R1	1	Access from the archive must be supported	U							
3.5	R2	1	Pkg/archive interaction must not interfere w/ other access to the archive	U							
3.5	R3	1	Security/integrity of the archive must be ensured during access/interface	U							
4.1			**General Calibration & Editing Requirements**								
4.1	R1	1	The pkg shall be able to handle all ALMA std cal modes	U							
4.1	R2	1	Cal, editing, & data correction shall be easily reversible	A	**A/E**	**A/E**					
4.1	R2.1	2	Logging of editing steps shall be in history table or 'data object'	I					**x**	**x**	
4.1	*R2.2*	*3*	*Individual edit undo is desirable*	I						**x**	
4.1	R3	1	Cal solution intervals should be optimized for the data (e.g.scan-based sols)	Missing	**A**	**A**				**x**	
4.1	R4		Data editing shall be possible based on:	Missing							
4.1	R4.1	1	- ointing data	Missing							
4.1	R4.2	1	- array tracking info (encoders);	Missing							
4.1	R4.3	1	- weather data	I							
4.1	R4.4	1	- Tsys data	I							
4.1	R4.5	1	- WVR data	Missing							
4.1	R4.6	2	- RFI monitoring	Missing							
4.1	R4.7	2	- Site-test interferometer (STI) and/or tipping radiometer	Missing							
4.1	*R4.8*	*3*	*- array monitoring points (e.g. dewar temps) if data provided in std format*	Missing							
4.1	*R4.9*	*3*	*- other site instruments (e.g. FTS) if data is provided in std format*	Missing							
4.1	R5	1	Data average cal solns should be possible w/ controlled interpolation, etc.	I	**I**	**I**				**x**	
4.1	R6		Inderactive data editing, cal & display of cal quanties: graphical & intuitive								
4.1	R6.1		Editing display tools shall include specification by:								
4.1	R6.1.1	1	- antenna	A	**A**	**A**				**x**	
4.1	R6.1.2	1	- baseline	A	**A**	**A**				**x**	
4.1	R6.1.3	1	- timerange	A	**A**	**A**				**x**	
4.1	R6.1.4	1	- uvrange	A	**A**	**A**				**x**	
4.1	R6.1.5	1	- pointing center	I		**U**				**x**	
4.1	R6.1.6	1	- plot versus Az, El	Missing							
4.1	R6.1.7	1	- plot versus HA range	Missing							
4.1	R6.1.8	1	- plot versus parallactic angle	Missing							
4.1	R6.1.9	1	- plot a slice through a data cube	Missing							
4.1	R6.2	1	Data editing tools should display spectra and spectral cubes	I	**A/E**	**A/E**			**x**	**x**	
4.1	R6.3	1	Data editing tools should display closure quantities	Missing							
4.1	R6.4	1	Data editing tools should display & select monitor data (e.g. Tatm, Tamb)	Missing							
4.1*	R6.5	1	Editing tools shall plot all the above vs BL, time, band, chan averaging	(missing)	**I**	**A/E**				**x**	Evaluate for parms that are available
4.1	R6.6	1	Edt tools shall plot amp/ph. vs time, vs time-BL w/ zoom, select, & clipping	I	**A**	**A/E**				**x**	
4.1	R6.7		Editing of data shall be possible based on stastical quantities, including:								
4.1	R6.7.1	1	- a data point vs a running mean over a timescale	Missing	**I**	**A/E**				**x**	
4.1	R6.7.2	1	- a data point versus a median over a timescale	Missing	**I**	**I**				**x**	
4.1	R6.7.3	1	- an rms scatter in a time range	Missing	**I**	**A/E**				**x**	
4.1	R6.7.4	1	- difierence versus a model	Missing							
4.1	R6.8	1	Editing display tools shall have auto-scaling & user-specified axis scaling	A	**A**	**A**				**x**	

4.1	R6.9	1	Editing display tools shall have auto-scaling & user-spec color/greyscale	A	**A**	**A**				**x**	
4.1	R6.10	1	Editing display tools shall include/mark flagged data in plots & auto-scaling	A	**A**	**A**				**x**	
4.1	R7		Non-interactive/automatic editing tools shall be available, including								
4.1	R7.1	1	- ability to edit with all capabilities in interactive editng	A	**A/E**	**A/E**				**x**	
4.1	R7.2	2	- automated editing w/ tunable criteria for auto selection of parm ranges	A							
4.1	R8	2	Data cal, correction, flagging possible based on std or user models	Missing			**A/E(P)**				
4.1	R9	2	Access to time history of cal info shall be built into cal engines.	I						**x**	
4.1	R10	2	Be able to establish/verify relative cal between epochs, configs,data subsets	I							
4.1	R11	2	Data disply/editing tools shall be applicable to SD and synthesis data.	A					**x**	**x**	
4.1	R12	2	Editing shall be possible in all visualization tools (e.g. cal solns, other plots)	I							
4.2			**Atmospheric Calibration**								
4.2	R1	1	A std atm model for Pipeline data processing shall exist-User-supplied too	Missing							
4.2	R2		Predict atm absorption, emission, pathlength based on the following data:								
4.2	R2.1	1	- temp, pressure, humidity	Missing							
4.2	R2.2	1	- measured atm emission	Missing							
4.2	R2.3	2	- data from site test interferometer or tipping radiometer	Missing							
4.2	*R2.4*	*3*	*- measured FTS data (if FTS available for ALMA)*	U							
4.2	*R2.5*	*3*	*- measured atm profiles of temp & water if available*	U							
4.2	R3	1	Atm models shall derive Tsys corrected for atm absorption to correct amps	Missing							
4.2	R4	1	Atm models shall convert WVR data to astronomical phase in all bands.	Missing							
4.3			**Interferometer data calibration**								
4.3	R1.1	1	Default ant-based cal solutions shall be available for antenna gains	A	**A**	**A**				**x**	
4.3	R1.2	1	Default ant-based cal solutions shall be available for polarization leakages	A							
4.3	R1.3	1	Default ant-based cal solutions shall be avail for ant-dependent bandpasses	A	**A**	**A**				**x**	
4.3	R2.1	1	BL-based cal solutions shall be available for WVR corrections to some BLs	A							
4.3	R2.2	1	BL-based cal solutions shall be available for closure errors	Missing							
4.3	R2.3	1	BL-based cal solutions shall be available for BL-dependent bandpasses	Missing			**A**			**x**	
4.3	R3	1	Gain corrections based on models shall be possible w/ automatic editing	A/E	**A/E**	**A/E**				**x**	
4.3	R4	1	Cal quantities shall be transferable between srcs &/or freq bands	I	**A/E**	**A**				**x**	
4.3	R5	1	Determining time-variable cmplx bandpass & transfer to srcs shall be simple	I	**I**	**I**				**x**	
4.3	R6	1	Full polarization calibration shall be possible	A							
4.3	R7	2	Determining , correcting, examining, flagging closer errors should be easy	Missing							
4.3	R8	2	Using std models shall be easy for cal ops (user supplied models possible)	A							
4.3	R9	2	Use redundance when possible to increase accuracy of or check cal solns.	Missing							
4.3	*R10*	*3*	*Provide synth pointing, focus, baseline, beam response fitting in pkg*	Missing							
4.4			**Single Dish data calibration**								
4.4	R1	1	Fitting of spectral bandpass from cal src obs should be available	A					**x**		
4.4	*R1.1*	*3*	*Remove standing wave ripples by fitting sine function to line-free channels*	new							
4.4	*R1.2*	*3*	*Provide "robust" fitting functions which are more tolerant to RFI*	new							
4.4	R2	1	De-striping/adjust must exist for SD OTF obs w/ overlap/crossing scans.	I					**x**		
4.4	*R3*	*3*	*Support cal of system parms (temp-controlled loads, noise sources)*	Missing							
4.4	*R4*	*3*	*Be able to process pointing, focus, tipping, beam-fitting data for SD data*	Missing							
4.4	R5	1	Be able to phase calibrate datasets with ACA 12m & 7m dishes	new							
4.4	R6		Be able to do sky subtraction with multiple techniques:								
4.4	R6.1	2	Specify an arbritrarily complex ref/source order for multiple sky subtractions	new							
4.4	R6.2	1	Support position switched sky subtractions	new					**x**		
4.4	R6.3	1	Support nutator switched sky subtraction	new							
4.4	R6.4	2	Support frequency switched sky subtractions	new					**x**		
4.4	*R6.5*	*3*	*Handle basic Tsys, gain cal, opacity corrections in sky subtractions*	new							
4.4	R7	1	Sky subtraction methods during slow OTF observing should be supported	new							
4.4	R8		All functions on SD data must support polarization:								
4.4	R8.1	2	Be able to calculate leakage terms from a cal source and correct the data	new							
4.4	R8.2	2	Be able to determine absolute P.A. from cal source & correct the data	new							
4.4	R9		Be able to easily flag individual spectra or channels:								
4.4	R9.1	1	User should be able to set whole or part of a spectra as invalid (flag)	new					**x**		
4.4	R9.2	1	User should be able to set individual or range of spectral points as invalid	new					**x**		
4.4	R9.2.1	2	User can flag a channel & interpolate value from adjacent good data	new							
4.4	*R9.3*	*3*	*User can plot average spectral flux across band, interactively flag data*	new							
4.4	*R9.4*	*3*	*Fitting routines should be able to select RFI-tolerant (robust) algorithms*	new							

4.4	*R9.5*	*3*	*Auotmatically find birdies or RFI-corrupted data - indicate data as invalid*	new							
4.5			**Mosaicing Considerations for calibration**								
4.5	R1	1	Determination of pting offsets & polarized primary beam must be available	U		**A(P)**				**x(P)**	evaluate correction for primary beam only
4.5	R2	2	Be able to cross check, correct relative cal between synth & SD mosaics	U							
4.5	*R3*	*3*	*Allow user-input of scan pointing info from pattern or interpolated from list*	A/E							
4.6			**Ancillary & Diagnostic Data considerations for calibration**								
4.6	R1	1	Output from atm monitoring (WVR, FTS) shall be importable to cal sftw	U							
4.6	R2	1	Cal solns/correction based on pting, focus, subreflector status shall exist	Missing							
4.6	R3	2	Be able to import for cal procedures environmental data (weather)	U							
4.6	*R4*	*3*	*Be able to read and use in cal procedures engineering monitor data*	U							
5.1			**General Imaging Requirements**								
5.1	R1	1	Imaging of all ALMA exported data must be provided	U							
5.1	R2	1	Efficient selection of subsets of imaging data must be provided	A	**A/E**	**A/E**	**A/E**			**x**	
5.1	R3		Provide a variety of imaging, deconvolution, analysis algorithms, including:								
5.1	R3.1	1	- 'dirty' images with selectable weighting	A	**A**	**A**	**A**			**x**	
5.1	R3.2	1	- residual images after model subtraction	A	**A**	**A**	**A**			**x**	
5.1	R3.3	1	- single-scale CLEAN deconvolution (Hogbom, Clark, Cotton-Schwab)	A	**A**	**A**	**A**			**x**	
5.1	R3.4	1	- maximum entropy deconvolution (MEM)	A	**A**	**A**	**A**			**x**	
5.1	R3.5	1	- linear mosaicing algorithms	A		**U**					
5.1	R3.6	1	- non-linear mosaicing algorithms	A		**A**	**A**			**x**	
5.1	R3.7	2	- non-negative least-squares (NNLS)	A/E							
5.1	R3.8	2	- multi-scale CLEAN	A/E						**x**	
5.1	R3.9	2	- model fitting (point, Gaussian, disk)	I						**x(P)**	evaluate model fitting with point models only
5.1	R3.10	2	- multi-frequency synthesis w/ different spectral models	I						**x(P)**	evaluae multi-freq synthesis, no spectral models
5.1	*R3.11*	*3*	*- special function deconvolution (Pixon, wavelet)*	I							
5.1	R4	1	Image pixel and spectral channel blanking must be supported	A							
5.1	R5	1	Interactive graphical selection of deconvolution region masks shall exist	A	**A/E**	**A/E**	**A/E**			**x**	
5.1	R6	2	Support multiple dataset input to tools (not previously concatenated)	I						**x**	
5.1	R7	2	Provide integrated deconvolution,sel-cal,editing tool for novices	A/E							
5.1	R8	2	Compare images on different coord systems, equinoxes, or projections	A						**x**	
5.1	R9	2	Transform & merge correctly image cubes using diff vel definitions/frames	A						**x**	
5.2			**Interferometric Imaging**								
5.2	R1	1	Incorporation of the polarized primary beam response of the array is required	I		**A(P)**	**A(P)**			**x(P)**	Use *unpolarized* primary beam
5.2	R2	1	Imaging of RR, LL, RL, LR or I,Q,U.V must be selectible and interchangable	A/E	**A**	**A**	**A**			**x**	
5.2	R3	1	Imaging data from multiple epochs/configurations must be possible	A/E	**A/E**	**A/E**	**A/E**			**x**	
5.2	R4	1	Simultaneous multiple-field imaging & deconvolution must be supported	A		**U**	**U**			**x**	
5.2	R5	1	Cont. subtraction in uv & image planes shall be available & flexible	I	**A/E**	**A**				**x**	
5.2	R6	1	Include zero-spacing/short-spacing data (ALMA & non-ALMA) w/ weighting	I			**A/E(P)**			**x(P)**	Include zero-spacing data, non-ALMA
5.2	R7	2	There shall be the choice of FFT & DFT imaging (esp. for small datasets)	Missing							
5.2	R8	2	Be able to do near-field imaging of solar-system objects	A							
5.3			**Mosaicing and Single Dish Imaging Considerations**								
5.3	R1	1	Combine interferometer & single dish in mosaic imaging	A/E			**A(P)**				
5.3	R1.1	1	Cross correlation between 12 array & ACA must be supported	U							requirement text changed
5.3	R2	1	Incorporate (polarized) primary beam & pointing correction in mosaics.	I		**A(P)**					
5.3	R2.1	1	Primary beam calcs & corrections must take into account OTF effects	U		**U**					
5.3	R2.2	1	ALMA std beam images will be made available and distributed with the pkg	U							
5.3	R2.3	2	Be able to specify primary beam in analytic, tabular & ALMA provided format	A							
5.3	R3	1	Image & uv-plane gridding parms/interpolation shall be selectable	A/E		**A**	**A**				
5.3	R4	1	Provide scaling,de-striping of scans on image-plane combo & SD OTF	A					**x**		priority changed
5.3	R4.1	1	Provide initial de-striping using spatial baselines from non-emission regions	new					**x**		
5.3	R4.2	1	Define/implement algorithms to remove residual striping	new							
5.3	R5	2	Produce an image by combining data observed on different rasters	A							
5.3	R6	2	Apply pointing corrections to the date during imaging	Missing							
5.3	R7	2	Be able to mitigate the effects of non-coplanar baselines & sky curvature	A							
5.3	R8	1	Be able to grid SD data in a cube if desired	new					**x**		
5.3	R9	1	Automatically & manually adjust weights when combining SD & synth data	new						**x**	
5.3	R9.1	1	Combine synth & SD data using image feathering technique	new						**x**	
5.3	R9.2	1	Combine synth, SD data with joint deconvolution, manually set weights	new							
5.3	R9.3	2	Combine synth, SD data with joint deconvolution, weights auto determined	new						**x**	

5.3	R10	2	Provide a list of deconvolution algorithms appropriate for mosaics	new						x	
5.3	R11		Account for different primary beam patterns:								
5.3	R11.1	1	3 Primary beam patterns for 12m array, 7m array, & TP antennas	new							
5.3	*R11.2*	*3*	*Primary beam patterns for each individual antenna*	new							
6.1			**General Analysis Requirements**								
6.1	R1		Provide image and uv plane analysis tools:								
6.1	R1.1	1	- analysis based on goodness-of-fit to models in uv & image planes	A				**I**			
6.1	R1.2	2	- Fourier transform images between angular and uv-domains	A							
6.1	R2		Provide facility to remove spectral and scanning baselines:								
6.1	R2.1	1	- support polynomial baseline fitting	A							
6.1	R2.2	1	- support BL fitting based on image stats (e.g. median filtering)	I							
6.1	R2.3	2	- provide tool for Fourier analysis/removal of standing waves from spectra	Missing							
6.1	R3		Provide translation between astronomical quantities & units, including:								
6.1	R3.1	2	- flux density (Jy, mJy, microJy, mag)	A/E							
6.1	R3.2	2	- temperature (K, mK (Rayleight-Jeans, Planck)	I							
6.1	R3.3	2	- surface brightness (Jy/bm, Jy/sr, mJy/sr, mag/arcsed^2)	A/E							
6.1	R3.4	2	- frequency (Hz, MHz, GHz, cm^-1 or wavenumber)	A							
6.1	R3.5	2	- velocity (km/s, m/s, z or redshift)	A							
6.1	R3.6	2	- wavelength (m, cm, mm)	A/E							
6.1	R4	2	Astronomers should be able to develop own tools, good interface to data	A							
6.2			**Spectral Line Analysis**								
6.2	R1	1	Automatic & user-controlled measurement of line parms shall be available	A							
6.2	R2	1	User shall be able to specify vel or freq windowing region for line fitting	A							
6.2	R3		Available line fitting parameters and profiles shall include:								
6.2	R3.1	1	- Gaussians for single & multiple lines	A	**A**	**A**	**A**			x	
6.2	R3.2	2	- Damping profiles (Lorentzian)	I							
6.2	R4	1	ALMA std line catalogs shall be available & distributed with the pkg	U							
6.2	R5	2	Support user importable line catalogs in ASCII table and std ALMA format	U							
6.2	R6	2	Let user set flexible fit constraints for spectral lines	I							
6.2	*R7*	*3*	*Export fit results in ASCII-format is desired*	A							
6.3			**Image Cube Analysis & Manipulation**								
6.3	R1		Support construction/analysis of image cubes with different axes, including:								
6.3	R1.1	1	- time	A							
6.3	R1.2	1	- position	A			**A**			x	
6.3	R1.3	1	- fourier coordinates (uv)	A							
6.3	R1.4	1	- channel (freq, vel, chan no., band, IF)	A			**A**			x	
6.3	R1.5	1	- polarization	A							
6.3	R2	1	faces.	I							
6.3	R3	1	Be able to define multi-dim cube regions interactively & manually.	I							
6.3	R4		Identify & report image features interactively (where appropriate). Features:								
6.3	R4.1	1	- output in pixel coords (e.g. row, column)	A			**A/E**			x	
6.3	R4.2	1	- output in world coords (e.g. RA, Dec, vel)	A			**A/E**			x	
6.3	R4.3	2	- convertible to other supported coord systems (e.g. precess to B1950)	A							
6.3	*R4.4*	*3*	*- exportable (e.g. as an ASCII file)*	A							
6.3	R5		Be able to extract structures from data cubes:								
6.3	R5.1	1	- extract 'cubical' sub-structures aligned with original cube axes	A							
6.3	R5.2	1	- extraction criteria must be possible through GUI & script.	I							
6.3	R5.3	2	- extract sub-structures w/ arbitrary orientation	I							
6.3	*R5.4*	*3*	*- extract data structures based on std database (SQL) queries*	A/E							
6.3	R6	1	Data 'moments' shall be possible along any direction cube axis direction	A			**A(P)**			x	
6.3	*R6.1*	*3*	*Be able to make moments along arbitrary user-specified direction in cube*	Missing							
6.3	R7	1	Be able to assemble lower-dimensional structures into higher-dim cubes	A						x	
6.3	R8	1	Maintain pixel blanking through the analysis process	A							
6.3	R8.1	1	Be able to turn on & off different blanking (mask) levels	A							
6.3	R8.2	2	Blanking shall not be destructive, save original pixel value (if defined)	A							
6.3	R8.3	2	Be able to set blanking interactively or automatically	A							
6.3	R9		Provide imaging processing & filtering operations on a cube, including:								
6.3	R9.1		- Smoothing and convolution, with kernels including:								
6.3	R9.1.1	1	- Uniform kernel (box car or top-hat)	A							

6.3	R9.1.2	1	- elliptical Gaussian kernel	A							
6.3	R9.1.3	2	- Symmetric polynomial	A/E							
6.3	*R9.1.4*	*3*	*- User supplied kernel*	A							
6.3	R9.2	1	- Clipping	A							
6.3	R9.3	1	- Windowing & boxing with regions recordable & passable	A							
6.3	R9.4		- Arithmetical operations, including:								
6.3	R9.4.1	1	- addition of a uniform level	A			**U**				
6.3	R9.4.2	1	- multiplicative scaling	A			**U**				
6.3	R9.4.3	2	- logarithm	A							
6.3	R9.4.4	2	- exponential	A							
6.3	R9.5		- Statistical operations over a defined region, including:								
6.3	R9.5.1	1	- mean	A			**A**			**x**	
6.3	R9.5.2	1	- RMS	A			**A**			**x**	
6.3	R9.5.3	1	- std deviation from mean	A			**A**			**x**	
6.3	R9.5.4	1	- median	A			**A**			**x**	
6.3	R9.5.5	2	- mode	A							
6.3	R9.6		- Fourier & correlation operations on cube or cubical sub-region, including:								
6.3	R9.6.1	1	- Fourier transform	A							
6.3	R9.6.2	1	- power spectrum	A/E							
6.3	R9.6.3	1	- autocorrelation	A/E							
6.3	R9.6.4	2	- structure function	A/E							
6.3	R9.7		-Scalar arithmetic between regions(masked,different shaped reg.) including:								
6.3	R9.7.1	1	- sum (difference)	A							
6.3	R9.7.2	1	- product (division)	A							
6.3	R9.7.3	1	- spectral index	A							
6.3	R9.7.4	2	- median	A							
R9.7.5	R9.7.5	2	- maximum (minimum)	A							
6.3	R9.8		- Construction and comparison of vector quantities in a cube, including:								
6.3	R9.8.1	1	- polarization (E) vector at each pt in cube	A							
6.3	R9.8.2	1	- rotation measure between diff frequencies	A							
6.3	R9.9.1		- Vector arithmetic between regions(masked,different shaped reg) including:								
6.3	R9.9.1	1	- sum (difference)	A/E							
6.3	R9.9.2	2	- dot product	A/E							
6.3	R9.9.3	2	- cross product	A/E							
6.3	R9.10	1	- Provide Interpolation across blanked or masked regions	Missing							
6.3	R9.11		- Fitting of models, shapes, profiles, functions over regions, including:								
6.3	R9.11.1	1	- polynomials	A/E							
6.3	R9.11.2	1	- exponentials	I							
6.3	R9.11.3	1	- Fourier modes	I							
6.3	R9.11.4	1	- elliptical Gaussian compontns	A							
6.3	R9.11.5	2	- uniform (multi-dimensional) spheres	I							
6.3	R9.11.6	2	- trigonometric functions	I							
6.3	R9.11.7	2	- Lorentzian profiles	I							
6.3	*R9.11.8*	*3*	*- user-supplied functions*	A/E							
6.3	R9.12		- Filtering, including:								
6.3	R9.12.1	2	- Fourier (Wiener) filtering	A/E							
6.3	*R9.12.1*	*3*	*- Sobel filtering*	A/E							
6.3	*R9.12.3*	*3*	*- unshapr mask*	A/E							
6.3	*R9.12.4*	*3*	*- user-supplied filtering functions*	A/E							
6.3	R9.13	2	- Deconvolution	A							
6.3	R9.14	2	- Resampling (e.g. at lower temporal or spectral resolution) after processing	A							
6.3	R9.15		- Calculus on scalar and vector fields in a cube, including:								
6.3	*R9.15.1*	*3*	*- differentation along paths*	Missing							
6.3	*R9.15.2*	*3*	*- integration over regions*	Missing							
6.3	*R9.15.3*	*3*	*- gradient of scalar fields*	Missing							
6.3	*R9.15.4*	*3*	*- divergence of vector fields*	Missing							
6.3	*R9.15.5*	*3*	*- curl of vector fields*	Missing							
6.3	*R9.15.6*	*3*	*- Laplacian of vector fields*	Missing							
6.3	*R10*	*3*	*Manipulate data cubes as genl data structs so ops applied as obj methods.*	A							

6.4			**Single dish-specific analysis:**								
6.4	R1	1	Be able to average spectra with different velocity shifts	new					x		
6.4	R2	2	Provide various robust averaging (median averaging, clipped means)	new							
6.4	R3	2	Calculate the flux integral in a spectrum over a range of channels	new							
6.4	R4	2	Calculate FWHM of a spectral line	new							
6.4	*R5*	*3*	*Provide FFT filtering for high and low-pass filtering and tapering*	new							
6.4	*R6*	*3*	*Be albe to FFT SD data to & from power spectra and auto-corr function*	new							
6.4	*R7*	*3*	*Be able to compute cross-correlation function of 2 spectra*	new							
6.4	R8	1	Provide CLI spectral calculator to perform series of basic fctns on spectra	new					x		
6.4	R9		Allow SD data to be split into separate spectra:								
6.4	R9.1	1	- Be able to take multi-IF or pol data and split out splice of spectral portions	new					x		
6.4	R9.2	1	- Be able to select range of spectral channels to split out	new					x		
6.4	R9.3	1	- Be able to append rows from one scan-table to another	new					x		
6.4	*R10*	*3*	*Provide Zeeman splitting scaling factors for common transitions.*	new							
6.4	R11	1	Support plugins which have full access (read/write) to spectral data/headers	new					x		any plugin software available to test this?
6.4	R12	2	Plugins should be able to create 'derived' spectra with reduced dimensions	new							
6.4	R13	2	Be able to take simple grid of spectra and fit position of peak emission	new							
6.4	*R14*	*3*	*Calculate kinematic distance of source using Galactic rotation model*	new							
6.4	*R15*	*3*	*Compute RMS as a function of freq across spectra from off-pulse data*	new							
6.4	*R16*	*3*	*Print molecular formula with super/sub scripts (pretty), plain text in CLI*	new							
6.4	R17	2	Support multiple lines per IF by storing a set of rest freqs/IF(not single value)	new							
7.1			**General Visualization & Plotting Requirements**								
7.1	R1	1	Plotting/display capabilities shall be integrated into GUIs throughout pkg	A/E							
7.1	R2.1	1	Support x-y plots	A	**A**	**A**	**A**	**A/E**	x	x	
7.1	R2.2	1	Support histogram plots	A					x		
7.1	R2.3	1	Support contour plots	A	**A**	**A**	**A**		x	x	
7.1	R2.4	1	Support vector plots	A							
7.1	R2.5	1	Support 2D images	A	**A**	**A**	**A**		x	x	
7.1	R2.6	1	Support wireframe 3D surfaces;	Missing							
7.1	R3	1	Support "blinking" 2 images/stepping thru set of images w/ user-adjusts	I	**A/E**	**A/E**	**A/E**		x	x	
7.1	R4		Support std plotting formats (displayed and hardcopy):								
7.1	R4.1	1	- Support at least one std output format (e.g. postscript)	A	**A**	**A**	**A**		x	x	
7.1	R4.2	2	- support other formats such as FITS, ps, pdf, gif and/or jpeg	I					**x(P)**	**x(P)**	FITS only available
7.1	R5	1	Identification of cursor position shall be available for interactive plots.	I	**A/E**	**A/E**	**A/E**		x	x	
7.1	R6	2	Be able to encode extra axis of info on std plots using color/and/or intensity	I							
7.1	R7	2	Displays shall have similar look/feel to reduce plotting learning curve.	A					x	x	
7.2			**Display Appearance & Interactivity**								
7.2	R1	1	Plot selection parms (axes, limits, colormap) shall be easily controllable.	I	**I**	**A/E**	**A/E**		x	x	
7.2	R2	1	Provide interactive display zooming/unzooming within plot windows.	I	**A/E**	**A**	**A**		x	x	
7.2	R3	1	Benchmark plot update speed, make commensurate with other plot pkgs.	I					x	x	
7.2	R4	1	Provide diff line style/size/thickness/color. Be able to adjust/save/reload	A	**A/E**	**A/E**	**A/E**		x	x	
7.2	R5.1	1	Be able to plot Logarithmic amplitude and intensity scale	I	**A**	**A**	**A**		x	x	
7.2	R5.2	1	Be able to plot different time/coord units & formats (e.g. hrs, hhmmss)	I							
7.2	R6.1	1	Be able to overlay images w/ same axes, size, orientation	A/E	**A/E**	**A/E**	**A**		x	x	
7.2	R6.2	1	Overlay layer style shall be selectable, e.g. contours, grayscale	A/E	**A**	**A**	**A**		x	x	
7.2	R6.3	1	Overlay of selectable coordinate grids (e.g. J2000, galactic) shall exist	I							
7.2	R6.4	2	Be able to overlay functional fits (polymomials) or points read in from file	I							
7.2	R6.5	2	Be able to place data sets in layers that can be interactively colormapped	A							
7.2	*R6.6*	*3*	*Be able to overlay data w/ diff coordinate systems*	I							
7.2	*R6.7*	*3*	*Be able to shift, rotate, scale images interactively*	I							
7.2	R7	2	Be able to synchronize multiple display windows	Missing							
7.2	R8	2	Be able to add pretty annotation interactively and w/ scripts	A/E							
7.3			**Visibility Data visualization**								
7.3	R1	1	Plot basic data & cal quantities such as:					**I**			
7.3	R1.1	1	- real and/or imaginary data	A	**A**	**A**		**U**	x	x	
7.3	R1.2	1	- amplitude and/or phase	A	**A**	**A**		**A/E**	x	x	
7.3	R1.3	1	- delay and/or rate;	Missing				**U**			
7.3	R1.4	1	- time	A	**A**	**A**		**A/E**	x	x	
7.3	R1.5	1	- hour angle;	Missing				**A/E**	x	x	

7.3	R1.6	1	- parallactic angle;	Missing				**A/E**			
7.3	R1.7	1	- uv distance;	I	**A/E**	**A**		**A/E**		**x**	
7.3	R1.8	1	- u and/or v;	I	**A/E**	**A**		**U**		**x**	
7.3	R1.9	1	- baseline	A	**A**	**A**		**A/E**		**x**	
7.3	R1.10	1	- channel, freq, or vel	A	**A**	**A**		**A/E**	**x**	**x**	
7.3	R1.11	1	- azimuth and/or elevation;	Missing				**A/E**	**x**	**x**	
7.3	R2	1	select	I					**x**	**x**	
7.3	*R3*	*3*	*Be able to interpolate any tabulated val onto visibility of cal solution pt.*	I							
7.3	R1.1	1	Be able to plot ancillary data amps or single dish power vs AZ and EL	I					**x**		
7.4			**Other ALMA Data**								
7.4	R1		Be able to plot standard ALMA-format ancillary data, including:								
7.4	R1.1	1	- amplitude or SD power vs Az and El	I							
7.4	R1.2	2	- focus data and curves	U							
7.4	R1.3	2	- pointing data and offset vectors	U							
7.4	R1.4	3	- WVR output data	U							
7.4	R1.5	3	- holography and beam map data	U							
7.4	R1.6	3	- monitor point values (e.g. temperatures)	U							
7.5			**Image Cube Manipulation**								
7.5	R1	1	Histograms of pixel values must be produced for selected regions of cube.	I						**x**	
7.5	R2		It shall be possible to view subsets or slices of data cubes:								
7.5	R2.1	1	- for axes aligned with cube faces	A							
7.5	*R2.2*	*3*	*- for arbitrarily aligned axes*	Missing							
7.5	R3	1	Be able to plot a pixel value in diff. cube layers/images against each other	A							
7.5	R4	1	Data cubes must be viewable as movies with selectable rates & directions	A	**A**	**A**	**A**		**x**	**x**	
7.5	R5	2	Support interactive display of spectra corresponding to pixel or image region	A					**x**	**x**	
7.5	R6	2	Provide interactive display of 1D slice taken from 2D image	Missing							
7.5	R7	2	Be able to plot spectra on pseudo-grid - thumbnail spectra in panels	I					**x**		
7.6			**Single dish plotting:**	new							
7.6	R1	1	Line & histogram plots of spectra should be possible	new					**x**		
7.6	R2		The user should be able to specify:								
7.6	R2.1	1	- line thickness	new					**x**		
7.6	R2.2	1	- line style	new					**x**		
7.6	R2.3	1	- Character size	new					**x**		
7.6	R2.4	1	- colors	new					**x**		
7.6	R3	1	Be able to produce hard copies without an interactive plotter starting	new					**x**		
7.6	R4	3	Be able to flexibly select data to plot (any header values for any scans)	new							
7.6	R5	2	Be able ot auto-average integrations of a scan for plotting.	new							
7.6	R6	2	Be able to step back & forth between many spectra in multi-page plots	new							
7.6	R7	2	With multi-panels, automatically update plot when dimensions change	new							
7.6	R8	2	Plot full and zoomed copy of spectrum on same plot (to see weak features)	new							
7.6	R9	2	Allow offset in Y direction when stacking multiple spectra on one plot	new							
7.6	*R10*	*3*	*Plot auto update to reflect user processing (from CLI or GUI), turn on/off*	new							
7.6	*R11*	*3*	*Be able to plot individual ints in a "waterfall" plot with interactive zoom/pan*	new							
7.6	*R12*	*3*	*Be able to interactively edit waterfall plots*	new							
7.6	*R13*	*3*	*Be able to export waterfall plots to FITs images*	new							
7.6	R14	1	Be able to plot line catalog overlays (individual catalogs)	new					**x**		
7.6		2	Be able to plot line catalog overlays (ALMA combined spectral line catalog)	new							
7.6	R14.1	2	Be able to plot user catalog overlays	new							
7.6	*R14.2*	*3*	*Auto identify spectral lines if peak is above some threshold*	new							
7.6	R15	1	Be able to plot residual data w/ or w/out subtraction of fit functions	new					**x**		
7.6	R16	2	Display basic header data on plot or next to it	new							
7.6	*R16.1*	*3*	*Be able to define where the plot header info will appear on the plot*	new							
7.6	R17	2	Be able to define simple annotations (text and simple graphics)	new							

8.1			**Special Features: Simulations**								
8.1	R1	2	Provide simulation capability - what ever pipeline has.								
	R1.1	1	Provide flexible simulation capability for the offline user too.	new						x	
8.1	*R2*	*3*	*Provide single dish specific simulation capability.*	new							
8.2			**Special Features: VLBI**								
8.2	*R1*	*3*	*Be able to support VLBI processing of ALMA data*	I							
8.3			**Special Features: Solar System Object Observing**								
8.3	R1		Be able to calculate and compensate for moving objects in solar system								
8.3	R1.1		Ephemerides must be provided for major solar system objects, including:								
8.3	R1.1.1	1	- sun	A							
8.3	R1.1.2	1	- moon	A							
8.3	R1.1.3	1	- planets	A							
8.3	R1.1.4	1	- major asteroids (all >50km dia.);	Missing							
8.3	R1.1.5	1	- known short period comets;	Missing							
8.3	R1.2	1	Ephemerides must be calculated in all available reference frames	A							
8.3	R1.3	2	Be able to import a user-supplied ephemeris in tabular form	A							
8.3	R1.4	2	Be able to calculate positions from user-provided orbital elements.	Missing							
8.3	R2	1	The pkg must carry out astronetry for moving sources	A							
8.3	R3	1	Compute visibility amp correction for dist from ephemeris or user-supplied	Missing							
8.3	R4		Calculate physical ephemeris quantities for solar system objects, including:								
8.3	R4.1	2	- sub-Earth latitude and longitude	Missing							
8.3	R4.2	2	- sub-solar latitude and longitude	Missing							
8.3	R4.3	2	- sub-solar angle of North Pole	Missing							
8.3	R4.4	2	- season	Missing							
8.3	R4.5	2	- phase angle	Missing							
8.3	R5		Do coord trans from sky plane to planetocentric projections in OL-3.3-R4 &:								
8.3	R5.1	2	- 3D backprojection (onto planetary sphere)	Missing							
8.3	R6	2	Include imaging corrections for the near-field	A							
8.3	R7		In addition to std models, provide the following:								
8.3	R7.1	2	- prolate and oblate ellipsoids	I							
8.3	R7.2	2	- limb-darkened disks (polynomial, cosn, Legendre polynomial)	Missing							
8.3	*R8*	*3*	*Support 3D reconstruction of emission using obs of target at different aspec angles &/or rotational phases.*	Missing							
8.4			**Special Features: Pulsar Observing**								
8.4	*R1*	*3*	*Support time-series data folding into multiple phase bins for pulsar periods*	Missing							
8.4	*R2*	*3*	*Support at least 16 phase bins*	A							
8.4	*R3*	*3*	*Interpolate into phase bins from correlator output*	Missing							
8.4	*R4*	*3*	*Support SD - sky subtractions of pulsar observations*	new							
8.5			**Array Analysis Support**								
8.5	R1		The package shall be able to calculate baseline delays (fringe fitting), e.g:								
8.5	R1.1	1	Phase versus frequency (slope tells you how good delays are)	new				**U**			
8.5	R1.2	1	Phase versus time (calculate rates)	new				**U**			