Unified EVLA/ALMA handling of calibration quantities within the A/SDM data structures.

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Abstract

This memo summarizes discussions on the proposed handling of EVLA and ALMA calibration quantities required for post-processing calibration. We recommend an additional table in the SDM to handle switched power measurements for the EVLA; we recommend adding two SDM tables to the MS to handle the calibration quantities from both instruments (over the use of the existing SYSCAL table). A UVFITS definition of this information is also appended.

Introduction/Background

The Science Data Model (A/SDM) should provide all the information necessary to interpret and analyze useful scientific results for both EVLA and ALMA data.

For the EVLA, a summary of the handling of correlation products is provided in EVLA Memo 145 (http://www.aoc.nrao.edu/evla/geninfo/memoseries/evlamemo145.pdf). To enable scaling and calibration of EVLA correlations, synchronous power detectors record measurements, before the requantizer, on the filter chips of the Station Boards in the WIDAR correlator. These measurements need to be recorded along with the science data in the SDM, hence, we propose a new SDM table for storing this (EVLA-specific) information: SysPower.

In addition, both observatories need to store key calibration values to complete the required information from their respective calibration sequences. ALMA and EVLA provide different hardware

implementations to enable this, however, they are both accommodated by the current CalDevice table of the SDM.

- EVLA will use the noiseCal field to store the quasi-stable TCAL values.
- ALMA will use the temperatureLoad field to store the ACD information.

Finally, this information will need to be passed into the MS for use in subsequent post-processing packages. The existing MS V2 SYS_CAL table does have fields for holding some of this information, however, the current definition mixes both spectral-window-based and channel-based fields as well as laboratory (e.g., TCAL) and derived (e.g., TSYS) values and neglects clear areas to store other values; as such, we propose to migrate the CalDevice table information to an analogous CAL_DEVICE MS table for directly storing this information in the same way as the (A)SDM.

The Proposed Tables are listed below. This proposal has been agreed by the EVLA and ALMA projects and will be adopted according to the Actions to Resolution. A subsequent memo will be required to detail the implementation of the handling of these quantities for the calibration/scaling of visibilities in post-processing.

Proposed SDM SysPower table (EVLA-only)

This table is intended to store power measurements based on a synchronous power detector as used at the EVLA. While the table is intended to be general enough for use with other arrays, it is deeply entwined with the EVLA data acquisition scheme.

SysPower		
Name	Type	Comment
Key		
antennaId	Tag	Refers to a unique row in AntennaTable
spectralWindowId	Tag	Refers to a unique row in SpectralWindow Table
timeInterval	ArrayTimeInterval	The period of validity of the data recorded in this row.
feedId	Int	Refers to the collection of rows in FeedTable having this value of feedId in their key.
Required Data		
numReceptor	Int	The number of receptors
Optional Data		
switchedPowerDifference	Float[N_Rec]	Pdiff=G*(Pon-Poff)
switchedPowerSum	Float[N_Rec]	Psum=G*(Pon-Poff)
requantizerGain	Float[N_Rec]	EVLA requantizer gain; gain inserted after synchronous power detection.

The data recorded in a given SysPower row are based on the entire bandwidth of that Spectral Window, regardless of how many channels (spectral points) it has. This allows one to re-use Spectral Window entries for visibilities (many channels per SpW) and SysPower measurements (one channel per SpW).

It is not required that the Spectral Windows referred to in this table also be used for any other data (visibilities or otherwise)

No current placeholder in the MS for this information; draft a new table to hold this (next section).

Further information required (TCAL values) in order to derive the Tsys values , weights.

Use of Existing CalDevice table

CalDevice		
Name	Type	Comment
Key		
antennaId	Tag	Refers to a unique row in AntennaTable
spectralWindowId	Tag	Refers to a unique row in SpectralWindow Table
timeInterval	ArrayTimeInterval	The period of validity of the data recorded in this row.
feedId	Int	Refers to the collection of rows in FeedTable having this value of feedId in their key.
Required Data		
numCalload	Int	N_Cal, the number of calibration loads.
calLoadNames	CalibrationDevice [N_Cal]	Identifies the calibration loads (an array with one value per load).
Optional Data		
numReceptor	Int	N_Rec, the number of receptors
calEff	float[N_Rec][N_Cal]	The calibration efficiencies (one value per receptor per load).
noiseCal	Double[N_Cal]	The equivalent temperatures of the noise sources used (one value per load).
temperatureLoad	Temperature[N_Cal]	The physical temperatures of the loads for a black body calibration source (one value per load).

Proposed MS V2.1 SYS_POWER table

SYS_POWER				
Name	Format	Units	Measure	Comments
Key				
ANTENNA_ID	Int			Antenna ID
FEED_ID	Int			Feed ID
SPECTRAL_WINDOW_ID	Int			Spectral Window ID
TIME	Double	s	EPOCH	Midpoint time of measurement
INTERVAL	Double	s		Interval of measurement
Data				
(SWITCHED_DIFF)	Float(Nr)			Switched power difference (cal on-cal off)
(SWITCHED_SUM)	Float(Nr)			Switched power sum (cal on+cal off)
(REQUANT_GAIN)	Float(Nr)			Requantizer gain

Notes:

This table contains time-variable calibration measurements for each antenna, as indexed on feed and spectral window. Not that Nr=number of receptors (in FEED table).

ANTENNA_ID

Antenna identifier, as indexed by ANTENNAn in MAIN

FEED_ID

Feed identifier, as indexed by FEEDn in MAIN.

SPECTRAL_WINDOW_ID

Spectral window identifier.

TIME

Mid-point of the time interval for which the data in this row are valid. Required to use the same TIME Measure reference as that in MAIN.

INTERVAL

Time interval.

SWITCHED_DIFF

Power difference between integrations with cal on and cal off in interval.

SWITCHED_SUM

Sum of power with integrations with cal on and cal off in interval.

REQUANT_GAIN

GAIN setting for requantizer.

Proposed MS V2.1 CAL_DEVICE table

CAL_DEVICE				
Name	Format	Units	Measure	Comments
Key				
ANTENNA_ID	Int			Antenna ID
FEED_ID	Int			Feed ID
SPECTRAL_WINDOW_ID	Int			Spectral Window ID
TIME	Double	s	EPOCH	Midpoint time of measurement
INTERVAL	Double	s		Interval of measurement
Data				
NUM_CAL_LOAD	Int			Number of calibration loads
CAL_LOAD_NAMES	Str(Ncal)			Calibration load names
(NUM_RECEPTOR)	Int			Number of receptors
(CAL_EFF)	Float(Nrec)(Ncal)			Calibration efficiencies (one per receptor per load)
(NOISE_CAL)	Double(Ncal)	K		Equivalent temperatures of the noise sources (TCAL for EVLA)
(TEMPERATURE_LOAD)	Double(Ncal)	K		Physical

Actions to Resolution

McMullin: end out draft of SDM_SysPower proposal as agreed; iterate until accepted (10Sep10).

Moeser: EVLA: SysPower table implementation in MCAF (updated 03Sep10).

Moeser: EVLA :CalDevice table implementation in MCAF (10Sep10).

Caillat: asdm2MS: Filler supports SYS_POWER table in MS (need date).

Caillat: asdm2MS: Filler supports CAL_DEVICE table in MS (need date).

McMullin: Updated document MS V2.1 which includes updated tables (01Oct10).

Other ASDM targets:

Rupen: Updated draft of SDM tables document (31Jul10-currently late).

Young/Caillat: Add SDM schema to CASA SVN version control.

Appendix

UVFITS SysPower table definition

SysPower		
Name	Type(Shape)	Description
Keywords		
NIF		**Number IFs (spectral windows)**
NPOL		**1 or 2 (number of polarizations)**
Columns		
TIME	D	Center time (days)
TIME INTERVAL	R	Interval surround Time
SOURCE ID	I	Source number
ANTENNA NO.	I	Antenna number
SUBARRAY	I	subarray
FREQ ID	I	Frequency ID
POWER DIF1	R(NIF)	(P_on-P_off)*G (polarization 1)
POWER SUM1	R(NIF)	(P_on+P_off)*G (polarization 1)
POWER GAIN1	R(NIF)	Post switched power gain (polarization 1)
POWER DIF2	R(NIF)	(P_on-P_off)*G (polarization 2)
POWER SUM2	R(NIF)	(P_on+P_off)*G (polarization 2)
POST GAIN2	R(NIF)	Post switched power gain (polarization 2)

UVFITS CalDevice table definition

CalDevice		
Name	Type(Shape)	Description
Keywords		
NIF		**Number IFs (spectral windows)**
NPOL		**1 or 2 (number of polarizations)**
RDATE		**DATE: YYYMMDD**
Columns		
ANTENNA NO.	I	Antenna number
SUBARRAY	I	Subarray
FREQ ID	I	Frequency ID
TCAL1	R(NIF)	Cal temp [degrees K] (polarization 1)

TCAL2	R(NIF)	Cal temp [degrees K] (polarization 2)