MWAX Metafits Changes

To facilitate the new capabilities of the MWAX system, a few new key/value pairs have been added to the metafits file format. Default values can be assumed, in the absence of these new key/value pairs.

- Delay Corrections within the Correlator
  - Human-readable header cards summarising the delay mode setting combination
  - Machine-readable header cards used to control delays in mwax_u2s
  - Current contents of the 'delaymodes' table used to define calibration corrections:
- Visibility Scaling Factor

Delay Corrections within the Correlator

The metafits primary header contains cards used by MWAX to control what delays are applied in real-time - CABLEDEL, GEODEL and CALIBDEL - as well as two cards designed for human readability, summarising the particular combination of delay settings used (DELAYMOD and DELAYDESC).

If these cards are set and non-zero, then MWAX has applied the given corrections, and downstream code should automatically use these cards to determine which corrections should NOT be applied, to avoid duplication.

Human-readable header cards summarising the delay mode setting combination

Key	Values	Default (if not present)	Notes
DELAYMOD	"NODELAYS", "CABLE", etc (see table below)	"NODELAYS"	Human readable representation of the delay mode.
DELDESC	"No delays applied", "Apply cable delays only", etc (see table below)	"No delays applied"	Human readable description of the delay mode.

The contents of the DELAYMOD card is the string provided to the '–delaymode' argument on the command line, when the observation was scheduled. This string is used to generate the actual header cards used by the correlator - CABLEDEL, GEODEL, and CALIBDEL- to control how delay corrections are handled. The individual card values are looked up in the 'delaymodes' table in the schedule database, using this mode string. **The DELAYMOD and DELDESC cards are intended to be used only by humans, not read and interpreted by any code that uses the metafits file.**

Machine-readable header cards used to control delays in mwax_u2s

Key	Values
CABLEDEL	• 0 == No real-time cable delays applied in MWAX • 1 == Corrections for the length of each tile cable and receiver clock fibre (the 'Length' column in the main metafits HDU) applied in MWAX. • 2 == Corrections for tile cable and receiver clock cable lengths AND the pointing-dependent delays due to beamformer dipole delays applied in MWAX. These beamformer dipole delays are necessary for MWA tiles if they are to be correlated with one or more other instrument (eg EDA2).
GEODEL	• 0 == No real-time geometric (tile and source position dependent) delays applied in MWAX • 1 == Delays to phase up to the zenith (using the height of each tile) applied in MWAX • 2 == Delays to phase up to the primary beam direction (fixed over the course of each observation) applied in MWAX • 3 == Delays to phase up to the source RA/Dec as the Earth rotates applied in MWAX, with az/el values changing over the duration of an observation
CALIBDEL	• 0 == No real-time calibration delays applied in MWAX • 1 == Real-time calibration corrections in the 'Calib_Delay' and 'Cailib_Gains' columns in the metafits files (from a future real-time calibration pipeline, when it exists) applied in MWAX

Current contents of the 'delaymodes' table used to define calibration corrections:

DELMOD	CABLEDEL	GEODEL	CALIBDEL	
NODELAYS	0	0	0	No delays applied
CABLE	1	0	0	Apply cable delays only
CABELZEN	1	1	0	Apply cable delays and phase up to zenith

BCABLE	2	0	0	Apply BF pointing and cable delays
BCABLEZEN	2	1	0	Apply BF pointing and cable delays, phase to zenith
TILEBEAM	2	2	0	Phase up to primary beam pointing direction
FULLTRACK	2	3	0	Phase up to track source
FULLCAL	2	3	1	Phase up to source, with real-time calibration

Visibility Scaling Factor

Key	Values	Default (if not present)	Notes
RAWSCALE	floating point	1	The multiplier that was used by the MWAX correlator to scale raw visibilities down to Jansky-like units