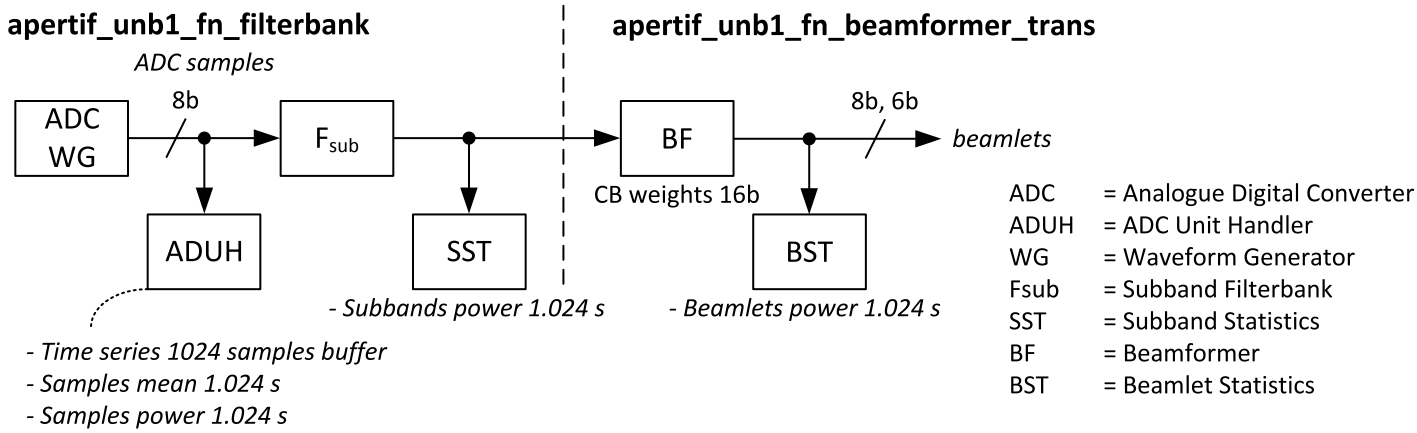
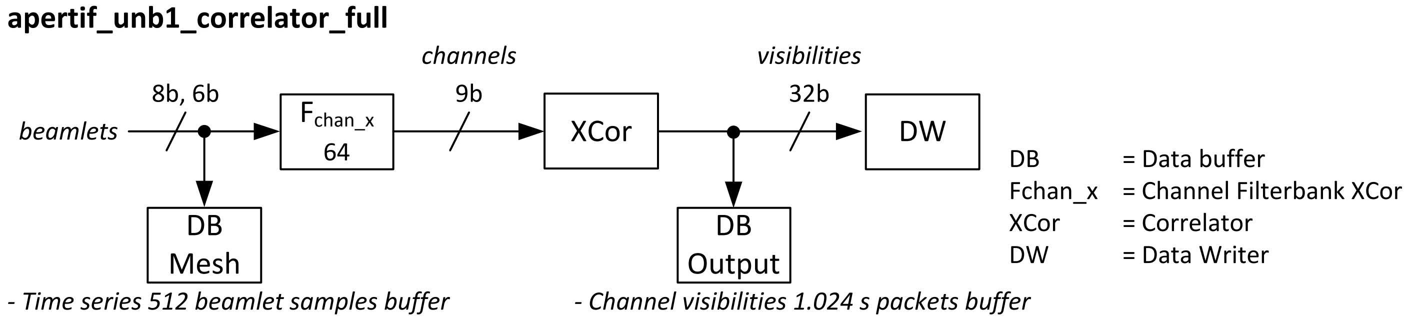
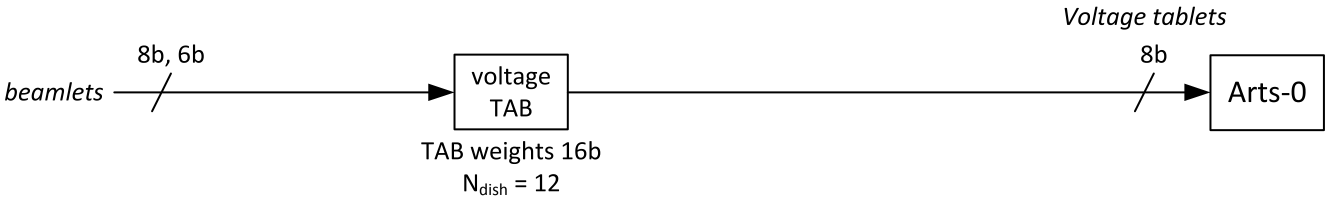


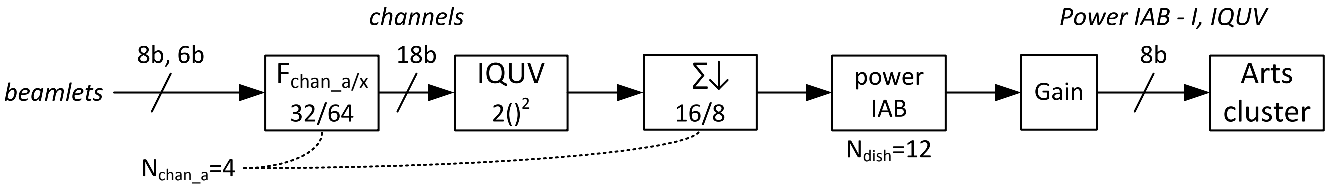


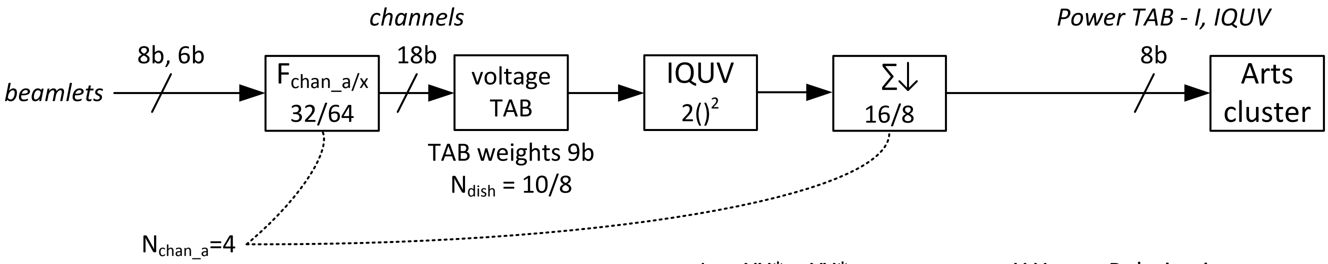
The WG can generate a sinus signal with amplitude, phase and on average any frequency between 0 and fs/2 Hz. Using the BSN scheduler it is possible to start multiple WG on different dishes at the same time. In the data path processing at the dish the signal can be monitored via the MM interface at the ADUH, the SST and the BST. At the central XC a snapshot of the input beamlets can be captured in the mesh DB. The output visibilities of the XC are further processed on the external DW, but a snapshot of N_chan_x = 64 channel visibility packets can be captured in the output DB. The DB can capture data from the sync start of a 1.024s interval and the DB dev can capture data starting at any sample within a sync interval.

arts_unb1_sc1



arts_unb1_sc4/sc3

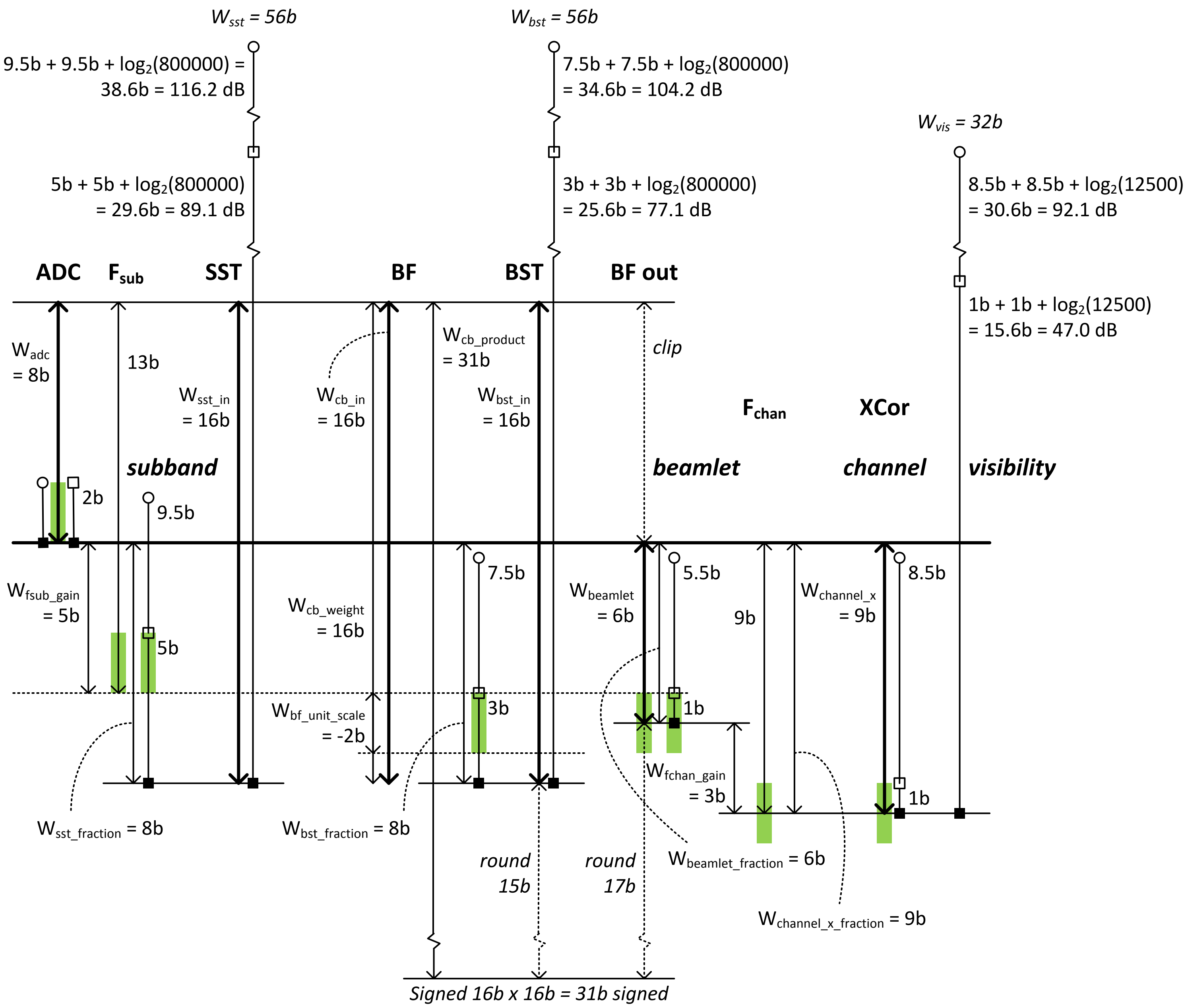




$I = XX^* + YY^*$		X,Y	= Polarizations
$Q = XX^* - YY^*$		IQUV	= Full Stokes
$U = 2\mathrm{Re}\{XY^*\}$		IAB	= Incoherent Array Beam
$V = -2\mathrm{Im}\{XY^*\}$		TAB	= Tied Array Beam

The SNR of the channel samples for both Apertif XC and Arts IAB / TAB is < 1. This means that the quantization in the data path firmware can and should be such to preserve sufficient bits to represent the input system noise. The weak sources only become apparent during correlation (Apertif XC) or folding (Arts). At the ADC the system noise is sampled such that the sigma is represented by about 3 bits. Two more bits can represent four sigma. The ADC has 8 bits and the extra bits provide more dynamic range to avoid overflow and clipping due to RFI. At the ADC clipping must be avoided, because the non-linear clipping disturbs all subbands. Similar the internal data path processing is dimension to have sufficient bits to avoid internal overflow. The external interface at the dish BF output to the central UniBoard forms a bottleneck, because the beamlets are represented by 6 bits. The WG provides a coherent source and even with a small amplitude the coherent WG input will cause clipping at the 6 bit beamlets and at the 9 bit channels.

Apertif FB, BF, XC:



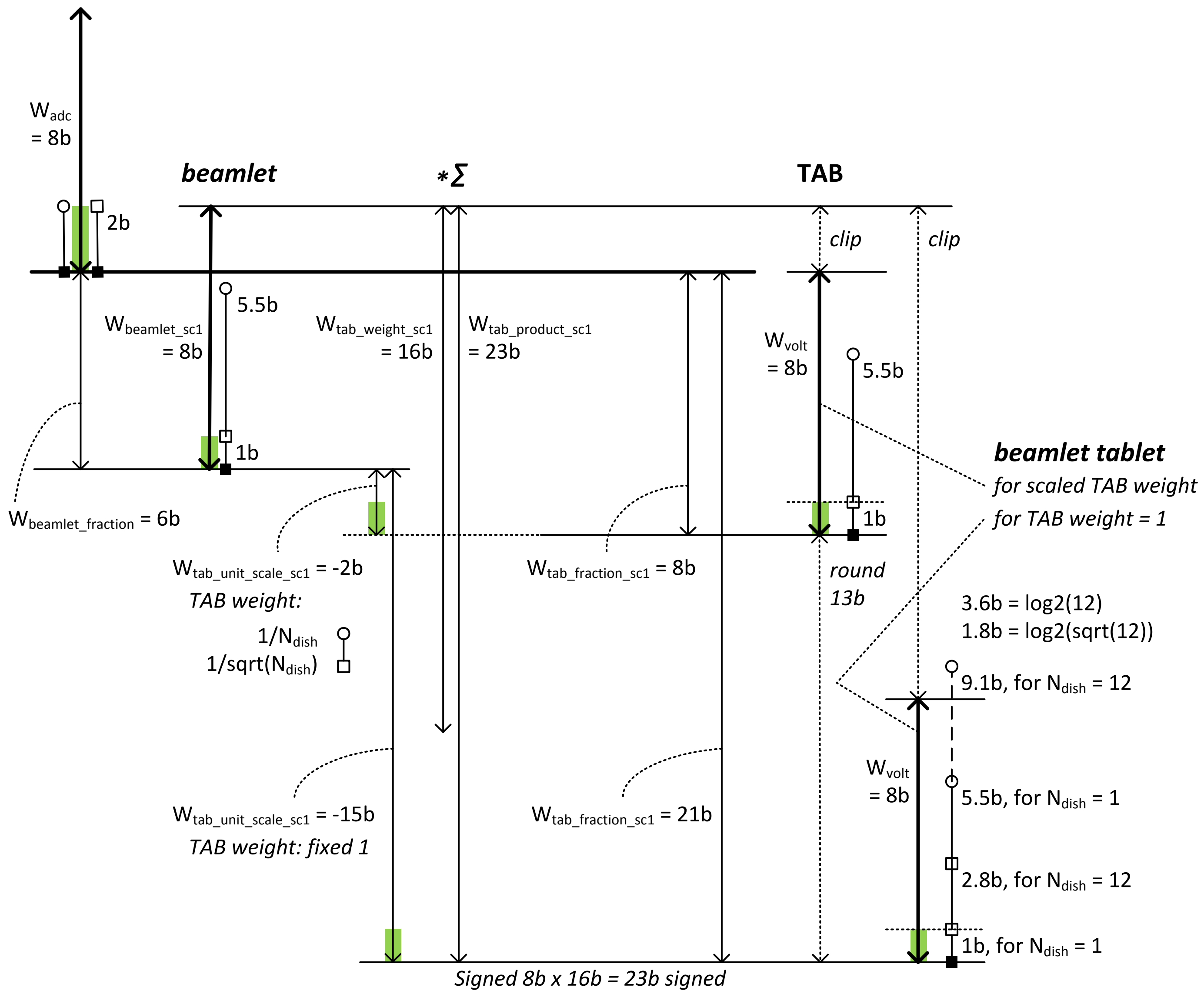
= Coherent level for ADC rms = 4 (2 bit), WG sinus with amplitude 4 * sqrt(2) = 5.66

= Incoherent level for ADC rms = 4 (2 bit), AGWN

For –ampl 37 the measured SST = 132.45 dB. Amplitude 37 is sigma = 26.163 = 4.71b. The coherent gain is 7.5b so in total the subband sigma becomes 4.71b + 7.5b = 12.21b. The SST is 12.21b + 12.21b + log2(800000) = 44.03b = 132.54 dB. This agrees well with the measured SST level.

The SST and BST have 16b input, so signed 16b x 16b = 31b signed. The integration period is N_{int_x} = 800000 samples, so $\log_2(800000)$ = 19.6b. Therefore in total the SST and BST require at least 51b.

Arts SC1:



○—■ = Coherent level for ADC sigma = 4 (2 bit), WG sinus with amplitude 4 * sqrt(2) = 5.66

□—■ = Incoherent level for ADC sigma = 4 (2 bit), AGWN

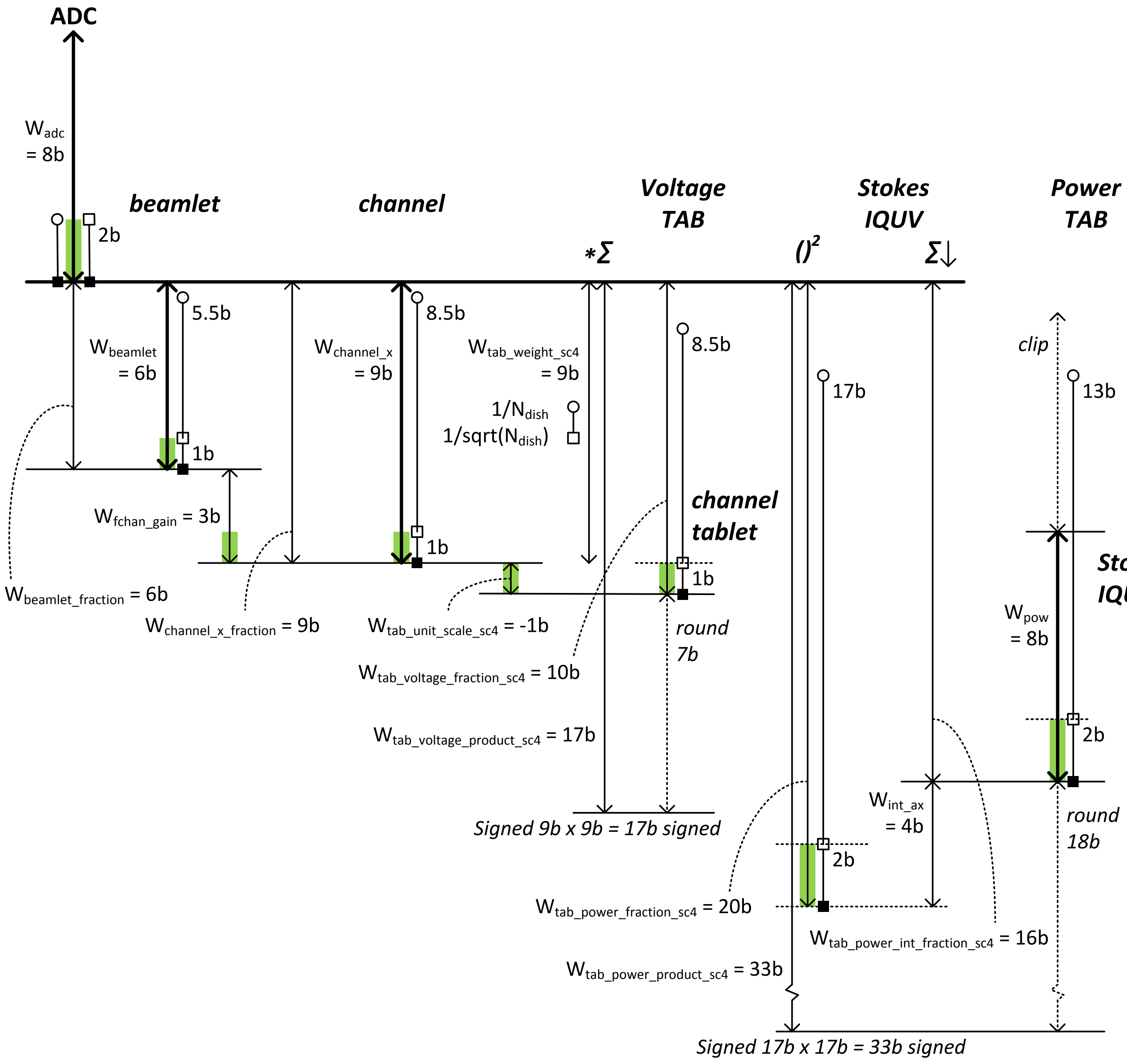
The arts_unb1_sc1.vhd use out_raw_sosi instead of requantized out_qua_sosi. Only the lowest W_{volt} = 8b of out_raw_sosi.re,im are used. The out_raw_sosi.re,im are truncated without requantization, so strong signals will wrap. Using the lowest bits implies that the TAB1 weights are 1 and cannot be scaled for nofDishes, because 1is the smallest number. Therefore instead of using out_raw_sosi the out_qua_sosi output of the bf_unit should be used with the following settings:

-- in_dat_w = 16 → must be $W_{beamlet}$ = 8b
-- in_weight_w = 16 → = $W_{tab\_weight\_sc1}$ = 16b
-- bst_gain_w = 0
-- bst_dat_w = 16
-- out_gain_w = -3 → = -$W_{tab\_fraction\_sc1}$ = -3b
-- out_dat_w = 8 → = W_{volt} = 8b
-- apply clipping in bf_unit bst and out requantizers

The default TAB weight for unit gain then becomes 2**($W_{tab\_weight\_sc1}$ + $W_{\_tab\_gain}$ – 1) / nofDishes = 2**(16 + -1 -1) / nofDishes = 8192 / nofDishes = 682 for nofDishes = 12.

Alternatively keep using out_raw_sosi and except that effectively the TAB weight can only be 0 (= disable input) or 1 (add input): Current out_gain_w = 1 and minimum TAB weight 1 as unit weight probably means that all TAB1 voltage data is even, so the Lsbit is not used → check this and then change to out_gain_w = 0 and use clipping in bf_unit. Then it may be ok to keep using out_raw_sosi, because with W_{volt} = 8b and sigma = 2 bit + log2(sqrt(12)) = 1.8b and 1 sign bit this requires about 7 bit to contain 4 sigma, so then there is still some dynamic range for RFI. Strong RFI may be rare in the direction of a known pulsar, because with strong RFI the pulsar could not be detected anyway.

Arts SC4 coherent Tied Array Beam (TAB):



Arts SC4 coherent Tied Array Beam (TAB):