



New default for the Bandwidth used for Sensitivity in the OT

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Starting in Cycle 10 the default for the Bandwidth used for Sensitivity (BufS) in the “Control and Performance” section of the Observing Tool (OT) has changed for Spectral Line modes. The new default, “RepWindowEffectiveChannelWidth”, uses the “effective bandwidth” (eff-BW; defined below) for sensitivity calculations. eff-BW includes the effects of both the correlator binning and the online smoothing of the data. The use of RepWindowEffectiveChannelWidth in the OT ensures that the OT calculations more closely match the sensitivity evaluation that takes place during the Quality Assurance process after observations have been taken.

Background:

There are three ways of defining the frequency width of a channel:

1. the physical channel width, which we will call simply *channel width* (**chan-BW**; also referred to as *channel spacing*)
2. the *resolution width* (**res-BW**), related with the ability to distinguish apart spectral features
3. the *effective bandwidth* (**eff-BW**), related with the sensitivity of each measurement.

The chan-BW is defined by the characteristics and specific settings of the (auto-)correlator, as described in the Technical Handbook (THB) §5.1. **The correlator spectral setting fixes these three quantities simultaneously.** Because these definitions are jointly specified by a given correlator setup, the “bandwidth” of your data can be defined using any of the three choices above. That is, a given channel always has the three associated properties. However, the property “effective Bandwidth” is the width that should be used when discussing or assessing spectral line sensitivity.

New in Cycle 10:

In the “Control and Performance” panel the Cycle 10 OT now defaults to using the Effective Bandwidth (eff-BW) as the BufS for the chosen spectral setup. In the Cycle 10 OT the Effective Bandwidth (eff-BW) has been renamed to RepWindowEffectiveChannelWidth. **This is the quantity used for sensitivity calculations** for time estimations in the OT, and also for Quality Assurance and data reduction.

The RepWindowEffectiveChannelWidth is proportional to the Channel Width (**chan-BW**) associated with the representative spectral setup. The constant of proportionality depends on the selected spectral averaging number (***b***) and is given by:

$$EBWR(b) = \begin{cases} \frac{8}{3}, & b = 1 \\ \frac{b}{b-\frac{3}{4}}, & b > 1 \end{cases}$$

Similarly, the “FinestResolution” option for BufS has been redefined as “FinestEffectiveChannelWidth” and this redefined option is an Effective Bandwidth parameter that uses the same constant of proportionality above.

One direct consequence of these new definitions is that the default value of the BufS in the Control and Performance (RepWindowEffectiveChannelWidth) is no longer the same as the value “Resolution (smoothed)” in the OT Spectral setup. Note that in the “Spectral Setup” panel, the OT shows the ‘Resolution (smoothed)’ – that is the Resolution Width (res-BW), commonly referred to as Spectral Resolution, not eff-BW.

Selecting a “User” defined value of the BufS in the Control and Performance is still available. From Cycle 10 the OT will validate only when this value is not smaller than the RepWindowEffectiveChannelWidth of the selected representative spectral window.

Fundamentally, compared to Cycle 9, nothing has changed with respect to the physical spectral setup of chan-BW (channel width or channel spacing), nor have the properties of ‘Spectral Resolution’ or ‘Effective Bandwidth’ changed.

Examples:

b=1

From Table 5.2 in the [Technical Handbook](#), we can see that for a setup with 468.75 MHz Bandwidth, the channel spacing/width (chan-BW) is 0.122 MHz and the spectral resolution 0.244 MHz.

Baseband-1							
Fraction	Centre Freq (rest,lsrk)	Centre Freq (sky,bar)	Transition	Bandwidth, Resolution (smoothed)		Spec. Avg.	Representative Window
1(Full)	230.53800 GHz	230.53822 GHz	CO v=0 2-1	468.750 MHz(610 km/s), 244.141 kHz(0.317 km/s) (2-bit)		1	

In this case, $EBWR(1) = 8/3$ and thus the effective bandwidth (eff-BW) or RepWindowEffectiveChannelWidth is $0.122 \text{ MHz} * 8/3 = 0.325 \text{ MHz}$

Bandwidth used for Sensitivity Frequency Width

b=2:

In this case, the channel spacing is 0.244 MHz and the spectral resolution 0.282 MHz.

Baseband-1							
Fraction	Centre Freq (rest,lsrk)	Centre Freq (sky,bar)	Transition	Bandwidth, Resolution (smoothed)		Spec. Avg.	Representative Window
1(Full)	230.53800 GHz	230.53822 GHz	CO v=0 2-1	468.750 MHz(610 km/s), 282.227 kHz(0.367 km/s) (2-bit)		2	

$EBWR(2) = 2/(2-3/4) = 1.6$ and thus the effective bandwidth (eff-BW) or RepWindowEffectiveChannelWidth is $0.244 \text{ MHz} * 1.6 = 0.39 \text{ MHz}$

Bandwidth used for Sensitivity

RepWindowEffectiveChannelWidth

Frequency Width

b>4:

Channel spacing ~ spectral resolution and EBWR < 1.2.