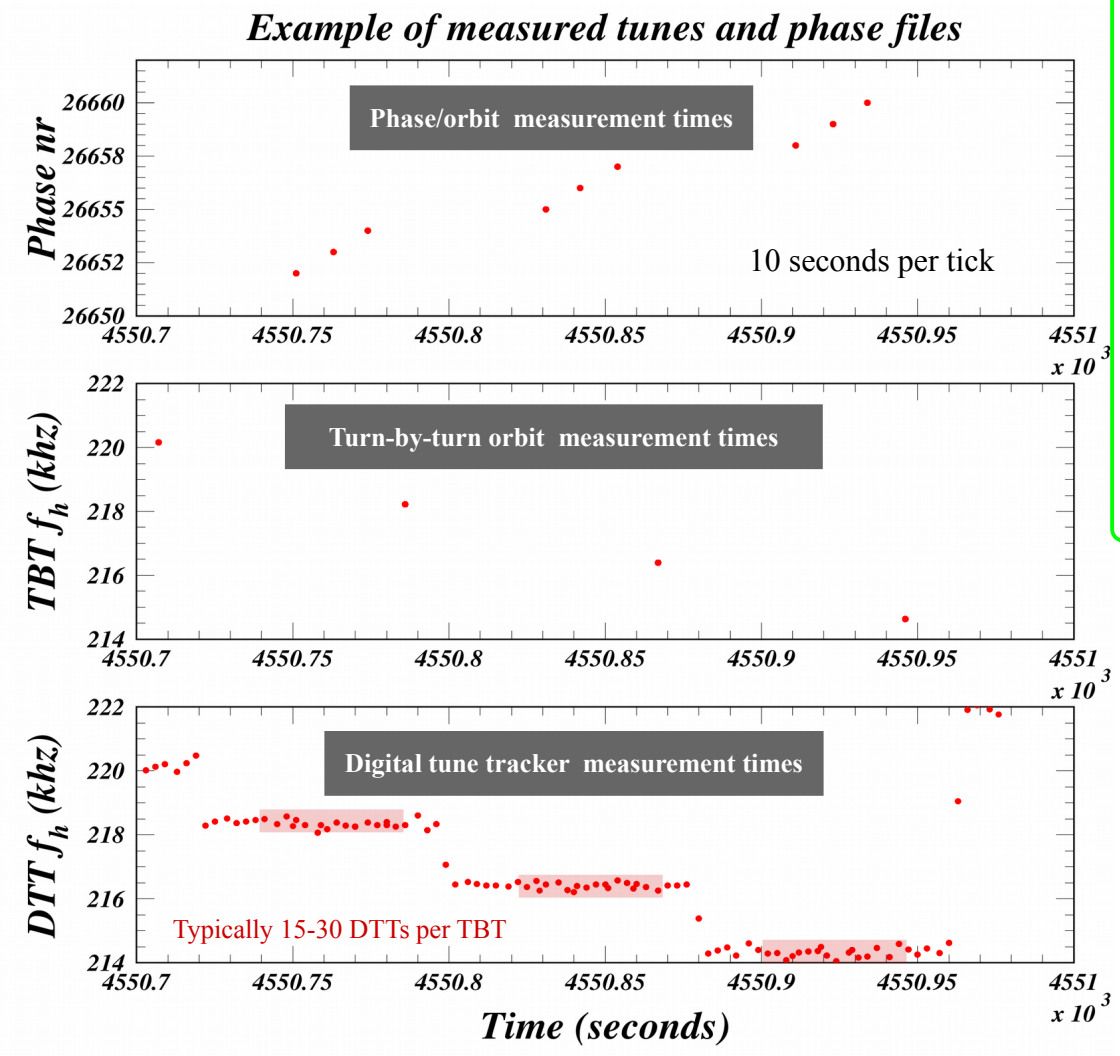
CESR Tune Measurement Precision



Updated
16 September 2021

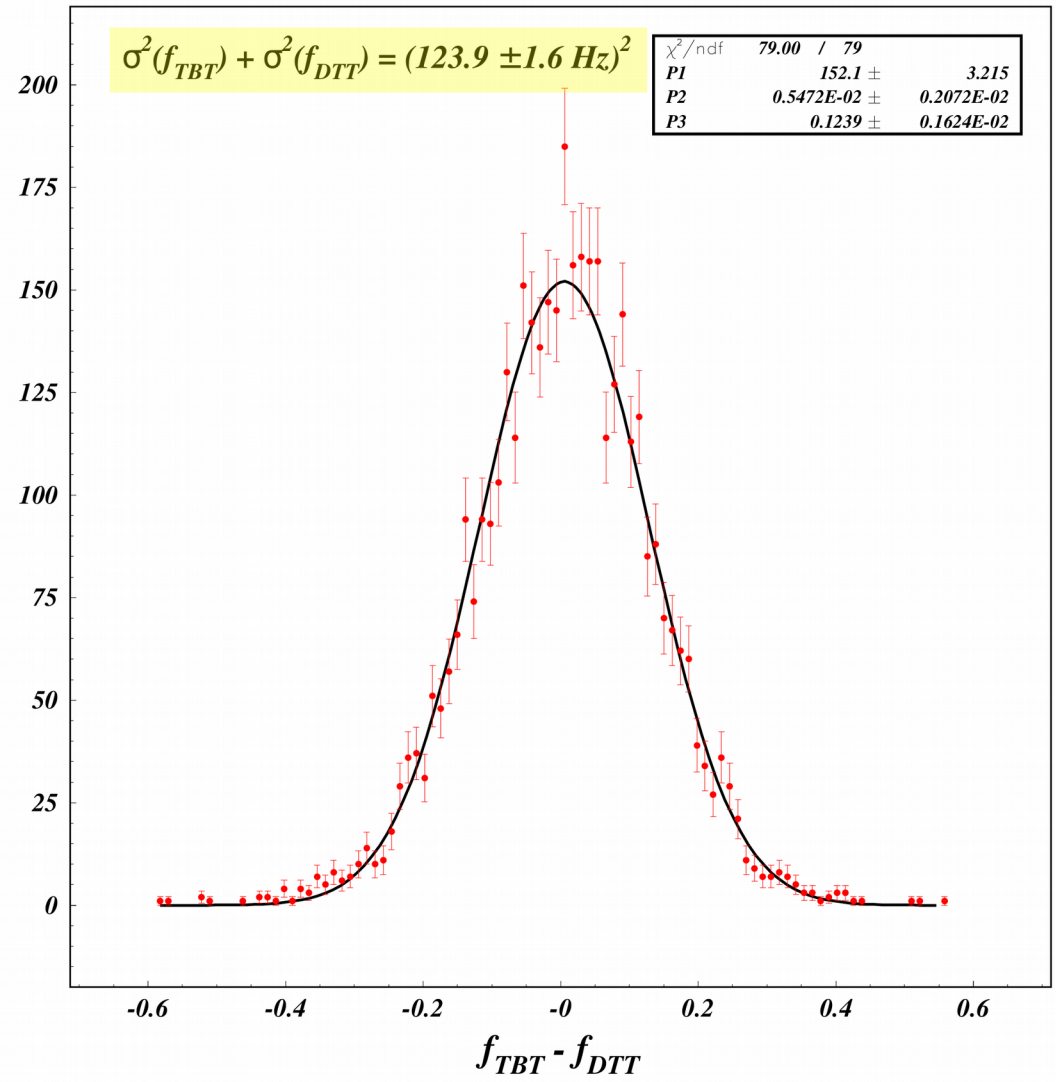
Slide 5 DTT weighting algorithm corrected

Slide 4
Added note about when DTT local settings are updated

Jim C. with
Vardan K. & Bob M.
Machine studies meeting
9 September 2021

$f_{TBT} - f_{DTT}$

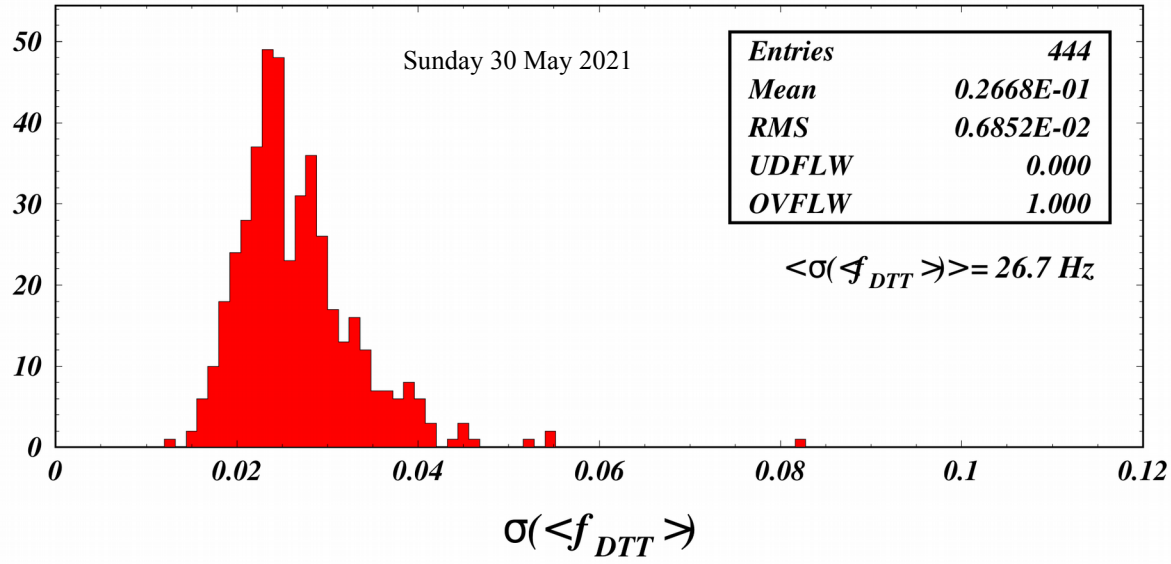
Sunday 30 May 2021 (H plane): Evaluate DTT and TBT tunes RMS

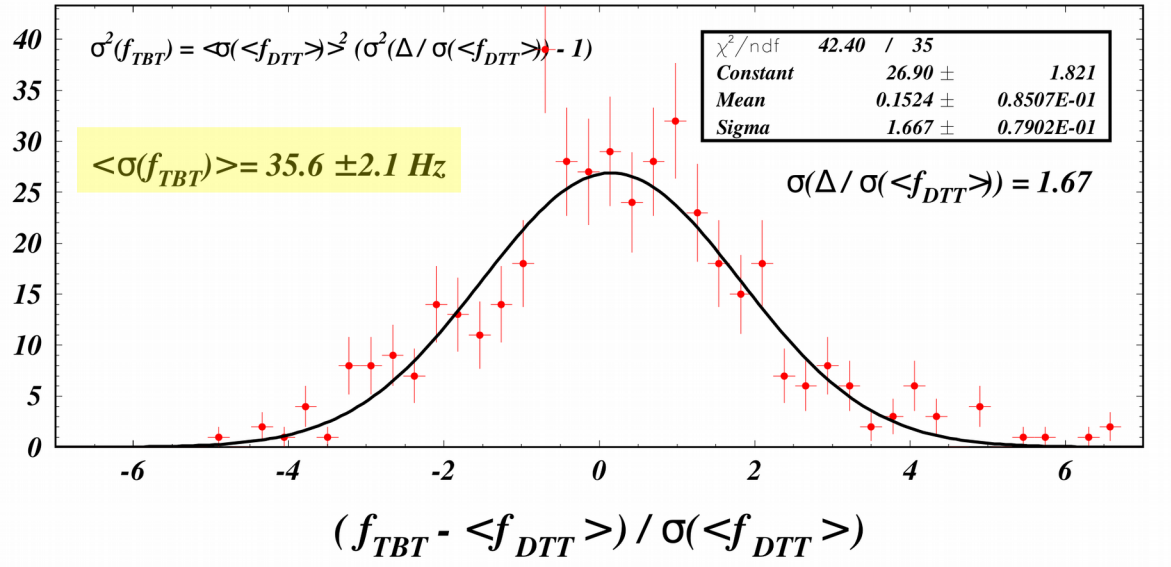


This already a pretty good estimate (10%) for the DTT accuracy, since the TBT accuracy is 30 – 40 Hz.

How to isolate $\sigma(f_{TBT})$?

$f_{TBT} - \langle f_{DTT} \rangle$





$$\Delta = f_{\mathrm{TBT}} - \langle f_{\mathrm{DTT}} \rangle$$

$$\sigma^2\left(\frac{\Delta}{\sigma_{\langle f_{\mathrm{DTT}}\rangle}}\right) = \frac{\sigma^2_{f_{\mathrm{TBT}}}}{\left\langle \sigma^2_{\langle f_{\mathrm{DTT}}\rangle}\right\rangle} + 1$$

If the f_{TBT} variance is much smaller than that of the averaged f_{DTT}, the width of this distribution is unity.

The accuracy in the determination of $\sigma(f_{TBT})$ is given by the accuracy with which the difference of this width from unity can be measured.

$$\sigma^2(f_{TBT}) = 26.7^2\,(1.67^2 - 1)$$
$$= 35.6 \pm 2.1 \text{ Hz}$$

Table with tune tracker shaker amplitude settings

The local DTT settings are loaded from the database when TT_TEST starts. Thus the initial settings are those in the save set.

Horizontal plane

	Shaker Saveset cu	dB	Stats	$(\sigma^2(f_{\mathrm{TBT}})+\sigma^2(f_{\mathrm{DTT}}))^{\frac{1}{2}}$	Stats	$\sigma(f_{\mathrm{TBT}})$	$\sigma(f_{\mathrm{DTT}})$
All data			11395	124.0 ± 1.2	1309	41.2 ± 1.2	117.0 ± 1.8
Friday 19 February 2021	1500	-16.5	136	— ± —	31	— ± —	— ± —
Sunday 21 February 2021	1500	-16.5	852	118.0 ± 3.9	120	52.3 ± 9.3	105.8 ± 6.2
Monday 22 February 2021	1500	-16.5	43	— ± —	16	— ± —	— ± —
Sunday 11 April 2021	3350	-9.5	3058	107.6 ± 1.3	344	34.9 ± 2.3	101.8 ± 1.9
Saturday 29 May 2021	603	-24.4	1079	135.8 ± 4.4	116	26.8 ± 5.6	133.1 ± 6.3
Sunday 30 May 2021	603	-24.4	4034	123.9 ± 1.6	442	35.6 ± 2.1	118.7 ± 2.4
Tuesday 22 June 2021	603	-24.4	1975	136.8 ± 2.7	221	36.1 ± 3.9	132.0 ± 4.0

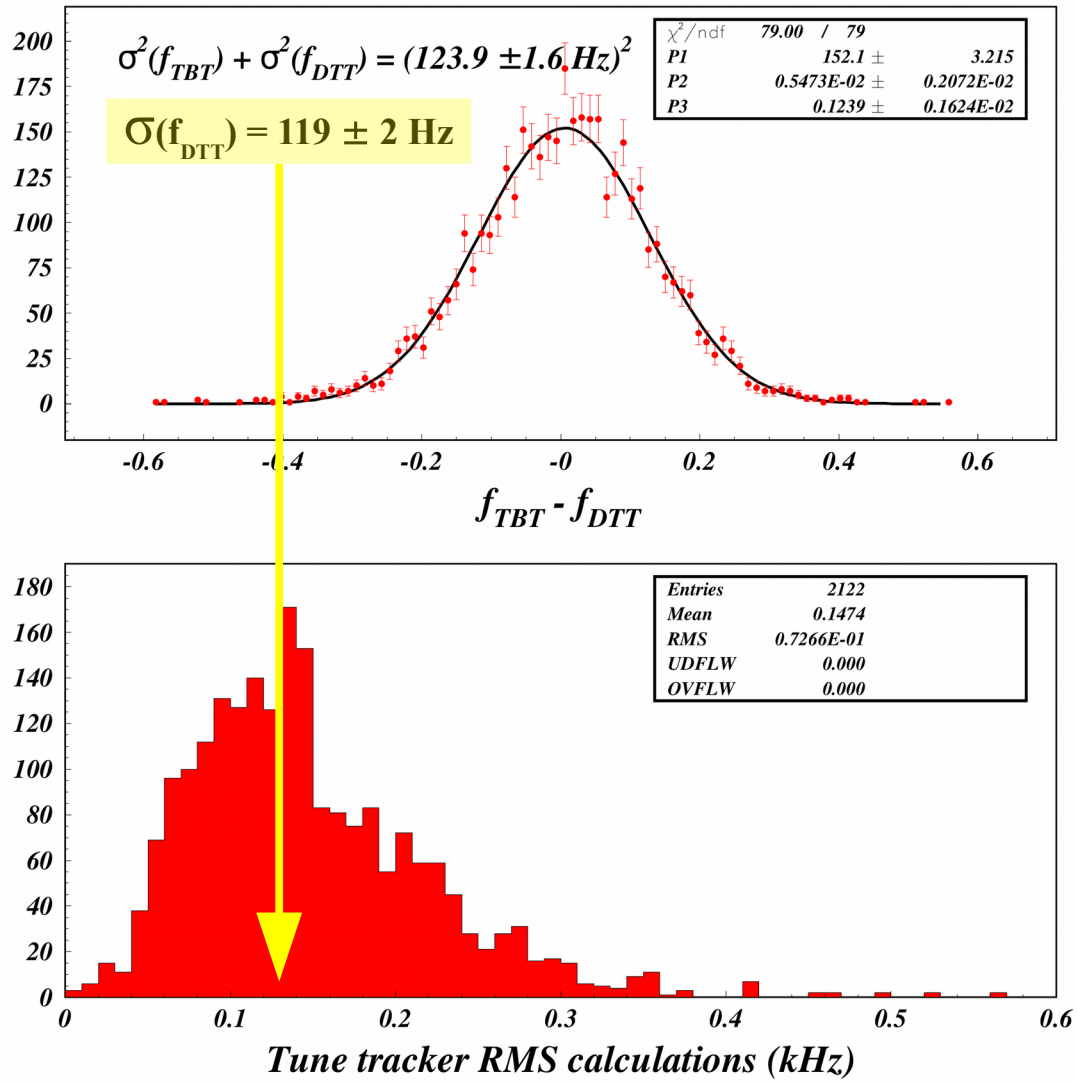
Vertical plane

	Shaker Saveset cu	dB	Stats	$(\sigma^2(f_{\mathrm{TBT}})+\sigma^2(f_{\mathrm{DTT}}))^{\frac{1}{2}}$	Stats	$\sigma(f_{\mathrm{TBT}})$	$\sigma(f_{\mathrm{DTT}})$
All data			11428	180.2 ± 1.7	1276	52.3 ± 1.6	172.4 ± 2.5
Friday 19 February 2021	170	-35.4	136	— ± —	30	— ± —	— ± —
Sunday 21 February 2021	170	-35.4	852	199.8 ± 7.3	110	44.5 ± 13.8	194.8 ± 10.6
Monday 22 February 2021	170	-35.4	43	— ± —	13	— ± —	— ± —
Sunday 11 April 2021	279	-31.1	3062	213.0 ± 3.6	334	43.1 ± 4.8	208.6 ± 5.2
Saturday 29 May 2021	170	-35.4	1083	156.9 ± 4.5	116	55.0 ± 8.8	146.9 ± 6.8
Sunday 30 May 2021	170	-35.4	4057	161.7 ± 1.9	444	47.8 ± 2.4	154.5 ± 2.8
Tuesday 22 June 2021	170	-35.4	1977	150.9 ± 2.6	221	34.7 ± 5.8	146.9 ± 3.8

Is there a clear correlation between tune measurement precision and shaker amplitude setting?
No.
There is an indication that the DTT horizontal tune measurement improves with higher shaker amplitude setting.

Digital tune tracker RMS measurements

Sunday 30 May 2021 (H plane): Evaluate DTT and TBT tunes RMS



The digital tune tracker returns an RMS value as well as the average from its exponential averaging procedure.

The weighted contributions from samples at approximately 60-Hz are weighted such that older samples have weights decreasing by factors of $1\text{-}2^{-n}$.

The database is showing that we are using values of n: H/V/L 2/2/6, so each of the four samples have a weight which decreases by a factor of 0.75 according to age discrimination.

The rms variation in the DTT RMS calculation is 73 Hz for the known width of 119 Hz.

The distribution shows a Poisson-like asymmetry. The RMS/Mean = 0.5 corresponds to $\lambda = 4$.