Argon scintillation light triplet component decay time in presence of O_2 and N_2 contaminant

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An average of the τ_T values obtained for each Arapuca channel gives the following values

Before 1st Leak

Run 8562

<Tau> Arap1 : 1263 ns
<Tau> Arap2 : 1297 ns

Run 9004

<Tau> Arap1 : 765 ns
<Tau> Arap2 : 762 ns

After 1st Leak

Run 9056

<Tau> Arap1 : 729 ns
<Tau> Arap2 : 753 ns

Run 9060

<Tau> Arap1 : 664 ns
<Tau> Arap2 : 677 ns

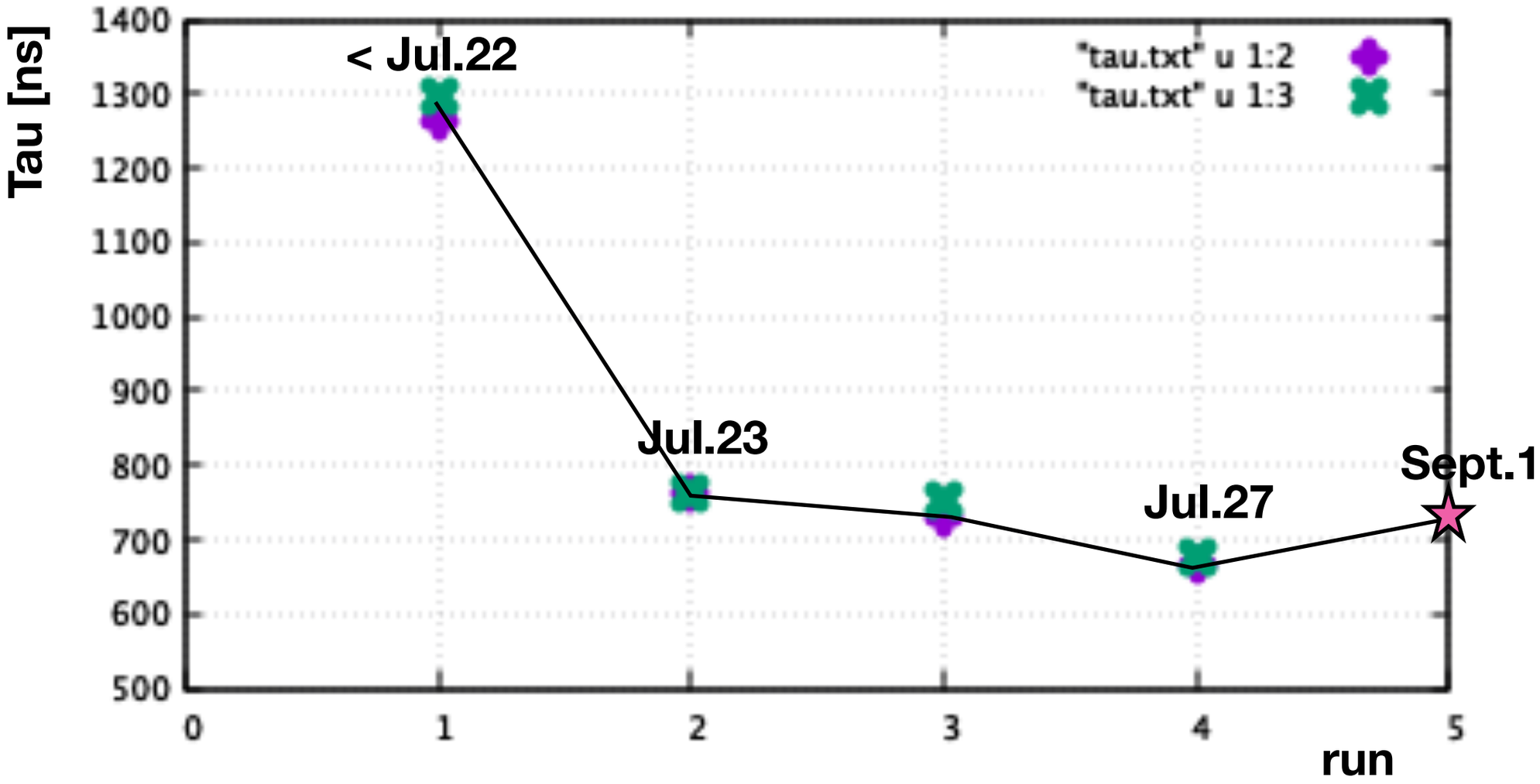
After 2nd Leak

Run 9611

<Tau> Arap1 : 722 ns
<Tau> Arap2 : 7xx ns

After Purity recovery (now)

Arap1: Arapuca module in APA 3 (beam side)
Arap2:Arapuca module in APA 6 (no-beam side)



1=run 8562
2=run 9004
3=run 9056
4=run 9060
5=run 9611

Purple =Arapuca 1 (APA 3)
Green = Arapuca 2 (APA 6)

<u>O2 Filter saturation history:</u>

FIRST Air Leak

(First) Air leak into GAr filter start: Sun. Jul.21 h.~14:00
(100% O2 trapped, 100% N2 go through)

GAr filter saturated: Sun. Jul.21 h.~24:00
(100% O2 go through GAr filter and trapped in LAr filter, 100% N2 go through)

LAr filter saturated: Mon. Jul.22 h.~8:00
(100% O2 and 100% N2 leak into cryostat - start purity drop)

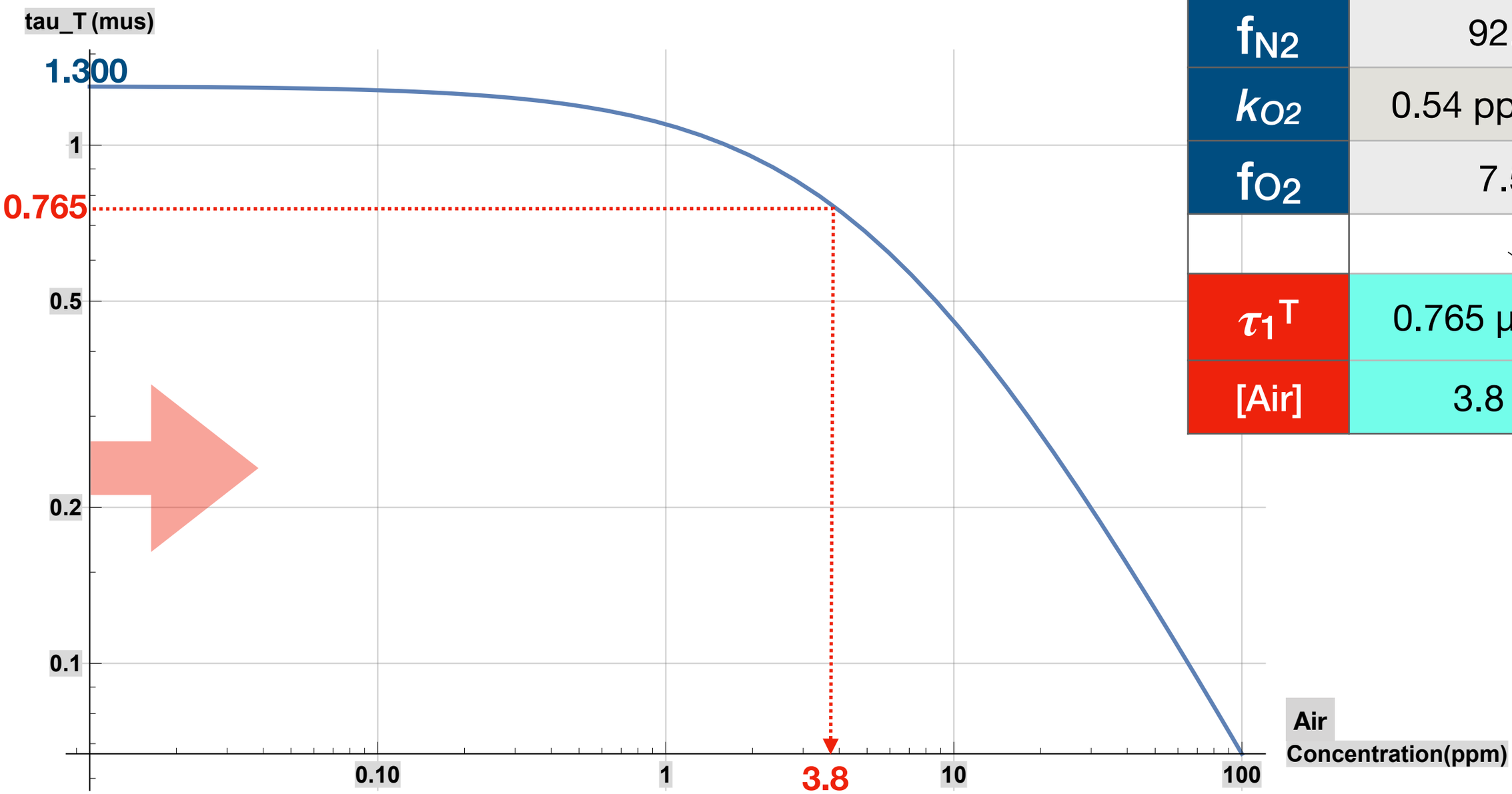
Recirculation closed: Mon. Jul.22 h.~18:00

O2 leak into cryostat: ~10 hrs.
N2 leak into cryostat: ~28 hrs.

N2 (only) Leak Time Ratio: R_1 = 18/28 = 0.64
N2+O2 (Air) Leak Time Ratio: R_2 = 10/28 = 0.36

Light Quenching

$$\frac{1}{\tau_1^T} = \frac{1}{\tau_0^T} + k_{N_2} f_{N_2} [Air] + k_{O_2} f_{O_2} [Air]$$



1st Air Leak

τ_0^T	1.300 µs *(meas)*
k_{N2}	0.11 ppm^{-1} µs-1
f_{N2}	92.2%
k_{O2}	0.54 ppm^{-1} µs-1
f_{O2}	7.5%
	⇓
τ_1^T	0.765 µs *(meas)*
[Air]	3.8 ppm

$$3.8\ ppm\ (\text{Air}) = 0.28\ ppm\ (O_2) + 3.50\ ppm\ (N_2)$$

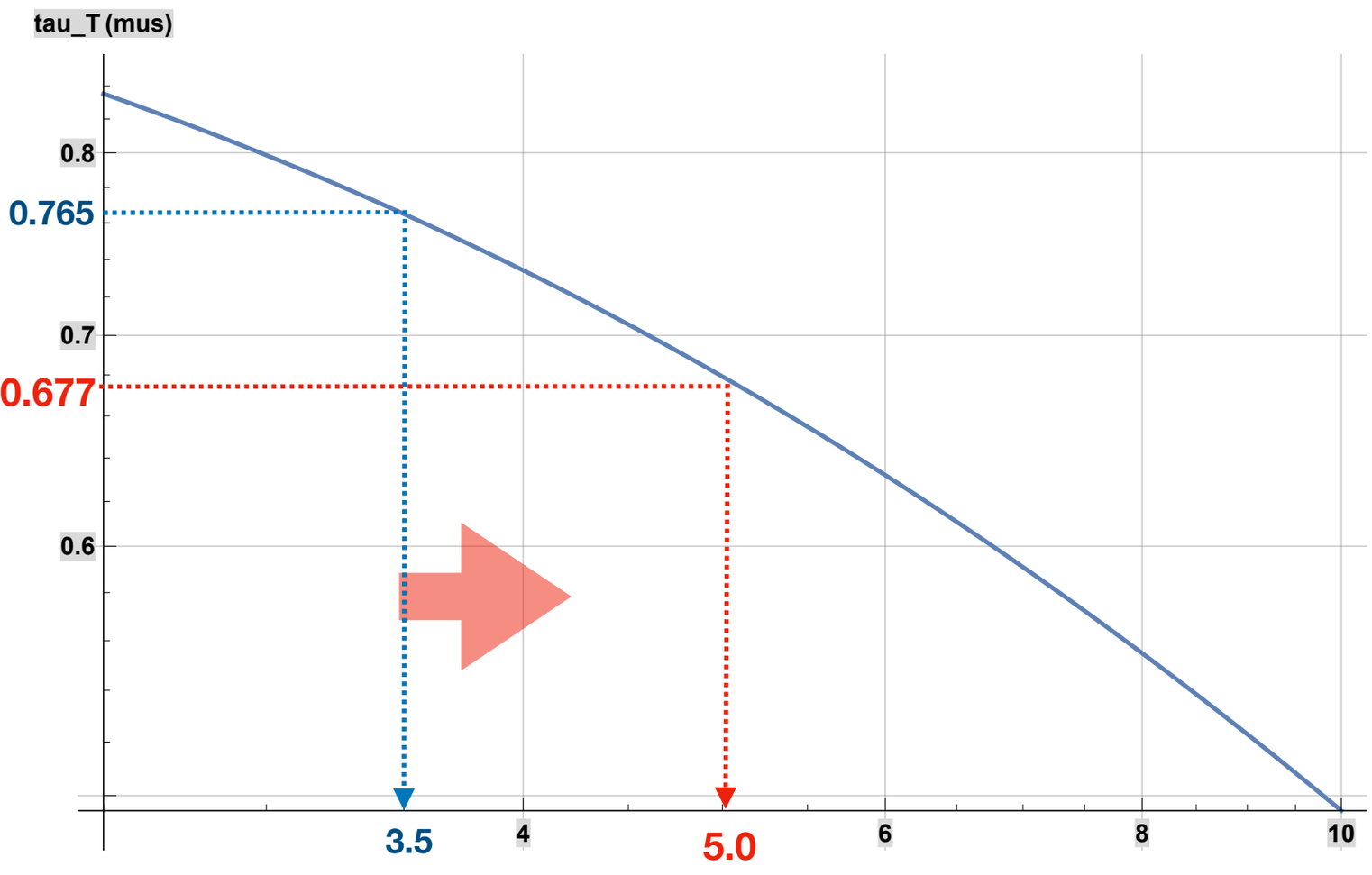
Second Leak

(Second) Air Leak into Gar filter start: Thu. Jul.25 h.~21

(100% O2 trapped, 100% N2 go through)

GAr filter saturated: Fri. Jul. 26 h ~5:00

Recirculation closed: Fri. Jul.26 h ??



2nd Air Leak
Assume only N2 leak
into cryostat (and no O2 leak)

τ_1^T	0.765 µs *(meas)*
[N2]	3.5 ppm
k_{N2}	0.11 ppm^{-1} µs-1
	⇓
τ_2^T	0.677 µs *(meas)*
[N2]	5.0 ppm

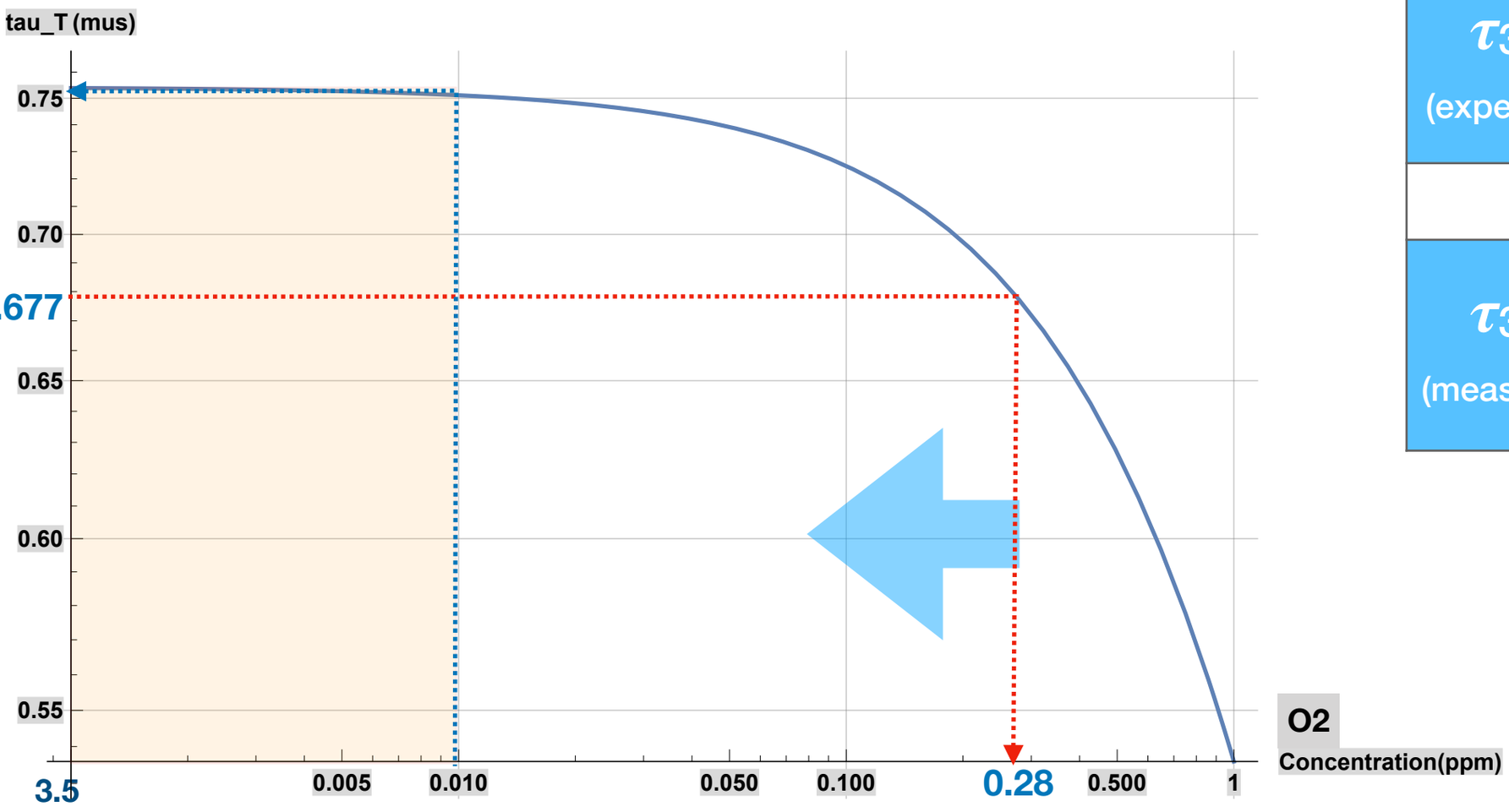
$$\frac{1}{\tau_2^T} = \frac{1}{\tau_1^T} + k_{N_2}\,[N_2 - 3.5]$$

$$5.0\ ppm\ (N_2)\ +\ 0.28\ ppm\ (O_2)$$

O2 removal completed (~6 weeks recirculation)

Recirculation ON: Aug to Mid Sept

$$\frac{1}{\tau_3^T} = \frac{1}{\tau_2^T} + k_{O_2}\,[O_2 - 0.28]$$



τ_2^T	0.677 µs *(meas)*
$[O_2]$	0.28 ppm
k_{O2}	0.54 ppm^{-1} µs-1
	⇓
$[O_2]$	<< 0.01 ppm
τ_3^T (expected)	0.750 µs
τ_3^T (measured)	0.722 µs (0.732 µs)

$$5.0\ ppm\ (N_2)\ +\ 0\ ppm(O_2)$$