Lab: Calibrating the ac-meters (Lab 1) **21 *July 2013***

INTRODUCTION

The WETLabs ac-meter, has been until recently, the only commercial in-situ spectrophotometer (Turner design has recently introduced the iCAM to measure the absorption coefficient at 9 wavelength). The ac-meters come in two versions, the nine wavelength ac-9 and the hyperspectral version, ac-s. The ac-meters also come in two standard length, 25 and 10cm, the latter is intended for coastal and turbid waters. For more background material about spectrophotometry and the ac-meters please see relevant appendix below.

Each ac-meter undergoes an absolute calibration at the factory to convert the detected digital signal into IOP units [m^{-1}] and to obtain the sensitivity of the electronics to changes in instrument temperature (not to be confused with the temperature-dependent variations in water absorption . Unfortunately, ac-meters are known to drift away from the factory calibration as function of time (+/-0.01m^{-1}/100 days, e.g. Twardowski et al., 1999) requiring that users calibrate the sensors (the instrument sensitivity to temperature is assumed to be invariant between factory calibration and is not performed by users).

Sometimes, in order to track an instrument, air calibrations are done. While a useful exercise, such calibration should not be used to derive absolute IOP units, but to track changes in the instrumentation between absolute calibrations (e.g. due to shipping, or in between pure water calibrations when pure water is difficult to obtain). The reason is that air calibration have high uncertainties as they are sensitive to air humidity and quality.

Absolute calibration requires some sort of reference material either to obtain a known signal (for the ac-meters we use the purest water we can produce, see below). Independent means of assessing the purity of the calibration material is vital for obtaining accurate absolute calibrations (e.g. measurements of conductivity, to insure the water has (almost) no salts).

WATER: the water used should be the cleanest possible, that is, devoid of salts (ions), particles (including bubbles) and dissolved materials. The problem with such water is that it is very reactive, and hence, if left for too long will adsorb ions, particles and organic materials from the tank in which it is stored and from the air. It should therefore be used within a few hours from making (but with sufficient time to be devoid of bubbles). The optical properties of water are assumed known (e.g. Pope and Fry, 1999) as well its sensitivity to temperature (Sullivan et al., 2006) and salts (Morel, 1974, Sullivan et al., 2006, Zhang et al., 2009).

ACTIVITY:

- Observe an instructor taking off the flow sleeves and cleaning an ac-meter instrument. ASK a question if any aspect of the cleaning is not clear.
- Observe an instructor calibrating an ac-meter instrument.
- Now, within your group perform several calibrations (i.e. Separate files of stable pure water readings) of the meter you were assigned.

- Measure the temperature of the water (near after if flows out of the instrument is best).
- Redo: clean/calibrate cycles until you get AT LEAST two calibrations that are within $0.005 m^{-1}$ from each other.
- If you have time, try the following procedure: pour water directly into the flow sleeves gently, put the black covers on the flow sleeve and gently rock the instrument to get rid of bubbles and collect a file. You will use this measurement to compare calibrations and sample reading with those collected with a flow thru configuration.

DATA PROCESSING:

Now that you have the data, use an excel spreadsheet to obtain:

1. The median and standard deviation absorption calibration spectra of each sample.
2. The median and standard deviation attenuation calibration spectra of each sample.
3. Perform a temperature correction (see appendix):

$$a_{cal} = a_{mes} - \Psi_T (T_{cal} - T_{factory})$$
$$c_{cal} = c_{mes} - \Psi_T (T_{cal} - T_{factory})$$

QUESTIONS:

1. Is the Milli-Q blank stable (e.g. when comparing between successive cals)?
2. over what time interval? what might cause instability?
3. How does your blank compare to the device file?
4. Why could your blank be different from device file (factory blank)?
5. What are the symptoms of a bad Milli-Q calibration?
6. How do you insure that the tubes and windows are clean?

APPENDIX (TABLES FROM AC-METER MANUAL)

Table 2. Volume absorption and scattering coefficients for pure water, $a_w(\lambda)$ and $b_w(\lambda)$, respectively. Values for $a_w(\lambda)$ are those of Sogandares and Fry (1997) (340 to 390 nm), Pope and Fry (1997) (400 to 700 nm), as derived from Kou *et al.* (1993) (705 to 750 nm). Alternative values of $b_w(\lambda)$ compared here are denoted (B) (Buitveld, et al. 1994) and (M) (Morel 1974). The linear temperature dependence of pure water absorption, $\frac{\partial a_w(\lambda)}{\partial T}$, is due to Pegau and Zaneveld (1993) and Pegau et al. (1997).

Table from Mueller et al., Ocean Optics Protocols for Satellite Ocean Color Sensor Validation, Revision 4, Volume IV, Erratum 1. NASA/TM-2003-211621. See Table 3 for pure water absorption coefficients for the ac-s meter.

λ	a_w	$\frac{\partial a_w(\lambda)}{\partial T}$	b_w	b_w	λ	a_w	$\frac{\partial a_w(\lambda)}{\partial T}$	b_w	b_w	λ	a_w	$\frac{\partial a_w(\lambda)}{\partial T}$	b_w	b_w
nm	m^{-1}	m^{-1} °C	m^{-1} (B)	m^{-1} (M)	nm	m^{-1}	m^{-1} °C	m^{-1} (B)	m^{-1} (M)	nm	m^{-1}	m^{-1} °C	m^{-1} (B)	m^{-1} (M)
340	0.0325	0.0000	0.0104	0.0118	500	0.0204	0.0001	0.0021	0.0022	630	0.2916	0.0002	0.0008	0.0009
350	0.0204	0.0000	0.0092	0.0103	505	0.0256	0.0001	0.0020		635	0.3012	0.0000	0.0008	
360	0.0156	0.0000	0.0082	0.0091	510	0.0325	0.0002	0.0019	0.0020	640	0.3108	-0.0001	0.0008	0.0008
370	0.0114	0.0000	0.0073	0.0081	515	0.0396	0.0002	0.0018		645	0.325	0.0000	0.0007	
380	0.0100	0.0000	0.0065	0.0072	520	0.0409	0.0002	0.0018	0.0019	650	0.340	0.0001	0.0007	0.0007
390	0.0088	0.0000	0.0059	0.0065	525	0.0417	0.0002	0.0017		655	0.371	0.0002	0.0007	
400	0.00663	0.0000	0.0053	0.0058	530	0.0434	0.0001	0.0017	0.0017	660	0.410	0.0002	0.0007	0.0007
405	0.00530	0.0000	0.0050		535	0.0452	0.0001	0.0016		665	0.429	0.0002	0.0006	
410	0.00473	0.0000	0.0048	0.0052	540	0.0474	0.0001	0.0015	0.0016	670	0.439	0.0002	0.0006	0.0007
415	0.00444	0.0000	0.0045		545	0.0511	0.0001	0.0015		675	0.448	0.0001	0.0006	
420	0.00454	0.0000	0.0043	0.0047	550	0.0565	0.0001	0.0014	0.0015	680	0.465	0.0000	0.0006	0.0006
425	0.00478	0.0000	0.0041		555	0.0596	0.0001	0.0014		685	0.486	-0.0001	0.0006	
430	0.00495	0.0000	0.0039	0.0042	560	0.0619	0.0001	0.0013	0.0014	690	0.516	-0.0002	0.0006	0.0006
435	0.00530	0.0000	0.0037		565	0.0642	0.0001	0.0013		695	0.559	-0.0001	0.0005	
440	0.00635	0.0000	0.0036	0.0038	570	0.0695	0.0001	0.0012	0.0013	700	0.624	0.0002	0.0005	0.0005
445	0.00751	0.0000	0.0034		575	0.0772	0.0002	0.0012		705	0.704	0.0007	0.0005	
450	0.00922	0.0000	0.0033	0.0035	580	0.0896	0.0003	0.0011	0.0012	710	0.827	0.0016	0.0005	0.0005
455	0.00962	0.0000	0.0031		585	0.1100	0.0005	0.0011		715	1.007	0.0029	0.0005	
460	0.00979	0.0000	0.0030	0.0031	590	0.1351	0.0006	0.0011	0.0011	720	1.255	0.0045	0.0005	0.0005
465	0.01011	0.0000	0.0028		595	0.1672	0.0008	0.0010		725	1.539	0.0065	0.0004	
470	0.0106	0.0000	0.0027	0.0029	600	0.2224	0.0010	0.0010	0.0011	730	1.983	0.0087	0.0004	0.0005
475	0.0114	0.0000	0.0026		605	0.2577	0.0011	0.0010		735	2.495	0.0108	0.0004	
480	0.0127	0.0000	0.0025	0.0026	610	0.2644	0.0011	0.0009	0.0010	740	2.787	0.0122	0.0004	0.0004
485	0.0136	0.0000	0.0024		615	0.2678	0.0010	0.0009		745	2.836	0.0119	0.0004	
490	0.0150	0.0000	0.0023	0.0024	620	0.2755	0.0008	0.0009	0.0009	750	2.857	0.0106	0.0004	0.0004
495	0.0173	0.0001	0.0022		625	0.2834	0.0005	0.0008						

Coefficient used for ac-9 correction based on Pegau et al., 1997 (computed with an ac-9):

Ψ_T	.0003	.0002	.0001	.0003	.0001	.0002	-.0001	-.0001	.0027
$\Psi_{S,a}$	.00018	.00008	.00008	.00009	.00004	.00008	.0001	.00007	-.00018
$\Psi_{S,c}$	.00007	-.00007	-.00007	-.00007	-.00008	-.00008	-.00005	-.00007	-.00032

Coefficient used for ac-9 correction based on Twardowski et al., 1999 (computed with an ac-9):

TABLE 1. Salinity corrections for absorption and attenuation for a 30 psu purified artificial seawater solution blanked against Nanopure water, and the resulting slopes for the ac-9 salinity correction. Slopes for the temperature correction are reprinted from Pegau et al. (1997) and their slopes for the salinity correction are provided for comparison.

λ (nm)	$a_{salt,\ 30\ psu}$ (m^{-1})	$c_{salt,\ 30\ psu}$ (m^{-1})	$\Psi_{s,a}$ (m^{-1} psu^{-1})	$\Psi_{s,c}$ (m^{-1} psu^{-1})	Ψ_t (m^{-1} $°C^{-1}$)
412	0.0079	0.0020	0.00026 (0.00018)*	0.00007 (0.00007)*	0.0001
440	0.0048	−0.0013	0.00016 (0.00008)	−0.00004 (−0.00007)	0.0000
488	0.0028	−0.0023	0.00009 (0.00008)	−0.00008 (−0.00007)	0.0000
532	0.0014	−0.0039	0.00005 (0.00004)	−0.00013 (−0.00008)	0.0001
555	0.0011	−0.0031	0.00004 (0.00008)	−0.00010 (−0.00008)	0.0001
630	0.0017	−0.0046	0.00005 (−)	−0.00015 (−)	0.0002
676	0.0005	−0.0032	0.00002 (0.00007)	−0.00011 (−0.00007)	0.0001
715	−0.0063	−0.0110	−0.00021 (−0.00018)	−0.00037 (−0.00032)	0.0029
750	0.0167	0.0136	0.00056 (0.00075)	0.00045 (0.00064)	0.0106

* values in parentheses are from Pegau et al. (1997).

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Table 3. Hyperspectral temperature dependencies (Ψ_T, m^{-1} °C^{-1}) for the absorption of pure water and salinity dependencies ($\hat{\Psi}_s$, m^{-1} S^{-1}) for the attenuation (subscript *c*) and absorption (subscript *a*) of pure water measured with the ac-s. To normalize different channels of the ac-s for averaging, the original wavelength outputs of the ac-s were linear interpolated and output at regular 2 nm wavelength steps (λ, nm). Standard deviations ($\sigma_{\Psi T}$ and $\sigma\hat{\Psi}_s$) for each measured value are also given. These measured Ψ_T and $\hat{\Psi}_s$ values represent ac-s instrument-specific correction factors. Taken directly from Sullivan et al, 2006.

λ (nm)	Ψ_T (m^{-1} °C^{-1})	$\sigma_{\Psi T}$ (m^{-1} °C^{-1})	$\hat{\Psi}_{s,c}$ (m^{-1} S^{-1})	$\sigma\hat{\Psi}_{s,c}$ (m^{-1} S^{-1})	$\hat{\Psi}_{s,a}$ (m^{-1} S^{-1})	$\sigma\hat{\Psi}_{s,a}$ (m^{-1} S^{-1})
400	0.0001	0.0002	-0.00001	0.00004	0.00003	0.00003
402	0.0001	0.0001	-0.00002	0.00004	0.00003	0.00003
404	0.0001	0.0001	-0.00002	0.00004	0.00003	0.00003
406	0.0001	0.0001	-0.00002	0.00004	0.00004	0.00003
408	0.0000	0.0001	-0.00002	0.00004	0.00004	0.00003
410	0.0000	0.0001	-0.00002	0.00004	0.00004	0.00003
412	0.0000	0.0001	-0.00002	0.00004	0.00004	0.00003
414	0.0001	0.0001	-0.00002	0.00003	0.00004	0.00003
416	0.0000	0.0001	-0.00002	0.00003	0.00004	0.00003
418	0.0000	0.0001	-0.00003	0.00003	0.00004	0.00003
420	0.0000	0.0001	-0.00003	0.00003	0.00004	0.00003
422	0.0000	0.0001	-0.00003	0.00003	0.00003	0.00003
424	0.0000	0.0001	-0.00003	0.00003	0.00003	0.00003
426	0.0000	0.0001	-0.00003	0.00003	0.00003	0.00003
428	0.0000	0.0001	-0.00003	0.00003	0.00003	0.00003
430	0.0000	0.0001	-0.00003	0.00003	0.00003	0.00003
432	0.0000	0.0001	-0.00003	0.00003	0.00003	0.00003
434	0.0000	0.0001	-0.00003	0.00003	0.00003	0.00003
436	0.0000	0.0000	-0.00003	0.00003	0.00003	0.00003
438	0.0000	0.0000	-0.00004	0.00003	0.00003	0.00003
440	0.0000	0.0000	-0.00004	0.00003	0.00002	0.00002
442	0.0000	0.0000	-0.00004	0.00003	0.00002	0.00002
444	0.0000	0.0001	-0.00004	0.00003	0.00002	0.00002
446	0.0000	0.0001	-0.00004	0.00003	0.00002	0.00002
448	0.0000	0.0001	-0.00004	0.00003	0.00002	0.00002
450	0.0000	0.0000	-0.00004	0.00003	0.00002	0.00002
452	0.0000	0.0000	-0.00004	0.00003	0.00002	0.00002
454	0.0000	0.0000	-0.00004	0.00003	0.00002	0.00002
456	0.0000	0.0000	-0.00004	0.00003	0.00002	0.00002
458	0.0000	0.0000	-0.00004	0.00003	0.00002	0.00002
460	0.0000	0.0000	-0.00004	0.00003	0.00002	0.00002
462	0.0000	0.0000	-0.00004	0.00003	0.00002	0.00002
464	0.0000	0.0000	-0.00004	0.00002	0.00002	0.00002
466	0.0000	0.0000	-0.00004	0.00002	0.00002	0.00002
468	0.0000	0.0000	-0.00004	0.00002	0.00002	0.00002

470	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
472	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
474	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
476	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
478	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
480	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
482	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
484	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
486	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
488	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
490	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
492	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
494	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
496	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
498	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
500	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
502	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
504	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00002
506	0.0000	0.0001	-0.00004	0.00002	0.00001	0.00002
508	0.0001	0.0001	-0.00004	0.00002	0.00001	0.00001
510	0.0001	0.0001	-0.00004	0.00002	0.00001	0.00001
512	0.0001	0.0001	-0.00004	0.00002	0.00001	0.00001
514	0.0001	0.0001	-0.00004	0.00002	0.00001	0.00001
516	0.0001	0.0001	-0.00004	0.00002	0.00001	0.00001
518	0.0001	0.0001	-0.00004	0.00002	0.00001	0.00001
520	0.0001	0.0001	-0.00004	0.00002	0.00001	0.00001
522	0.0001	0.0001	-0.00004	0.00002	0.00001	0.00001
524	0.0001	0.0001	-0.00004	0.00002	0.00001	0.00001
526	0.0001	0.0001	-0.00004	0.00002	0.00001	0.00001
528	0.0000	0.0001	-0.00004	0.00002	0.00001	0.00001
530	0.0000	0.0001	-0.00004	0.00002	0.00001	0.00001
532	0.0000	0.0001	-0.00004	0.00002	0.00001	0.00001
534	0.0000	0.0001	-0.00004	0.00002	0.00001	0.00001
536	0.0000	0.0001	-0.00004	0.00002	0.00001	0.00001
538	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00001
540	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00001
542	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00001
544	0.0000	0.0001	-0.00004	0.00002	0.00001	0.00001
546	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00001
548	0.0000	0.0000	-0.00004	0.00002	0.00001	0.00001
550	0.0000	0.0000	-0.00004	0.00001	0.00000	0.00001
552	0.0000	0.0000	-0.00004	0.00001	0.00000	0.00001
554	0.0000	0.0000	-0.00004	0.00001	0.00000	0.00001
556	0.0000	0.0000	-0.00004	0.00001	0.00000	0.00001
558	0.0000	0.0000	-0.00004	0.00001	0.00000	0.00001
560	0.0000	0.0000	-0.00004	0.00001	0.00000	0.00001
562	0.0000	0.0000	-0.00004	0.00001	0.00000	0.00001

564	0.0000	0.0000	-0.00004	0.00001	0.00000	0.00001
566	0.0000	0.0000	-0.00004	0.00001	0.00000	0.00001
568	0.0000	0.0000	-0.00004	0.00001	0.00000	0.00001
570	0.0000	0.0001	-0.00004	0.00001	-0.00001	0.00001
572	0.0000	0.0001	-0.00005	0.00001	-0.00001	0.00001
574	0.0001	0.0001	-0.00005	0.00001	-0.00001	0.00001
576	0.0001	0.0001	-0.00005	0.00001	-0.00001	0.00001
578	0.0001	0.0001	-0.00005	0.00001	-0.00001	0.00001
580	0.0002	0.0001	-0.00005	0.00001	-0.00001	0.00001
582	0.0003	0.0001	-0.00005	0.00001	-0.00001	0.00001
584	0.0003	0.0001	-0.00005	0.00001	-0.00001	0.00001
586	0.0004	0.0001	-0.00005	0.00001	-0.00001	0.00001
588	0.0005	0.0001	-0.00005	0.00001	-0.00001	0.00001
590	0.0006	0.0001	-0.00005	0.00001	-0.00001	0.00001
592	0.0006	0.0001	-0.00005	0.00001	-0.00001	0.00001
594	0.0007	0.0001	-0.00005	0.00001	-0.00001	0.00001
596	0.0008	0.0001	-0.00005	0.00001	-0.00001	0.00001
598	0.0009	0.0001	-0.00004	0.00001	-0.00001	0.00001
600	0.0010	0.0001	-0.00003	0.00001	0.00000	0.00001
602	0.0010	0.0001	-0.00003	0.00001	0.00001	0.00001
604	0.0010	0.0001	-0.00002	0.00001	0.00002	0.00001
606	0.0010	0.0001	-0.00001	0.00001	0.00003	0.00001
608	0.0010	0.0001	0.00000	0.00001	0.00003	0.00001
610	0.0009	0.0001	0.00001	0.00001	0.00004	0.00001
612	0.0009	0.0001	0.00001	0.00001	0.00005	0.00001
614	0.0008	0.0001	0.00002	0.00001	0.00005	0.00001
616	0.0007	0.0001	0.00002	0.00001	0.00006	0.00001
618	0.0006	0.0001	0.00002	0.00001	0.00006	0.00001
620	0.0006	0.0001	0.00002	0.00001	0.00006	0.00001
622	0.0005	0.0001	0.00002	0.00001	0.00006	0.00001
624	0.0004	0.0001	0.00002	0.00001	0.00006	0.00001
626	0.0003	0.0001	0.00002	0.00001	0.00006	0.00001
628	0.0003	0.0001	0.00002	0.00001	0.00006	0.00001
630	0.0002	0.0001	0.00002	0.00001	0.00005	0.00001
632	0.0001	0.0001	0.00002	0.00001	0.00005	0.00001
634	0.0001	0.0001	0.00001	0.00001	0.00005	0.00001
636	0.0000	0.0001	0.00001	0.00001	0.00005	0.00001
638	0.0000	0.0001	0.00001	0.00001	0.00004	0.00001
640	0.0000	0.0001	0.00001	0.00001	0.00004	0.00001
642	0.0000	0.0001	0.00000	0.00001	0.00004	0.00001
644	0.0000	0.0001	0.00000	0.00001	0.00004	0.00001
646	0.0000	0.0001	0.00000	0.00001	0.00003	0.00001
648	0.0000	0.0001	-0.00001	0.00001	0.00003	0.00001
650	0.0000	0.0001	-0.00001	0.00001	0.00003	0.00001
652	0.0000	0.0001	-0.00001	0.00001	0.00002	0.00001
654	0.0001	0.0001	-0.00001	0.00001	0.00002	0.00001
656	0.0001	0.0001	-0.00002	0.00001	0.00002	0.00001

658	0.0001	0.0001	-0.00002	0.00001	0.00002	0.00001
660	0.0002	0.0001	-0.00002	0.00001	0.00002	0.00001
662	0.0002	0.0001	-0.00002	0.00001	0.00002	0.00001
664	0.0002	0.0001	-0.00002	0.00001	0.00002	0.00001
666	0.0001	0.0001	-0.00002	0.00001	0.00002	0.00001
668	0.0001	0.0001	-0.00002	0.00001	0.00001	0.00001
670	0.0001	0.0001	-0.00002	0.00001	0.00001	0.00001
672	0.0000	0.0001	-0.00002	0.00001	0.00001	0.00001
674	0.0000	0.0001	-0.00003	0.00001	0.00000	0.00001
676	-0.0001	0.0001	-0.00004	0.00001	0.00000	0.00001
678	-0.0001	0.0001	-0.00005	0.00001	-0.00001	0.00001
680	-0.0001	0.0001	-0.00006	0.00001	-0.00002	0.00001
682	-0.0001	0.0001	-0.00006	0.00001	-0.00003	0.00001
684	-0.0001	0.0001	-0.00008	0.00001	-0.00004	0.00001
686	-0.0001	0.0001	-0.00009	0.00001	-0.00006	0.00001
688	0.0000	0.0001	-0.00010	0.00001	-0.00007	0.00001
690	0.0000	0.0001	-0.00011	0.00001	-0.00008	0.00001
692	0.0001	0.0001	-0.00013	0.00001	-0.00009	0.00001
694	0.0002	0.0001	-0.00014	0.00001	-0.00011	0.00001
696	0.0003	0.0001	-0.00016	0.00001	-0.00012	0.00001
698	0.0005	0.0001	-0.00017	0.00001	-0.00014	0.00001
700	0.0007	0.0002	-0.00018	0.00001	-0.00015	0.00001
702	0.0009	0.0002	-0.00019	0.00001	-0.00016	0.00001
704	0.0013	0.0003	-0.00020	0.00001	-0.00017	0.00001
706	0.0017	0.0003	-0.00021	0.00001	-0.00018	0.00001
708	0.0021	0.0004	-0.00022	0.00001	-0.00019	0.00001
710	0.0026	0.0004	-0.00022	0.00001	-0.00020	0.00001
712	0.0032	0.0004	-0.00023	0.00001	-0.00020	0.00001
714	0.0038	0.0004	-0.00023	0.00001	-0.00020	0.00001
716	0.0045	0.0005	-0.00023	0.00001	-0.00021	0.00001
718	0.0054	0.0005	-0.00024	0.00001	-0.00021	0.00001
720	0.0063	0.0006	-0.00024	0.00001	-0.00021	0.00001
722	0.0073	0.0006	-0.00024	0.00001	-0.00021	0.00001
724	0.0083	0.0007	-0.00024	0.00001	-0.00021	0.00001
726	0.0094	0.0007	-0.00022	0.00001	-0.00020	0.00001
728	0.0104	0.0007	-0.00021	0.00001	-0.00017	0.00001
730	0.0113	0.0006	-0.00017	0.00001	-0.00013	0.00001
732	0.0121	0.0005	-0.00012	0.00001	-0.00008	0.00001
734	0.0128	0.0004	-0.00006	0.00001	-0.00001	0.00001
736	0.0133	0.0003	0.00002	0.00001	0.00007	0.00001
738	0.0136	0.0003	0.00012	0.00001	0.00016	0.00001
740	0.0136	0.0004	0.00022	0.00002	0.00026	0.00001
742	0.0133	0.0005	0.00031	0.00002	0.00037	0.00001
744	0.0129	0.0006	0.00041	0.00002	0.00046	0.00002
746	0.0124	0.0007	0.00049	0.00003	0.00054	0.00002
748	0.0116	0.0008	0.00056	0.00003	0.00061	0.00002
750	0.0107	0.0009	0.00062	0.00003	0.00067	0.00003

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