Answering Objections to the Nuclear Analysis of the Shroud of Turin

Robert A. Rucker, MS (Nuclear), February 1, 2026

Abstract

In 1988, samples from the Shroud of Turin were carbon dated to 1260-1390 AD (Ref. 1), thus supposedly disproving the authenticity of the Shroud. However, proper evaluation of this 1260-1390 AD range requires an understanding of how carbon dating is done, how statistical analysis should be done on the measured values, and the difference between random measurement errors and systematic measurement errors. When these issues are properly considered, as discussed below, the best hypothesis to explain all the evidence related to the carbon dating of the Shroud is the neutron absorption hypothesis. This hypothesis proposes that neutrons were emitted from Jesus' body in his resurrection that were absorbed in N-14 to produce new C-14 on the Shroud, which shifted the carbon date forward relative to its true date. Since the neutron absorption hypothesis is the only hypothesis that is consistent with all the evidence, and since it is based on neutrons being emitted from Jesus' body in his resurrection, the carbon dating of the Shroud becomes one of the best arguments in favor of the authenticity of the Shroud instead of being the best argument against the authenticity of the Shroud.

Introduction

With the Shroud of Turin held horizontally with the front image to the left, the samples that were cut from the Shroud for carbon dating in 1988 were cut from the upper-left corner of the Shroud. These samples were sent to dating laboratories in Oxford, Zurich, and Tucson. The laboratories in Oxford and Zurich each received one sample whereas the laboratory in Tucson received two samples - a smaller sample that was immediately put into a vault so was not carbon dated, and a larger sample that was to be carbon dated. Each of these laboratories cut their sample to be dated into smaller subsamples, resulting in 12 subsamples that were carbon dated. Oxford submitted 3 subsamples to be dated, Zurich submitted 5 subsamples, and Tucson submitted 4 subsamples.

These three laboratories also carbon dated three control standards using the same methods as they used on the 12 subsamples from the corner of the Shroud. One of these control standards is from 110 BC to 75 AD, and the other two are from the Middle Ages. These control standards were carbon dated at about the same time as the subsamples from the Shroud. The purpose of carbon dating these three control standards was to confirm that everything used to carbon date the Shroud samples was working properly, as proven by reasonably accurate carbon dates being obtained for the control standards. As a result of the control standards being carbon dated with reasonable accuracy, it should be accepted that the 1988 measurements of the ratio of C-14 to C-12 for the 12 Shroud subsamples were also measured with reasonable accuracy.

In the carbon dating process, after the C^{14}/C^{12} ratios are measured, an equation is used to calculate dates from the C^{14}/C^{12} ratios. This equation assumes that a C^{14}/C^{12} ratio has only changed due to the decay of the C-14. If anything other than C-14 decay has significantly changed the C^{14}/C^{12} ratio, then the equation is no longer valid to calculate a date from the measured C^{14}/C^{12} ratio.

An experimental measurement should usually produce two values – the value itself and its uncertainty. The measurement uncertainty helps to indicate the meaning of the value. Two types of errors can also be present in experimental measurements. These are called ransom and systematic errors. Random measurement errors are normally present in a measurement, but the magnitude of the error is normally small and can randomly be positive or negative. Since the positive and negative effects of ransom measurement errors tend to cancel each other in multiple measurements, the normal equation can still be used to calculate dates from C^{14}/C^{12} ratios that have been affected by random measurement errors. But the presence of a systematic measurement error is very different. The magnitude of a systematic measurement error can be significant, and it can have effects that are always positive or always negative, so systematic measurement errors do not tend to cancel each other in multiple measurements. If the magnitude of the systematic error is not known so that it cannot be corrected for in the measured value, which is almost always the case, then the normal equation used to calculate dates from the C^{14}/C^{12} ratios is no longer valid. In this situation, dates cannot be calculated from the C^{14}/C^{12} ratios, so that no dates can be calculated from the carbon dating measurements. The common phrase for this situation is that the measurements are to be rejected. It is the statistical analysis of the dates relative to their uncertainties that indicates whether a systematic measurement error is probably present or not. If the dates are not consistent with each other within their uncertainties, then it implies that a systematic measurement error is probably present, so that the measurements should be rejected.

Based on the measured dates and their uncertainties for the Shroud, there is likely a systematic measurement error present in the 1988 carbon dating of the 12 subsamples from the Shroud. Four papers in peer reviewed journals (Ref. 3 to 6) concluded that the 1988 measurements of the carbon dates for the 12 subsamples were not homogeneous, i.e. they were heterogeneous. This means that the 12 subsamples had significant differences from each other so that it could not be claimed that they are all representative of the rest of the Shroud. This situation results from the presence of a systematic measurement error. As stated above, since the three control standards were measured with reasonable accuracy, the C^{14}/C^{12} ratios for the 12 subsamples should also be accepted as being measured accurately. The presence of the systematic measurement error in the Ref. 1 dates would thus not be caused by the C^{14}/C^{12} ratio measurements, so there must have been something other than C-14 decay that had altered the C^{14}/C^{12} ratios. It is proposed that the C^{14}/C^{12} ratios in the 12 subsamples were altered by production of new C-14 on the fibers due to neutron absorption primarily in the trace amount of N-14 in the fibers. This new C-14 was produced by the [N-14 + neutron produces C-14 + proton] reaction. This is called the neutron absorption hypothesis. New C-14 produced in the fibers would have shifted the measured carbon date in the forward direction relative to its true date, thus causing the systematic measurement error. The evidence that supports this neutron absorption hypothesis is primarily discussed in papers 13, 33 and 44 on www.shroudresearch.net.

The carbon dates and the statistical analysis of the data for the 12 subsamples and the three control standards were reported in Ref. 1. The dates and uncertainties in Ref. 1 are organized in

Table 1 below, which is taken from Table 1 of Ref. 2. In Table 1, material 1 is the 12 subsamples from the Shroud and materials 2, 3, and 4 are the three control standards. The dates are given in years before present (BP) where the "present" is assumed to be 1950 according to standard procedures in the carbon dating industry. A date BP is related to the year AD by the equation AD = 1950 – BP. But in using this equation, it must be recognized that if the year BP is the measured date, and thus prior to correcting it for the changing quantity of C-14 in the atmosphere, then the date AD will also be an uncorrected date, i.e. not corrected for the changing quantity of C-14 in the atmosphere. Table 2 below, taken from Table 5 of Ref. 2, shows Rucker's statistical analysis of the data assuming a normal or Gaussian distribution and using the same method of Statistical analysis for Shroud samples as was used for the control standards, so that a weighted mean of the laboratory means was used for the Shroud as was used for the control standards. The statistical analysis in Table 2 includes two additional digits to the right of the decimal point to allow for easy comparison, though they may not be statistically significant.

The term "measured value" or "measured date" refers to the date that is obtained when the normal equation is applied to the measured C^{14}/C^{12} ratio, before it is corrected for the changing C-14 concentration in the atmosphere. This measured value or date can be given in units of BP or AD, with the equation AD = 1950 – BP used to calculate the date AD from the date BP. This means that a date in terms of the unit AD can be either an uncorrected value (before correcting it for the changing C-14 concentration in the atmosphere) or a corrected value (after correcting it for the changing C-14 concentration in the atmosphere). It is important to clearly state whether an AD date is an uncorrected date or is a corrected date. Needles confusion can result if this issue is not made clear.

The normal procedure is to do the statistical analysis on the uncorrected dates. This statistical analysis can be done in units of BP or AD (uncorrected) because either option, if done correctly, will lead to the same conclusions. The statistical analysis in Ref. 1 (Damon) was done on the uncorrected dates in units of BP. The resulting mean or average date of the 12 subsamples from the Shroud was 691 BP ± 31 years (Table 2 of Ref. 1), which is equivalent to 1259 AD ± 31 years, which can be rounded to 1260 AD ± 31 years. These values, whether in units of BP or AD are all uncorrected values. When the 1260 ± 31 uncorrected value is corrected for the changing concentration of C-14 in the atmosphere, the result given in Ref. 1 is 1260 to 1390 AD. This result assumes a range of two standard deviations, which is equivalent to a 95% confidence that the true value would be within this range of 1260-1390. If one standard deviation had been assumed, then the confidence would be about 67%, and if three standard deviations had been assumed, then the confidence would be about 99%. The important point is that whatever confidence range is used, for the stated range to be true, the underlying uncorrected date of 1260 ± 31 must be true. However, since a statistical analysis of the dates and uncertainties for the Shroud's 12 subsamples indicate a lack of consistency with each other (Ref. 3 to 6), there is likely a systematic measurement error in the Ref. 1 reported values, so that the mean or average uncorrected value of 1260 ± 31 should be rejected, i.e. given no credibility. This means that the stated range of 1260-1390 should also be rejected.

<u>Rucker's Response to Hugh Farey's Comments on January 13, 2026</u>

Bob Rucker was interviewed by Mike Creavey on his “The Gracious Guest” program to make the video (https://www.youtube.com/watch?v=vSAU2ushM1M) titled “The Shroud of Turin New Research!” that was released onto YouTube on January 9, 2026. This video contained the latest results of Rucker’s MCNP nuclear analysis computer calculations related to the 1988 carbon dating of the Shroud of Turin. These results included evidence contrary to Hugh Farey’s medieval Shroud hypothesis. Hugh Farey responded to Rucker’s MCNP results on his blog (https://medievalshroud.com/rucker-revisited/) on January 13, 2026. Below is Rucker’s response to Hugh Farey’s blog post. Selected sections from Hugh Farey’s blog are included in red to provide the context.

In Rucker’s video, the figures at 21:18 and 23:23 in the video were altered, for some unknown reason, by the process of making the video. In the video at 21:18, the location of the values produced by the statistical analysis were scrambled. In the video at 23:23, the range on the y-axis was increased, which had the effect of shifting its intersection with the x-axis from the bottom of the figure up toward the middle of the figure.

Farey: As a simple way of illustrating a late medieval date for a lay audience which might not recognise 700BP, subtracting the BP dates from 1950 is understandable, but as a basis for any further interpretation, it is wholly inadequate. The BP dates must be calibrated against dendrochronological data in order to provide accurate AD dates, which, had that been done, would have produced a rather different graph.

The dates in these figures are the uncorrected carbon dates, i.e. without correcting the dates for the changing C-14 concentration in the atmosphere. These values are listed in units of AD rather than BP (years Before Present where present =1950) because people are much more familiar with AD than BP. The measured values in Damon are in units of BP, so Rucker calculated these AD values from Damon’s BP values using the equation AD = 1950 – BP. This equation does not include accounting for the changing C-14 in the atmosphere. Rucker fully realizes this. In normal practice, this correction for the changing C-14 in the atmosphere is done after the statistical analysis is completed.

Farey: It’s not clear to me that Rucker really understands this, but it does show that neither the spread (48 years rather than 104) nor the gradient (17 years per centimetre rather than 36) of these points is as severe as he says.

In Farey’s second figure, he converts (prematurely, since this is not after the statistical analysis was completed, see above) Rucker’s uncorrected carbon dates to corrected carbon dates, and plots the results using large green circles, but without indicating the uncertainties for each value, as Rucker did. If Farey had included the uncertainties, it would be clear that the measured dates depend on the location, which should not be the case if the Shroud was entirely made at one time in the Middle Ages. The main point of this plot is to show that the measured dates depend on the location, which indicates that something strange is going on. The main point is not to show that the slope is of a particular value, so Farey’s calculation of a slope of 17.22 years/cm compared to Rucker’s value of 35.87 years/cm is of secondary importance. The difference between the two values is the result of Farey comparing his corrected carbon dates to Rucker’s uncorrected carbon dates.

Farey: Next, we note that the x-coordinates of the samples on the graph above have no error bars at all, as if every measurement was taken at an exact distance along the sample strip, and as if that distance were known. Neither of these is true

The measurements of the width of the samples are good enough to use in such a plot. But Rucker's plot is not based on their measured widths. The x-values in Rucker's plot is based on his calculation of the sample widths from the sample weights assuming a constant height. Considering how the subsamples were cut from each of the samples, it should be clear that some of the subsamples would have been to the right of the sample's central point and thus a little higher than the average value, and some of the subsamples would have been to the left of the sample's central point and thus a little lower than the average value. Since the higher values will tend to compensate for the lower values, calculating the average value of the subsamples and plotting it at the mid horizontal point of the sample is a legitimate thing to do. This type of plot has been made by multiple Shroud researchers, including in papers published in peer reviewed journals, with the conclusion that the measured carbon date is dependent on the distance from the short end of the cloth, with some of the slopes even higher than Rucker's value of about 36 years/cm. Farey's estimation of about 7.5cm x 1.5cm for the size of the sample would still indicate that the carbon date is a function of the distance from the short end of the cloth. Farey indicated that he agrees with this when he said, "these distances hardly affect Rucker's model above."

Consequently to assume a straight line correlation is not justified, and the equation derived from it is meaningless. In fact Rucker is well aware of this. Although he cheerfully explains that at the same gradient, a sample from further along would date far into the future, his own model shows that a sample from further still would return almost to where it started, and in fact, his own calculations do not relate to the equation at all. Here is his own graph (black), compared to his earlier prediction (red, by me), at about 27:30 in the video:

In Farey's second figure, Rucker has not unreasonably extrapolated the data because the x-axis only goes from 4.0 to 8.0 cm and the data is between 5.0 and 7.7 cm. The data shown in black dots in Farey's fifth figure are not an extrapolation of the data in Farey's second figure, but are values calculated in the MCNP nuclear analysis computer codes based on: 1) the assumption of neutrons homogeneously emitted from the body, 2) the physics properties of neutron scattering and absorption in the materials in the tomb, and 3) the model of the body, cloth, and limestone used in the MCNP calculations as described in Rucker's paper 13 on his website on Shroud Research Network.

Farey: Rucker's decisions can be used to show that the data support the neutron radiation hypothesis, they cannot be used to suggest it.

When Rucker first read Ref. 1, which was in about 1993, the relative mean dates from the three laboratories suggested the neutron absorption hypothesis to him, contradicting the above statement.

Farey: Here we can see no significant difference between the Zurich and Tucson dates

On Farey's fourth figure, the slope in the data becomes obvious when he averages the multiple values into a single value for each laboratory, so that the data does suggest a reasonably straight sloped line as shown in Farey's first figure. The slope also becomes obvious when the top two points for Oxford, Zurich, and Tuson are compared, and when the bottom two points for Zurich and Tucson are compared. The way in which the subsamples were cut from the samples produced a middle value, between the upper two data points and the lower two points, for Zurich, but no middle value for Tucson. The way in which the subsamples were cut from the samples also did not produce two lower points for Oxford. Regarding Farey's reference to Schwalbe and Walsh's speculation in two (Rucker remembers only one) of their papers that this slope in the carbon dates could have been the result of inadequate cleaning, it should be kept in mind that they also speculated that this slope in the carbon dates, which they concluded was true, could have been due to something that had altered the ratio of C-14 to C-12 in the samples as a function of location. Their speculation that the slope in the data was caused by a problem in the laboratory's cleaning process is contrary to the laboratory's good dating results for the three control standards. Their speculation that something had "altered the ratio of C-14 to C-12 in the samples as a function of location" is explained by Rucker's MCNP nuclear analysis computer calculations. These calculations have shown that emission of about 2×10^{18} neutrons homogeneously from the body is consistent with, i.e. can explain, the four types of evidence from the 1988 carbon dating of the Shroud: 1) The mean or average date of about 1260 to 1390 AD, 2) the uncorrected carbon dates as they change according to their distance from the short end of the cloth at a rate of about 36 years/cm (91 years/inch), 3) the distribution of the carbon dates for the 12 subsamples, and 4) the carbon date (about 700 AD) for the Sudarium of Oviedo which is believed to be the face cloth of Jesus in John 20:7. The medieval Shroud hypothesis can only explain the first of these four evidences whereas the neutron absorption hypothesis explains all four of these evidences. Thus, the neutron absorption hypothesis is superior to the medieval Shroud hypothesis because it is much more consistent with the evidence.

Farey: Consequently, to assume a straight line correlation is not justified, and the equation derived from it is meaningless. In fact Rucker is well aware of this.

This is totally false. Farey's rejection of the carbon date being dependent on its distance from the short end of the cloth is entirely unfounded.

Regarding Farey's fifth figure, he said regarding Rucker that "his own calculations do not relate to the equation at all. Here is his own graph (black), compared to his earlier prediction (red, by me)". In this sentence, "the equation" refers to "Y = 35.87x + 1030.67" in Farey's figures 1 and 2, and "compared to his earlier prediction (red, by me)" refers to the red line in Farey's fifth figure. The red line should only have a length of about 4 cm as in Farey's figures 1 and 2. This is the length over which the carbon dating values apply but Farey extrapolated it to a length of about 200 cm, which is certainly not justified. But then Farey makes an even more significant mistake in believing that the equation (Y = 35.87x + 1030.67) for the red line, which applies to only about a 4.0 cm length near the feet, when extrapolated is a prediction of the distribution of the carbon dates over the entire length of the body. This is 100% false! The black dots that form the black line in Farey's fifth figure are the carbon dates that result from Rucker's MCNP nuclear analysis computer calculations. The black line should only be compared to the red line over about 4.0 cm near the feet, consisting of the left-most three black dots. The comparison between these three black dots and the red line is very good over this short range at the feet. The left-most three black dots indicate a slope that is a little steeper than the red line. This is because the black dots were MCNP calculated values at the centerline of the body, whereas the red line is the result of the experimental carbon dating measurements from the corner of the Shroud, which would have been a distance from the centerline of the body. This indicates an excellent agreement between the 1988 experiments and Rucker's MCNP calculations.

The sixth figure shows Rucker's MCNP results for the 12 subsamples relative to the measured values. Starting at 37:59 in Rucker's video, using a standard chi-squared analysis to compare the predicted carbon dates for the 12 subsamples to the measured carbon dates, Rucker shows that his MCNP results for the neutron absorption hypothesis have a chi-squared value that is 4.5 times lower than occurs for Farey's medieval Shroud hypothesis (chi-squared = 7.30 for Rucker vs 32.69 for Farey). This indicates that Rucker's neutron absorption hypothesis is much closer to the measured carbon dates for the 12 subsamples than the medieval Shroud hypothesis, so that if science alone is considered, the neutron absorption hypothesis should be accepted as a better hypothesis than the medieval Shroud hypothesis.

Farey: However, since the configuration was chosen to fit the chronological gradient, it's not surprising that there is a correlation.

When doing forensic science on a non-repeatable event, the normal practice for the researcher is to make assumptions that lead to the best agreement with reality. For example, if a researcher is trying to determine a hypothesis for how the planets in our solar system were formed, he chooses assumptions that result in the best agreement between his hypothesis and the planet's current characteristics. Rucker is doing the same thing in his research on the Shroud of Turin. In his MCNP calculations for the 12 subsamples, the most significant things that we do not know are: 1) how the three samples were cut into the 12 subsamples, and 2) where the group of 12 subsamples was at the instant of Jesus' resurrection. The MCNP results shown in Farey's sixth figure is only the first iteration of Rucker's MCNP calculations. These MCNP calculations took about two weeks of continuous run time on his quad-core desk top computer. In future iterations with MCNP, he plans to make a better evidence-based decision how the 3 samples were probably cut into the 12 subsamples and will search in other locations where the 12 subsamples could have been located at the instant of Jesus' resurrection. The optimum assumptions for these two unknowns will probably result in MCNP calculated carbon dates that are much closer to the measured carbon dates for the 12 subsamples. This will increase the advantage of the neutron absorption hypothesis over the medieval Shroud hypothesis. When these optimum assumptions are determined, they will then become part of the neutron absorption hypothesis, which is part of the Vertically Collimated Radiation Burst (VCRB) Hypothesis when image formation is also included.

Regarding Farey's figures seven and eight, he said "Returning to Rucker's most misleading approximations, the idea that calendar dates can be achieved by subtracting BP dates from 1950 …" Rucker claims he has never believed this, claimed this, or used this. This only arises because Farey misunderstands what Rucker has said. To repeat it, the equation AD = 1950 – BP does not account for the changing C-14 concentration in the atmosphere. It does not produce what is called a "calendar date", defined as the date AD after taking into account the changing C-14 concentration in the atmosphere. But this equation can be used to convert an uncorrected carbon date in BP units to an uncorrected carbon date in AD units. In doing this, Rucker is only changing units for the convenience of his readers and listeners, but he is not taking into account the changing C-14 concentration in the atmosphere.

After Farey's eighth figure, he said that Rucker's plan, i.e. goal, "was to find a neutron emission which would increase the apparent date of the Shroud". Rucker denies this saying that his goal was to find a hypothesis that best explains all the data related to the 1988 carbon dating of the Shroud. This includes the mean value, the slope of the carbon dates, the distribution of the carbon dates for the 12 subsamples, and the mean carbon date for Jesus' face cloth. This "best hypothesis" is the neutron absorption hypothesis. Farey said that MCNP does not measure carbon dates. This is true because MCNP does not measure anything. MCNP calculates the distribution of neutron densities, i.e. neutron flux, which can then be used to calculate the carbon dates at any location. Again, Farey said that Rucker used the equation AD = 1950 – BP to calculate the calendar dates, i.e. corrected carbon date, and again Rucker denies this.

Table 1. Measurements and Analysis Listed in Damon (Ref. 1)

	Material 1	**Material 2**	**Material 3**	**Material 4**
Source of material:	Shroud of Turin	Linen from tomb at Qasr Ibrim, Egypt	Mummy of Cleopatra from Thebes, Egypt	Cope of St. Louis d'Anjou of France
Expected date:		11^{th} to 12^{th} Century AD	110 BC to 75 AD	1290 to 1310 AD
Laboratory	**Individual Measurements* of C^{14} Date, Years Before Present (YBP, Present = 1950)**			
Tucson, Arizona	591 ± 30	922 ± 48	1838 ± 47	724 ± 42
	690 ± 35	986 ± 56	2041 ± 43	778 ± 88
	606 ± 41	829 ± 50	1960 ± 55	764 ± 45
	701 ± 33	996 ± 38	1983 ± 37	602 ± 38
		894 ± 37	2137 ± 46	825 ± 44
Zurich, Switzerland	733 ± 61	890 ± 59	1984 ± 50	739 ± 63
	722 ± 56	1036 ± 63	1886 ± 48	676 ± 60
	635 ± 57	923 ± 47	1954 ± 50	760 ± 66
	639 ± 45	980 ± 50		646 ± 49
	679 ± 51	904 ± 46		660 ± 46
Oxford, England	795 ± 65	980 ± 55	1955 ± 70	785 ± 50
	730 ± 45	915 ± 55	1975 ± 55	710 ± 40
	745 ± 55	925 ± 45	1990 ± 50	790 ± 45
Laboratory	**Mean C^{14} Dates (YBP) Based on Above Values**			
Tucson, Arizona	646 ± 31	927 ± 32	1995 ± 46	722 ± 43
Zurich, Switzerland	676 ± 24	941 ± 23	1940 ± 30	685 ± 34
Oxford, England	750 ± 30	940 ± 30	1980 ± 35	755 ± 30
	Analysis of Interlaboratory Scatter			
Unweighted mean of the weighted means **	**691 ± 31**	936 ± 5	1972 ± 16	721 ± 20
Weighted mean of the weighted means ***	689 ± 16	**937 ± 16**	**1964 ± 20**	**724 ± 20**
χ^2 value (2 degrees of freedom)	6.4	0.1	1.3	2.4
Significance level (%), ****	5	90	50	30

* - The values are from Tables 1 and 2 of Ref. 1. Uncertainties are 1 standard deviation.
** - Standard errors based on scatter. Bold values are final values in Ref. 1.
*** - Standard errors based on combined quoted errors.
**** - The probability of obtaining, by chance, a scatter among the three dates as high as that observed, assuming the quoted random errors reflect all sources of variation.

Table 2. Recalculated Statistical Analysis with 4 Tucson Values

	Material 1	Material 2	Material 3	Material 4
Source of material:	Shroud of Turin	Linen from tomb at Qasr Ibrim, Egypt	Mummy of Cleopatra from Thebes, Egypt	Cope of St. Louis d'Anjou of France
Expected date:		11^{th} to 12^{th} Century AD	110 BC to 75 AD	1290 to 1310 AD
Laboratory	**Individual Measurements of C^{14} Date, Years Before Present (YBP, Present = 1950)**			
Tucson, Arizona	591 ± 30	922 ± 48	1838 ± 47	724 ± 42
	690 ± 35	986 ± 56	2041 ± 43	778 ± 88
	606 ± 41	829 ± 50	1960 ± 55	764 ± 45
	701 ± 33	996 ± 38	1983 ± 37	602 ± 38
		894 ± 37	2137 ± 46	825 ± 44
Zurich, Switzerland	733 ± 61	890 ± 59	1984 ± 50	739 ± 63
	722 ± 56	1036 ± 63	1886 ± 48	676 ± 60
	635 ± 57	923 ± 47	1954 ± 50	760 ± 66
	639 ± 45	980 ± 50		646 ± 49
	679 ± 51	904 ± 46		660 ± 46
Oxford, England	795 ± 65	980 ± 55	1955 ± 70	785 ± 50
	730 ± 45	915 ± 55	1975 ± 55	710 ± 40
	745 ± 55	925 ± 45	1990 ± 50	790 ± 45
Laboratory	**Weighted Mean C^{14} Dates (YBP) Based on Above Values**			
Tucson, Arizona	646.44 ± 17.05	927.44 ± 19.70	1995.23 ± 19.89	721.67 ± 20.42
Zurich, Switzerland	676.14 ± 23.74	940.60 ± 23.16	1939.81 ± 28.47	685.16 ± 24.63
Oxford, England	749.17 ± 30.70	937.88 ± 29.43	1977.05 ± 32.71	755.76 ± 25.66
	Analysis of Interlaboratory Scatter			
Unweighted mean of the unweighted means (YBP)	695.09 ± 32.37	937.33 ± 6.26	1968.82 ± 14.74	732.16 ± 19.17
Unweighted mean of the weighted means (YBP)	690.59 ± 30.52	935.30 ± 4.01	1970.70 ± 16.31	720.86 ± 20.39
Weighted mean of the weighted means (YBP)	**672.21 ± 12.62**	**933.98 ± 13.37**	**1977.05 ± 14.59**	**720.16 ± 13.40**
χ^2 for weighted mean (2 degrees of freedom)	8.60	0.210	2.55	3.95
Significance level* (%)	1.40	90.1	28.0	13.9

* - The probability of obtaining, by chance, a scatter among the 3 laboratory weighted means as high as that observed, assuming the quoted random errors reflect all sources of variation.

References

1. P.E. Damon, and 20 others, “Radiocarbon Dating of the Shroud of Turin”, Nature, Feb. 16, 1989
2. Robert A. Rucker, “The Carbon Dating Problem for the Shroud of Turin, Part 2: Statistical Analysis”, August 7, 2018, paper 12 on shroudresearch.net
3. T. Casabianca, E. Marinelli, G. Pernagallo, and B. Torrisi, “Radiocarbon Dating of the Turin Shroud: New Evidence from Raw Data”, published March 22, 2019 in *Archaeometry*
4. Paolo Di Lazzaro, Anthony C. Atkinson, Paola Iacomussi, Marco Riani, Marco Ricci, and Peter Wadhams, “Statistical and Proactive Analysis of an Inter-Laboratory Comparison: The Radiocarbon Dating of the Shroud of Turin”
5. Bryan Walsh and Larry Schwalbe, “An Instructive Inter-Laboratory Comparison: The 1988 Radiocarbon Dating of the Shroud of Turin”
6. Bryan Walsh and Larry Schwalbe, “On Cleaning Methods and the Raw Radiocarbon Data from the Shroud of Turin”