Understanding the 1988 Carbon Dating of the Shroud

by

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Outline

- Basic principles & terminology
- Examples of measurements
- Carbon dating of the Shroud
- Objections to the carbon dating
- Evidence for neutron absorption
- Conclusion

The Mysteries of the Shroud

- Image
  - Why can we see the image?
  - How was the image formed?
- Date
  - What is the date of the Shroud?
  - What about the C^{14} dating?
- Blood
  - How did it get onto the Shroud?
  - Why is it still reddish?

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On the RESEARCH page:
Paper 11: “Carbon Dating Problem, Part 1: Background”
Paper 12: “Carbon Dating Problem, Part 2: Statistical Analysis”
Paper 13: “Carbon Dating Problem, Part 3: Neutron Absorption Hypothesis”
Paper 21: “Understanding the Statistical Analysis of the Carbon Dating …"

Two Types of Measurement Error

- Random measurement errors
  - Are always present in measurements
  - Can be randomly positive or negative
  - Effect can be minimized by averaging many measurements, since effects will cancel
- Systematic measurement errors
  - Are sometimes present, usually hard to detect
  - Can be only positive, or only negative
  - Are not minimized by many measurements

Homogeneous vs. Heterogeneous Samples

- "Homogeneous" means "the same"
- "Heterogeneous" means "different"
- Problem: Taking a small sample of an item
  - To produce an accurate measurement for the larger item, the small sample to be measured must be the same as the larger item, i.e. it must be representative.
- A homogeneous sample is representative.
- A heterogeneous sample is not.

Example 1. Distance Measured with a Ruler

- Measure the distance between two points
- 3 people, each with a ruler
- Results: 95’3”, 90’1”, and 86’2”
- Option 1
  - Average the values → 90’6”
  - Ignore the differences
- Option 2
  - Reject the data
  - Investigate what caused the differences

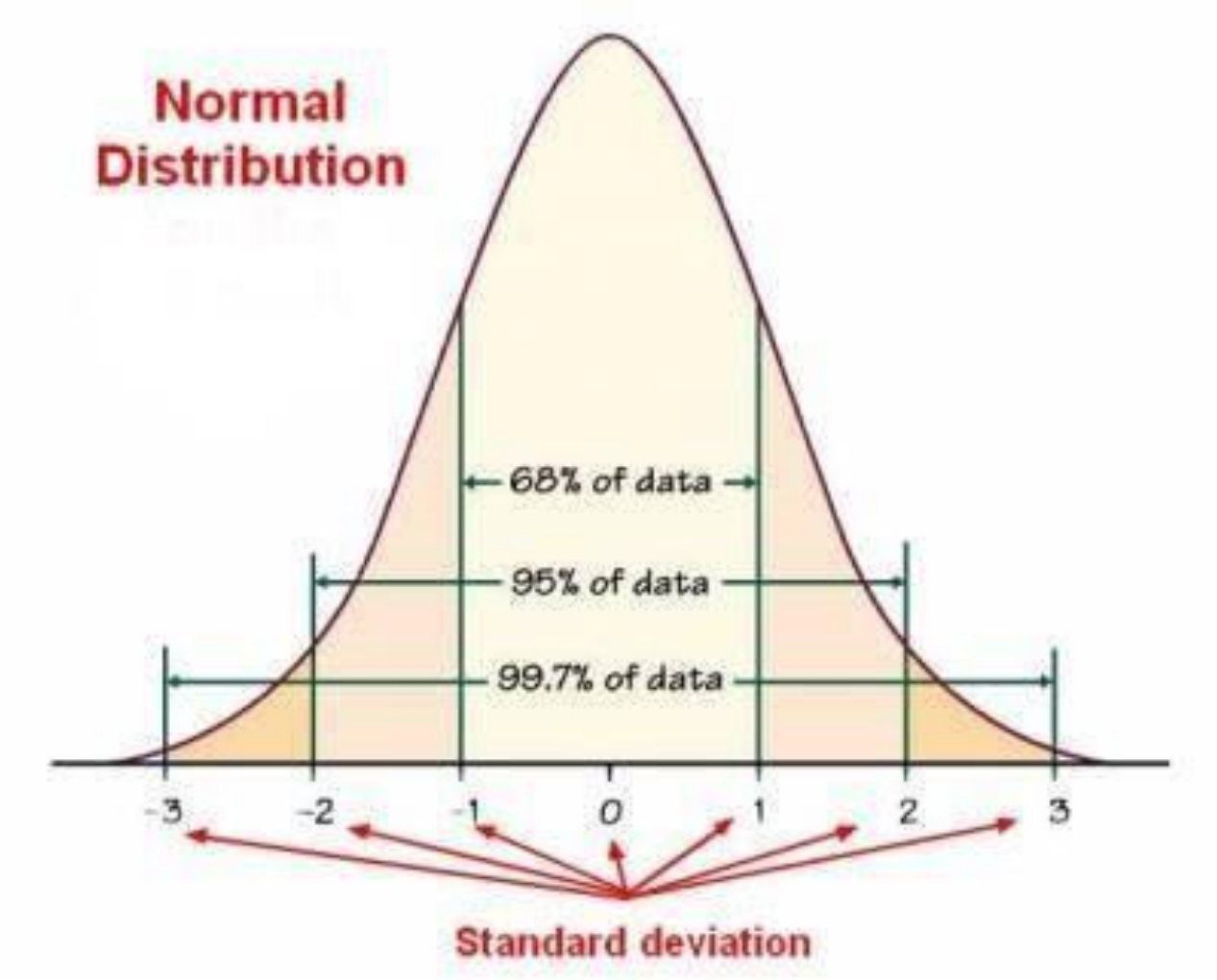
Example 1. Distance Measured with a Ruler

- Random error estimated at 2” to 3”
- Systematic error
  - rulers were longer than 12-inches
  - 5%, 11%, and 16% longer
- True distance = 100 feet
- Average measured value = 90 feet 6 in.
- Systematic error or bias = - 9 feet 6 in.

Example 2. Measurements in a Tank

- Assume a 2.17-meter (7’1”) high tank filled with Uranium (U) in a liquid
- Assignment:
  - Turn on the mixer in the tank for 24 hours
  - Measure the concentration of U in the tank
  - Take 3 measurements at different locations
  - Send to three different laboratories
  - Determine the total U in the tank from the three measurements

Probability Distribution



Example 2. Measurements in a Tank

- Measurement Results:

Sample	U (µg/g)	One Sigma Uncertainty	Depth cm	Depth inches
1	1200.8	30.7	5.0	2.0
2	1273.9	23.7	6.4	2.5
3	1303.5	17.2	7.7	3.0

- Question: What do the results mean?

Should the three values for U be averaged?

Laboratories Don't Agree

- Difference between Lab 3 & Lab 1

  Laboratory 3: 1303.5 ± 17.2 µg/g

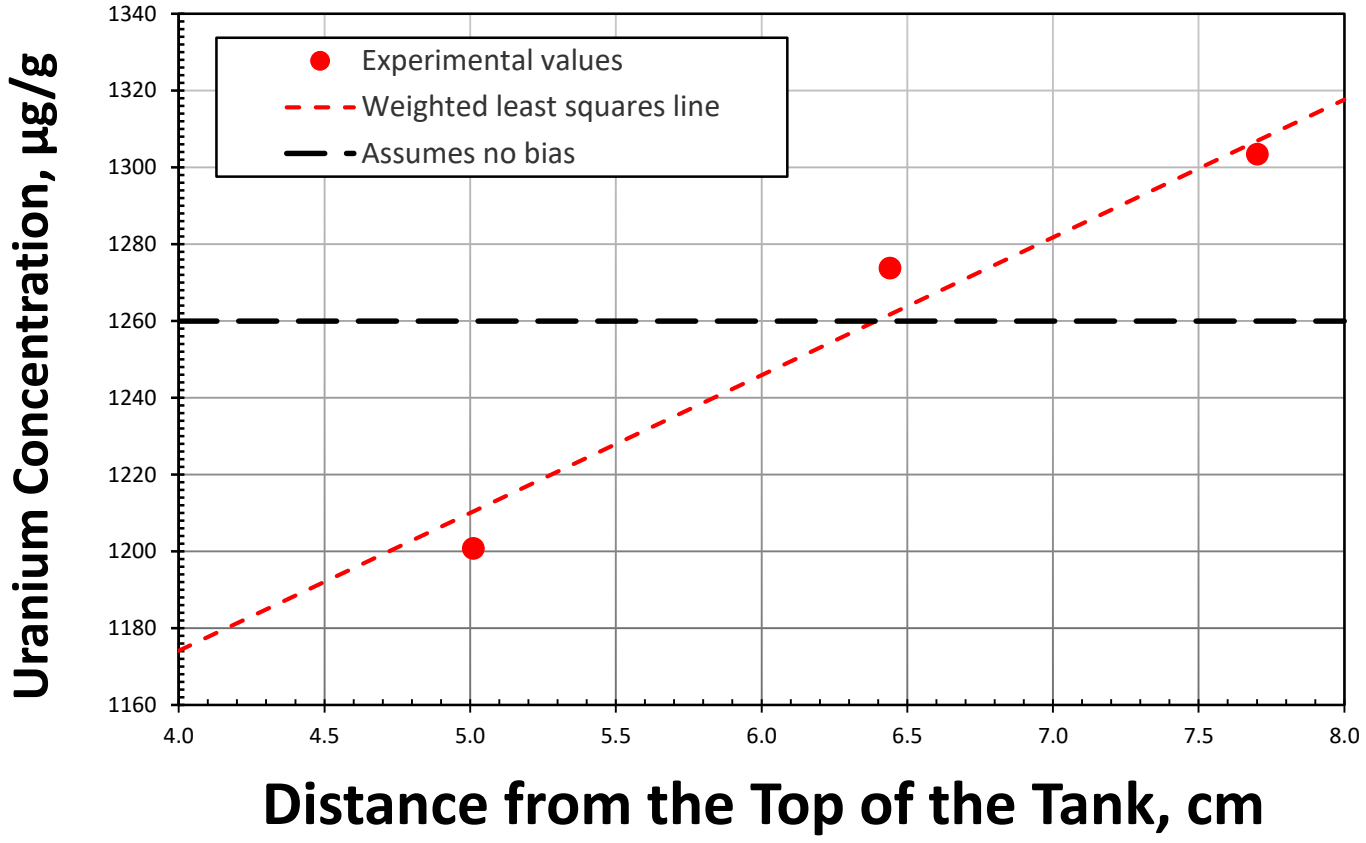
  Laboratory 1: - 1200.8 ± 30.7 µg/g

  Difference = 102.7 ± 34

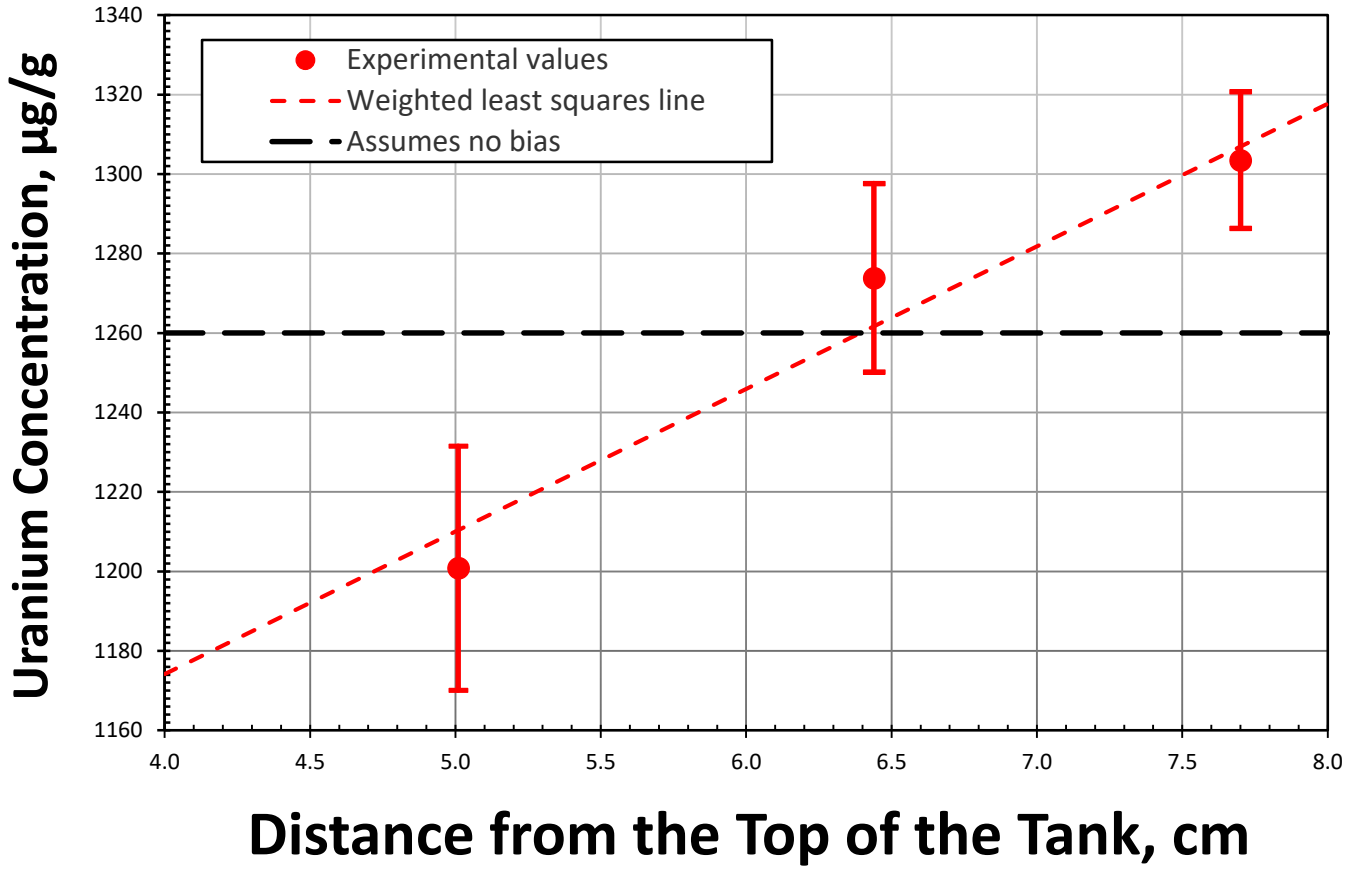
  Square root of $17.2^2 + 30.7^2 = 35.2$

- 102.7 / 35.2 = 2.9 sigma difference
- Conclusion: the samples tested by laboratories 3 and 1 were different

Measurements for Uranium in a Tank



Measurements for Uranium in a Tank



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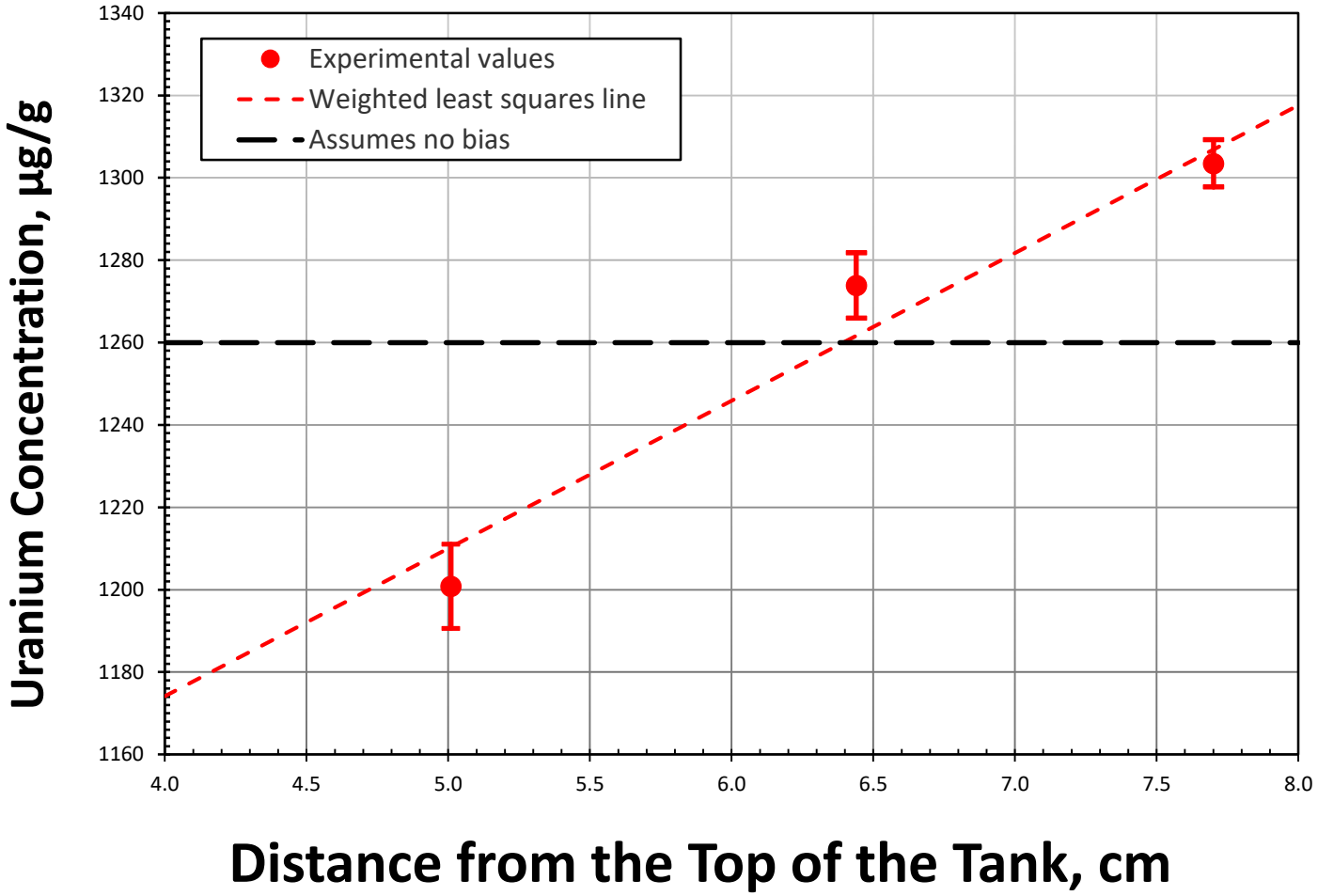

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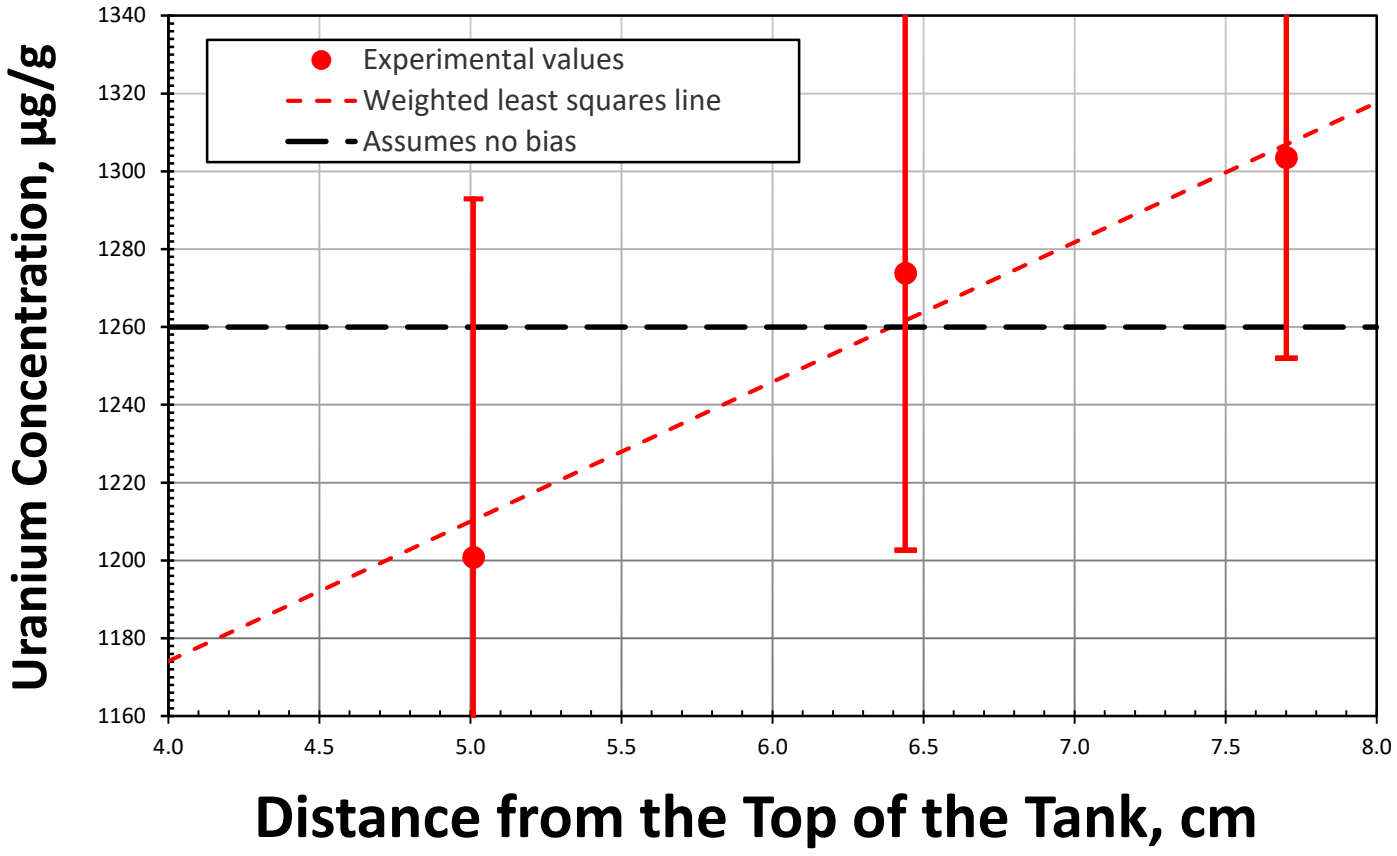

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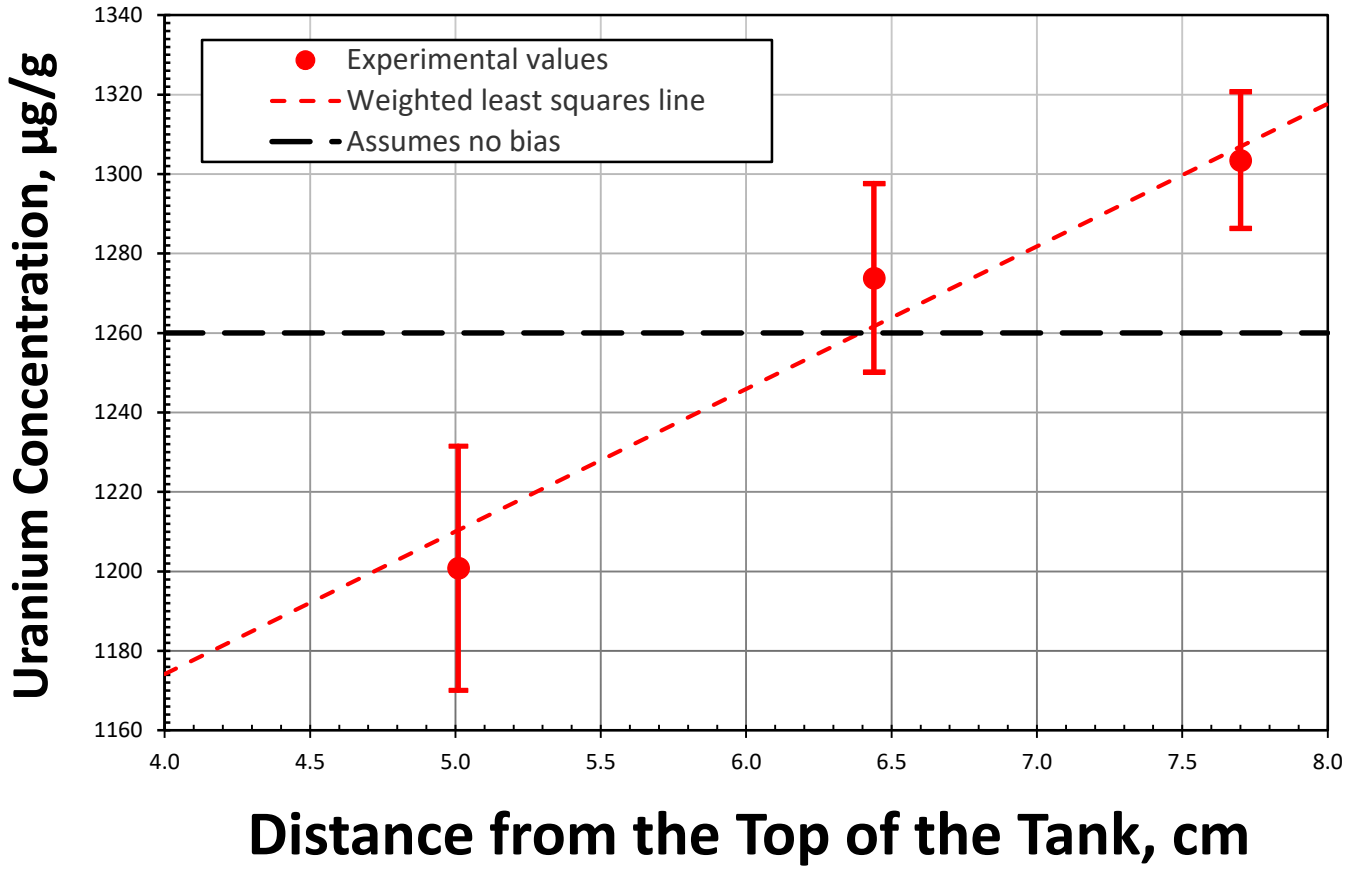

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- Question: What do the results mean?

Should the three values for U be averaged?

1988 Carbon Dating of the Shroud

- Measurement Results:

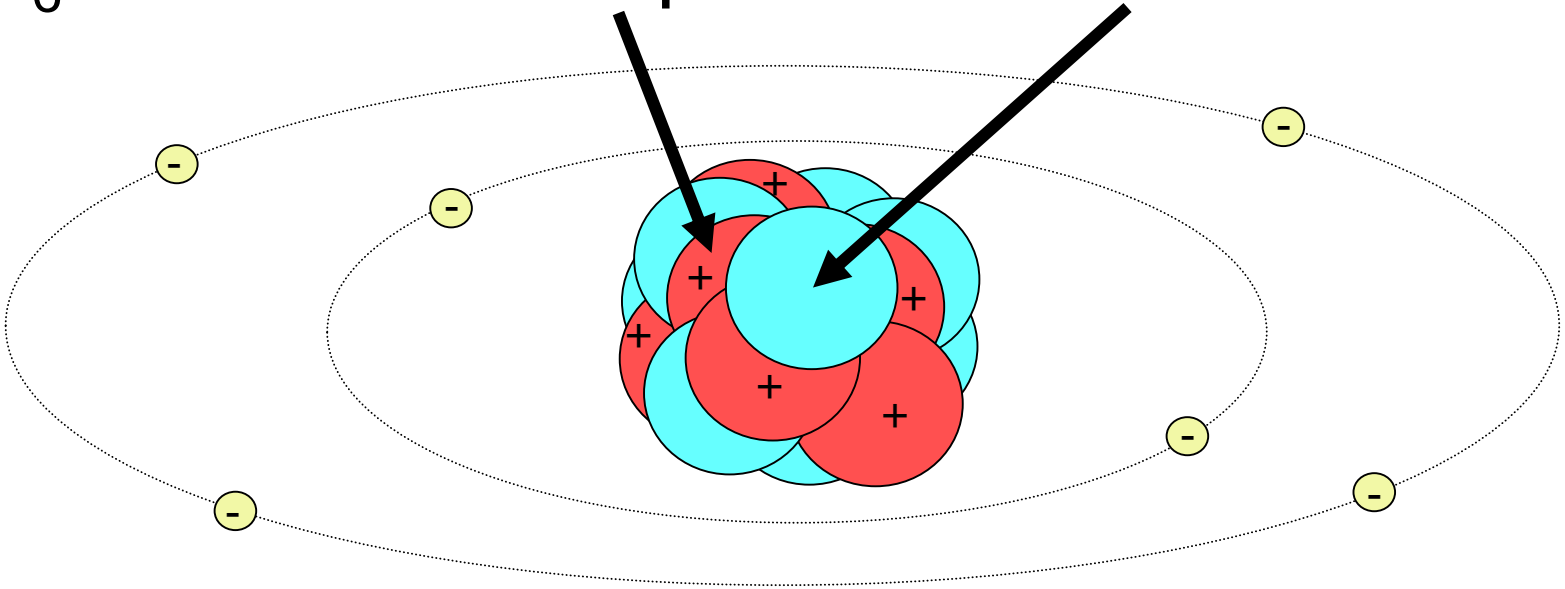
Laboratory	Date AD	One Sigma Uncertainty	Location cm	Location inches
1	1200.8	30.7	5.0	2.0
2	1273.9	23.7	6.4	2.5
3	1303.5	17.2	7.7	3.0

- Question: What do the results mean?

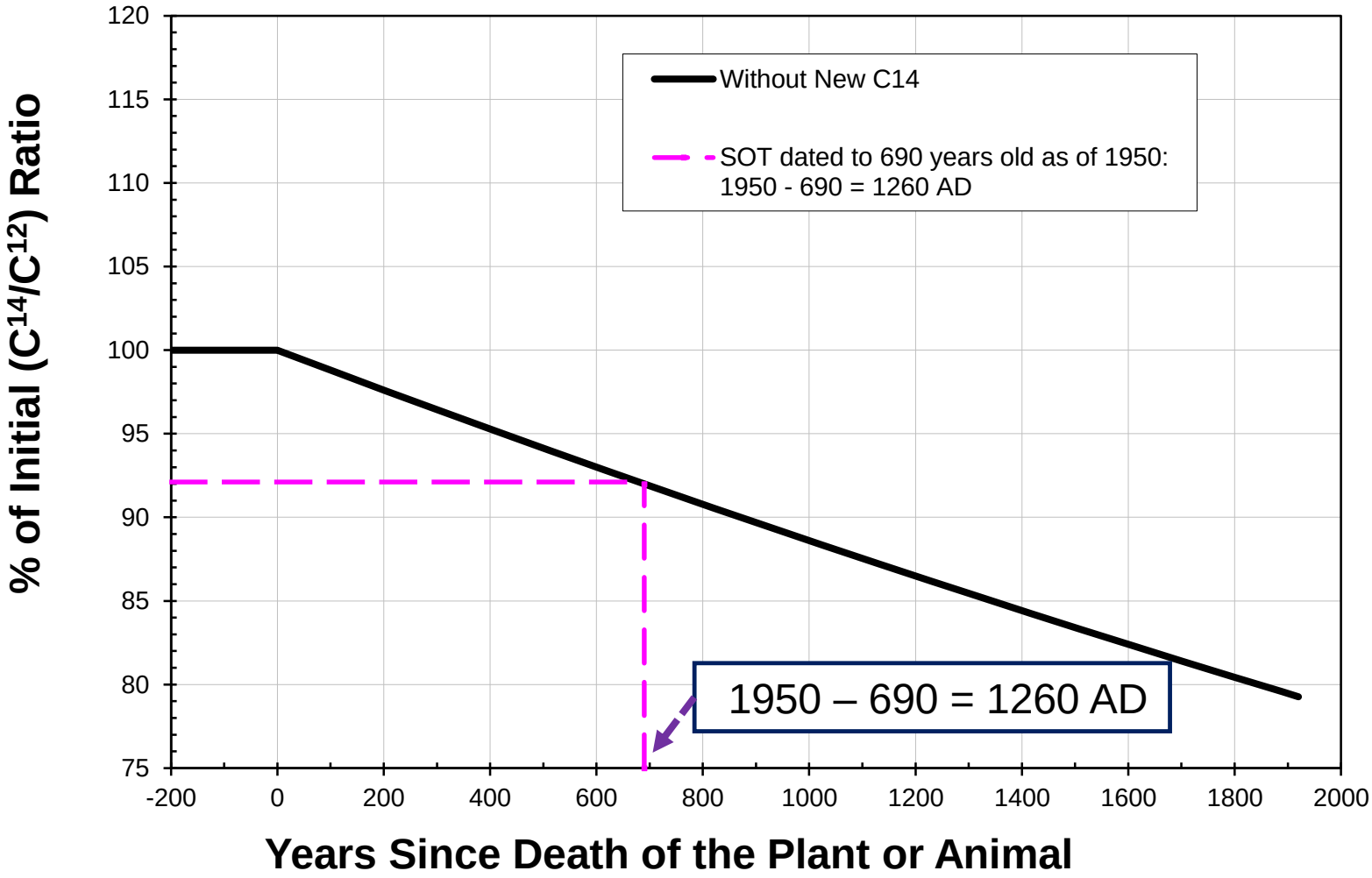
  Should the three dates be averaged?

What is a Neutron?

- $_{6}C^{12}$ atom has 6 protons and 6 neutrons
- $_{6}C^{14}$ atom has 6 protons and 8 neutrons

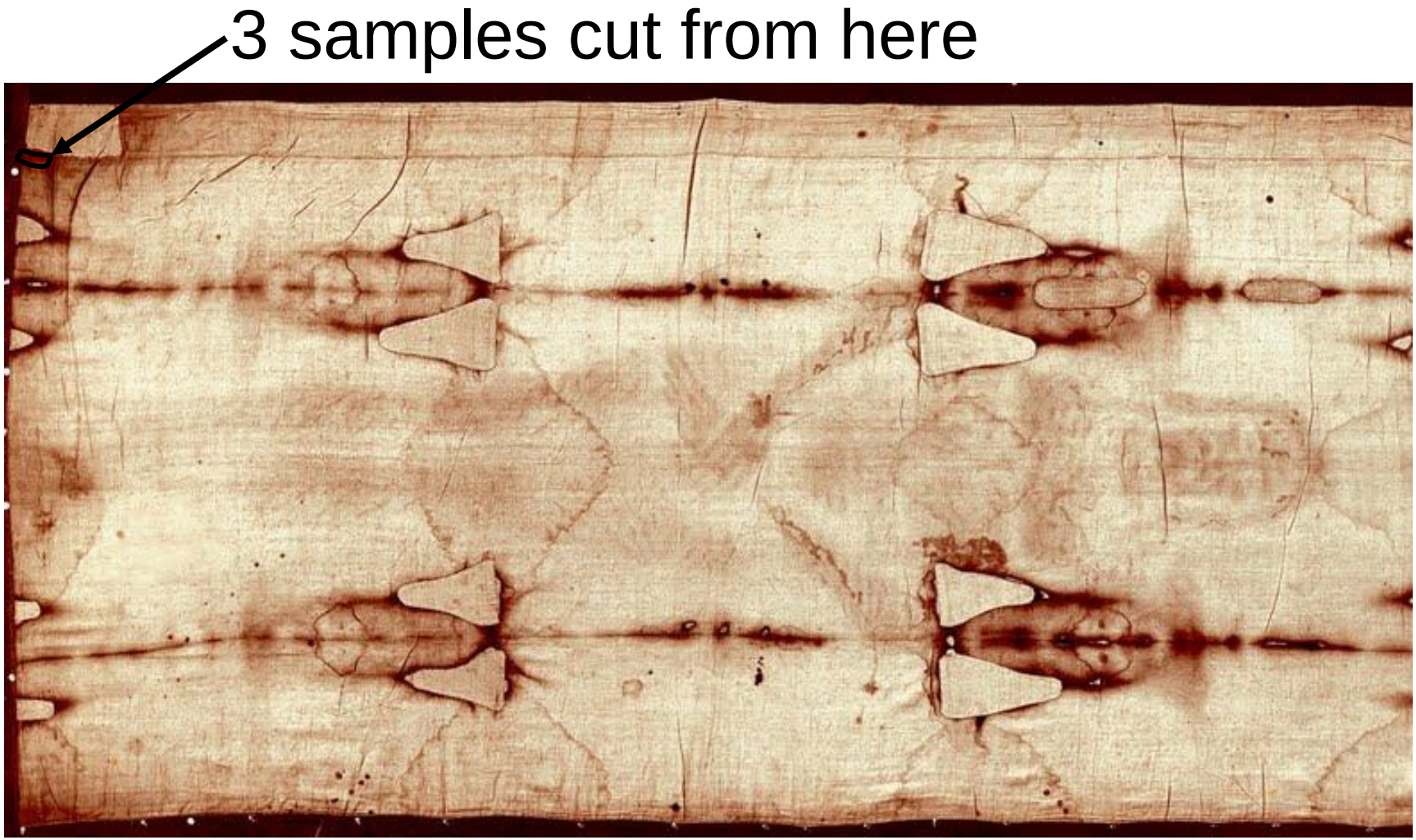


Normal Decay for C^{14}

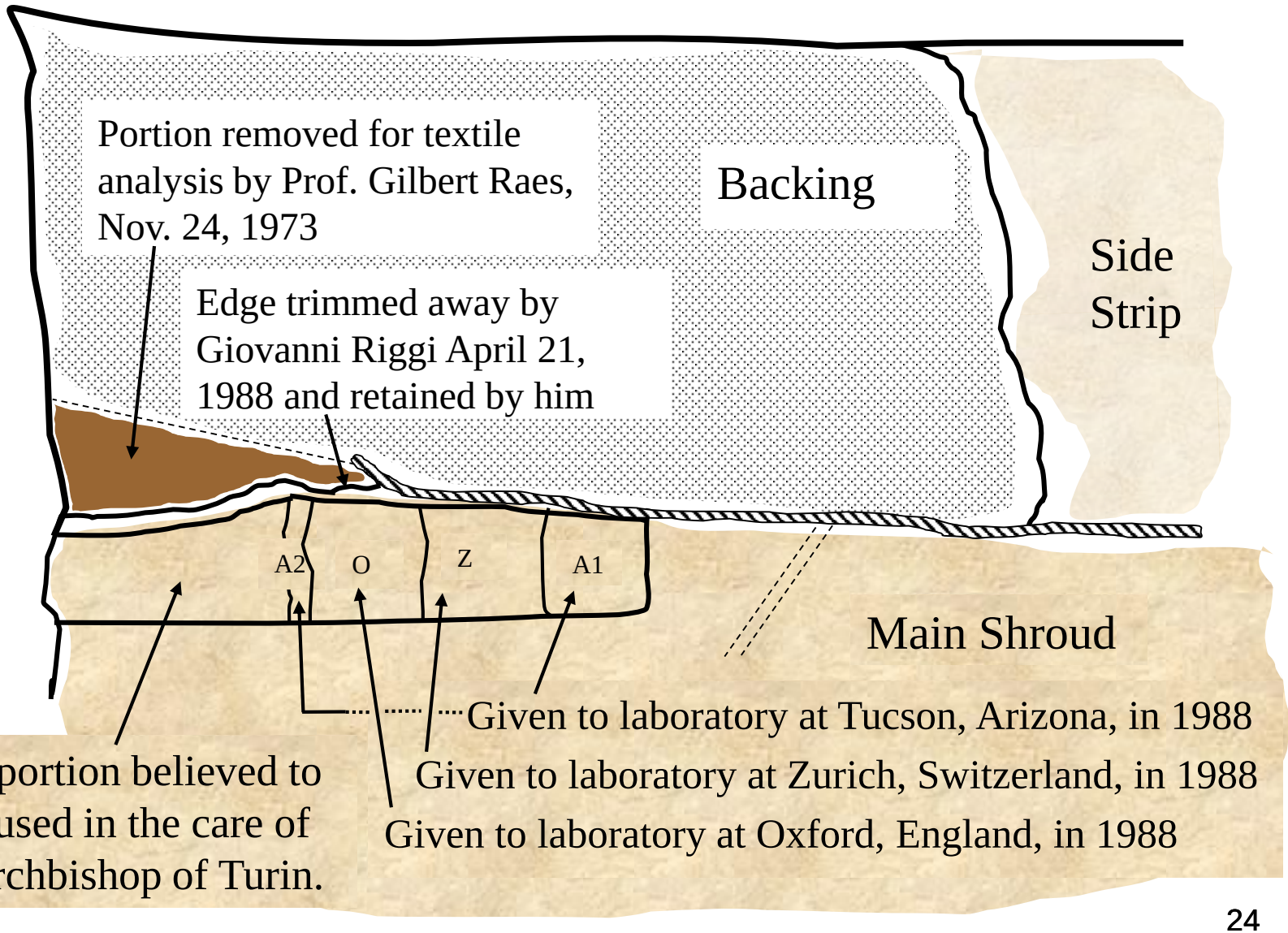


Cutting of the Samples, 1988

Location of Samples for C^{14} Dating



Location of Samples



1988 Carbon Dating of the Shroud

- Damon, et al, “Radiocarbon Dating of the Shroud of Turin”, *Nature*, Feb. 16, 1989
- Average of 3 laboratories = 1260 ± 31
- Correction for changing C^{14} in the atmosphere → 1260 to 1390 AD, 95%
- “These results provide conclusive evidence that the linen of the Shroud of Turin is mediaeval.”

Values by Carbon Dating (AD)

Oxford	Zurich	Arizona	
1155 ± 65	1217 ± 61	1249 ± 47	1249 ± 47
1205 ± 55	1228 ± 56	1197 ± 51	1318 ± 49
1220 ± 45	1271 ± 51	1274 ± 40	1410 ± 37
	1311 ± 45	1344 ± 41	1376 ± 45
	1315 ± 57		
1200.8±30.7	1273.9±23.7	1303.5 ± 17.2	

Dating the Shroud

- Early 80's → Shroud probably authentic
  - Tradition claims it to be authentic
  - Historical research allows it
  - Blood marks → real body in the Shroud
  - STURP → no normal process made image
  - Image probably produced by radiation
- 1988 Carbon dating
  - Average of measurements = 1260 ± 31 AD
  - Corrected range =1260 to 1390 AD, 95%

Objections to the Carbon Dating

- Image could not be made in 1260-1390
- 13 other date indicators
- The different laboratories don’t agree
- Date is a function of the sample location
- Detailed statistical analysis
  - Something had altered the samples
  - The measured dates should be rejected

The Technology Did Not Exist to Make the Image in 1260-1390

- No pigment, carrier, brush strokes, etc.
- The image is a negative
- Contains 3D or topographical information.
- Only top 2 layers of fibers discolored
- Fiber discolored only 0.2 microns thick
- Discolored due to single electron bonds changed into double electron bonds

14 Date Indicators

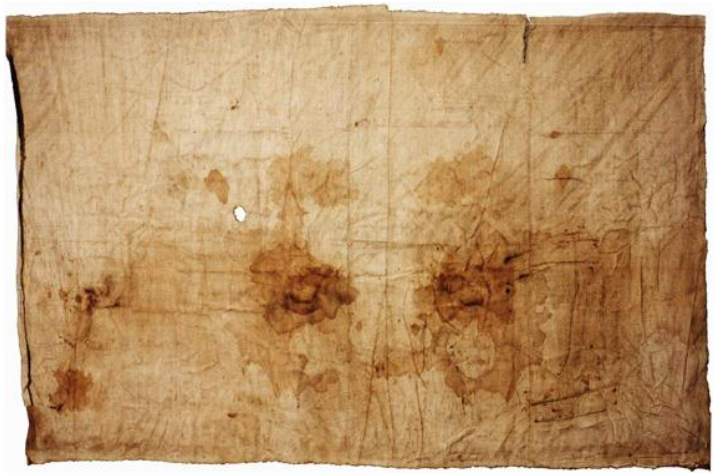
1. Carbon Dating: 1260 to 1390 AD
2. Micro-particles of gold coins: < 1204
3. Hungarian Pray Codex: < 1192-1195
4. Invention of the spinning wheel: < 1200
5. 8 x 2 cubit size of the Shroud: ancient
6. Coins with image of the face: ~ 675
7. Sudarium of Oviedo: ~ 570
8. Ancient paintings: ~ 550

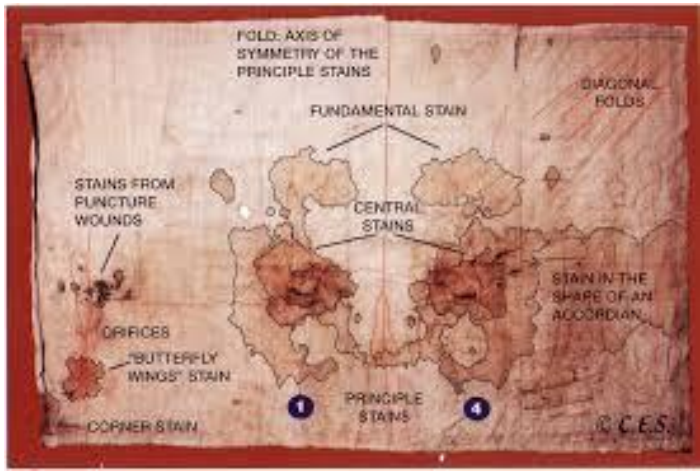
Ancient Coins

- I carry this coin in my wallet.
- An authentic Byzantine coin minted under Constantine VIII in 1025 to 1028 AD
- This coin disproves the C^{14} dating

Sudarium of Oviedo

- Located in Oviedo, Spain
- In Jerusalem area, 570 AD
- In Oviedo since 840 AD
- Cloth 33 by 21 inches
- No image but blood pattern similar to the Shroud
- Jesus' face cloth, Jn.20:7
- C^{14} dated to 700 AD





Christ Pantocrator, ~ 550 AD

Date Indicators

9. Crucifixion outlawed in 337: < 337 AD
10. Ancient traditions: < second century
11. Unique stitch on the Shroud: < 100 AD
12. Image of Jesus on the Shroud: 30 to 33
13. Possible coin over one eye: 29 to 32
14. Reflectance & tensile strength of linen as it ages: 33 BC ± 250
15. Radiation damage to linen: < 70 AD

Laboratories Don't Agree

- Difference between Arizona & Oxford:

  Arizona: 1303.5 AD $\pm$ 17.2

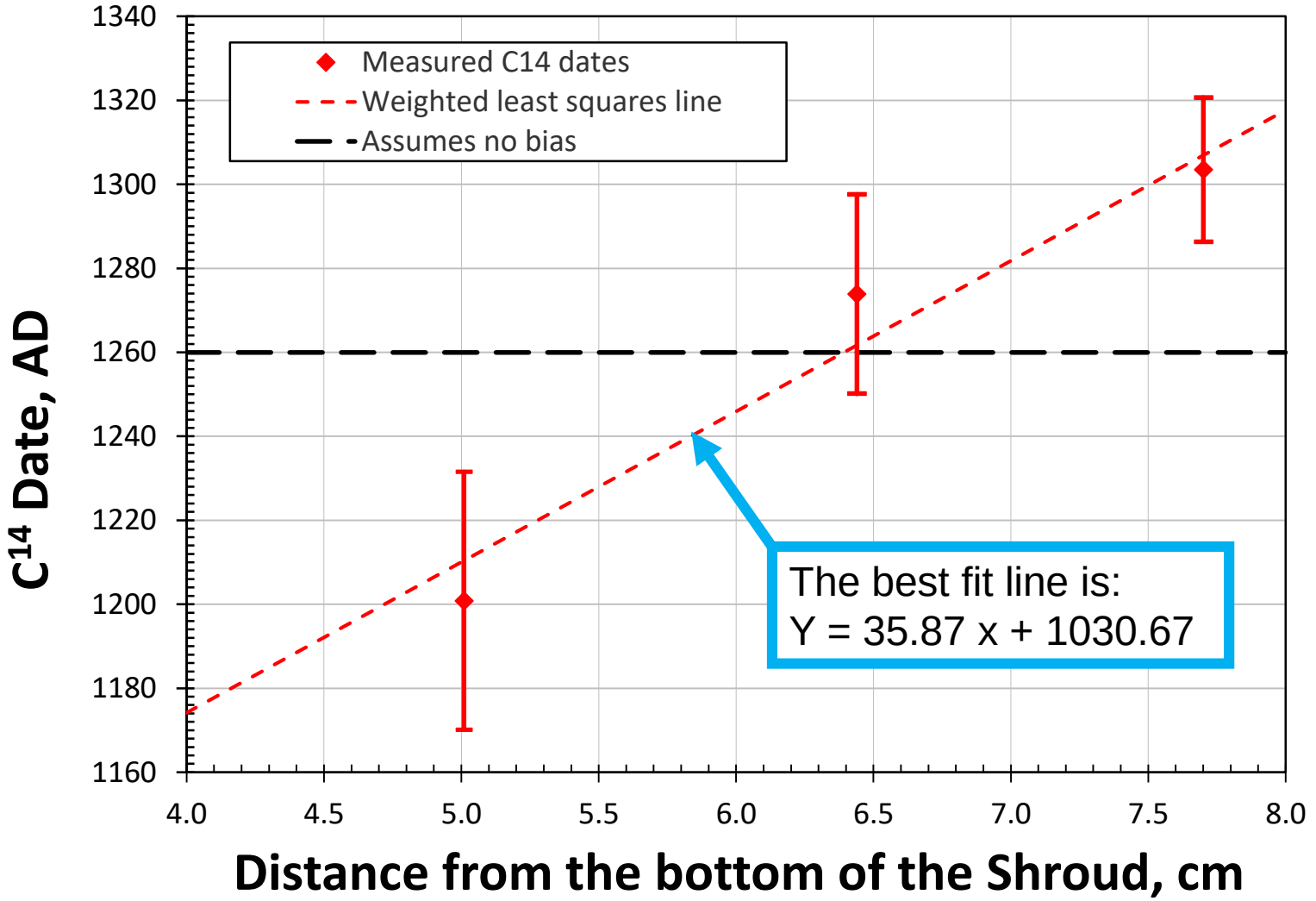
  Oxford: - 1200.8 AD $\pm$ 30.7

  Difference = 102.7 $\pm$ 35

  Square root of $17.2^2 + 30.7^2 = 35.2$

- 102.7 / 35.2 = 2.9 sigma difference
- Conslusion: the samples tested by Arizona and Oxford were different

Dates are a Function of Sample Location



Chi-Squared Statistical Analysis

- Probability that measurement variation is due to:
- Only random measurement errors = 1.4% probability
- Random errors + systematic bias about 98% probability
- Something had changed the samples
- Measured values should be rejected

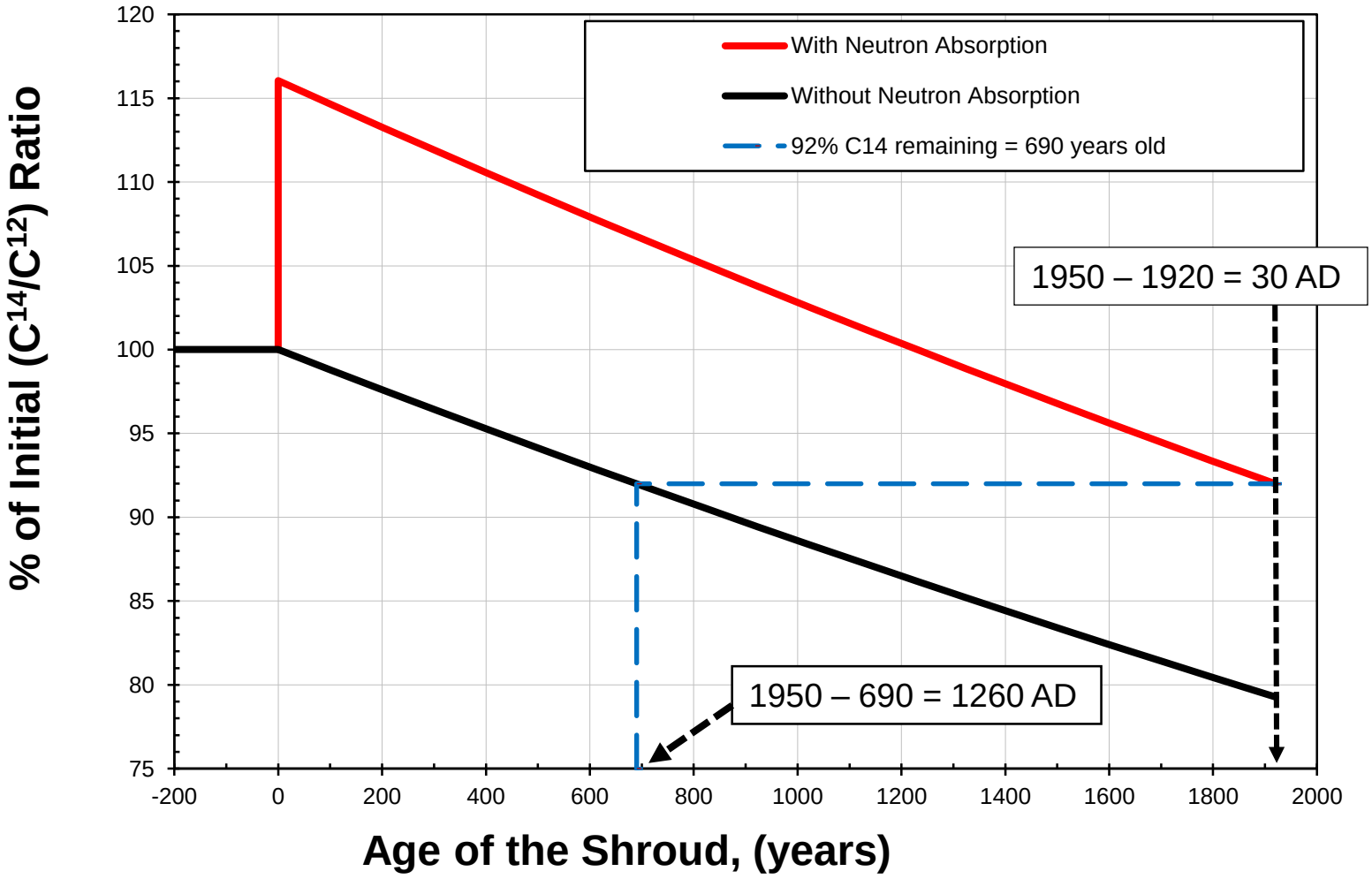
Neutron Absorption Hypothesis

If neutrons were included in the burst of radiation that caused the image, then some of them would have been absorbed in N^{14} in the Shroud to produce new C^{14} atoms.

N^{14} + neutron → C^{14} + proton

This would cause the Shroud to be C^{14} dated younger than its true age.

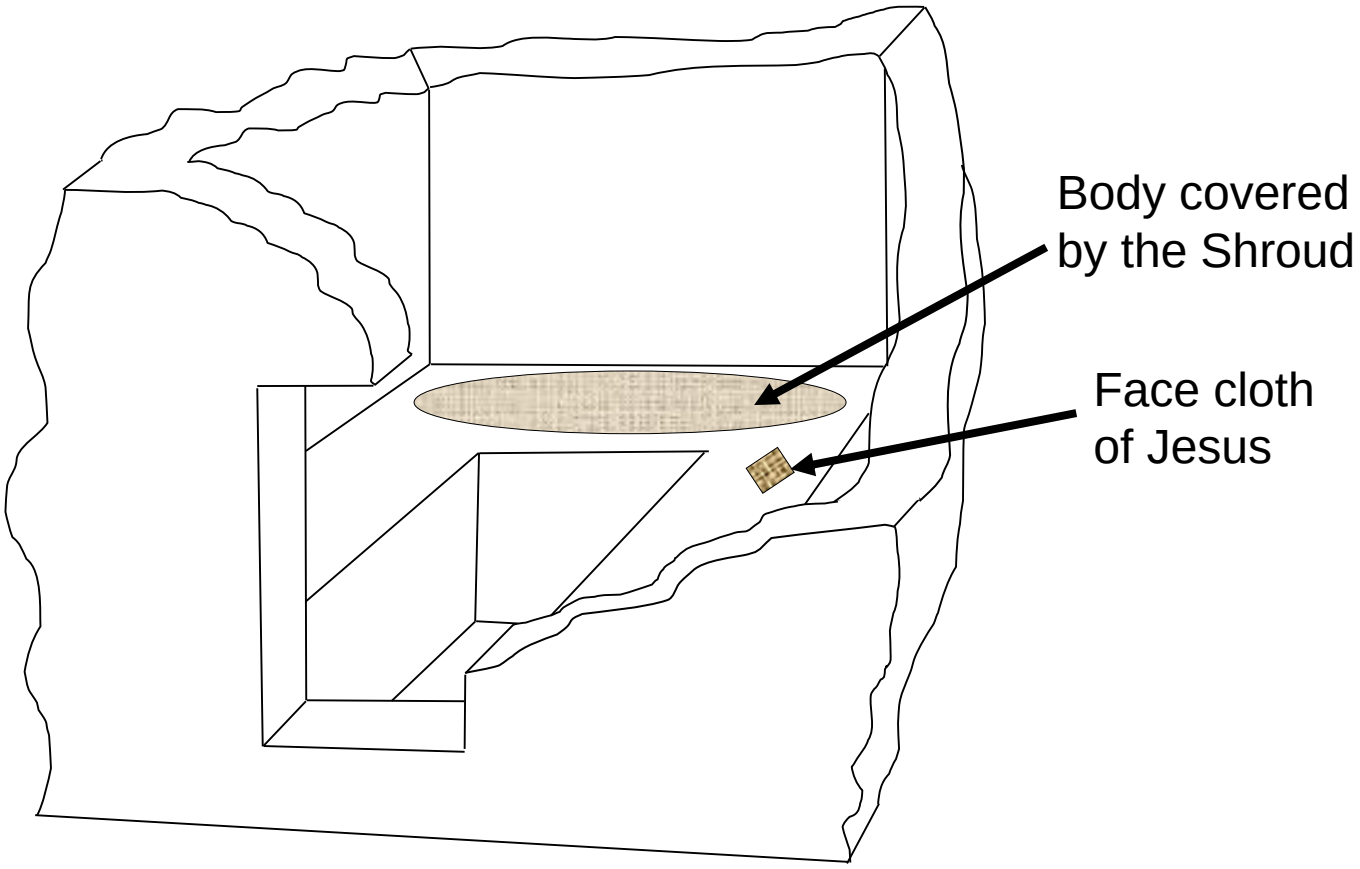
Effect of Producing New C^{14}



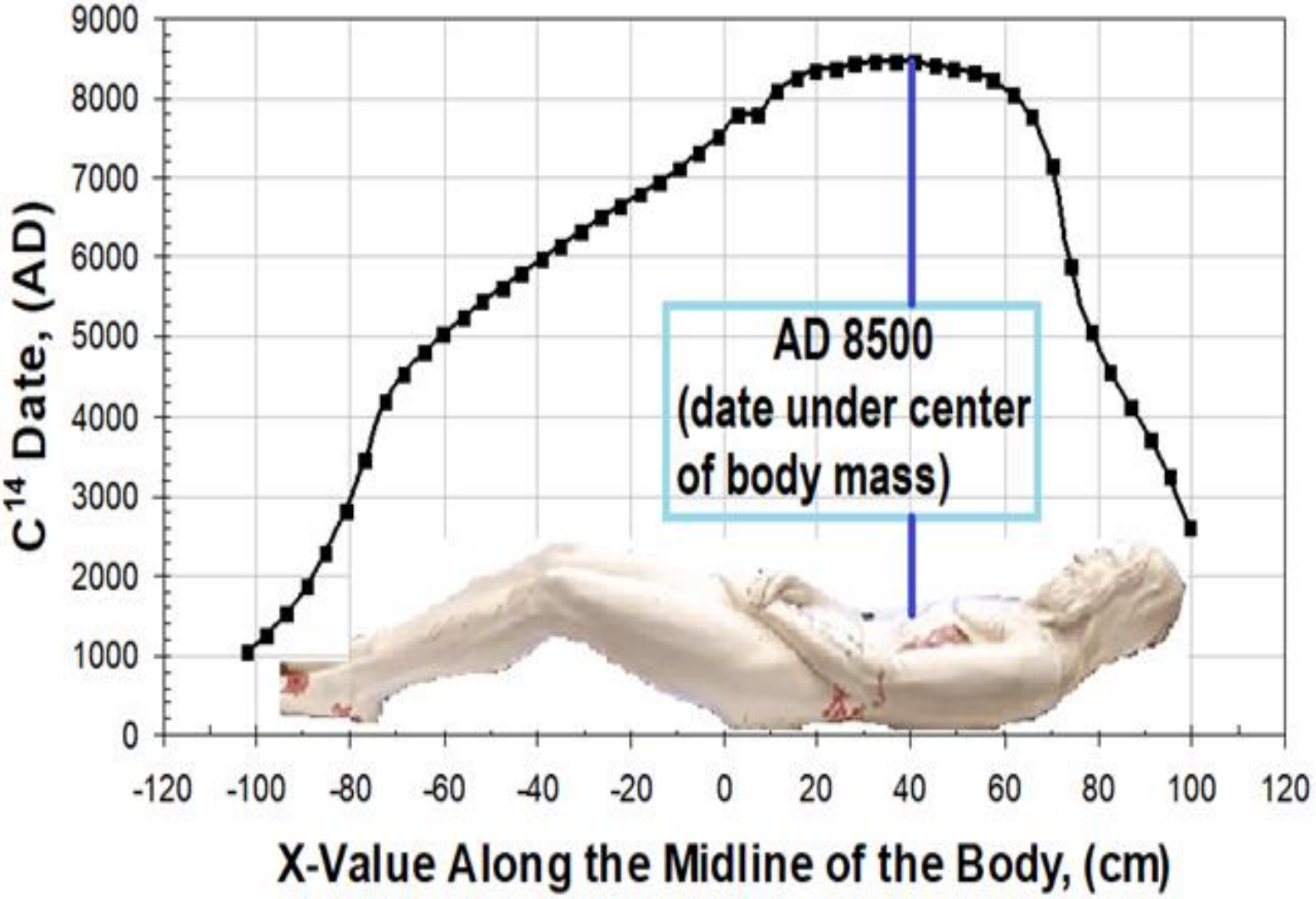
MCNP

- MCNP = Monte Carlo Neutron Particle
- Developed over the past six decades by the Los Alamos National Laboratory
- Verified to be accurate by comparison of calculated results with nuclear experiments

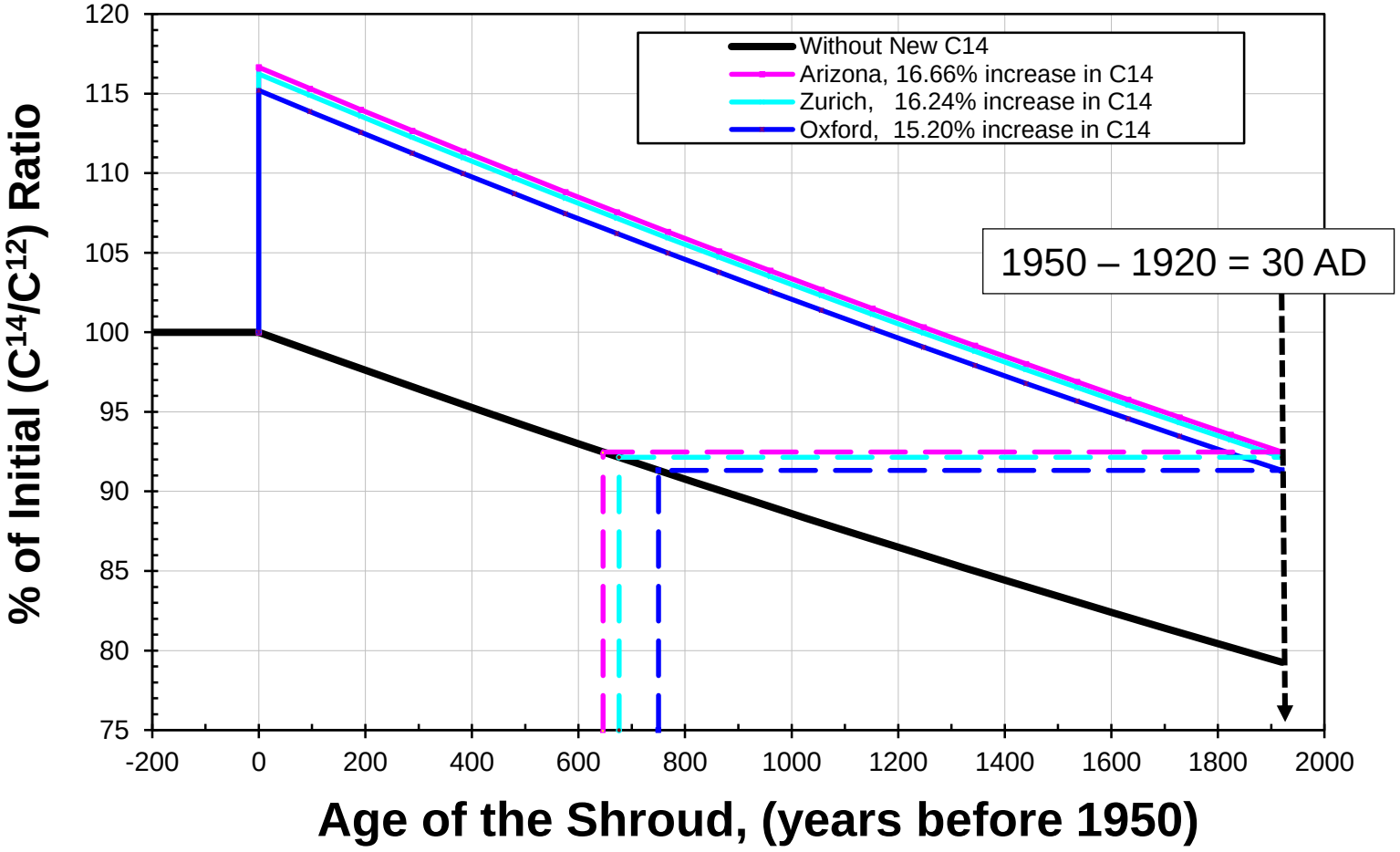
3D View Inside the Tomb



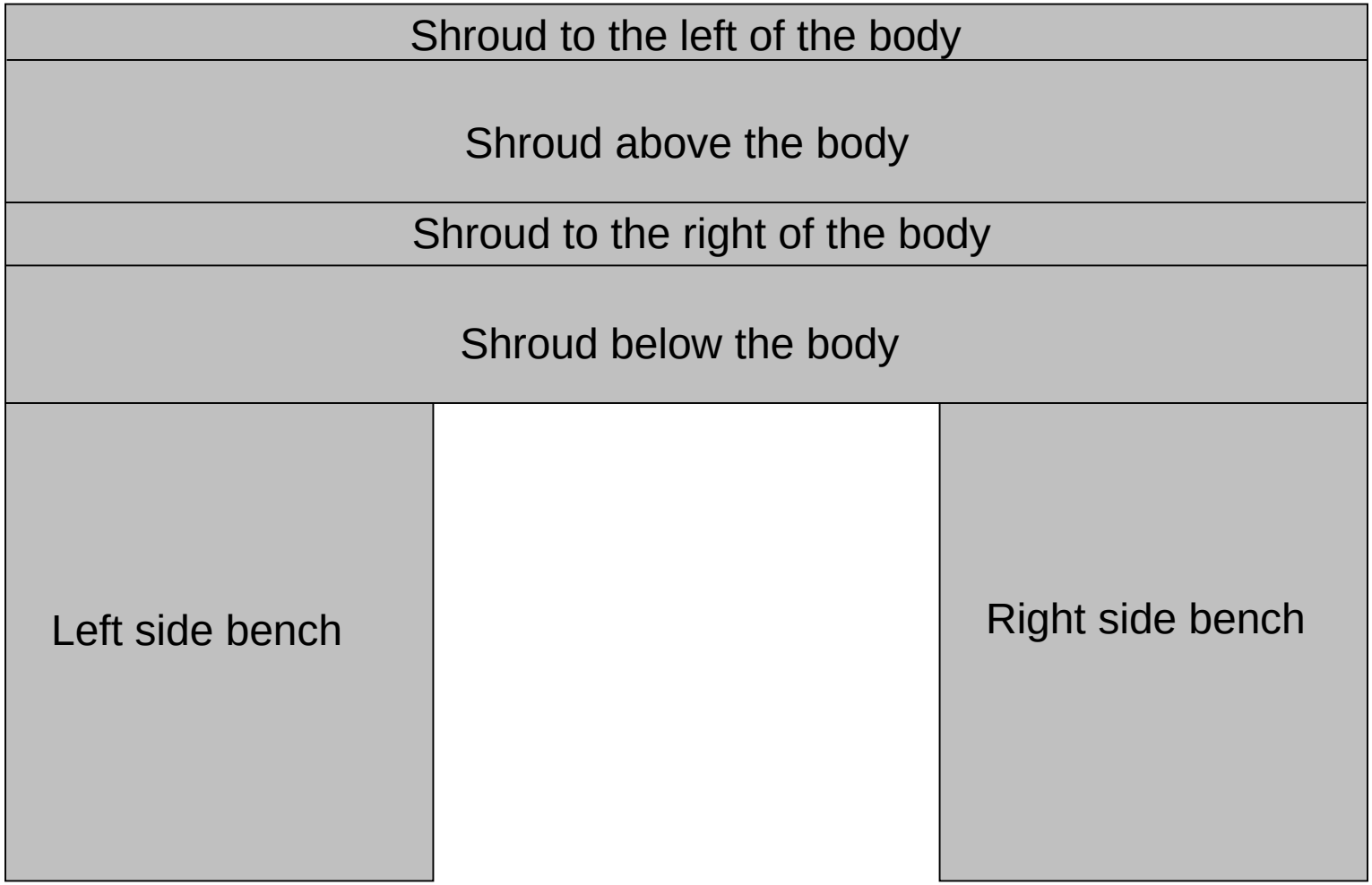
C^{14} Date in Shroud Below the Body



Different Increases in C^{14} for Each Sample Cause Different Dates



Large Tally Regions in the Tomb



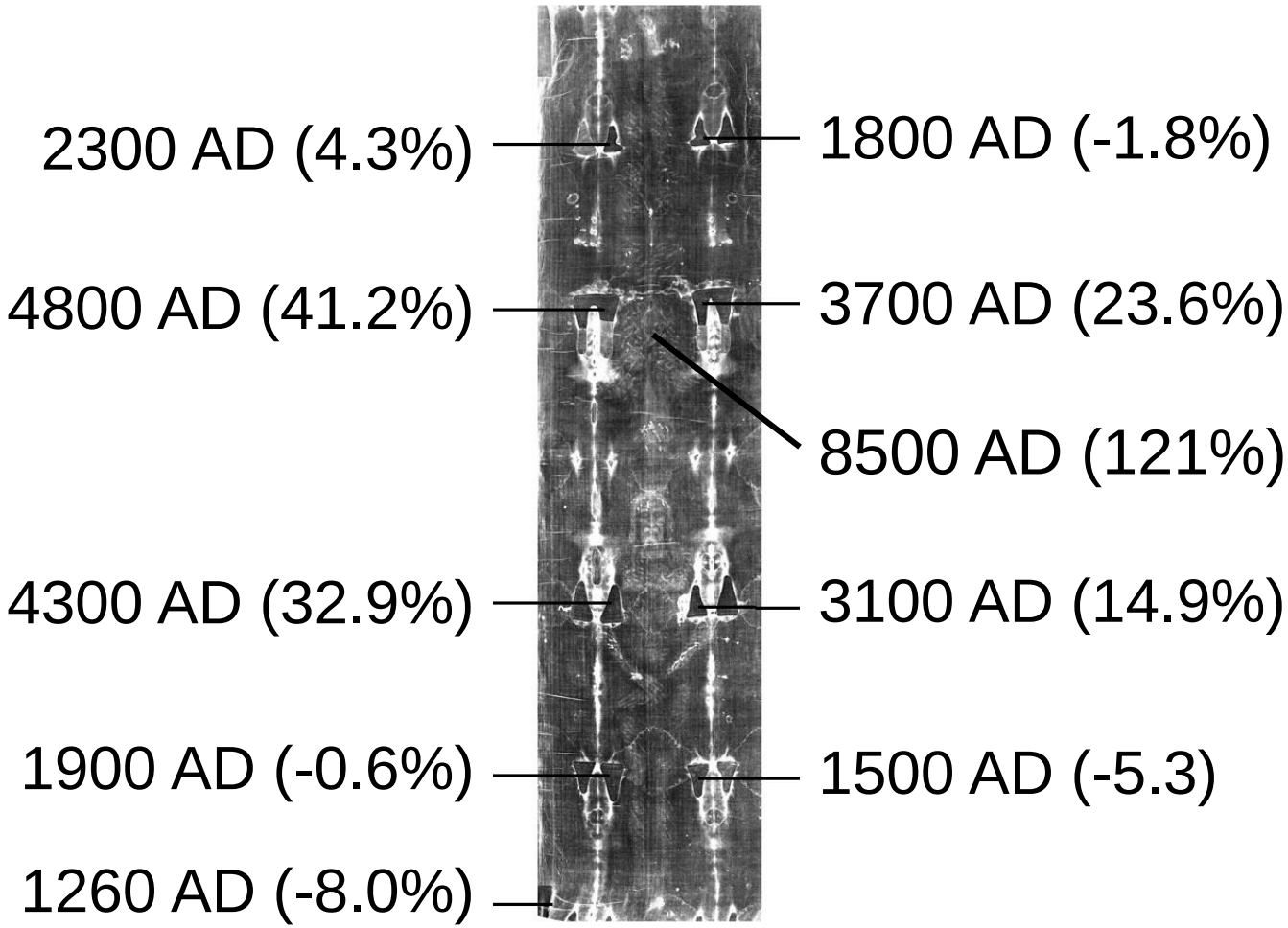
Predicted C^{14} Dates (AD)

Uncorrected C-14 Date (AD), Cases B182-B191								Uncorrected C-14 Date (AD), Cases B182-B191								
828	1017	1262	1542	1871	2252	2669	3085	3459	3676	3716	3719	3619	2954	2326	1683
824	1018	1202	1367	1542	1740	1976	2290	2836	3136	3171	3174	3130	2611	2156	1627
875	1086	1272	1436	1638	1841	2075	2408	2762	3012	3038	3033	2995	2525	2068	1571
983	1267	1477	1733	2044	2396	2783	3248	3534	3818	3862	3861	3785	3157	2348	1756
1067	1388	1618	1918	2293	2713	3133	3626	3750	3994	4048	4033	3958	3546	3057	2280
1005	1300	1541	1821	2159	2546	2937	3396	3654	3951	3984	3980	3912	3269	2547	1913
904	1154	1381	1612	1871	2141	2441	2829	3130	3392	3424	3409	3322	2825	2423	1826
866	1110	1363	1613	1884	2204	2590	3089	3897	4316	4379	4341	4166	3416	2620	1952
877	1123	1447	1831	2294	2813	3379	3954	4514	4819	4884	4849	4632	3746	2802	2025
958	1265	1659	2144	2692	3430	4326	5262	6141	6556	6620	6583	6320	4799	2994	2065
1197	1869	2985	4031	4950	5714	6341	6943	7603	8056	8147	8096	7811	5970	3679	2378
1317	2452	4260	5130	5745	6281	6779	7334	7909	8343	8459	8404	8115	6381	4235	2677
1143	1770	2880	3909	4819	5572	6200	6805	7477	7923	8023	7977	7697	5853	3468	2197
894	1136	1454	1853	2320	2997	3841	4760	5699	6081	6168	6161	5936	4462	2623	1789
581	637	693	754	838							1507	1364	1200	1060	925
557	601	638	682	747							1095	1022	947	876	802
532	569	599	627	679							888	843	803	760	700
506	543	566	588	630							764	734	704	678	636
486	514	536	554	588							680	660	640	616	577
458	490	504	523	546							619	599	579	562	534
442	466	480	494	516							568	550	533	520	490
419	441	455	468	491							522	508	496	485	459
405	423	434	444	465							491	478	464	455	429
384	408	416	425	447							460	448	439	429	411
371	393	401	412	426							440	432	420	409	391
356	374	385	393	411							424	411	401	392	374
343	363	372	383	402							410	398	387	376	356
322	344	359	370	391							401	387	374	357	333

Neutron Absorption Hypothesis

- Is the only hypothesis consistent with the 4 things we know about C^{14} dating as it applies to the Shroud
  1. C^{14} date to 1260 ± 31, uncorrected
  2. Slope of C^{14} date = ~ 36 years per cm
  3. Range of dates = 1155 to 1410 AD
  4. Date for Sudarium of Oviedo = 700 AD

Predicted Date (Change in C^{14})



Testing the Neutron Absorption Hypothesis

- C^{14} date at the elbows
  1. ~ 4500 AD toward the back wall
  2. ~ 3500 AD away from the back wall
- Detection of long half-life isotopes
  - C-14, Cl-36, Ca-41, Sc-45, Ni-59, Zr-93, Nb-94, U-233, Pu-239

Thank You

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