

Size and Structure of the Estimated Uncertainty in Radiation Doses Received by the Atomic Bomb Survivors in Hiroshima and Nagasaki

Harry M. Cullings

Radiation Effects Research Foundation
Hiroshima and Nagasaki, Japan

Outline

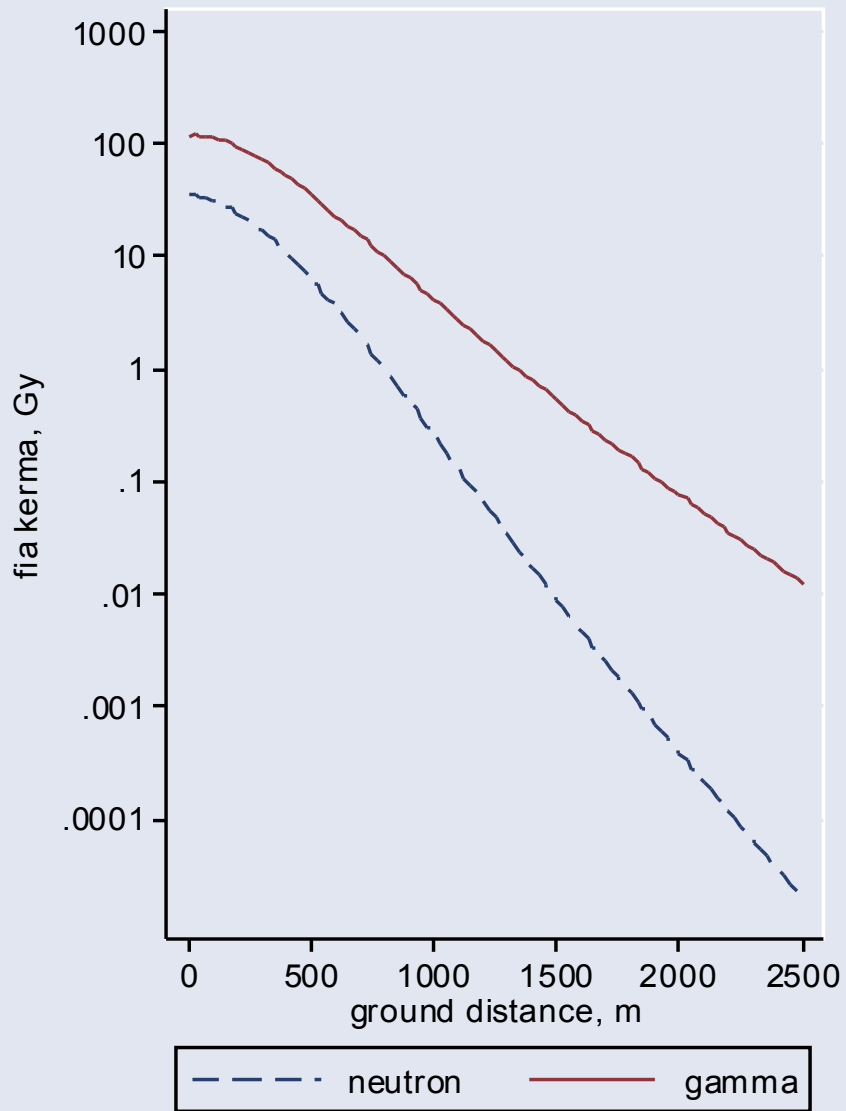
- Fundamental considerations relevant to dose uncertainty
 - cohort composition & exposure data
 - dose calculation
- Classical errors
- Berkson errors
- Systematic errors



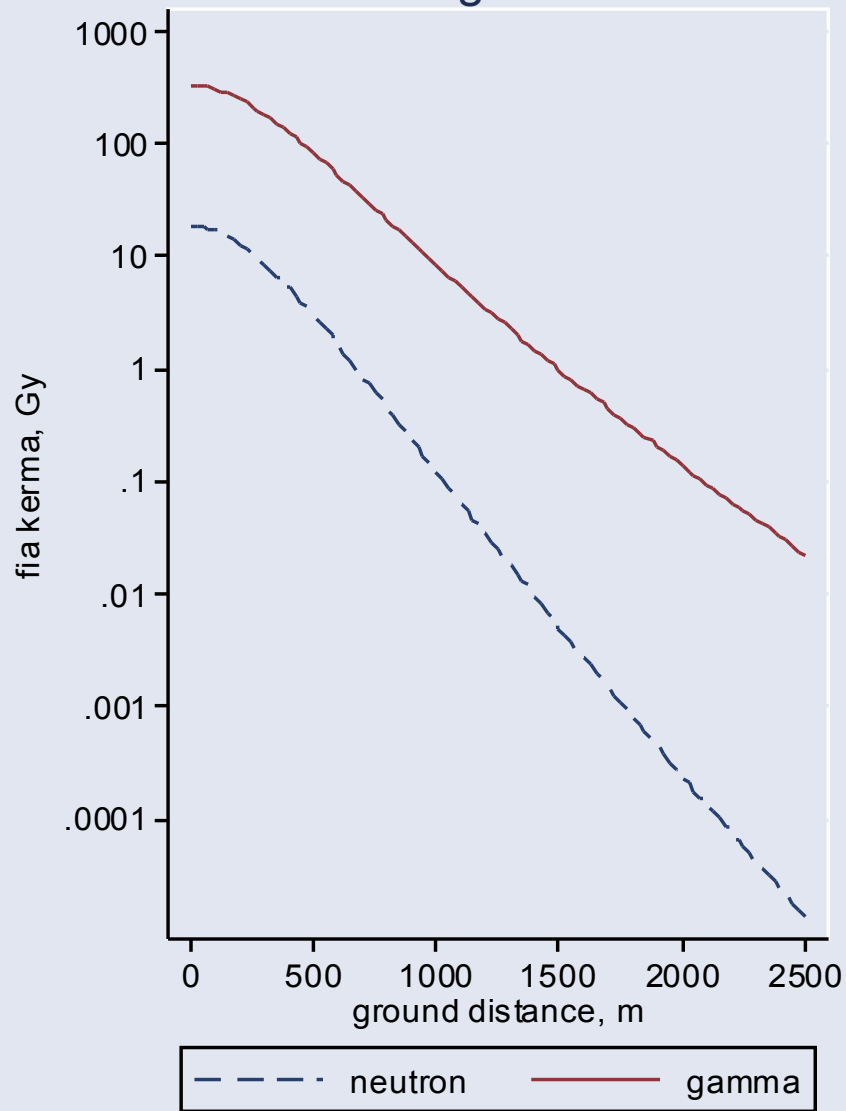
Distribution of Population and Shielding Category in the LSS

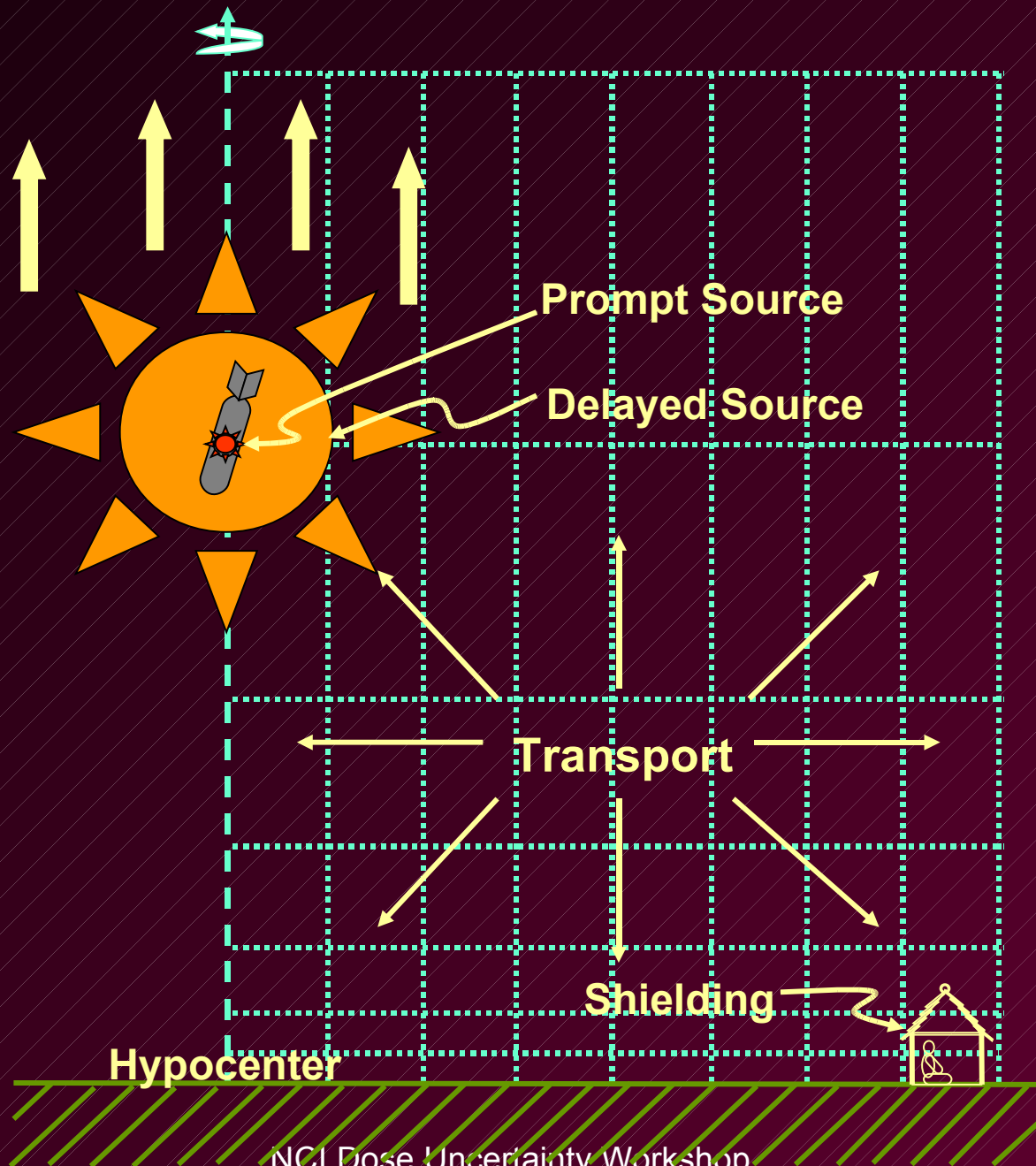
Type of Shielding		No shielding history or no DS02 model		Shielding history and DS02 model	
		Dose estimated	Dose not estimated	Dose estimated	Dose not estimated
Inside		44,844	5,548		
	House			12,858	0
	School			688	0
	Other wooden building			783	0
	Factory		205 (Hiroshima)	652 (Nagasaki)	
	Concrete building		696		
Outside		19,919	415		
	In open			1,139	0
	Near building			3,104	1
	Near small hill			308	7
No shielding information		2,376	198		
Not in city		26,580	0		
Column totals		93,719	7,062	19,532	8
Total	120,321				

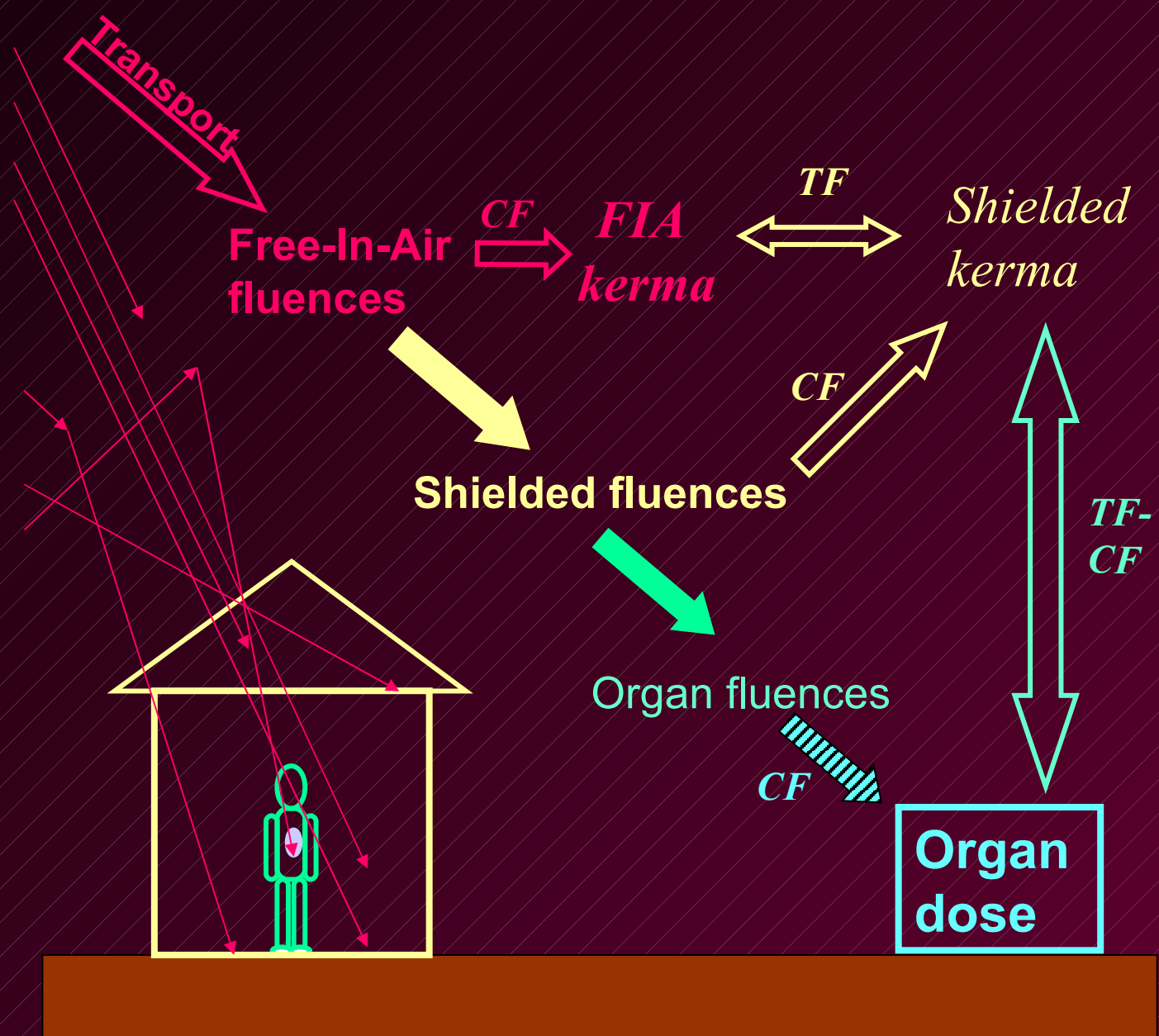
Hiroshima



Nagasaki

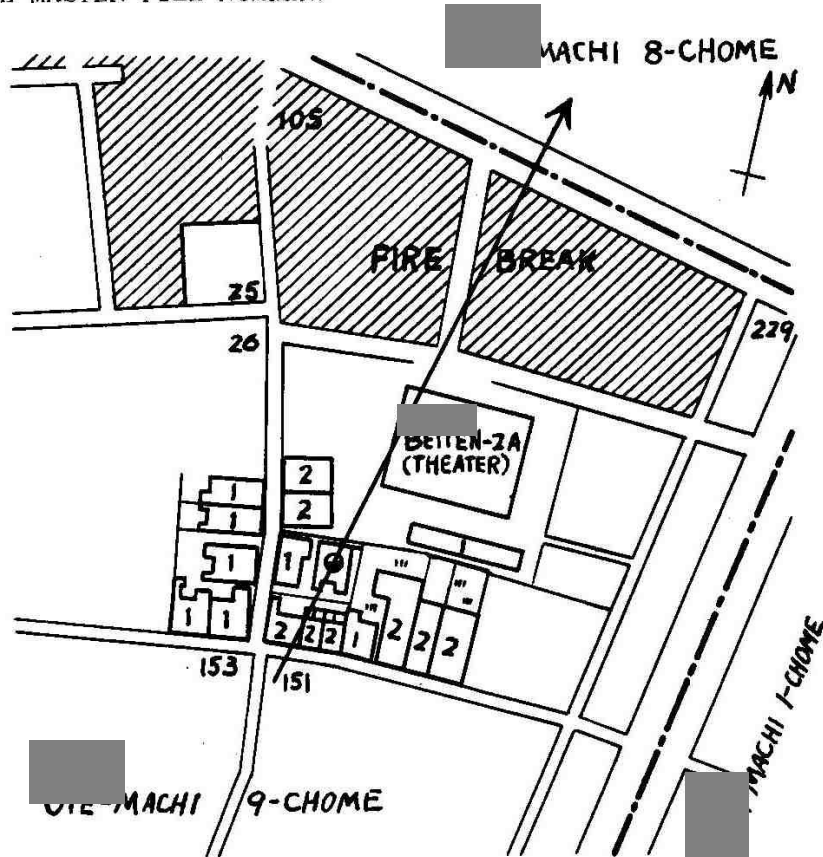






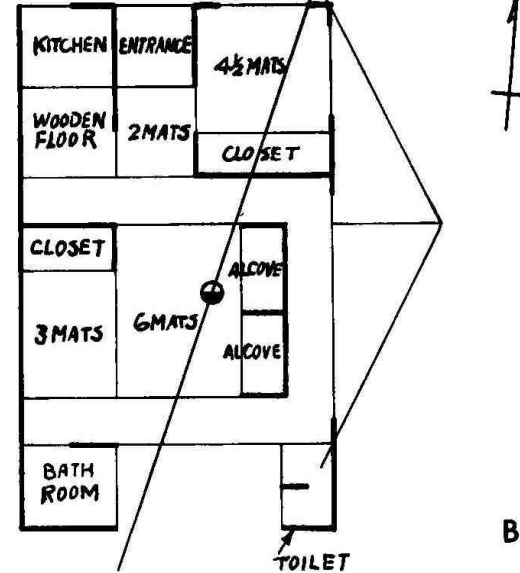
Master File Number	Name	
Location at Time of Bomb	machi 9chome 68	Scale:
Co-ordinates	Distance	1: 1200
44-0000	1,323 M.	

SEE MASTER FILE NUMBER:

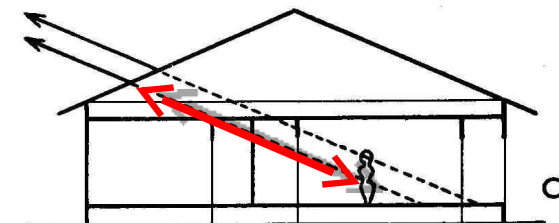
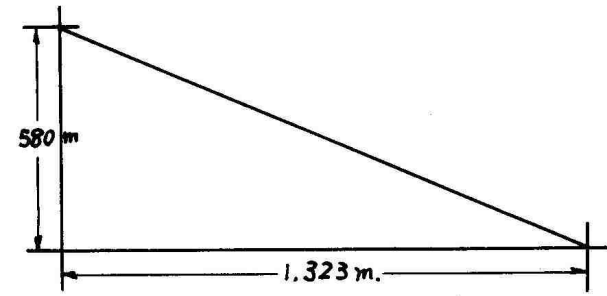


1- SINGLE STORY JAPANESE TYPE HOUSE
 2- 2 STORY "

A



B

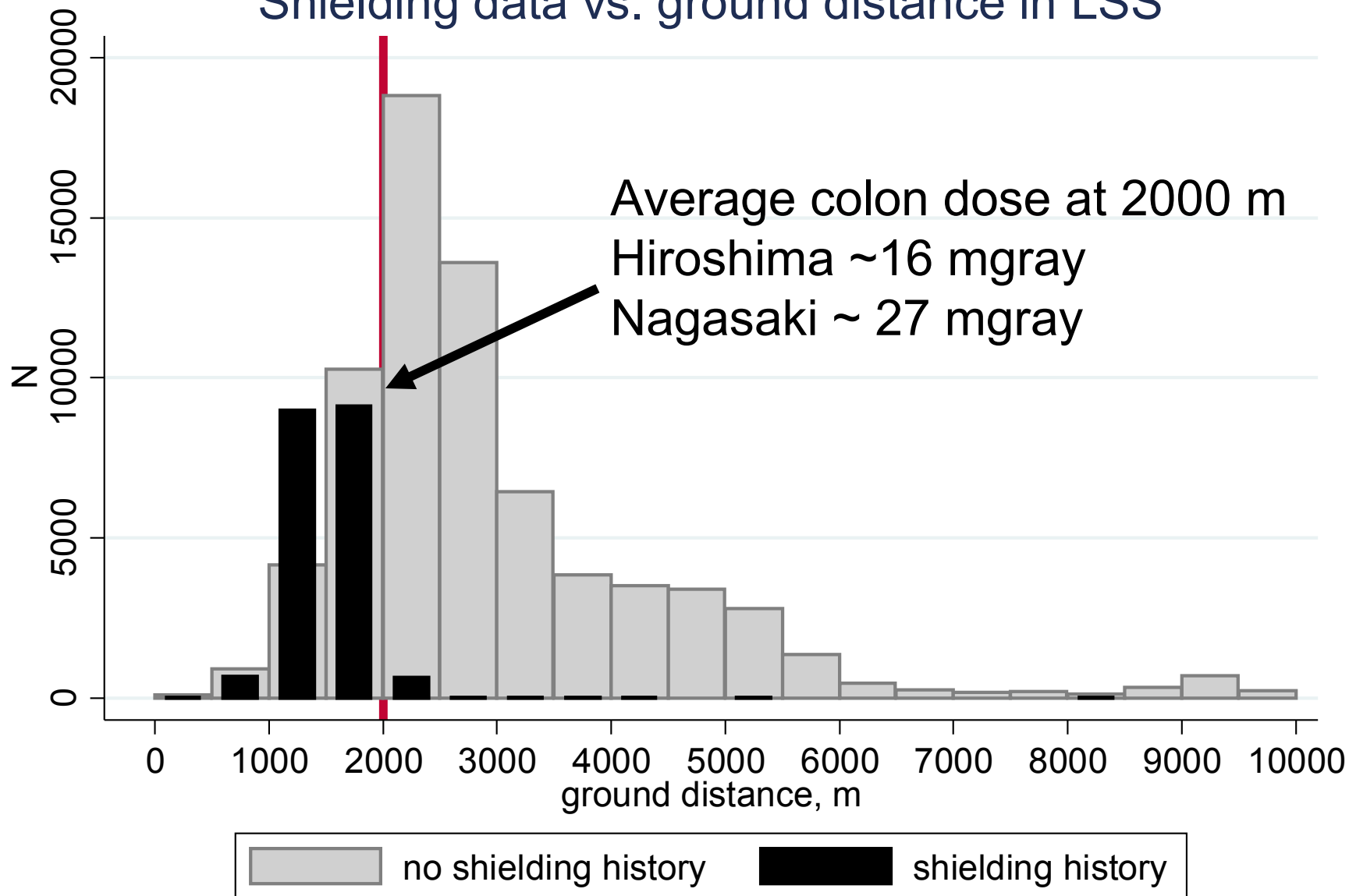


C

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Shielding data vs. ground distance in LSS



Classical/Measurement Error

- Generally assumed to be dominated by inaccuracy of survivor recall
- Other minor contributions from sources such as Monte Carlo imprecision in shielding calc's
- 35% to 40% *cv*
 - Gilbert; Pierce, Stram & Vaeth; Pierce, Vaeth & Cologne

Classical/Measurement Error

- 35% to 55% *cv*
 - Sposto, Stram & Awa
 - Based on chromosomal aberrations & epilation
- 45% *cv*
 - Miller, Ph.D. dissertation U Buffalo, April 2009
 - Based on chromosomal aberrations & GPA; epilation for radiosensitivity
 - Instrumental variables model in small (n = 316) subset of LSS/AHS
 - Assumed Berkson error ~29% *cv*, est. from DS02 Ch 13 and other sources

HOUSE AND TERRAIN SHIELDING

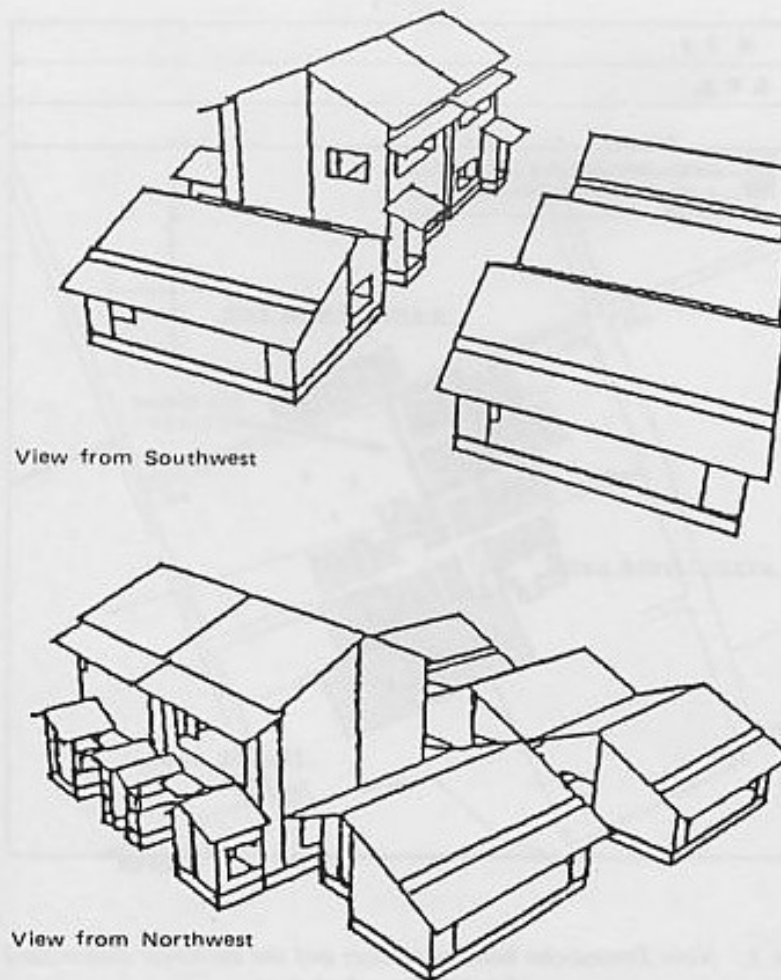


Figure 2. Combinatorial geometry of the six-house cluster model

HOUSE AND TERRAIN SHIELDING

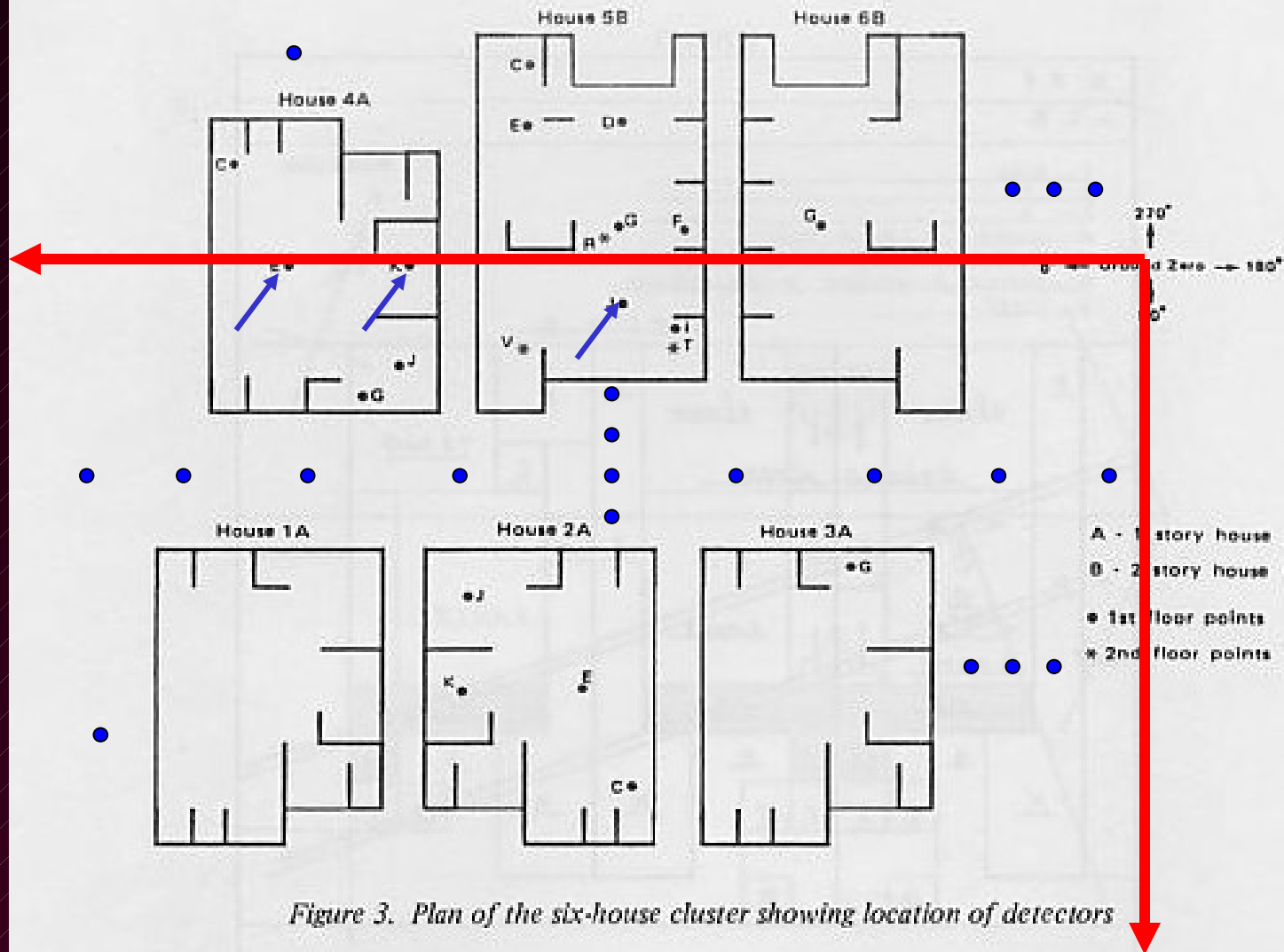


Figure 3. Plan of the six-house cluster showing location of detectors

Berkson/Grouping Error

- Detailed estimates in Ch 13 of DS02 Report
 - For persons in houses, *with shielding histories*, dominated by grouping error in aggregating 1296 calculations of model house cluster to 97 groups
 - Some classifications → 30% *cv*
 - Similar considerations for those outside but near houses, with shielding histories
- Survivors without shielding histories have considerably larger Berkson error in shielding
 - Between group σ > within group σ

Berkson/Grouping Error

- All survivors have other, lesser contributions
 - Error due to distance rounding in survivors with “100 yard” precision in map coordinates is minor
 - s.d. ~ 26 m $\rightarrow \sim 10\%$ in dose
 - “100 yard” (vs. 10 yard) precision mostly applies to survivors without shielding histories
- Total estimates of Berkson error cv recently calculated; range from $\sim 8\%$ to 44% for various classifications of survivor shielding and distance information
 - More detail in extended abstract for this talk

Systematic Errors

- Most systematic errors relate to a distance-dependent error in unshielded dose
- Error in hypocenter location → shared dose error with a unique structure
 - estimated size is rather small

Estimated cv of DS02

Unshielded Dose Calculation

Ground distance, m	Hiroshima		Nagasaki	
	Neutron	Gamma	Neutron	Gamma
700	0.16	0.13	0.14	0.12
1000	0.16	0.13	0.14	0.11
1500	0.17	0.13	0.16	0.11
2000	0.19	0.12	0.19	0.11
2500	0.25	0.13	0.26	0.11

Conclusions

- Predominant source of classical error is poorly estimated, but efforts underway to provide improved estimates.
- Size of estimated Berkson error varies considerably among defined subsets of survivors & variation in size is related to dose.
- There could be more work on incorporating effects of reasonably well estimated systematic errors (and random errors) on *uncertainty* in dose estimates