Logistic Regression in R

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Feb 4th, 2016

EDNS-RAD

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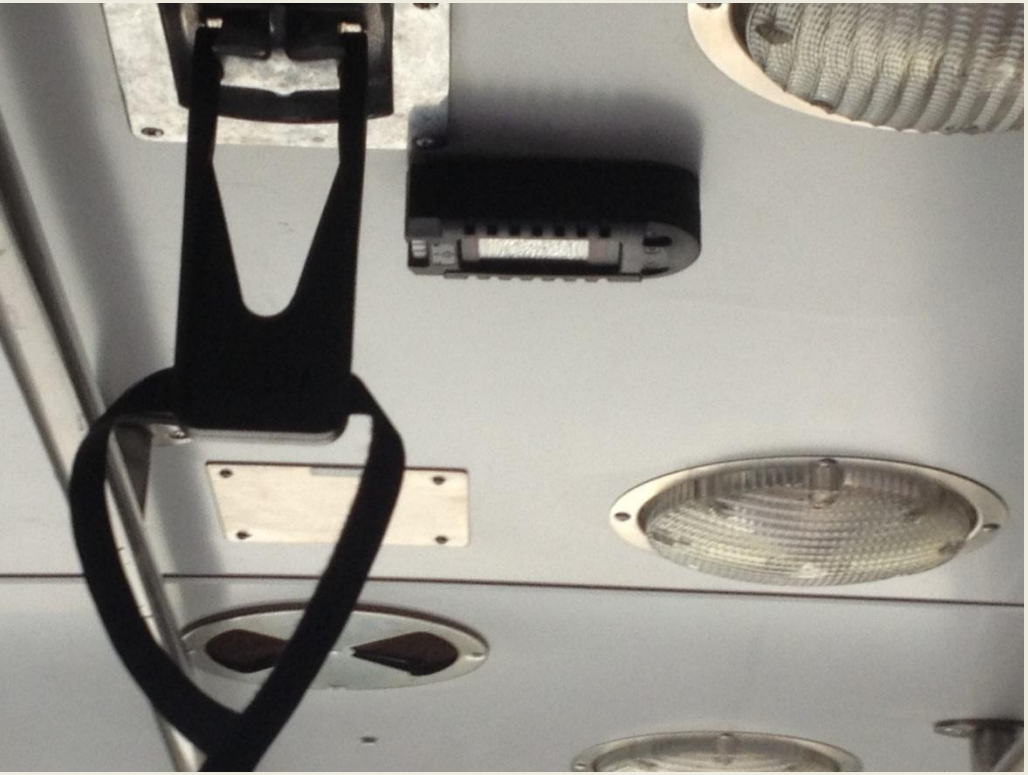
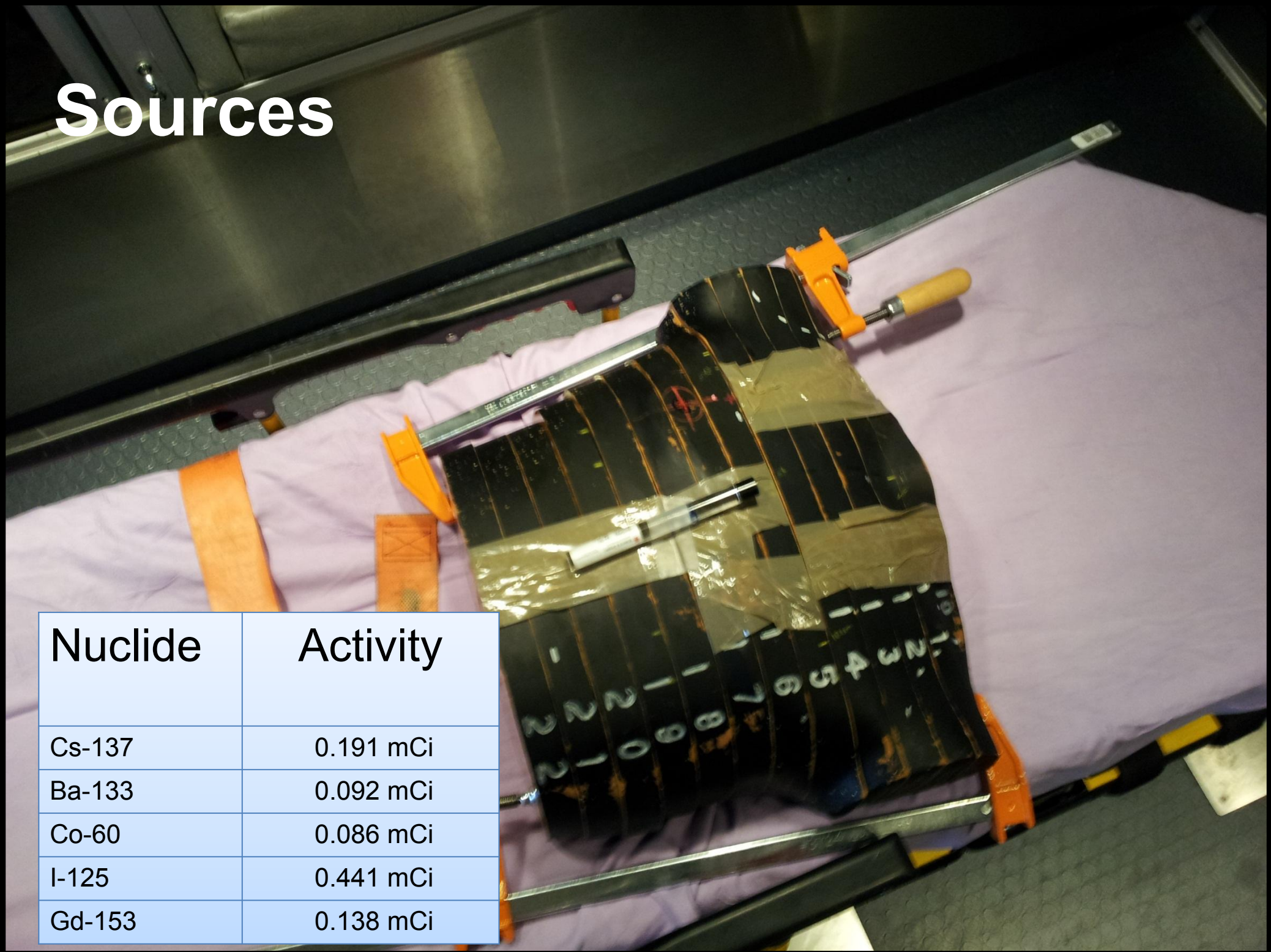
An evaluation of radioisotope detector performance for first-responder use.



Sources



Nuclide	Activity
Cs-137	0.191 mCi
Ba-133	0.092 mCi
Co-60	0.086 mCi
I-125	0.441 mCi
Gd-153	0.138 mCi

Identification

- Time-to-Identification
- Isotopes(s)
- Confidence Levels

Descriptive Range	Confidence Range
Low	40 - 64
Medium	65 - 84
High	85 - 100

Identification

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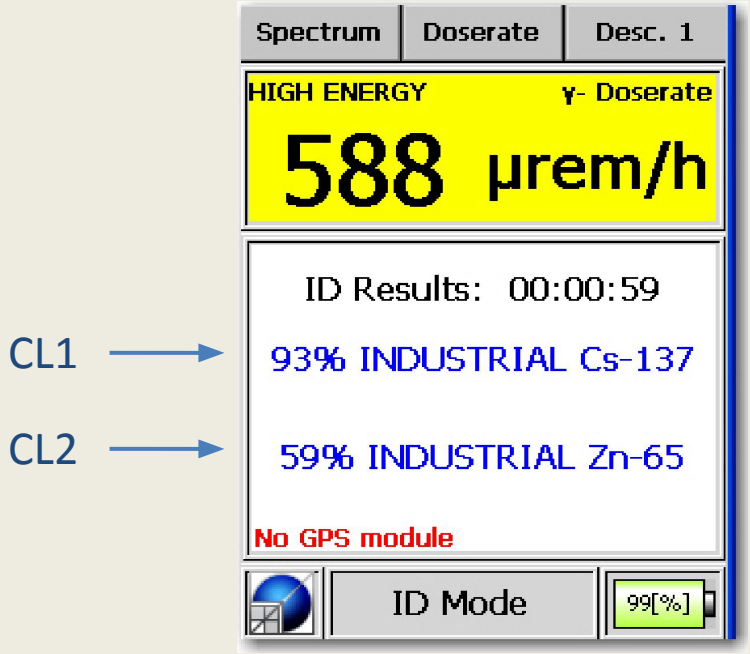


Descriptive Range	Confidence Range
Low	40 - 64
Medium	65 - 84
High	85 - 100

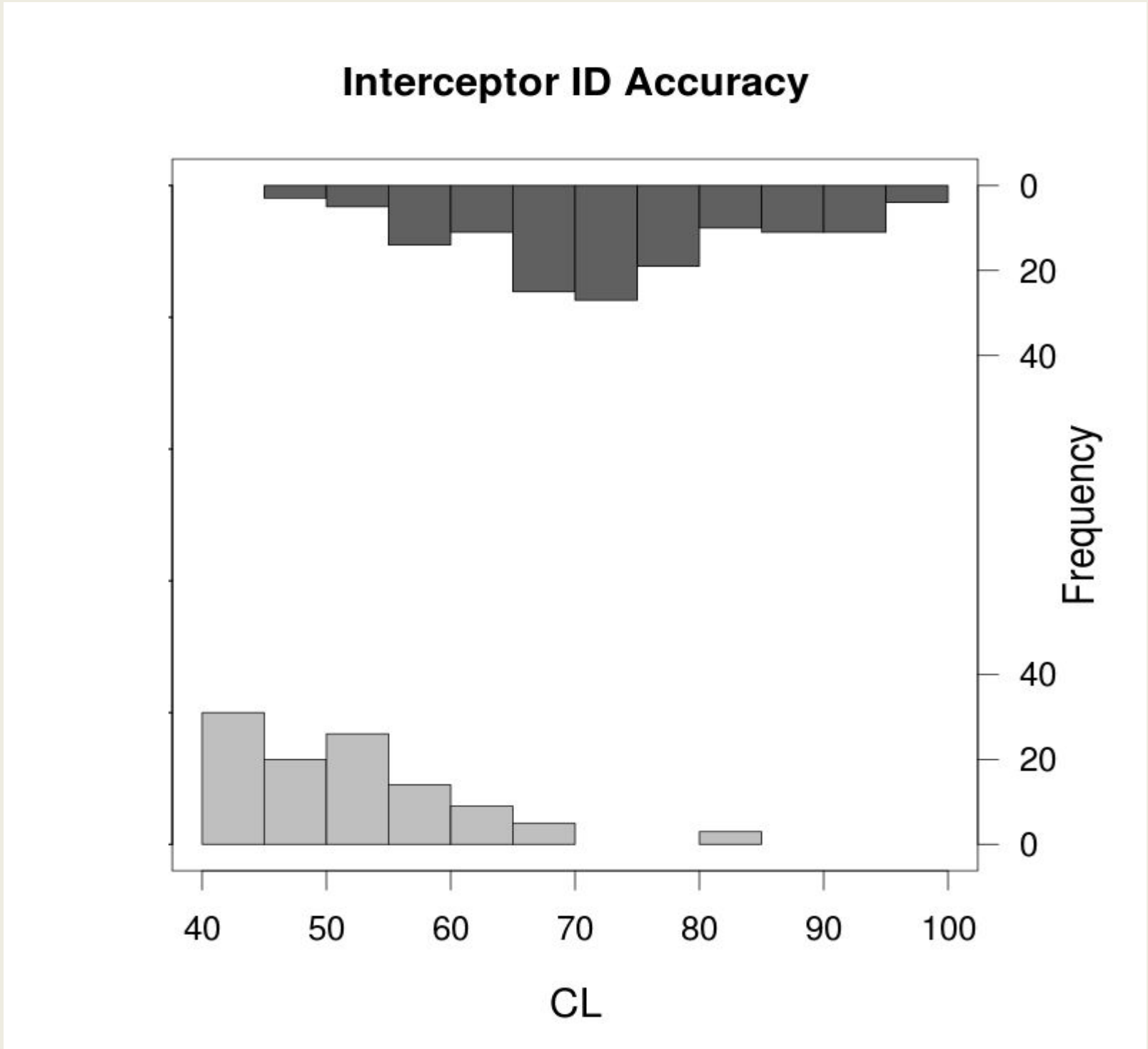
ID results

119 Trials: 54 Single Isotope; 65 Two isotope
Time-to-Identification typically under 5 minutes

clearly not big data

Zee Data

Source	TTI (s) tot	ID	CL	bolus	num	correct
Cs137	213	Cs137	93	0	0	1
Cs137	210	Cs137	95	0	0	1
Cs137	210	Lu177	41	0	1	0
Cs137	221	Cs137	93	0	0	1
Cs137	221	Pb214	44	0	1	0
Cs137	183	Cs137	92	3	0	1
Cs137	183	Se75	41	3	1	0
Cs137	185	Cs137	90	3	0	1
Cs137	185	Cr51	46	3	1	0
Ba133	90	Ba133	87	0	0	1
Ba133	90	I131	48	0	1	0
Ba133	100	Ba133	86	0	0	1
Ba133	100	I123	53	0	1	0

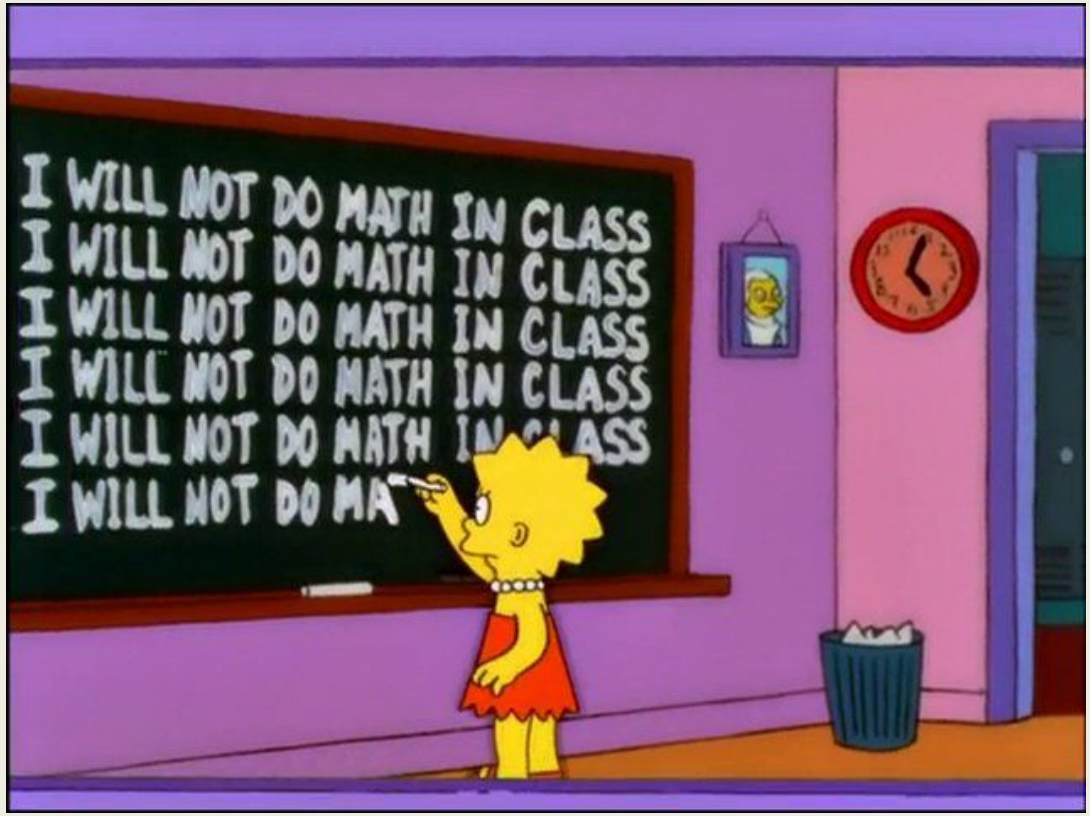

Interceptor ID Accuracy
0
20
40
Frequency
40
20
0
40
50
60
70
80
90
100
CL

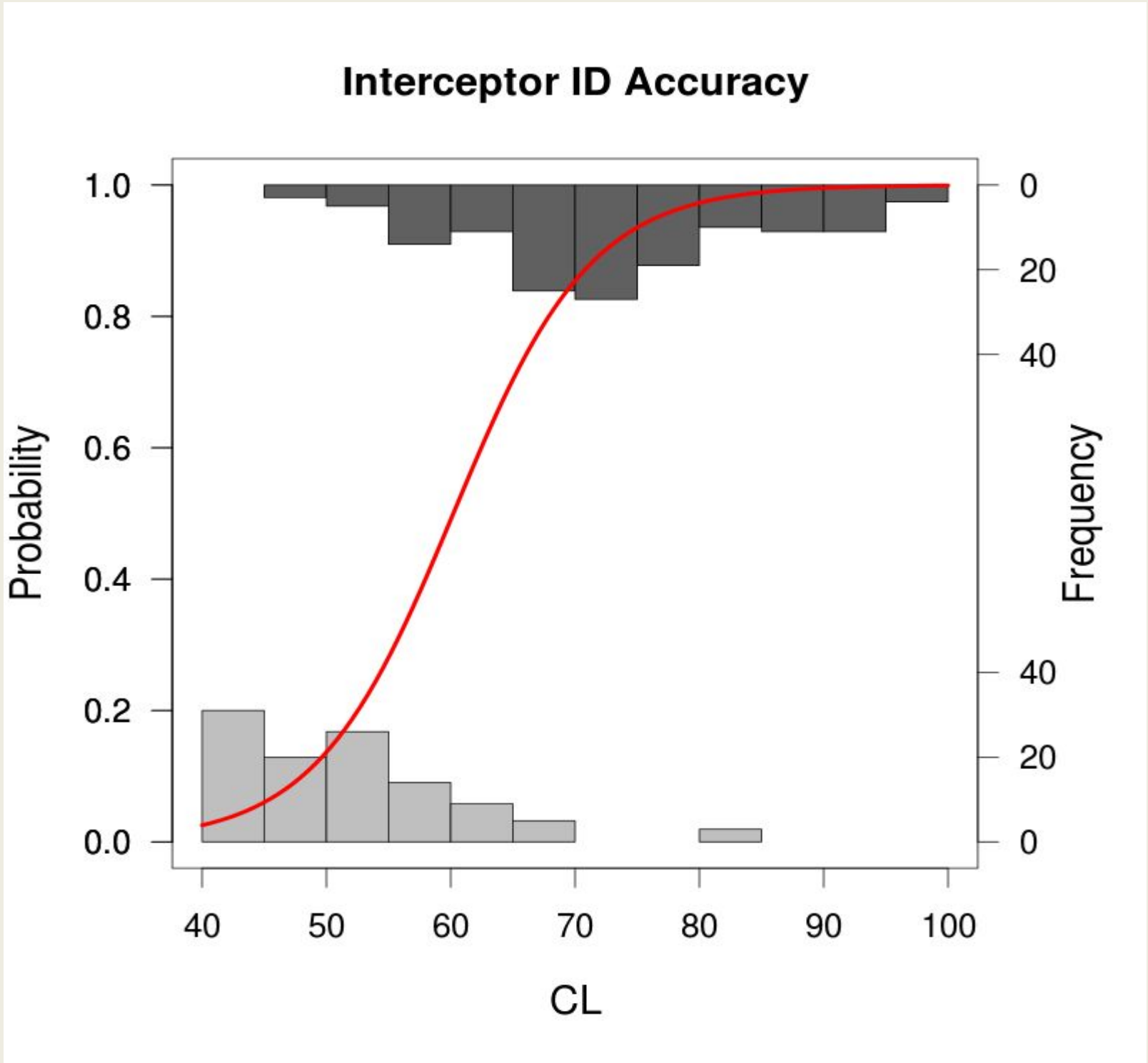
Logistic Regression

GLM - generalized linear model predicts a categorical dependent variable

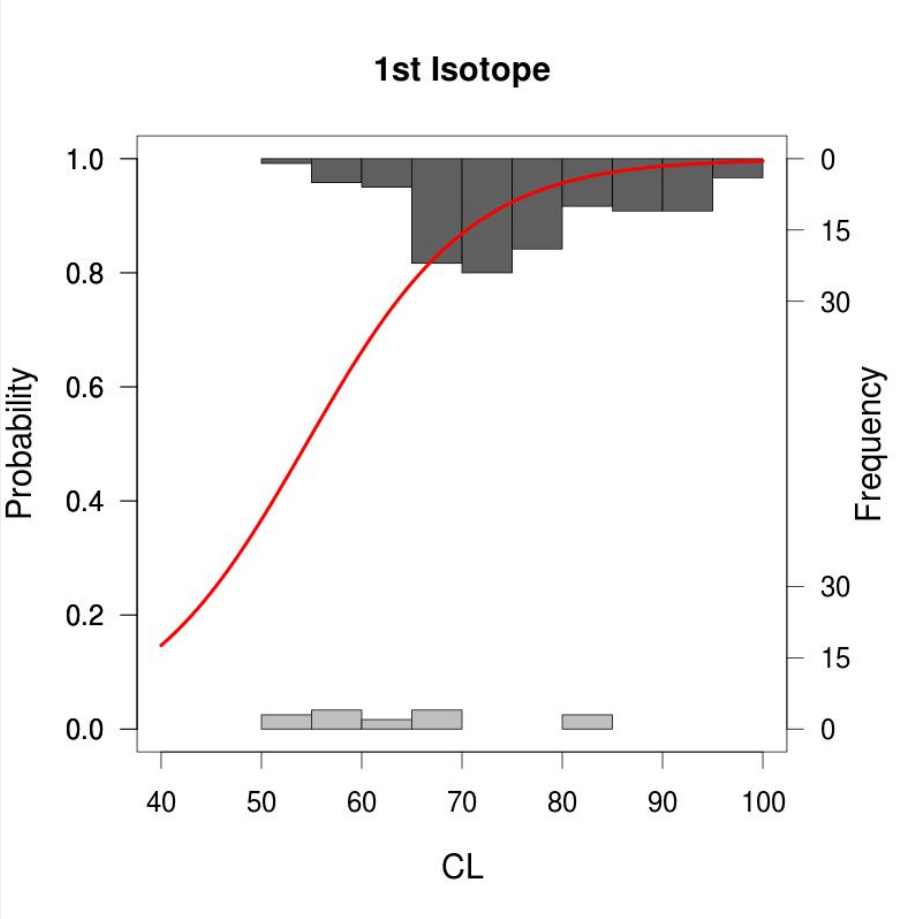
For this case, the binary result for correct identification.

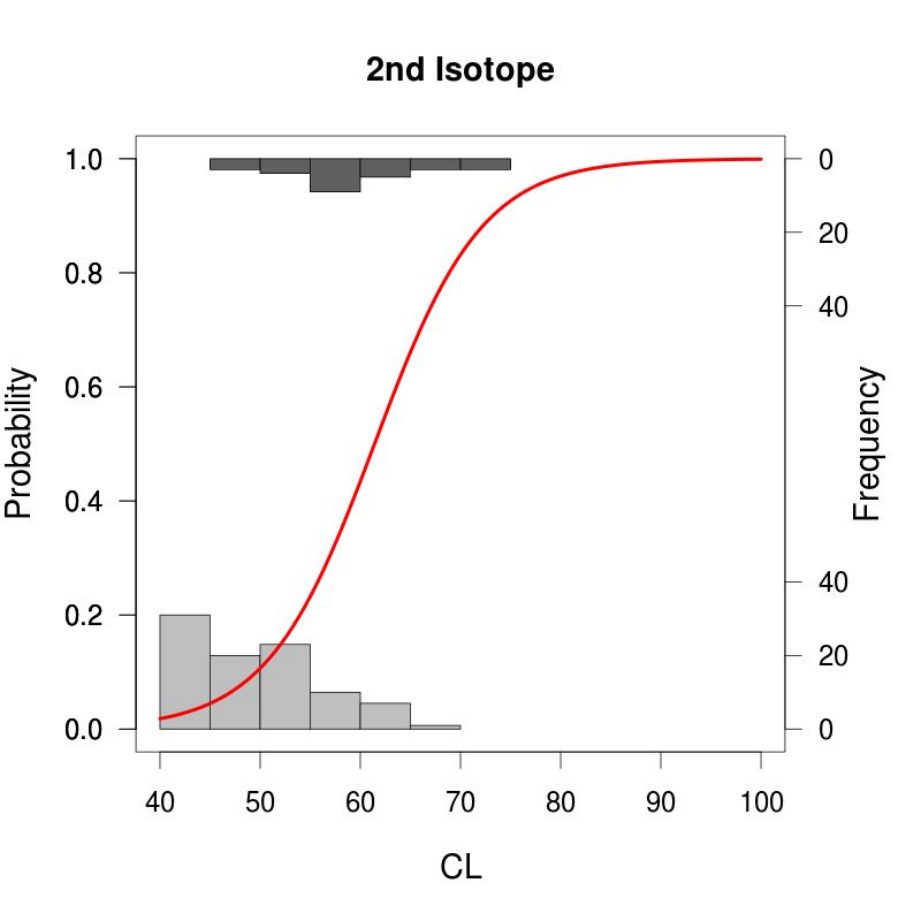
To the whiteboard...




Interceptor ID Accuracy
Probability
1.0
0.8
0.6
0.4
0.2
0.0
Frequency
0
20
40
40
20
0
40
50
60
70
80
90
100
CL

ID Results


1st Isotope
Probability
Frequency
CL
1.0
0.8
0.6
0.4
0.2
0.0
0
15
30
30
15
0
40
50
60
70
80
90
100


2nd Isotope
Probability
Frequency
CL
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
40
20
0
40
50
60
70
80
90
100

ID results

- 119 Trials: 54 Single Isotope; 65 Two isotope
- Time-to-Identification typically under 5 minutes
- Primary Isotope Correct 96% of the time
- Secondary Isotope was Problematic
  - Correct less than 10% of time in single isotope case
  - Only correct 42% of time in two isotope case
- Primary analysis question is one of ***confidence***
- Gd-153 identified as Sm-153, limits of device library

ID results

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- Time-to-Identification typically under 5 minutes
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- Sec
  - C pe case
  - C
- Prin dence
- Gd-153 identified as Sm-153, limits of device library

Descriptive Range	Confidence Range	ID1 Accuracy	ID2 Accuracy
Low	40 - 64	68% (n=19)	19% (n=105)
Medium	65 - 84	100% (n=80)	78% (n=14)
High	85 - 100	100% (n=20)	NA (n=0)

Further Reading and Links

- Example with apache II scores for predict sepsis
- Generalized_linear_model
- Readmission Risk and Pneumonia

Discussion of Capability

- Can set higher minimum ID Time, ~5 min
- Dose-rate measures hazard
- Mis-identification concerns.
  - One isotope listed is medical, one is not? Which is truly present?
- Operator demands
  - User Unattended mode mostly works
  - Ceiling position difficult to oberve
- Blind to alpha and beta emitters (no easy solution)

IAEA Emergency Guidelines

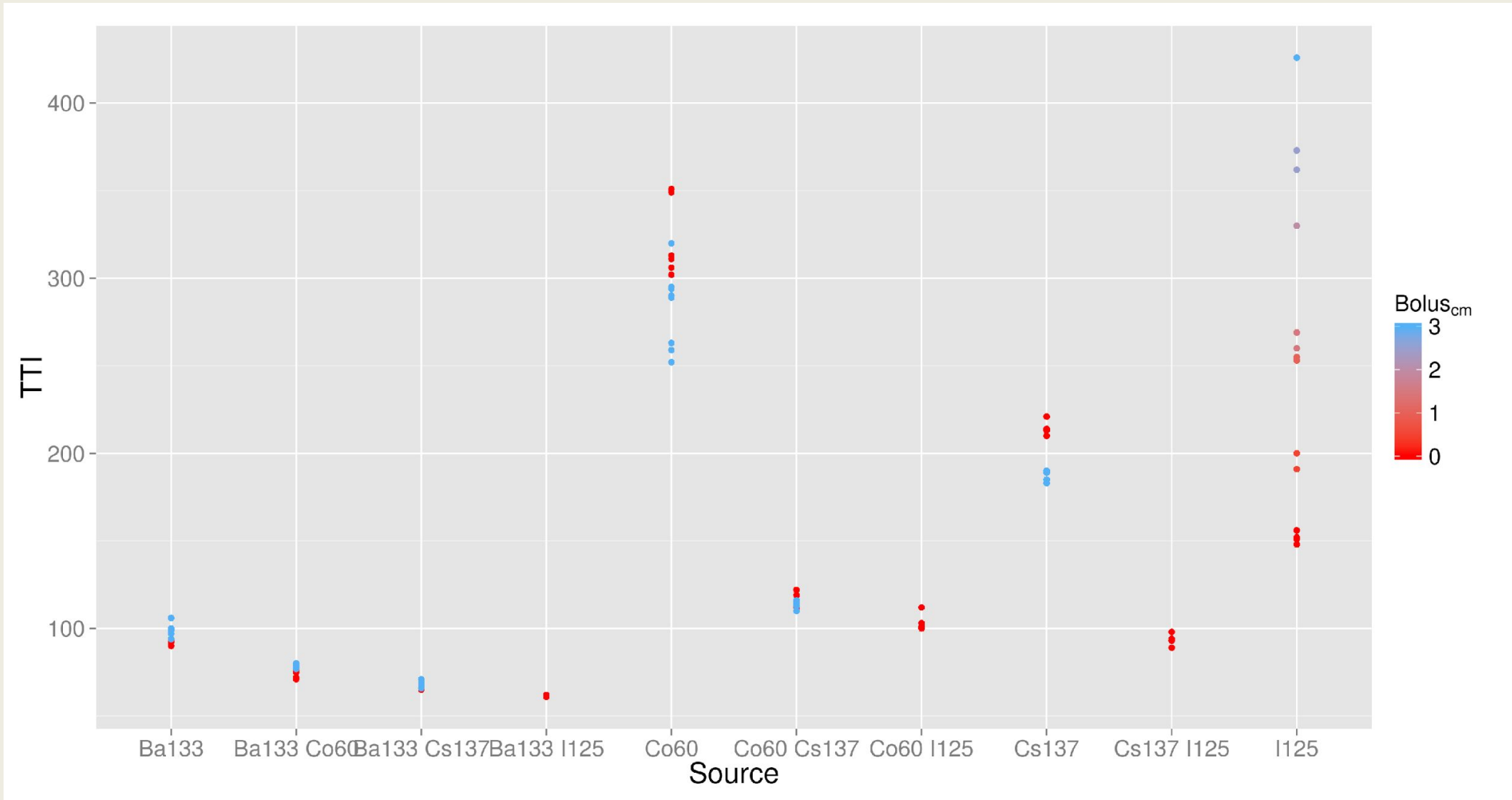
- Decontaminate using fire hoses, scrub brushes and detergents.
- Do not delay/interfere with the response to remove/replace contaminated filters.
- Re-survey the contaminated areas and perform the following:

If ambient dose rate at 10 cm is:	Perform the action:
> 1 μSv/h and <10 μSv/h	Use for response activities only.
> 10 μSv/h and <100 μSv/h	Use for critical response activities only (e.g. needed for transport of injured). The use of these items must be controlled. Once their use is no longer critical they should be isolated. The people who use this equipment must follow Instruction 2 and take all reasonable action to reduce their skin exposure (wear gloves) and limit use to less than a few hours.
> 100 μSv/h	Isolate and use only with radiological assessor approval.

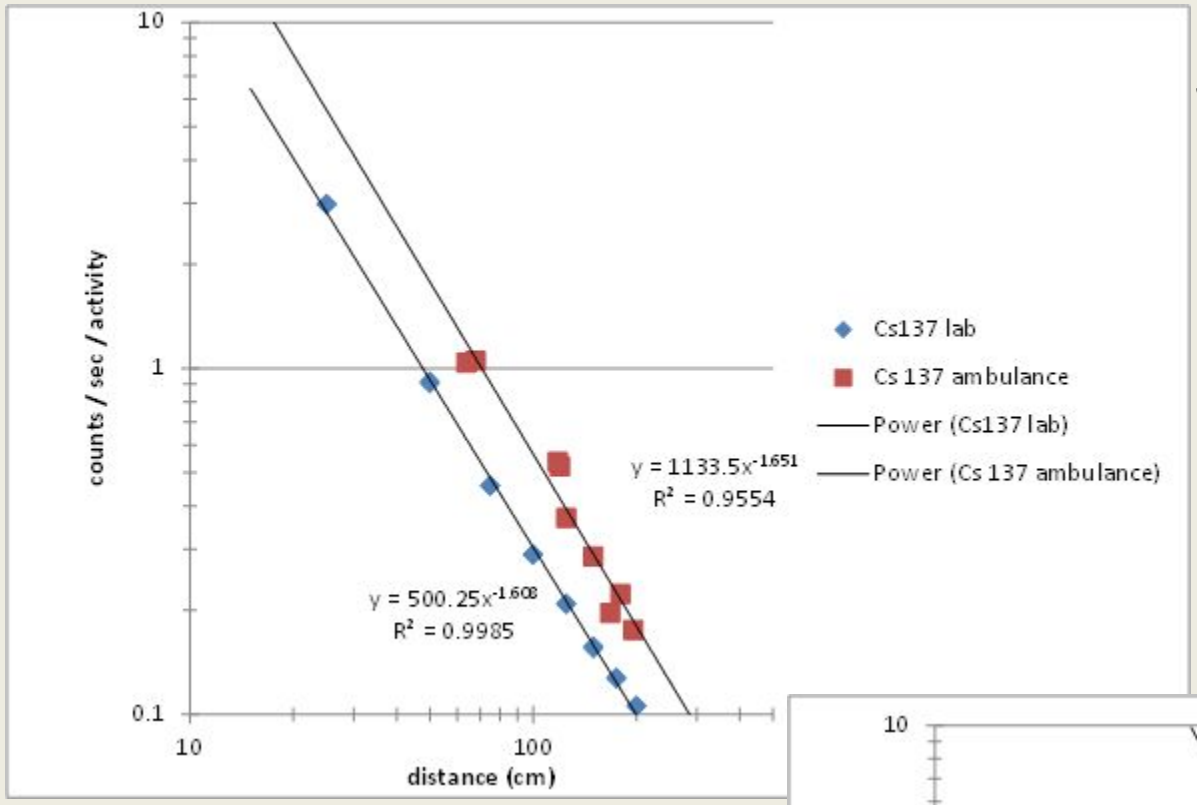
(7) Only release potentially contaminated vehicles and equipment for general use when assessed by a radiological assessor and found to meet national criteria.

Manual for First Responders to a Radiological Emergency, Oct. 2006

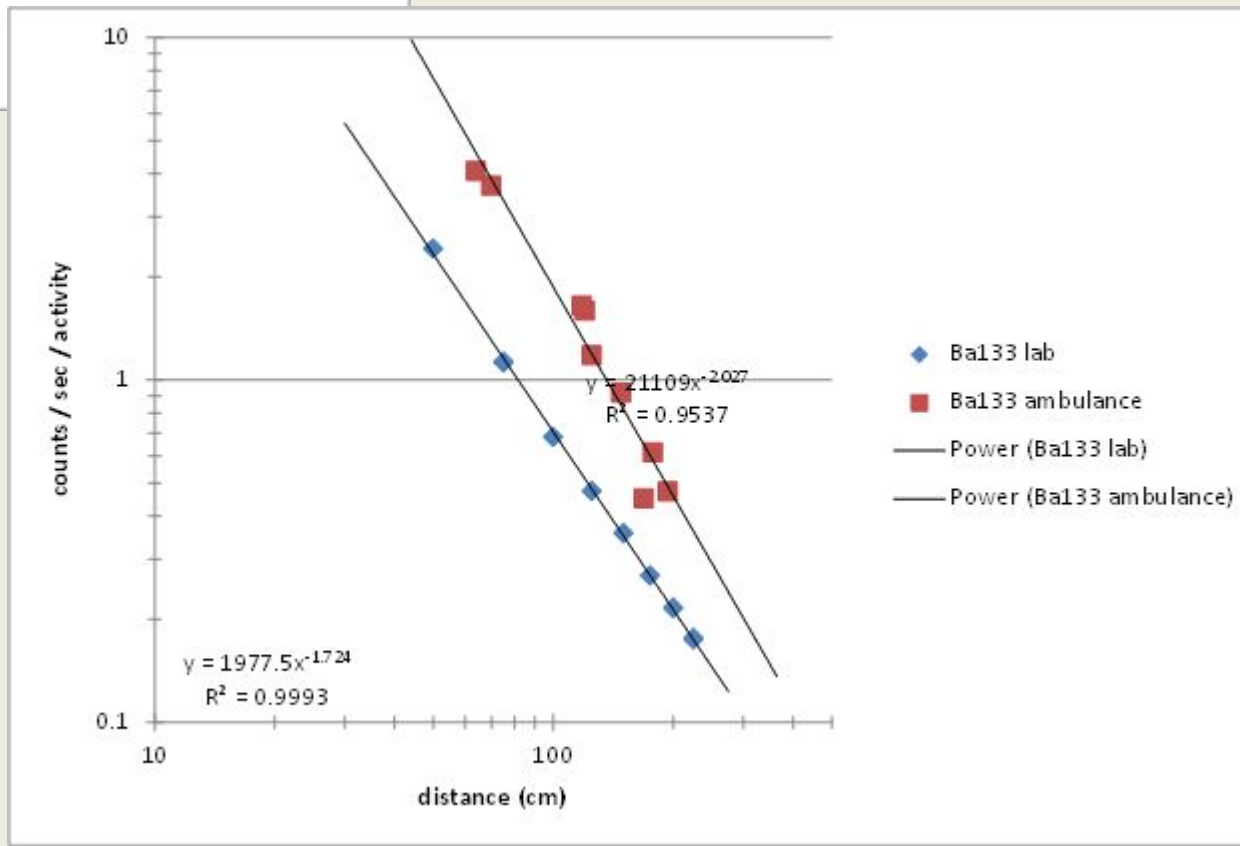
Backup and Additional Info


400
300
200
100
TTI
Ba133
Ba133 Co60
Ba133 Cs137
Ba133 I125
Co60
Co60 Cs137
Co60 I125
Cs137
Cs137 I125
I125
Source
Bolus_cm
3
2
1
0

Survey Results



- Higher count-rate than lab studies
- Power-law trend similar
- More pronounced for Ba-133
- Smaller environment



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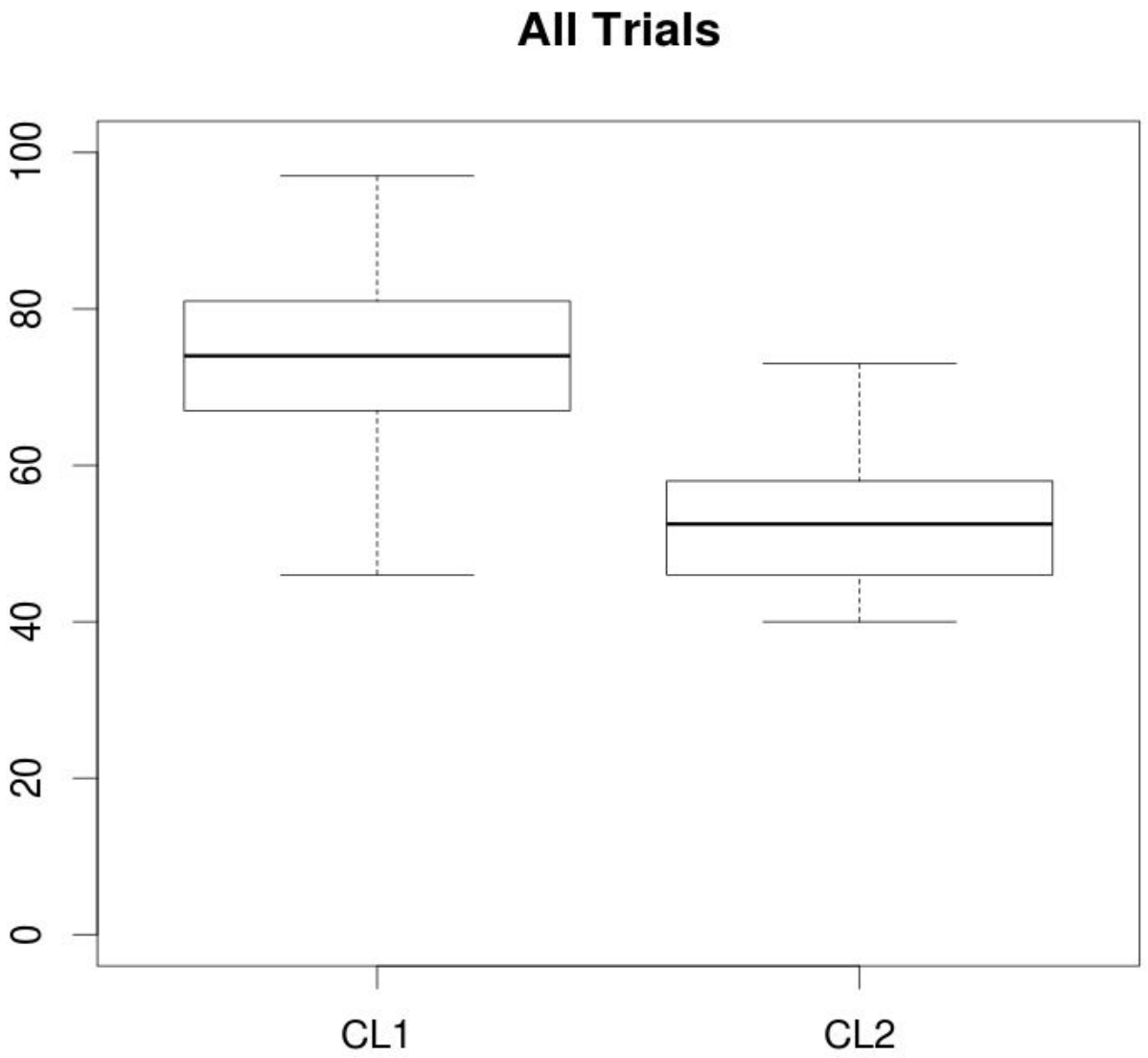
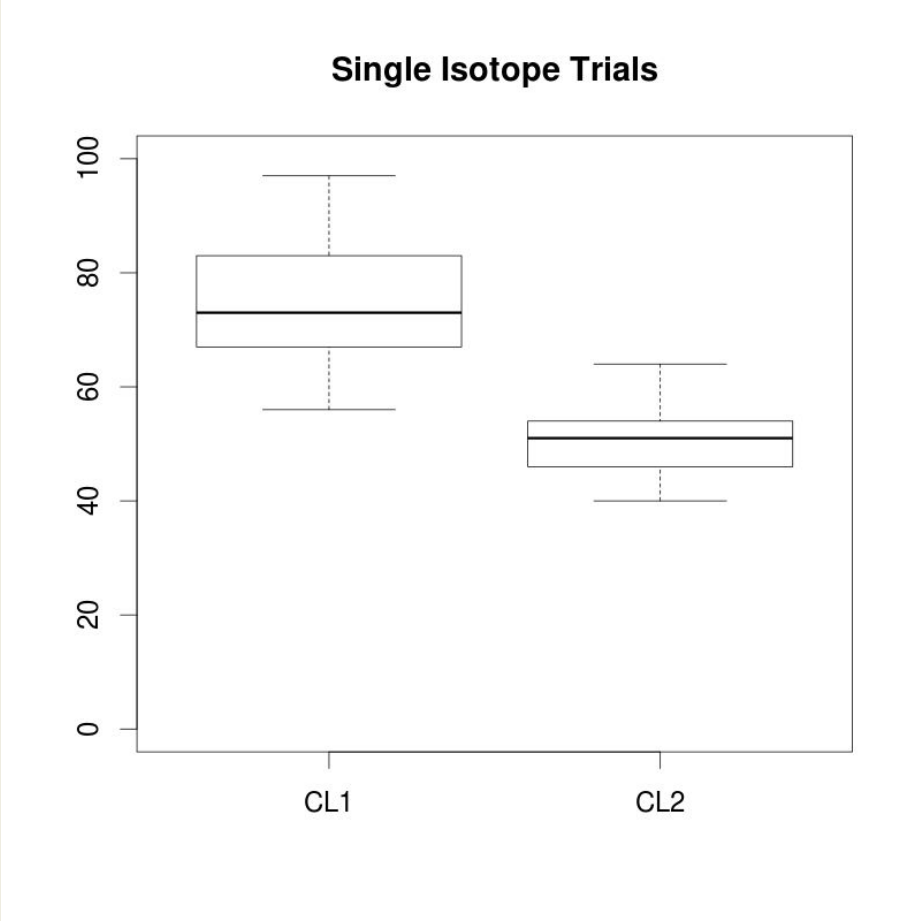
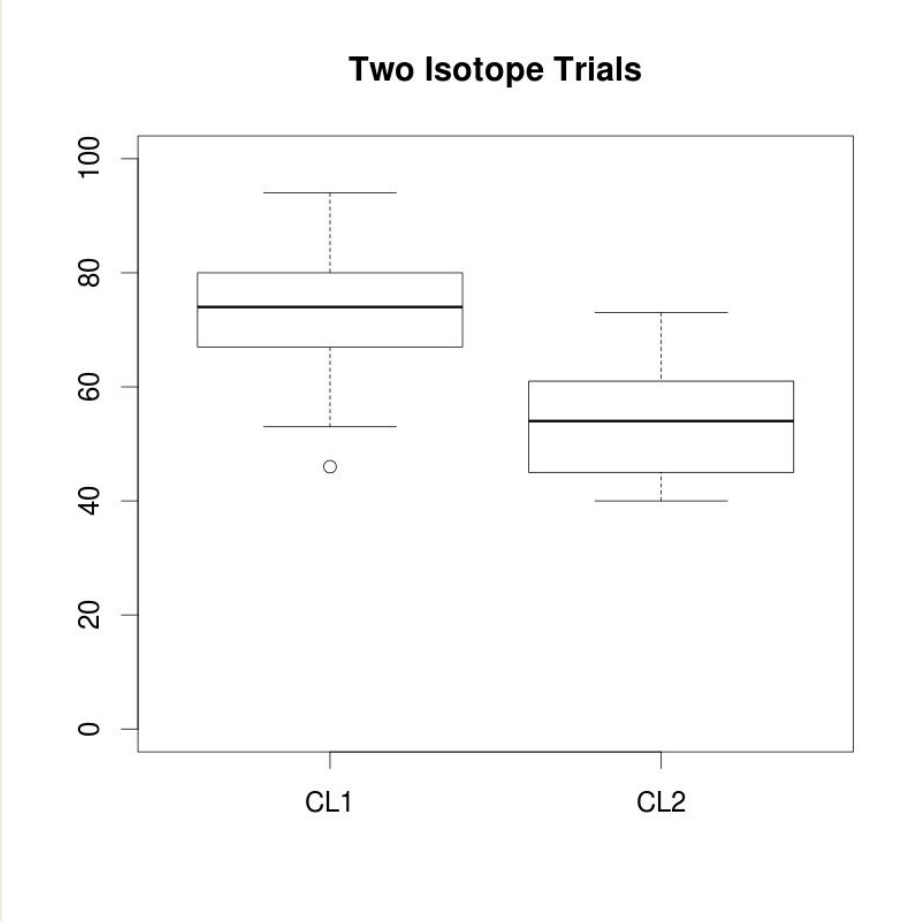
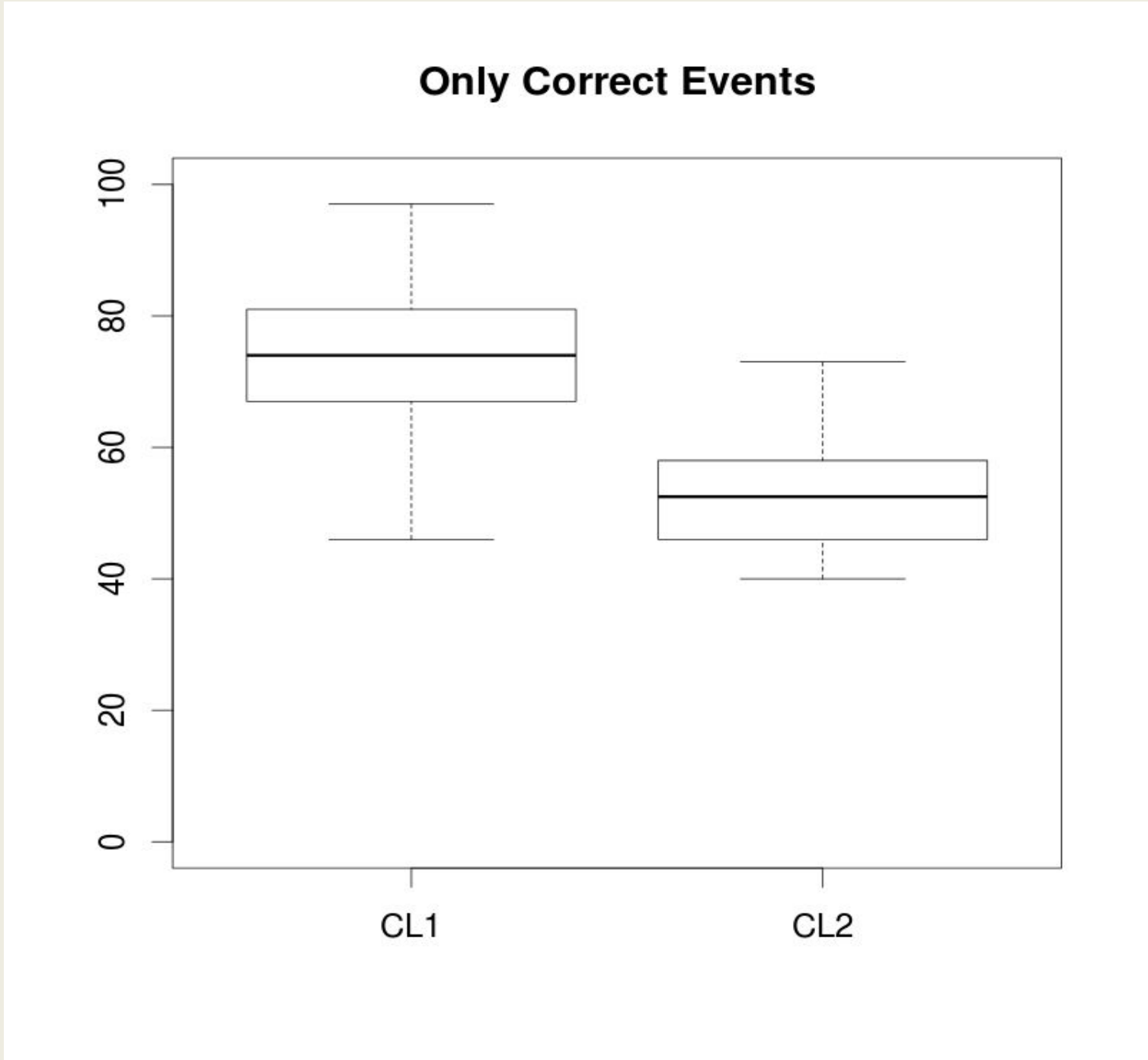
Interceptor Confidence Levels



CL1 >= CL2 by definition
Overlap in the 1st and 4th quartiles


Single Isotope Trials
0
20
40
60
80
100
CL1
CL2


Two Isotope Trials
0
20
40
60
80
100
CL1
CL2


Only Correct Events
100
80
60
40
20
0
CL1
CL2