Canadian National Calibration Reference Centre for Bioassay and *In Vivo* Monitoring

Human Monitoring Laboratory

www.hc-sc.gc.ca/ncrc

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PhantomCOMPARISON

- **How to do it?**
  - Borrow LLNL phantoms
- **Questions to ask:**
  - Did the design change with generation?
  - Did the material formulation change?
  - Is the material stable over time?

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The PHANTOMS

First generation LLNL phantom contains human bone

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The PHANTOMS

Later generations

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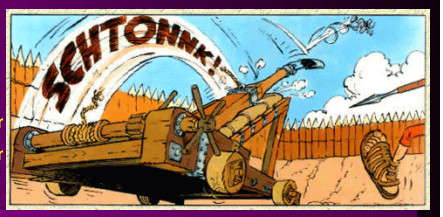
WhereDidTheyGO?

Laboratory	Country
Atomic Energy Research Establishment	United Kingdom
Argonne National Laboratory	USA
Atomic Weapons Research Establishment - Dounreay	United Kingdom
Environmental Protection Agency	USA
International Atomic Energy Agency	Austria
Los Alamos Scientific Laboratory	USA
Lawrence Livermore National Laboratory	USA
National Radiological Protection Board	United Kingdom
Oak Ridge National Laboratory	USA
Pacific Northwest Laboratories	USA
Rocky Flats	USA
Radiation Protection Bureau	Canada
Savannah River Project	USA
Winscale	United Kingdom
Winfrith	United Kingdom
Y-12 (Oak Ridge)	USA

2nd generation



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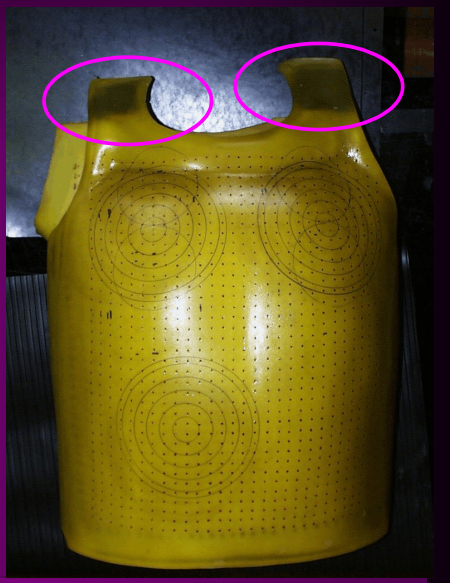
WhatDIDweUSE?

- First gen: PNNL loaned #2 (C)
- Second gen: HML has one (A, B, C)
- Second gen: IAEA loan (A, B, C)
- Third gen: CRL loan (A)
- Third gen: CEMRC loan (C)



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ThePROTOCOL

- Use the same lung set
  - Am-241/Eu-152
  - 17, 26, 45, 60, 122, 244, 344 keV
- Measure core and OVP's
- Weigh sections
- Measure CWT in HML counting region
- Convert CWT to MEQ-CWT
- Counting statistics kept <1.0%
- Counting times from 7,200 to 75,000 secs

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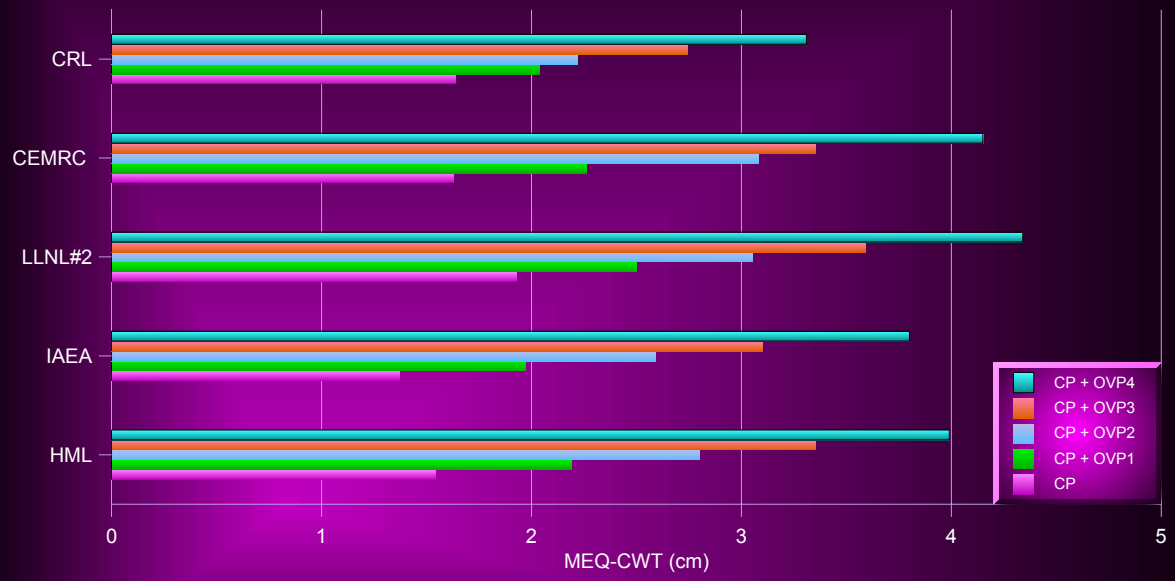
Thickness



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VISUALinspection

- There has been a major design change between 1st and later generations
- Subtle changes for 2nd to later generations

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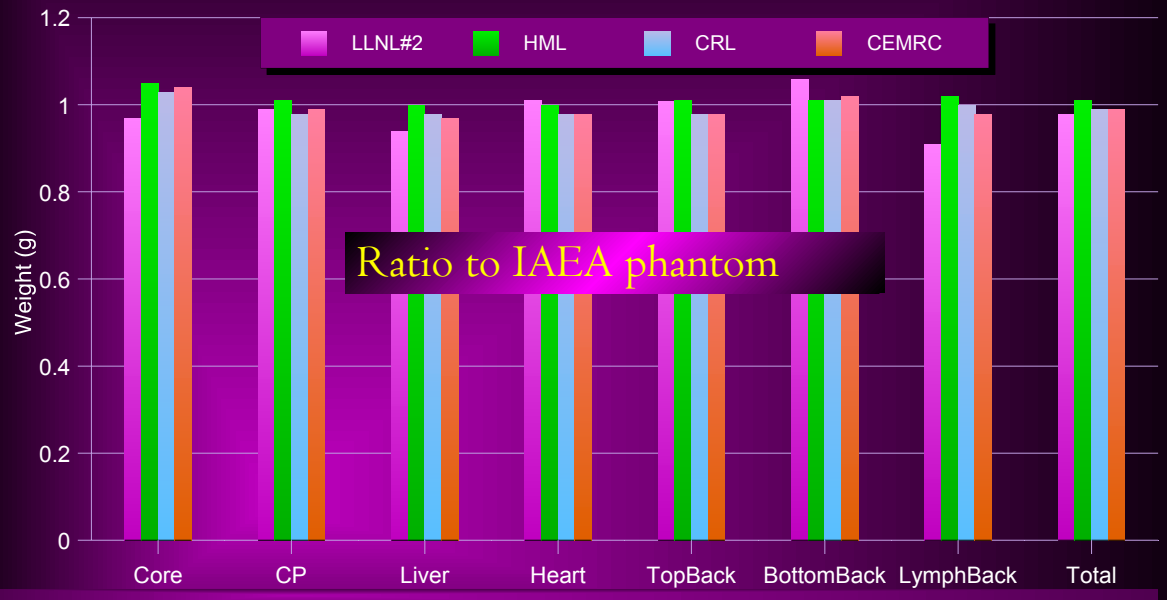
WEIGHTs



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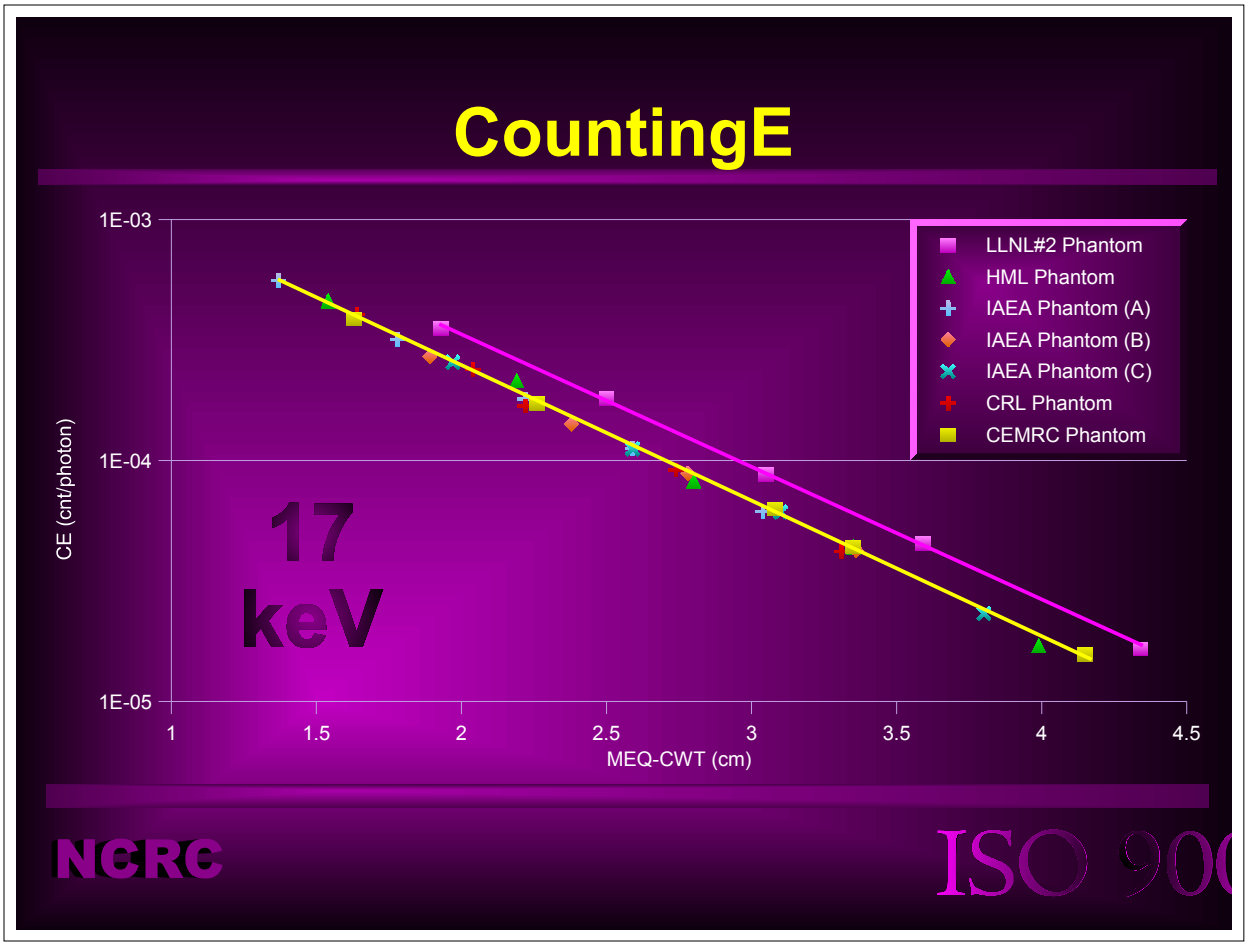
CountingE
1E-03
1E-04
1E-05
CE (cnt/photon)
17
keV
1
1.5
2
2.5
3
3.5
4
4.5
MEQ-CWT (cm)
LLNL#2 Phantom
HML Phantom
IAEA Phantom (A)
IAEA Phantom (B)
IAEA Phantom (C)
CRL Phantom
CEMRC Phantom
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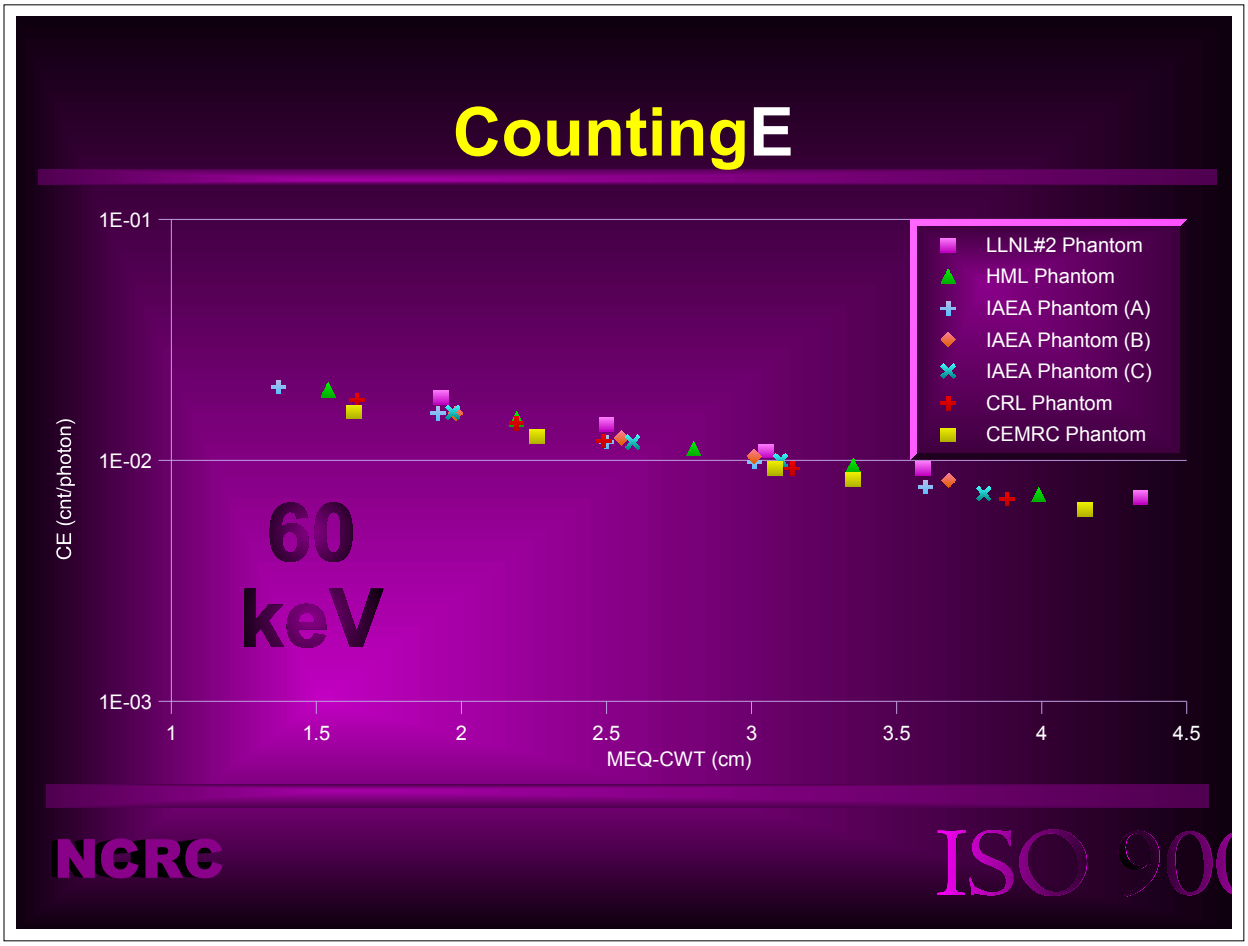
CountingE
1E-01
1E-02
1E-03
CE (cnt/photon)
60
keV
1
1.5
2
2.5
3
3.5
4
4.5
MEQ-CWT (cm)
LLNL#2 Phantom
HML Phantom
IAEA Phantom (A)
IAEA Phantom (B)
IAEA Phantom (C)
CRL Phantom
CEMRC Phantom
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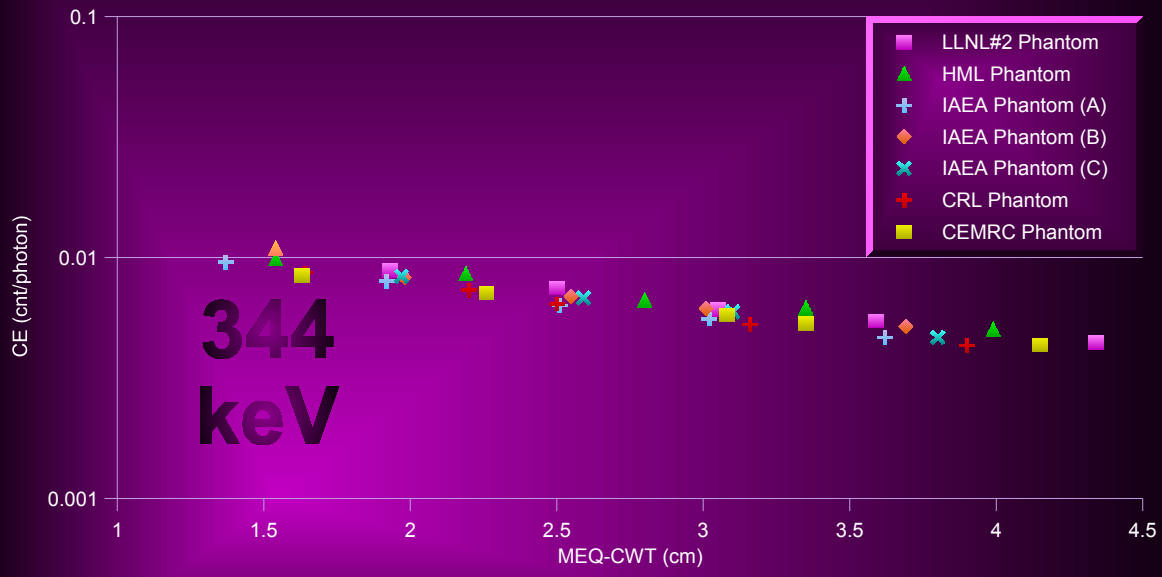
CountingE



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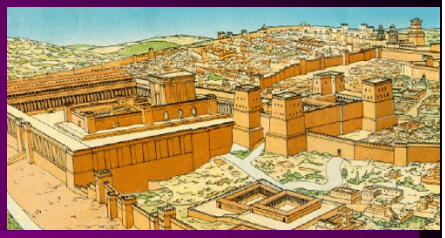
StatisticalTESTING

Linear Regression and t-testing

- Gradients are the same at 17 keV ($\alpha = 0.05$).
- CEMRC phantom has different gradient from HML, CRL, IAEA at 60 keV.
- CEMRC phantom has different gradient from CRL at higher energies.
- Intercepts are not the same (at any energy).



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CONCLUSIONS

- **The 2nd and 3rd gen are equivalent at low photon energies.**
- **The 1st gen shows an increased counting efficiency at low photon energies due to a design flaw.**
  - Goes away at higher energies.
- **At higher photon energies there appears to be a difference between the later generation phantoms.**
  - May be due to subtle differences in the material formulation.
- **It is also apparent that these phantoms have maintained their performance characteristics over an extended period of time.**
  - Phantoms cover a 20-yr time span.

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Questions?