Mathematical Modeling as a Tool in Source Replenishments

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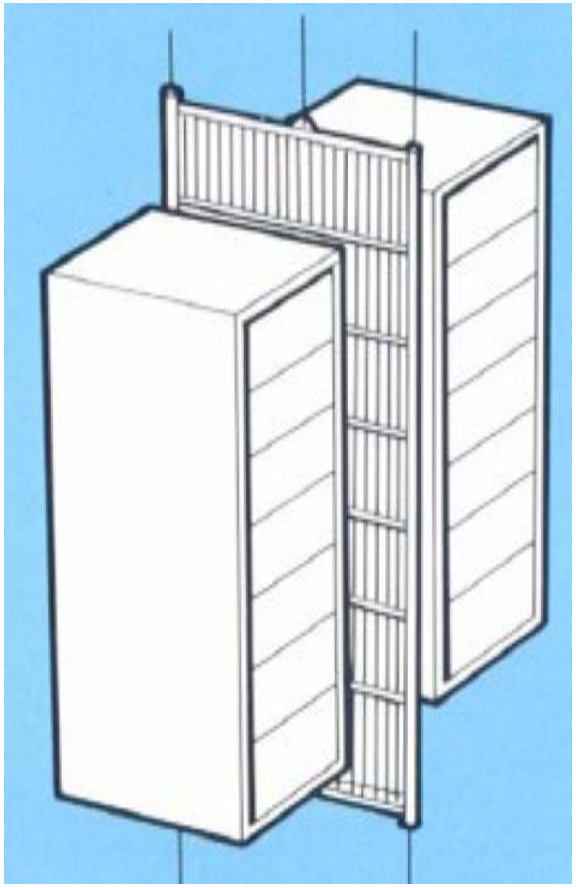
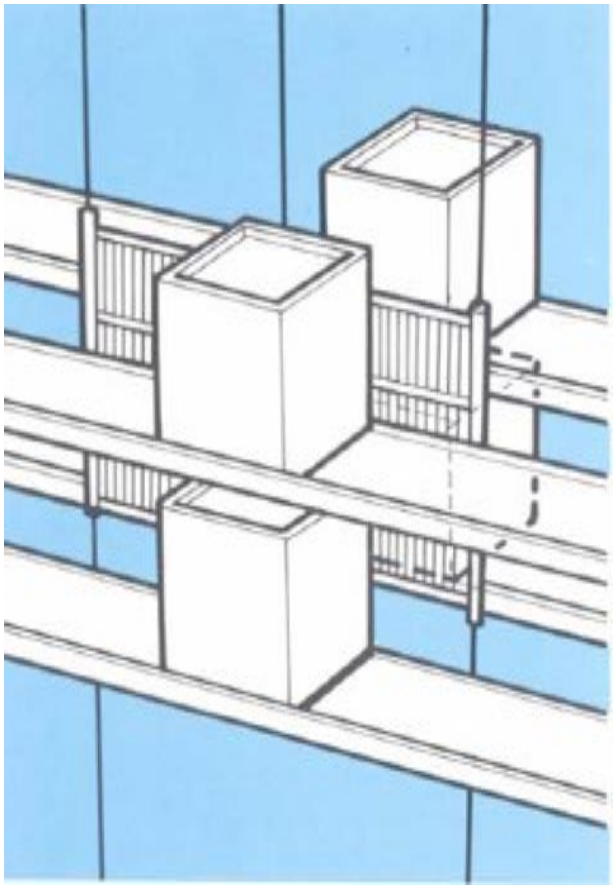
Irradiator Designs

Source Overlap



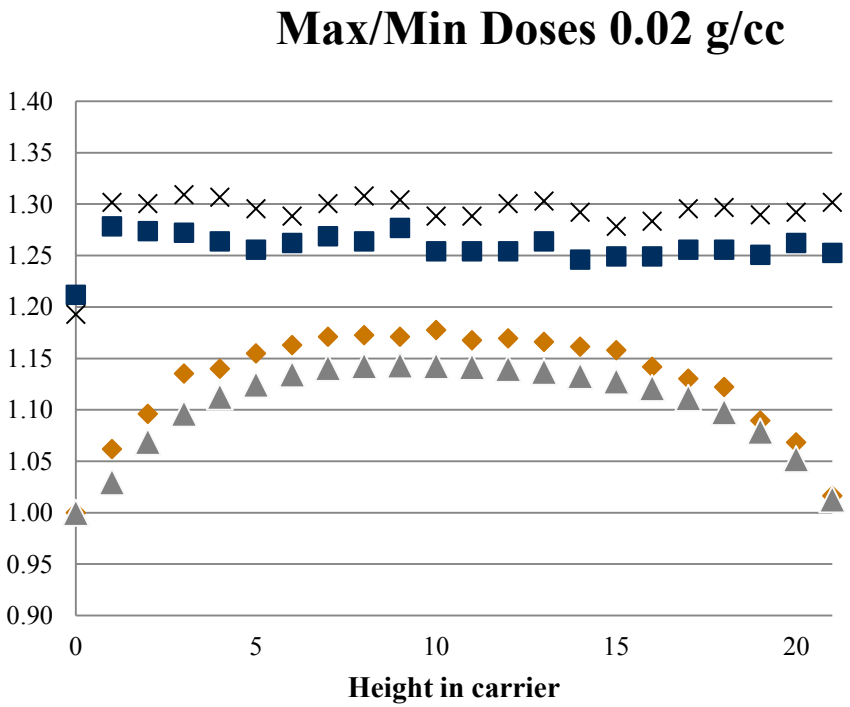
Product Overlap

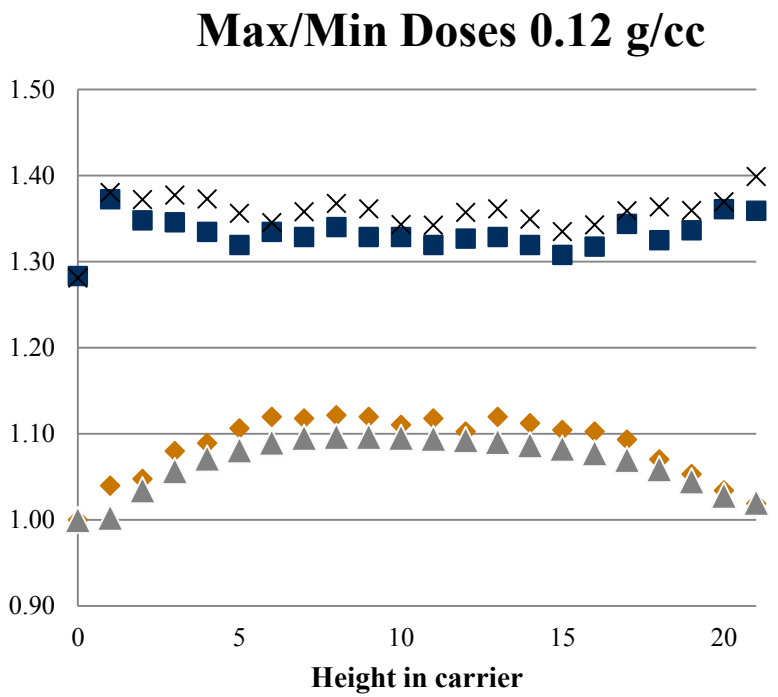


Changing product specifications

- **THE CHALLENGE**
  - The product mix in an irradiator changed, need to re-optimize the cobalt distribution to achieve best performance over a different density range
- **THE SOLUTION**
  - Model the existing distribution then iteratively adjust to optimize at the preferred product density range
- **THE RESULT**
  - Dose uniformity was significantly improved at target density range

Model validation





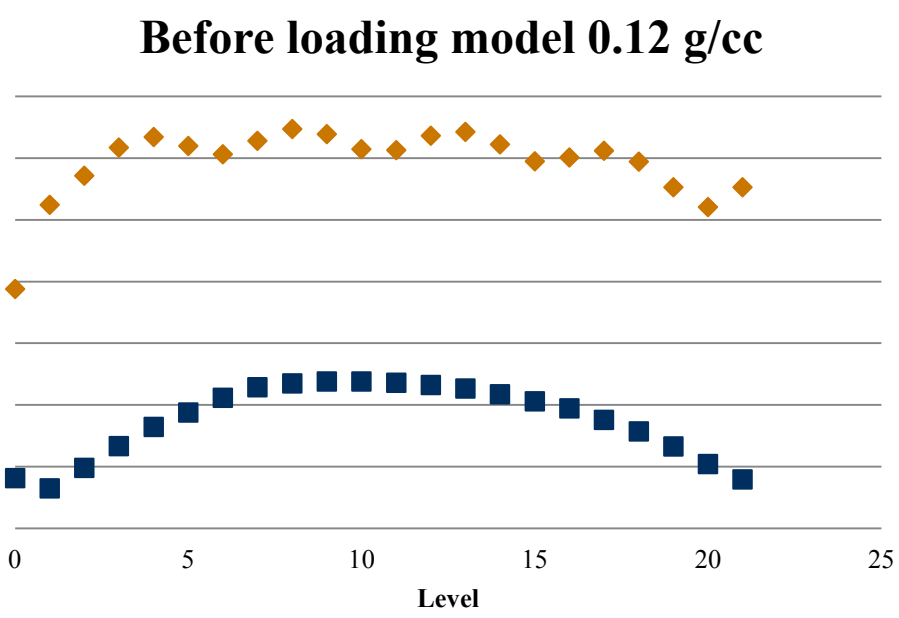
◆ OQ min

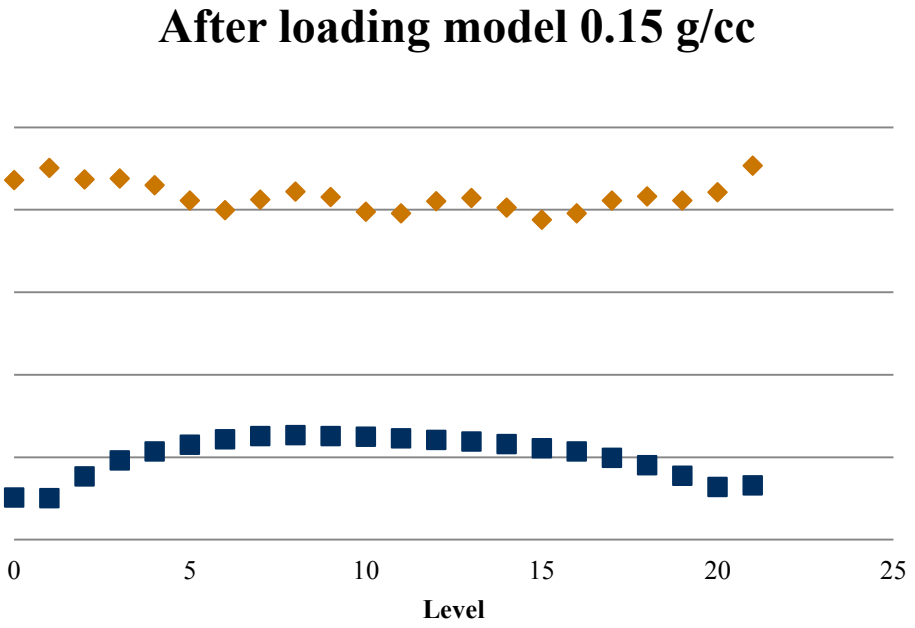
■ OQ max

▲ model min

× model max

Distribution shift





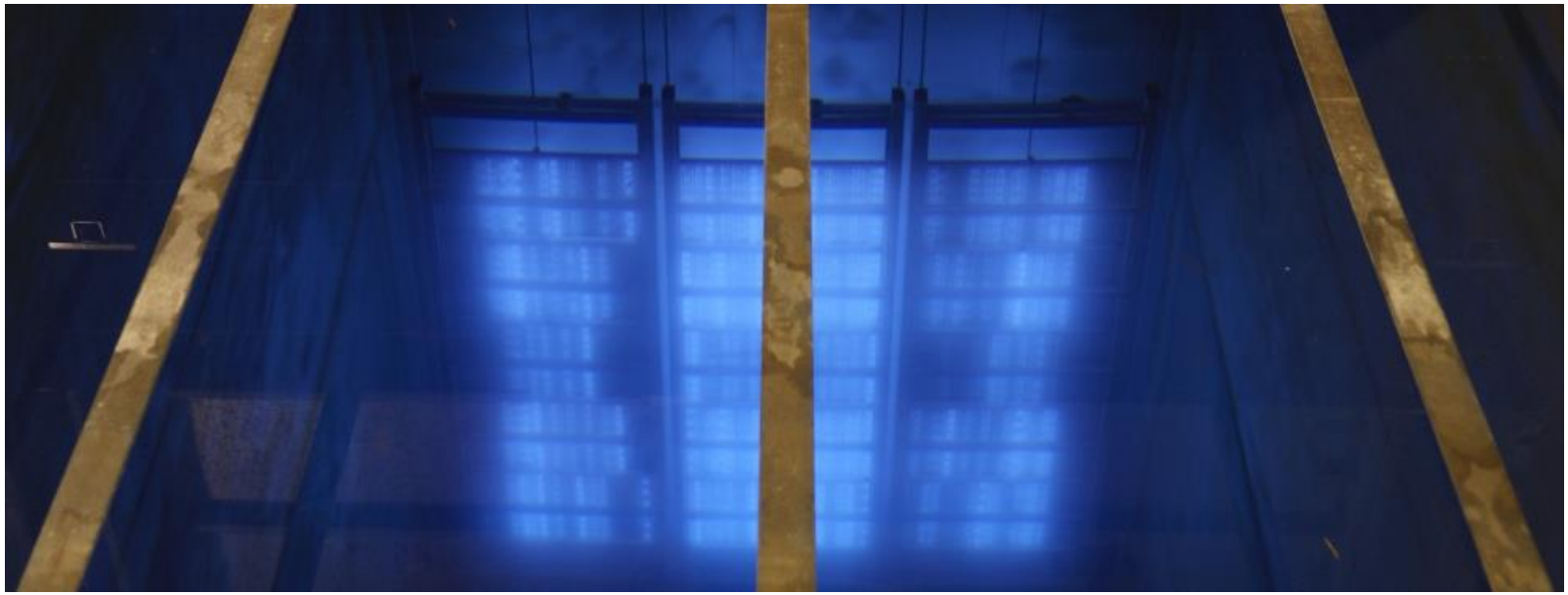
- Predicted vs Measured DURs

Density	Model	Density	Measured
0.05g/cc	1.29	0.02g/cc	1.26
0.10g/cc	1.33		
0.15g/cc	1.37	0.16g/cc	1.35

New mix of product

- **THE CHALLENGE**
  - A facility that needs to run both high density/low dose and low density/high dose product in the same irradiator, while optimizing the performance of both
- **THE SOLUTION**
  - Leverage the use of multiple racks to provide a distribution with one rack for low dose product and all racks for high dose with different distributions
- **THE RESULT**
  - Both product types run successfully

Steritech - Queensland

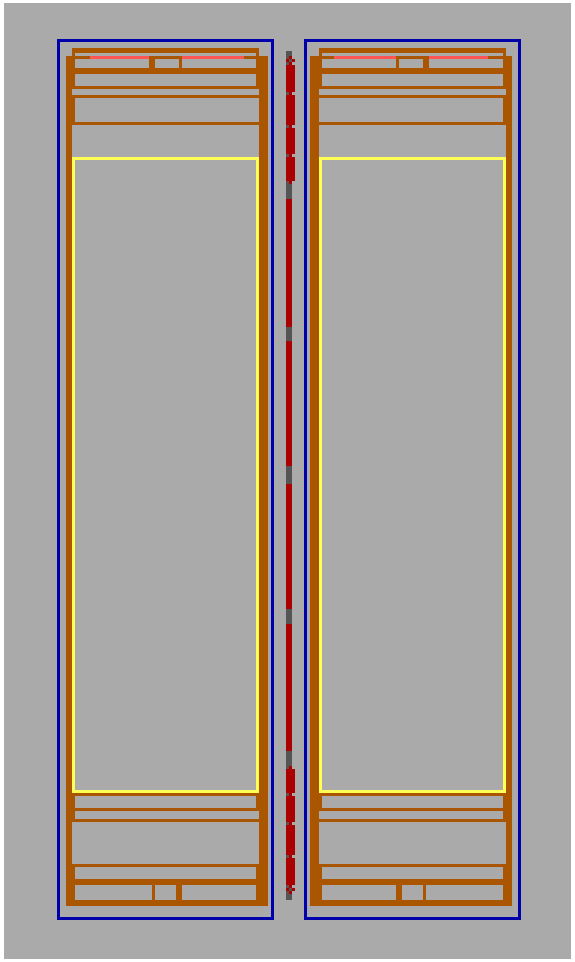


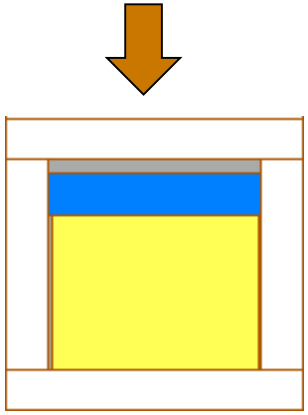
- **Running phytosanitary successfully with only Rack #3**
- **For new load, maintained distribution for Rack #3 but split across Racks #1 and #3 to provide more capacity and better horizontal distribution**
- **Rack #2 loaded to provide same overall vertical percentages for medical product**
- **Dosimetry confirmed required performance, we have since reloaded with same pattern successfully**

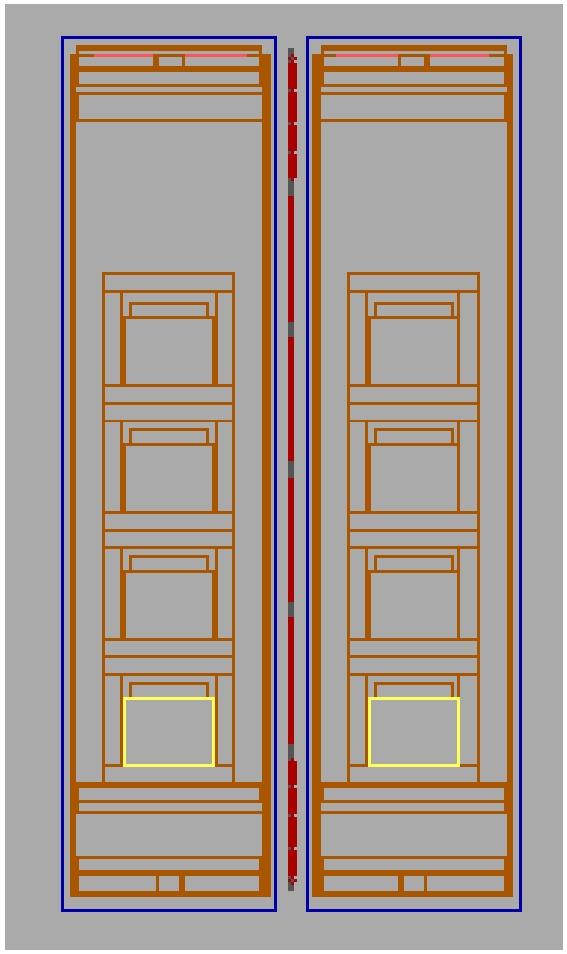
Special processing requirements

- **THE CHALLENGE**
  - Modeling the real dose to a product stack in an insulated shipper with dry ice which has to meet tight DUR requirements
- **THE SOLUTION**
  - Model individual products separately within a product stack
- **THE RESULT**
  - Model assessed that DUR could be met, confirmed with dosimetry

Model Comparison







Modeling to determine equivalency

- **THE CHALLENGE**
  - Reduce the amount of time needed to revalidate an irradiator when an equivalent load is planned
- **THE SOLUTION**
  - Use modeled OQ dose points to verify that locations and relative magnitudes of max, min and reference positions remain unchanged
- **THE RESULT**
  - Data remains consistent over # years of measured and modeled data

Modeling to determine equivalency

Loading	R_{mon}	Model min	Model max	DUR	$R_{mon/min}$	$R_{max/mon}$
7	20	18.76	22.46	1.20	1.07	1.12
8	20	18.76	22.47	1.20	1.07	1.12
9	20	18.72	22.47	1.20	1.07	1.12
10	20	18.68	22.52	1.21	1.07	1.13
11	20	18.61	22.53	1.21	1.07	1.13
12	20	18.62	22.57	1.21	1.07	1.13
13	20	18.66	22.55	1.21	1.07	1.13
14	20	18.71	22.56	1.21	1.07	1.13

- Data normalized to R_{mon}=20kGy

Conclusions

- Modeling is an effective tool in source distribution planning
- Process optimization through modeling is a collaborative effort
- Modeling can determine the best way to process certain products
- Modeling can save time in validation