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# PerFRACTION™ from Sun Nuclear

Automated Transit Dosimetry for In-Vivo QA

Jennifer R. Clark, M.S., DABR



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Conflict of Interest Statement:

I am an employee of Sun Nuclear Corporation

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Outline:

- Platform overview
- Dose Calculations
- Pre-treatment QA: Fraction 0
- In Vivo QA: Fraction  $n$
- "Superuser" Tips & Tricks
- System Benefits & Limitations ("Pros & Cons")
- Conclusion

Learning Objectives

1. What is PerFRACTION?
2. How automation and analyses function
3. Clinical workflows & applications

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# Platform Overview

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## SunCHECK™ // Patient Plan and Phantom-Less QA

**DoseCHECK™**  
Independent Secondary 3D Dose Calculations

**PerFRACTION™**  
Fraction 0™ – Phantom-Less Pre-Treatment QA

Fraction n™ – 2D/3D In-Vivo Monitoring



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## SunCHECK™ // Machine Testing and Test Management

**SNC Machine™**  
Image-Based TG-142/VMAT Imaging and Mechanical QA

**NEW! SNC Routine™**  
Daily, Monthly, and Annual QA, Including Device Integration



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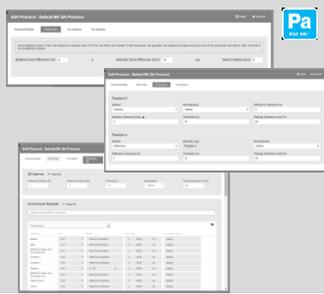
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### Analyses & Settings

QA Protocols contain tasks and settings used for plan analysis

- Default Protocol applied to all new incoming data automatically (can be edited)
- Point Dose, 2D and 3D tasks
- Custom Protocols can be created per site or physician preference
- Clinical Goals templates contain the Dose Volume constraints
  - 75 pre-configured templates (Quantec, RTOG, etc.)
  - Custom templates can be created
  - 7 dose volume metrics available




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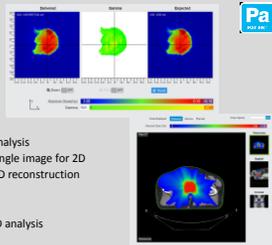
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### Imaging Techniques & Considerations

- Integrated Imaging
  - Varian C-Series & True Beam, Elekta
  - Used for 2D Analysis only
- Cine (continuous) Imaging
  - C-Series & Elekta: multiple cine frames
    - › Can be used for simultaneous 2D and 3D analysis
    - › PerFRACTION will composite frames into single image for 2D
    - › Frames will be used for MLC detection in 3D reconstruction
  - True Beam: MPEG encoding
    - › Lossy compression makes unsuitable for 2D analysis
    - › 3D reconstruction only
    - › Recommend collecting integrated imaging for 2D transit and using log-based reconstruction for 3D




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## Dose Calculations




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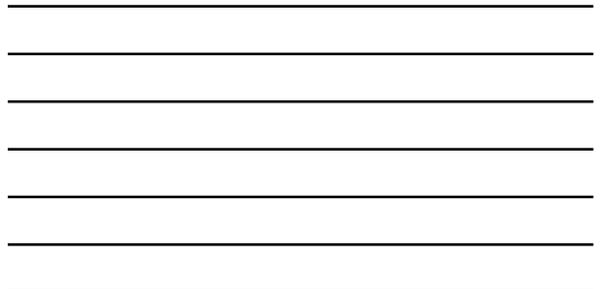
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### Dose Calculation Algorithm



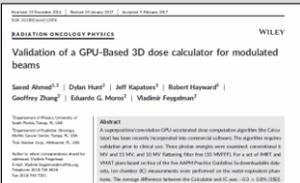
- Collapsed Cone Superposition/Convolution algorithm
  - Exclusively licensed from Johns Hopkins University
  - GPU accelerated
- References:
  - › *Real-time dose computation: GPU-accelerated source modeling and superposition/convolution.* Jacques, et al. [Med Phys](#), 2011 Jan;38(1):294-305.
  - › *Towards real-time radiotherapy: GPU-accelerated superposition/convolution.* Jacques, et al. [Comput Methods Programs Biomed](#). 2010 Jun;98(3):285-92.



### Latest Accuracy Publication – SNC Dose Calculator



- Publication in JACMP
- From the Moffitt Cancer Center in Tampa, FL
- Compares SunCHECK's Dose Calculator algorithm with:
  - Ion chamber
  - ArcCHECK
  - PDP 3D algorithm
  - Pinnacle 3D algorithm
- Evaluates 6 MV, 10FFF, and 15 MV energies



### Beam Models & Commissioning



- Beam Models
  - Pre-commissioned in the software
  - Created from aggregate measured commissioning data
  - Verified to match your machine before use
    - › User controlled adjustments coming soon
  - Simply select beam model for machine(s) from drop-down
- User "Commissioning"
  - Define Reference Dose for each beam energy
    - › Traceable absolute calibrated dose under specified conditions.
  - Enter CT-to-ED table for each scanner (and CBCT)
  - That is all!





# Fraction 0: Pre-Treatment QA







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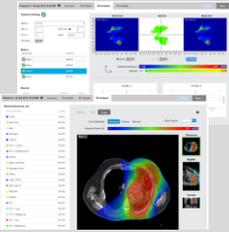
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## Fraction 0™

Phantom-less pre-treatment QA

- Fraction 0 Absolute Dose (FZAD)
  - 2D analysis of EPID images converted to dose
  - Calibration per energy and SID\*
- Fraction 0 3D
  - 3D dose reconstruction on planning CT
  - Same 3D analysis/review options as Fraction *n* for apples-to-apples comparison
- Use same RT Plan as for treatment – no additional QA plans or dose maps required



\*patent pending



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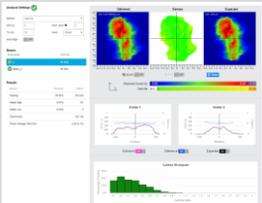
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## Fraction Zero Absolute Dose (FZAD)

- Proprietary panel calibration algorithm\*
- Expected Dose Maps are automatically created from RT Plan using SunCHECK Dose Calculator
- Delivered images are converted to dose and compared
- Views:
  - Delivered & Expected Dose Maps
  - Analysis Method map
  - X and Y profiles (click on dose maps to redraw)
  - Gamma Histogram
- Can be used in conjunction with log-based 3D reconstruction



\*patent pending



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### Fraction 0 3D

- Two Ways to perform
  - Cine imaging (EpiLog reconstruction)
  - Log-only reconstruction (if also performing FZAD)
- Point Dose and 3D Analysis tasks available
- Represents the actual conditions of delivery in patient anatomy



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## Fraction *n*: Transit In Vivo QA

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### Fraction *n*<sup>TM</sup>

**EPID-based mode**

- Includes daily position of patient
- Provides independent measurement of MLC positions
  - Log files alone are not reliable indicators of MLC positions<sup>1,2</sup>

**Log file-based mode**

- For use when EPID cannot be deployed
  - Large couch kicks, or extra-large field sizes
- For use alongside EPID option
  - For example, use EPID-based once a week and log-based the remainder of the week

*PerFRACTION<sup>TM</sup> can automatically switch between the two modes based on whether EPID images are available.*



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1. "A clinically observed discrepancy between image-based and log-based MLC positions," R. Neel, M. Ahmad, K. Kothurto, T. Watkins, K. Wijesooriya, and J. Siebers, Med Phys 43, 2933 (2016)  
 2. "Discrepancies in MLC positional error using independent log files and EPID measurements for IMRT and VMAT techniques," A. Agrawal, C. C. Agrawal, M. W. D. Grayson, A. R. Housheer, J. and F. McGarry, J Phys: Med Biol 59 (2014) N49-N63

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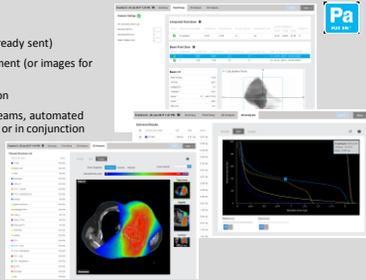
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### Fraction *n* 3D Log Mode

- Export dataset from TPS (if not already sent)
- No images collected during treatment (or images for some beams only)
- Logs are used for 3D reconstruction
- Can be used for non-imageable beams, automated deliveries (panel not deployable), or in conjunction with periodic imaging
- Point Dose and 3D Analysis
- More powerful with CBCT




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## Tips & Tricks




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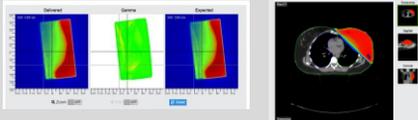
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### PerFRACTION Tips & Tricks

- Harnessing simultaneous 2D & 3D analysis
  - The power is in the combination!
  - 2D contains the transit information (patient), as well as MLC/collimator verification for each beam. Highly sensitive.
  - 3D shows the effect of the machine performance (and patient position with CBCT) on the total dose distribution.




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Thank You for Your Attention

Any questions not addressed can be answered in booth #5001

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The slide features a dark grey background with white text. At the top right is a small blue square with 'Pa' in white. The main text is centered. At the bottom, there is a row of five small icons: 'Pa', 'Me', 'De', 'Dx', and a circular logo. To the right of these icons is the text 'YOUR MOST VALUABLE QA AND DOSIMETRY TOOLS'. At the bottom right is the 'SUN NUCLEAR Corporation' logo, which includes a stylized sun icon.

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