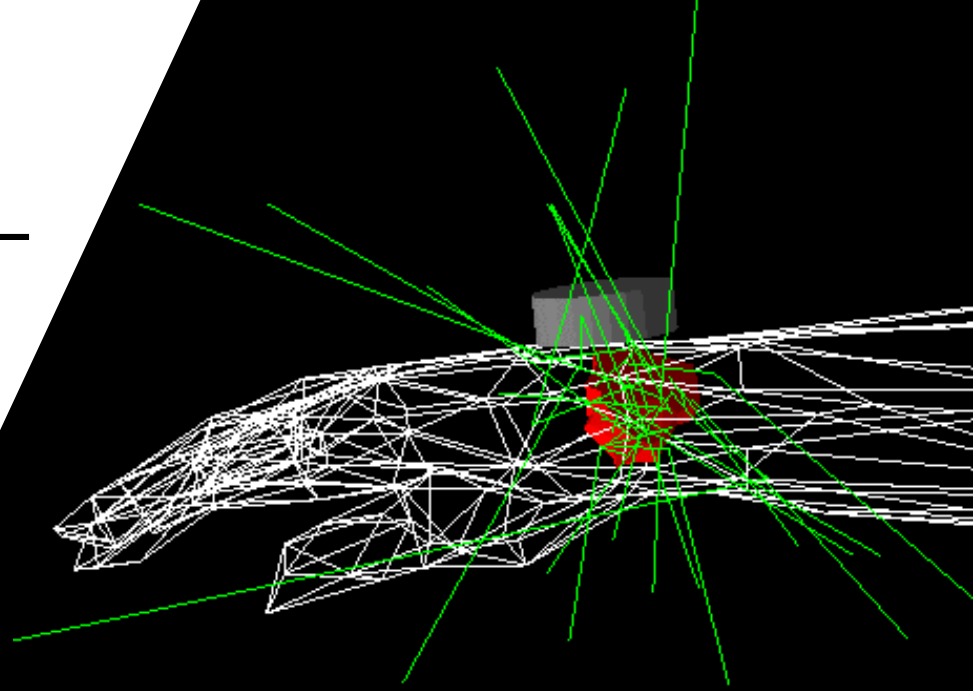
Nuclear Rheumatology?

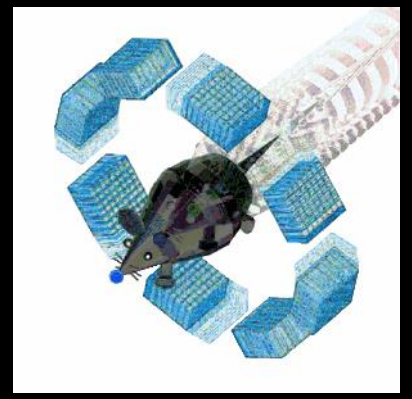
An initial investigation into use of simple, low-cost detectors for quantification and monitoring of RA disease progression.

Josh Knowland

Objective

Use GATE Monte Carlo simulations to show the potential efficacy of simple, low-cost topical detectors for quantification and monitoring of RA disease progression.





Geant4 Application for Emission Tomography
opengatecollaboration.org

DBCLS Database Center for Life Science

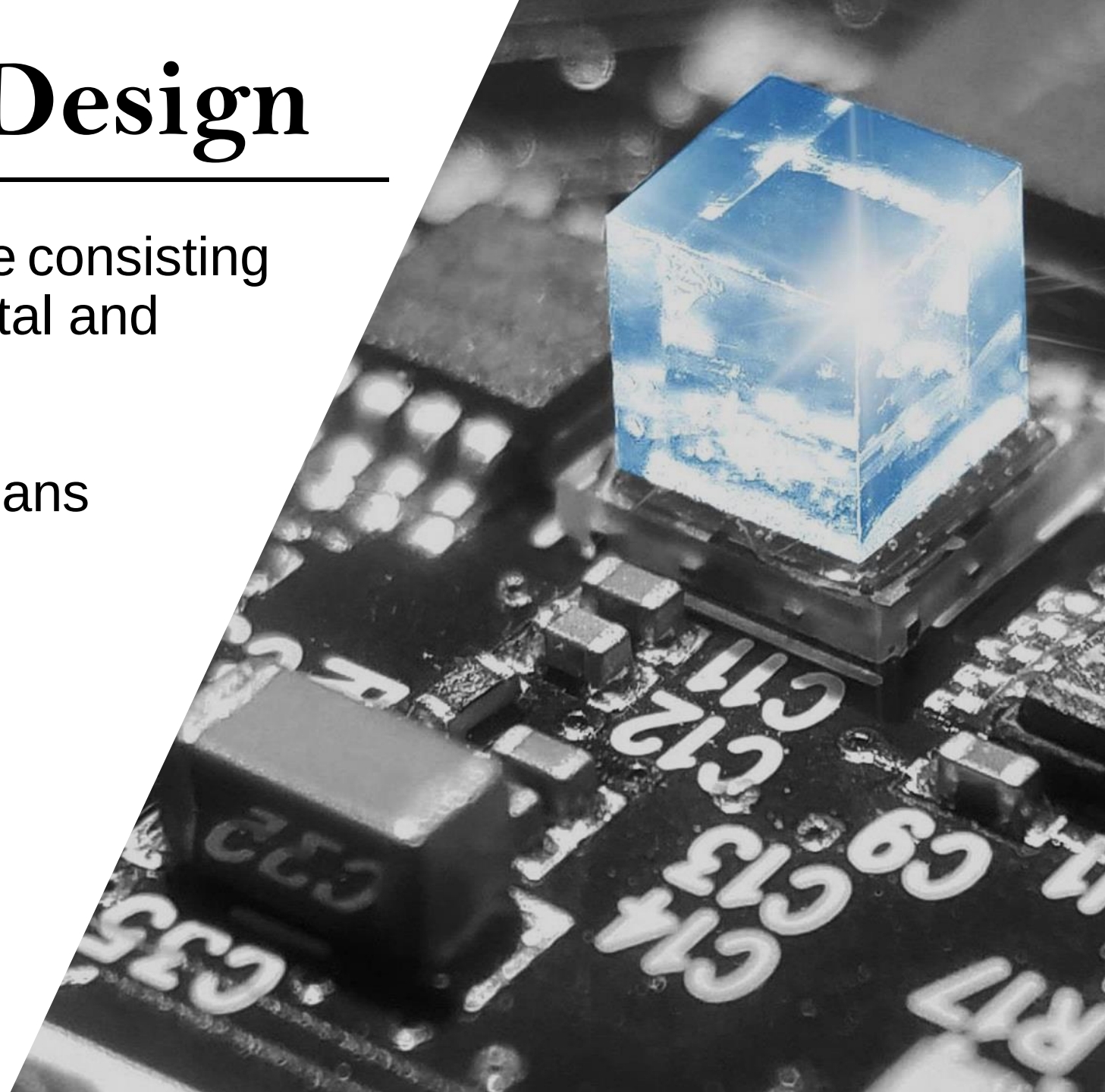
Anatomography BodyParts3D

Topical Sensor Design

Existing FDA listed uptake probe consisting of a single 3x3x3 mm BGO crystal and silicon photomultiplier.

No shielding or collimation – means omnidirectional detection of localized uptake.

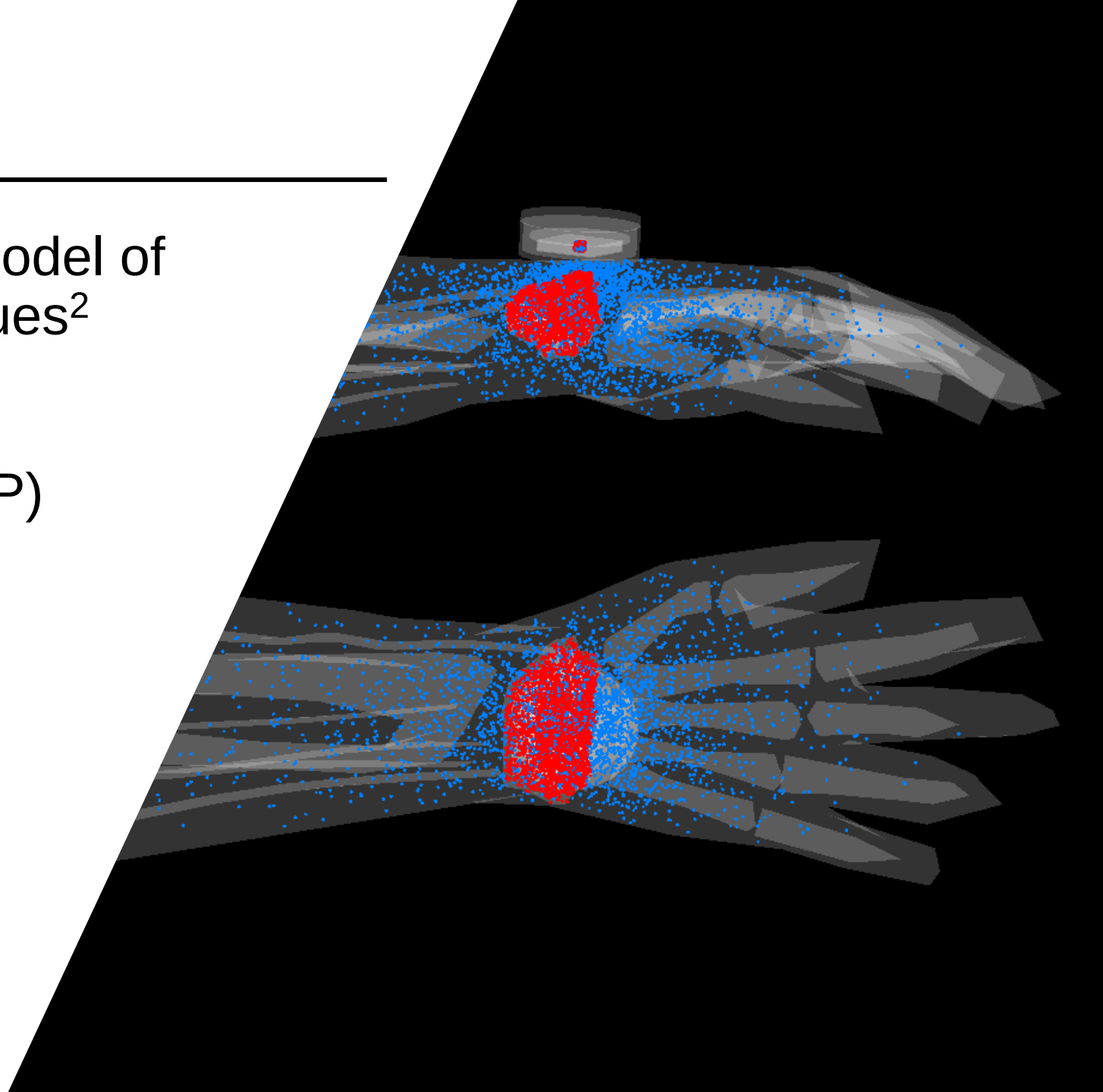
Generates a time-activity curve with 1-second resolution.



Methods

We used an anthropomorphic model of the arm and realistic uptake values[2] for two different radiotracers.

^{99m}Tc-diphosphonate (^{99m}Tc-MDP)
^{99m}Tc-Methotrexate (^{99m}Tc-MTX)

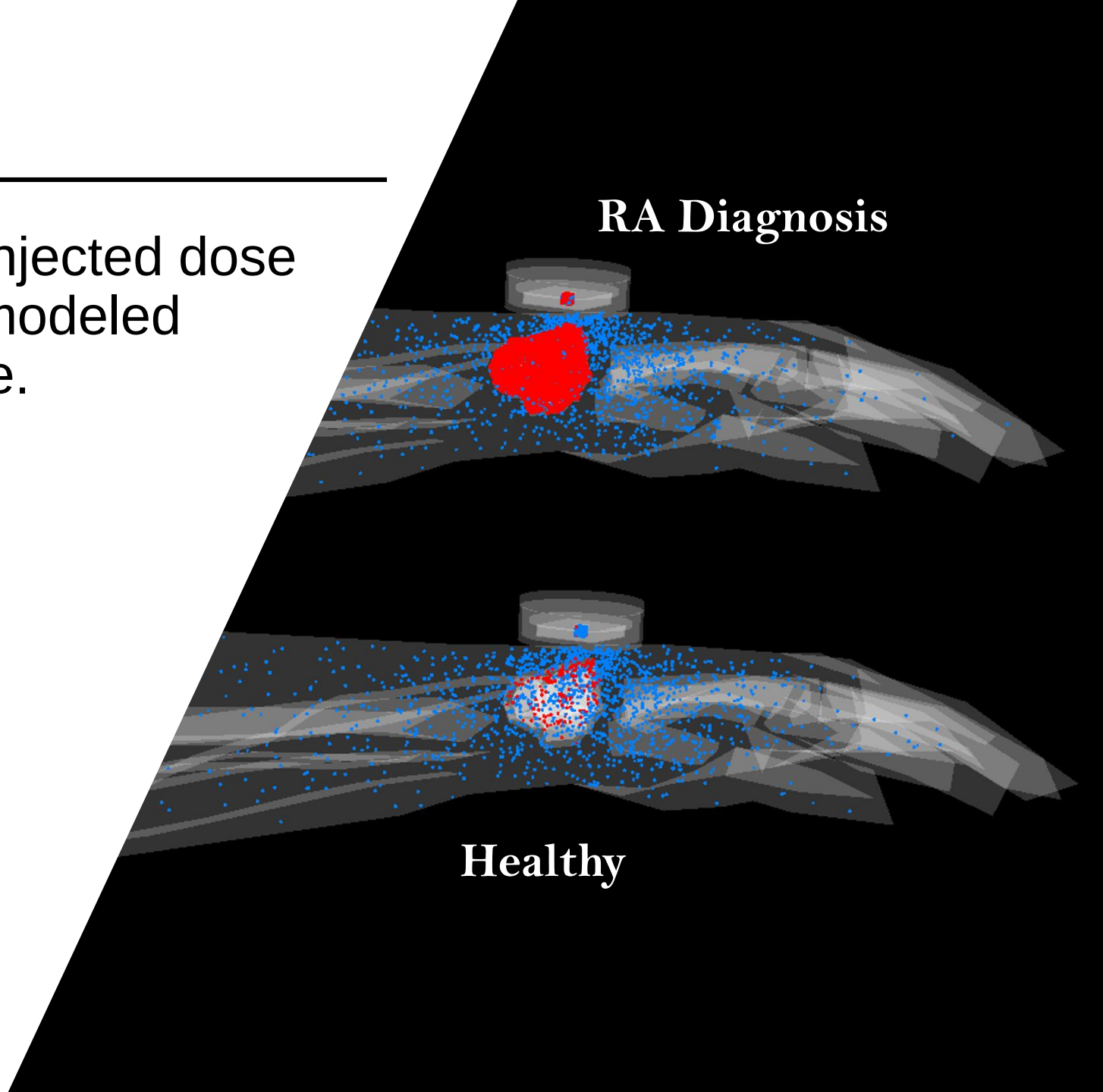


[2] Rasheed R. Tc99m Methotrexate (MTX): A Novel Complex for Imaging of Rheumatoid Arthritis (RA): First Clinical Trials. General Medicine: Open Access. 2015.

Methods

All simulations used a nominal injected dose of 10mCi. Specific uptake was modeled as a percentage of injected dose.

	RA Diagnosis	Healthy
99mTc-MDP Synovial	2.00%	0.68%
99mTc-MDP Background	6.80%	6.80%
99mTc-MTX Synovial	2.50%	0.03%
99mTc-MTX Background	3.20%	3.20%

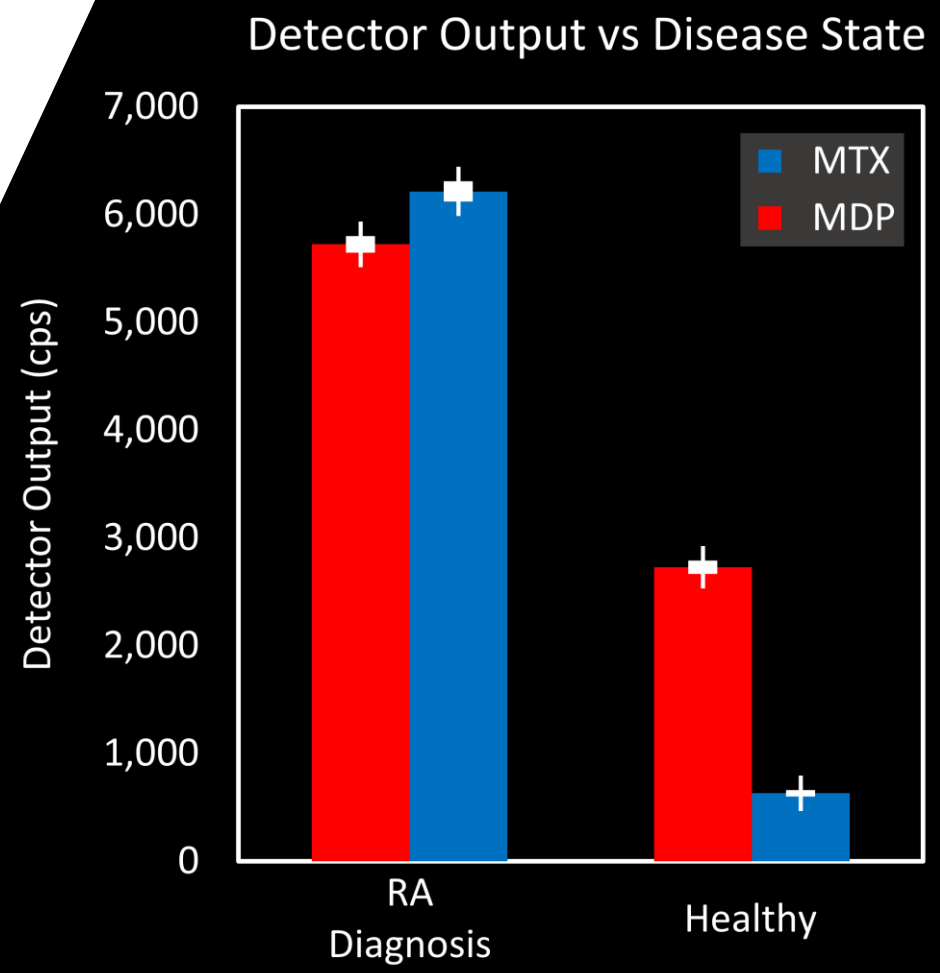


Results – Disease State

Difference in simulated detector output between diseased and healthy wrist:

-52.3% for ^{99m}Tc-MDP
-89.8% for ^{99m}Tc-MTX

^{99m}Tc-MTX is 1.7x more sensitive to disease state.



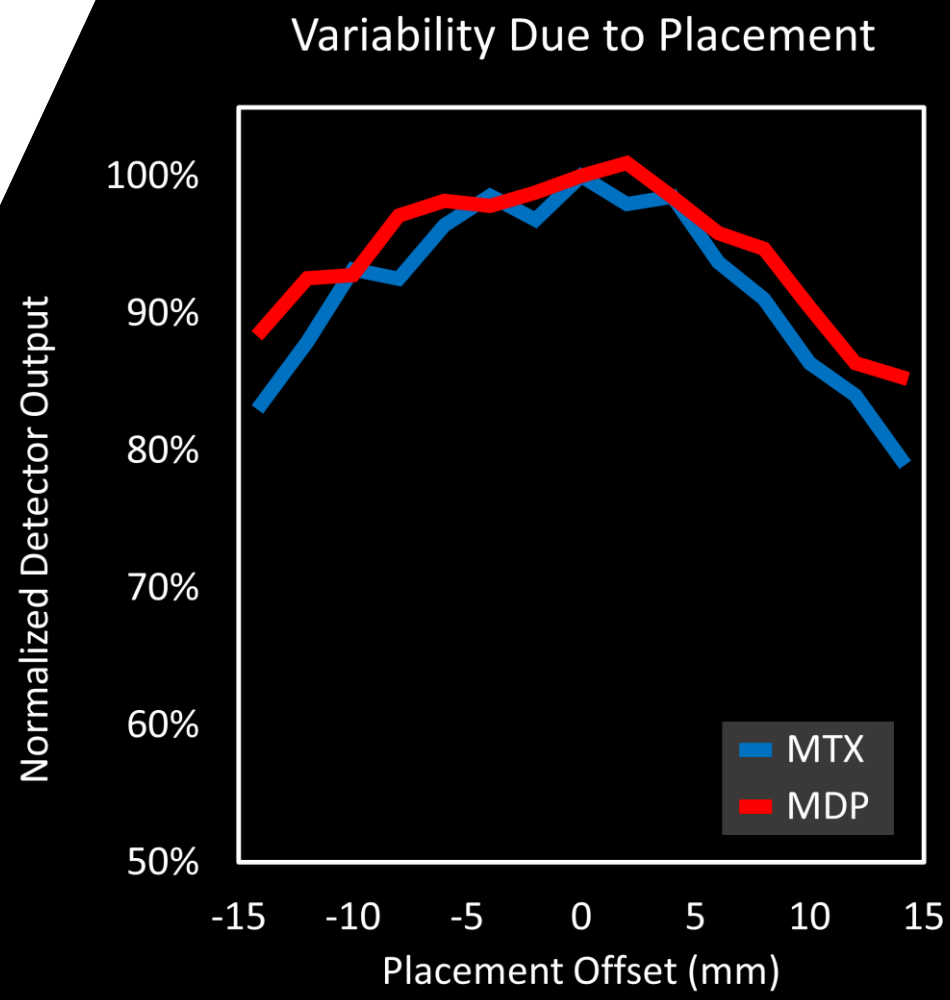
Results - Placement

Placement can lead to variability in detector output.

We simulated ±15mm variability in detector placement (distal/proximal).

Within ±5mm, output error is less than 5%.

May need a detector placement guide for serial human use.



Discussion

Simple topical detectors may be a useful tool to quantify disease state.

Might be possible to improve early diagnosis using baseline uptake measurements.

Treatment response could be tracked using periodic low-dose measurements.

Future Work

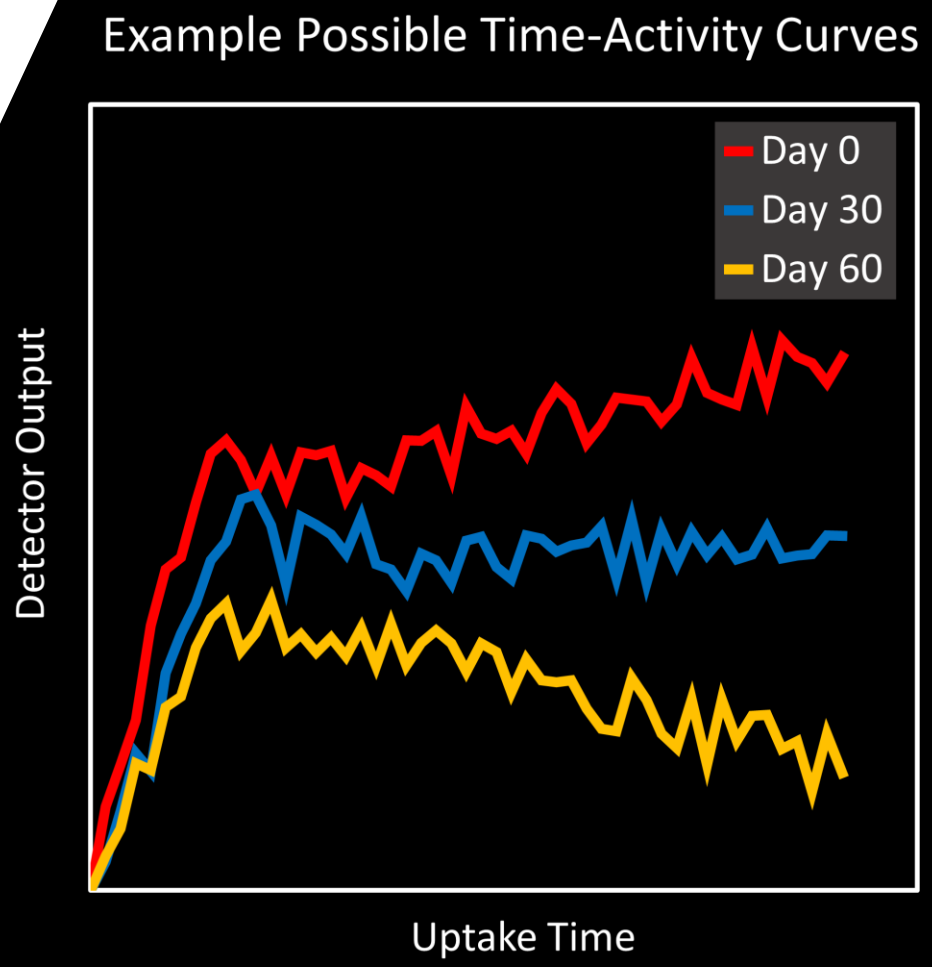
Investigate additional target joints, radiotracers and disease stages.

Additional molecular targets – T-cells, leukocytes, antibodies, apoptosis

Longitudinal human studies to follow treatment.

Future Work

Because the detectors provide time-activity curves, could the **kinetics** of tracer uptake be predictive of RA disease progression?



Thank You

Josh Knowland
Ron Lattanze
Samantha Lipman, PhD

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