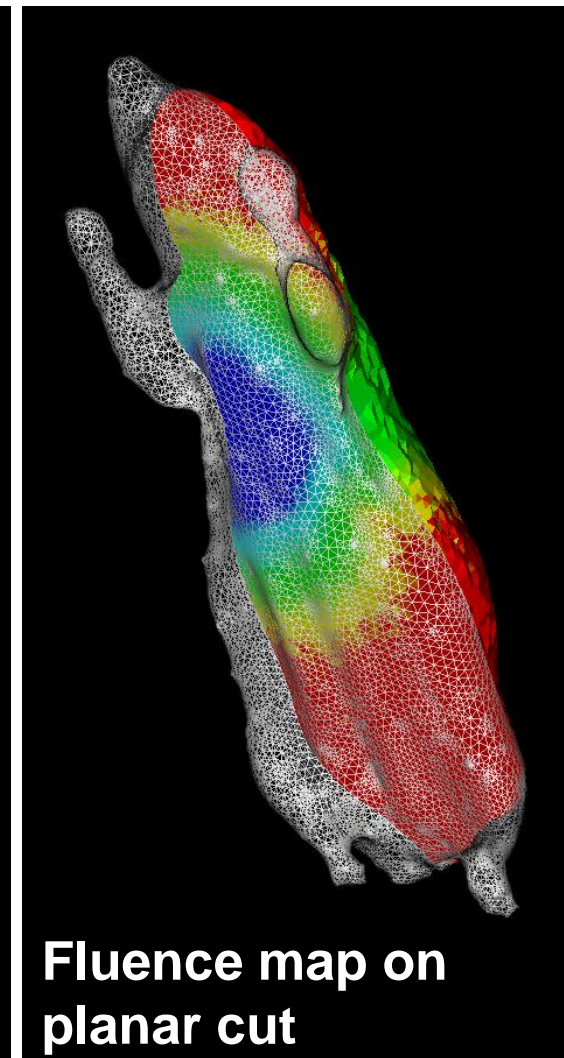
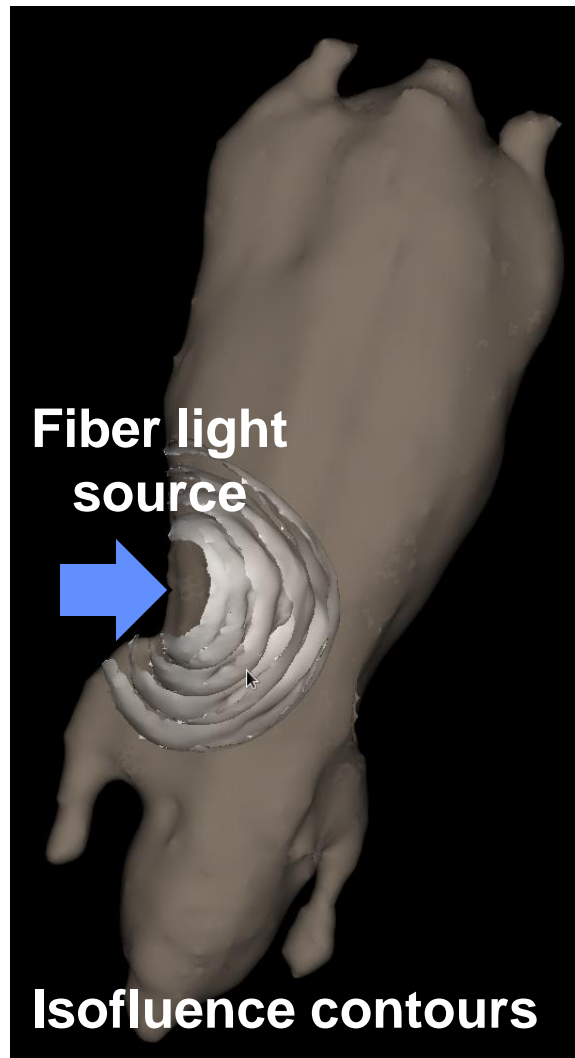
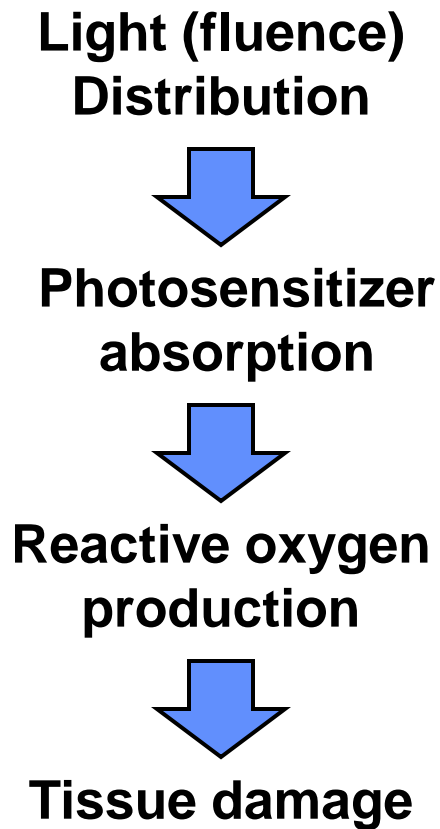

Fast & Accurate Biophotonic Simulation for Personalized Photodynamic Cancer Therapy Treatment Planning

Investigators: Vaughn Betz, University of Toronto
Lothar Lilge, University Health Network

Partner Organizations: IBM and Theralase



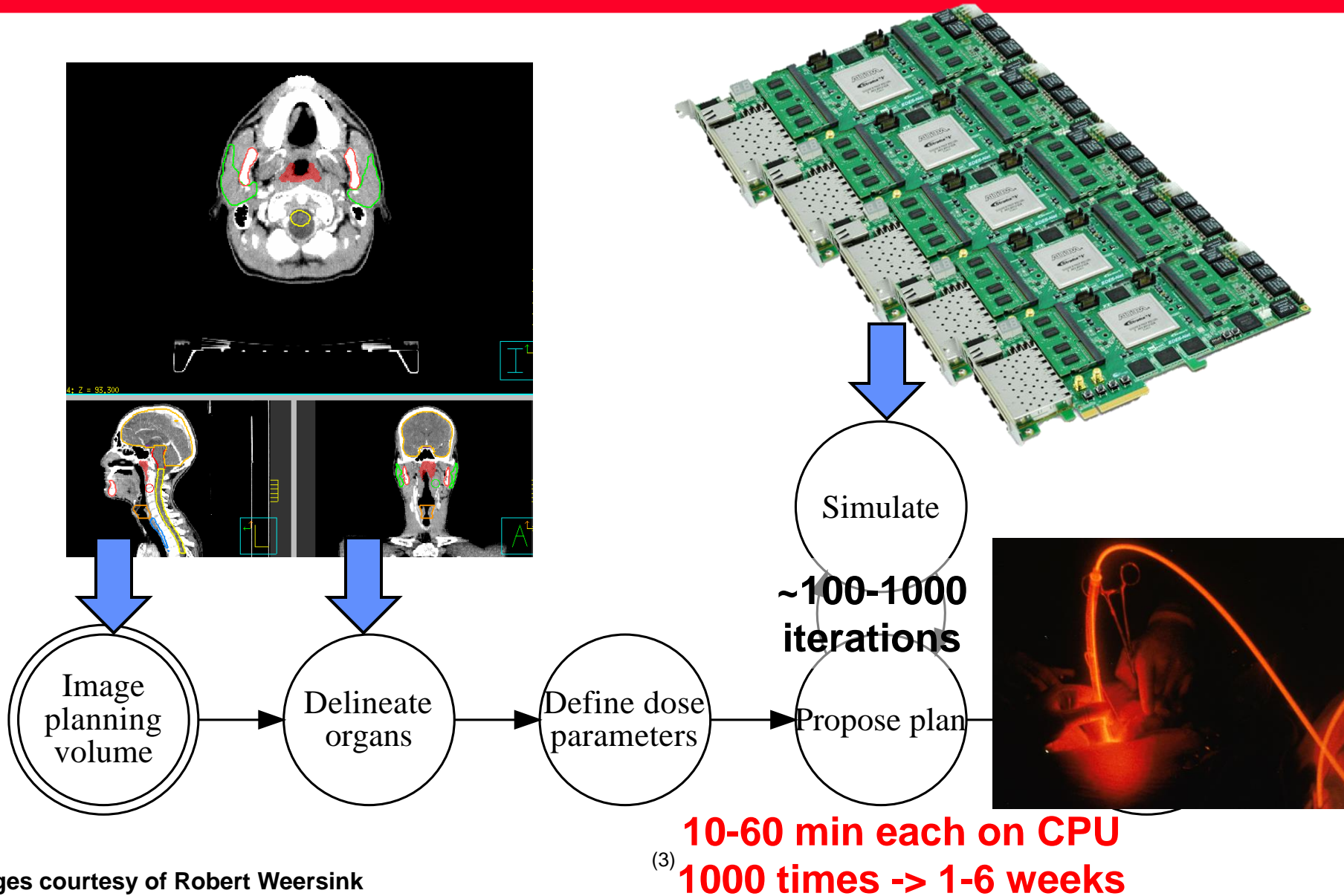
PDT Cancer Treatment Simulation



(2)

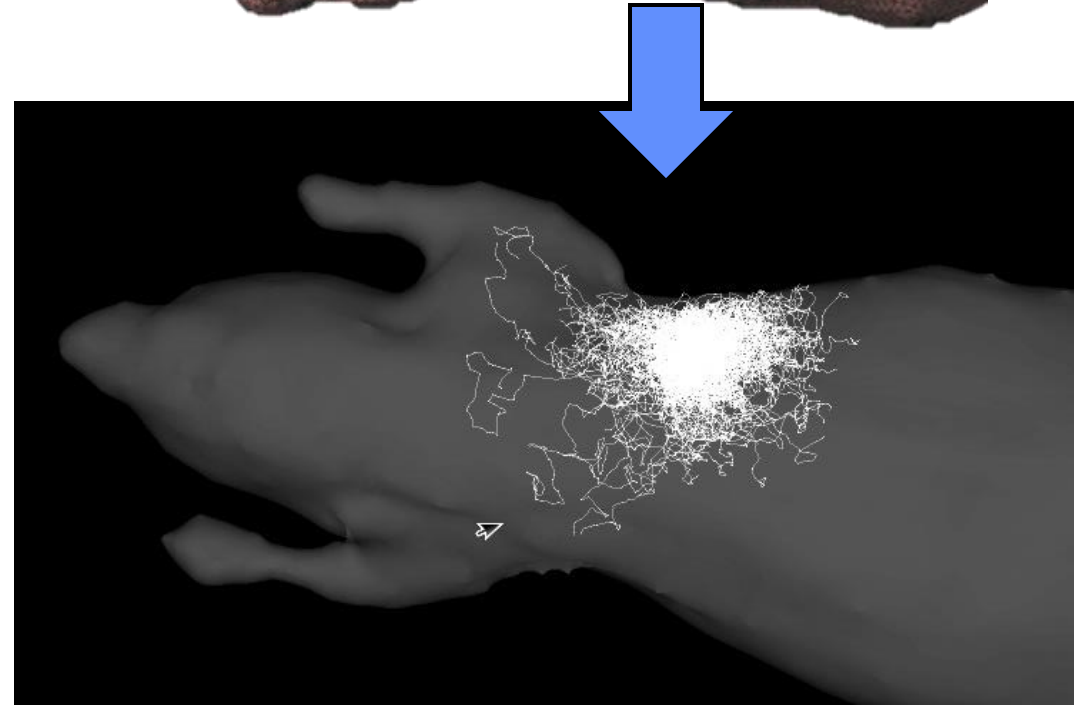
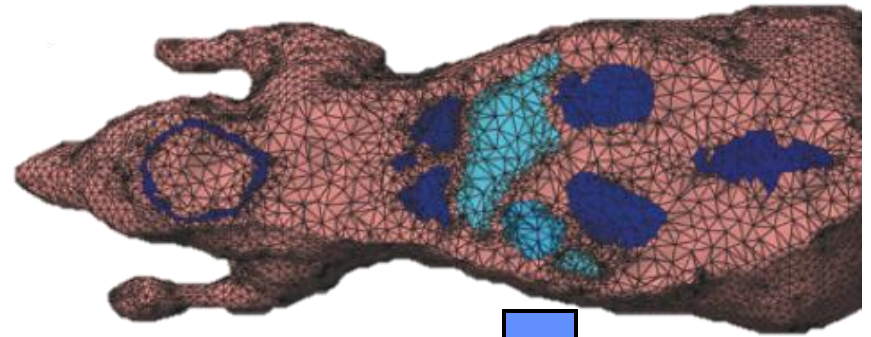
(Lab mouse typically used for pre-clinical testing)

PDT Cancer Treatment Optimization



Simulation Algorithm: Monte Carlo (MC)

- Trace photon packets as they scatter randomly and are absorbed
- Tetrahedral mesh for arbitrary shapes
- Compute-intensive
 - 10^7 - 10^9 packets
 - 10^2 - 10^3 steps each
 - 10-60s minutes with highly-optimized CPU code!



Goals: Research Team

1. Make PDT simulation **both fast** and **accurate**
2. Leverage fast simulator to enable **automatic optimization** of plan, and **robustness** evaluation with tissue variation
3. Develop full flow from MRI data through simulation to visualization
4. Increase PDT efficacy, and broaden applicability to more cancer indications

Goals: Partners

■ IBM

1. New application of IBM CAPI (agile) hardware in the medical space
2. General utilities / APIs created by research team open-sourced
→ enable other agile computing users

■ Theralase

1. Provider of PDT photosensitizers and lasers: better PDT treatment planning → larger market
2. Evaluate a treatment plan *in silico*: can tell if PDT plan will lead to a good result before treatment
3. Automatic optimization: create a better and more robust treatment plan, quickly

Roles

■ Research team:

- Betz: compute acceleration, software development
- Lilge: medical physics modeling, PDT expertise
- Together: develop complete software + hardware flow

■ IBM

- Agile hardware, APIs, and simulation environments
- Technical support and expertise on agile platform
- Interaction with IBM researchers working on related medical simulation and imaging problems

■ Theralase

- PDT and optical measurement expertise
- Calibrate simulator against measured light / PDT results

Achievements to Date

- World's fastest software simulator for general Monte Carlo simulation of light
- Agile hardware implementation in progress
 - Single compute pipeline functions in simulation
 - But still debugging in actual hardware
 - 4x performance of high-end, four-core CPU
 - Expect ~16x performance and 60x power-efficiency for scaled-up full system
- Prototype components of most of MRI image → simulation → visualization flow

OCE and SOSCIP Role & Support

- OCE **very** helpful through entire application process
 - Suggested the VIA program
 - Walked us through the rules and application procedure
 - Answering questions and overcoming roadblocks
- SOSCIP & IBM
 - Hardware & **great** technical support
 - Support for funding applications, and direct funding
 - Linkages and introductions to other researchers
- OCE and NSERC Funding
 - Strong matching → expand goals & team
 - Strong matching → encourages industrial support
 - Broadens team expertise
 - Key to realizing our larger vision!