

# Optically Stimulated Luminescent (OSL) dosimetry for skin dose verification in breast brachytherapy

Jonathon Van Schelt, Lori Young, Landon Wootton,  
Juergen Meyer, Janice Kim and Claire Dempsey

No conflicts of interests to disclose

# *Brachytherapy Lacks Dose Verification*

- External beam RT usually involves direct dose delivery verification:
  - In-vivo dosimetry
  - EPID dosimetry
- Typical HDR brachytherapy QA is another step removed:
  - Source calibration
  - Position verification
  - Catheter length measurement
  - Timer verification

Would HDR brachytherapy benefit from routine  
direct dose measurement?

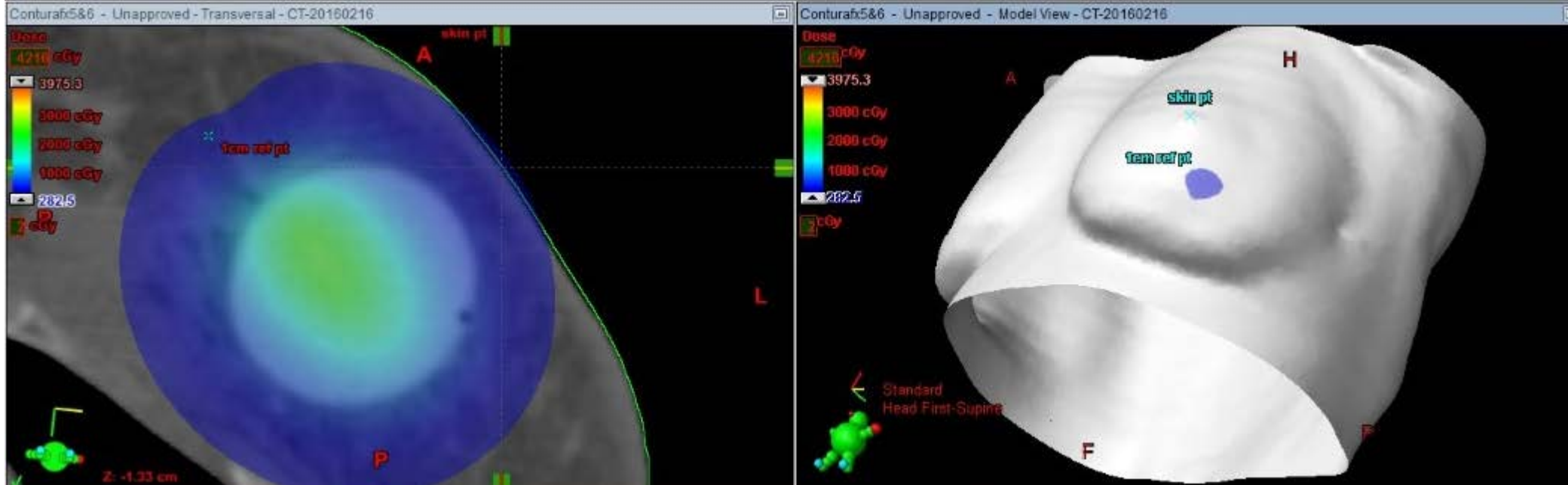
# *A Mysterious Skin Reaction*

- 64 year old female
- Breast brachytherapy treatment with Contura applicator
- Planned 3.4 Gy x 10 fractions



# *A Mysterious Skin Reaction*

- Showed dry desquamation after only 4 fractions
  - Investigation found no problems
  - Planned skin dose was “safe” at 305 cGy



## *A Mysterious Skin Reaction*

- Showed dry desquamation after only 4 fractions
  - Investigation found no problems
  - Planned skin dose was “safe” at 305 cGy



*Was it a mistreatment or unusual skin sensitivity?*

*Remains unknown...*

*It would have been helpful to have dose verification of the skin hot spot*

## *Goal: Develop skin IVD system for HDR*

- Can we use *in-vivo* dosimetry to measure patient skin dose and verify treatment as is done with EBRT?



Landauer nanoDot

- Al<sub>2</sub>O<sub>3</sub> OSLDs selected as dosimeter:
  - Easy to use and reliable
  - Manageable energy dependence
  - Already in use at UWMC and SCCA for external beam *in vivo* dosimetry

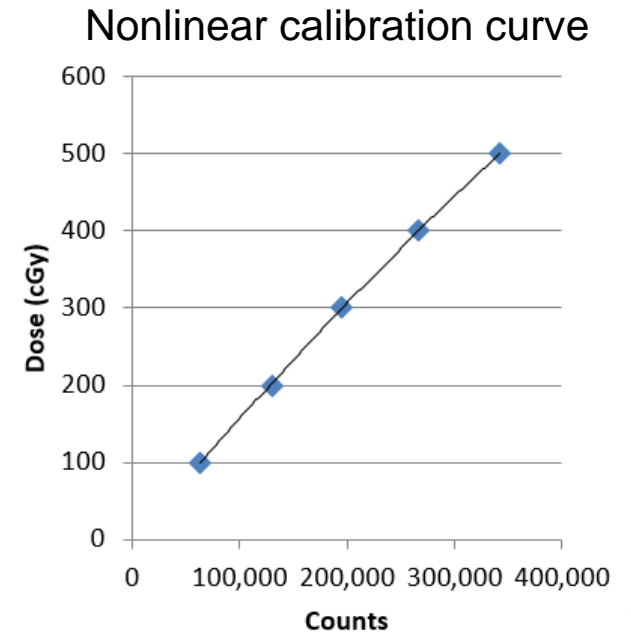
# Commissioning scheme

1. Calibrate OSLD to  $^{192}\text{Ir}$  irradiation under full scatter conditions
2. Measure surface doses with OSLD and find any trends with depth
3. Validate both sets of measurements with EBT3 film
4. Validate OSLD surface doses via Monte Carlo simulation
5. Create clinical IVD worksheet incorporating results
6. Test on patient



# *$^{192}\text{Ir}$ Calibration in HDR phantom*

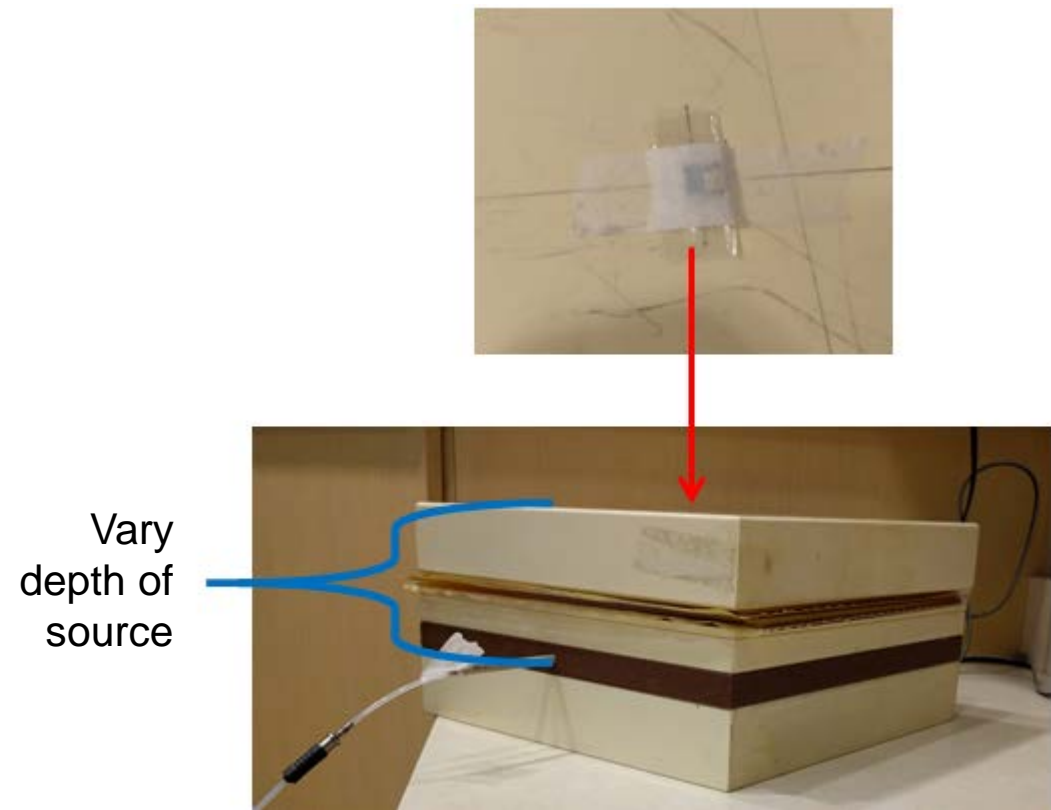
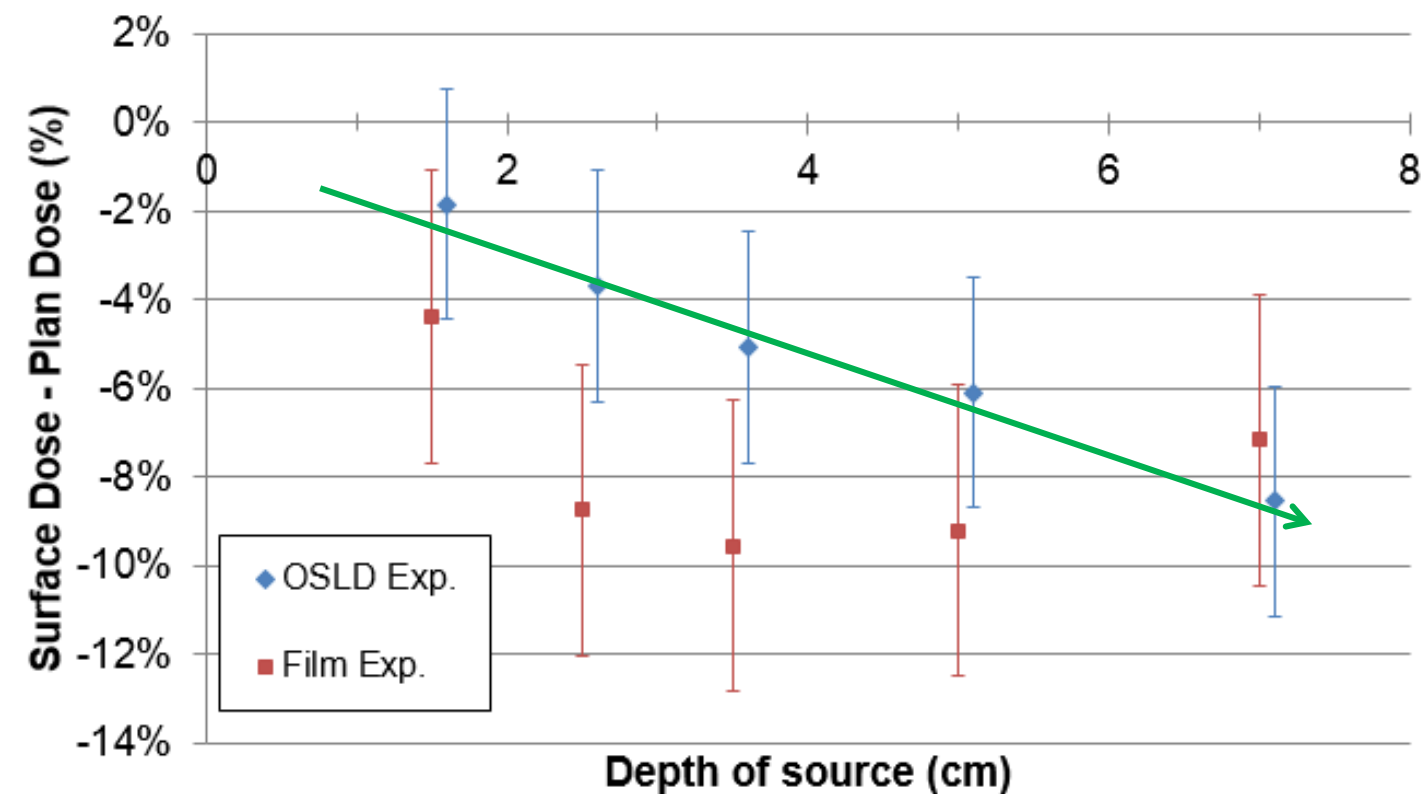
- A phantom with good geometric localization is needed for calibration and testing
- Guide tube from a Varian segmented cylinder applicator fits snugly inside A16 ion chamber cutout in solid water
- Cover OSLD in soft bolus for full scatter conditions



# Surface Measurements

What is the difference in measured surface dose?  
How does it depend on the depth of the source?

Measured with OSLDs and EBT3 film

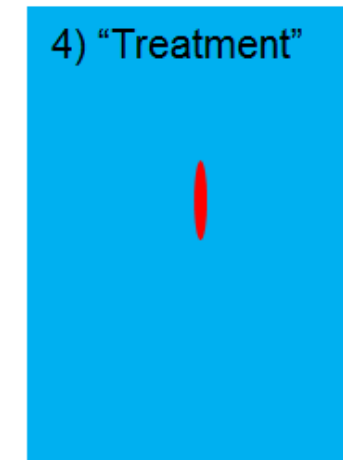
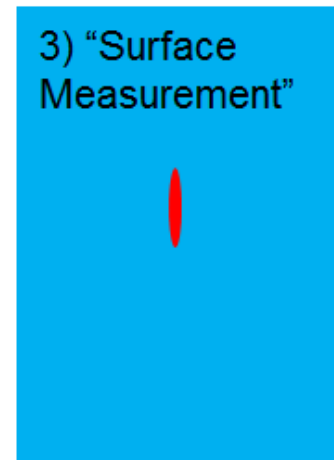
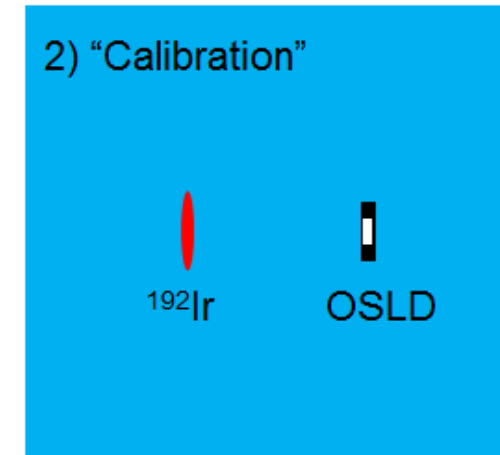
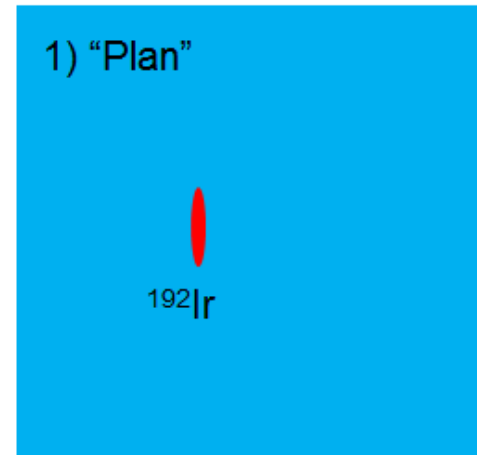


Is this trend real?  
Need theoretical verification

# Monte Carlo Validation

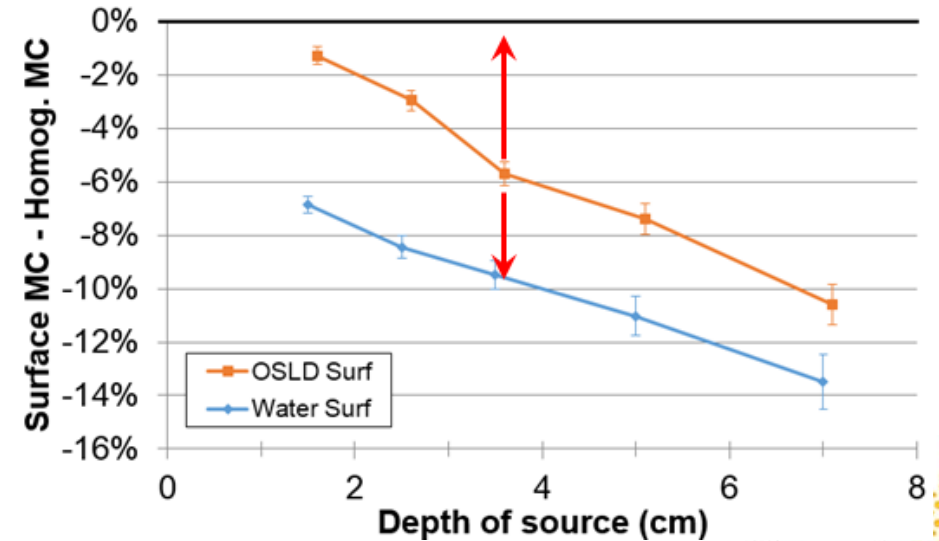
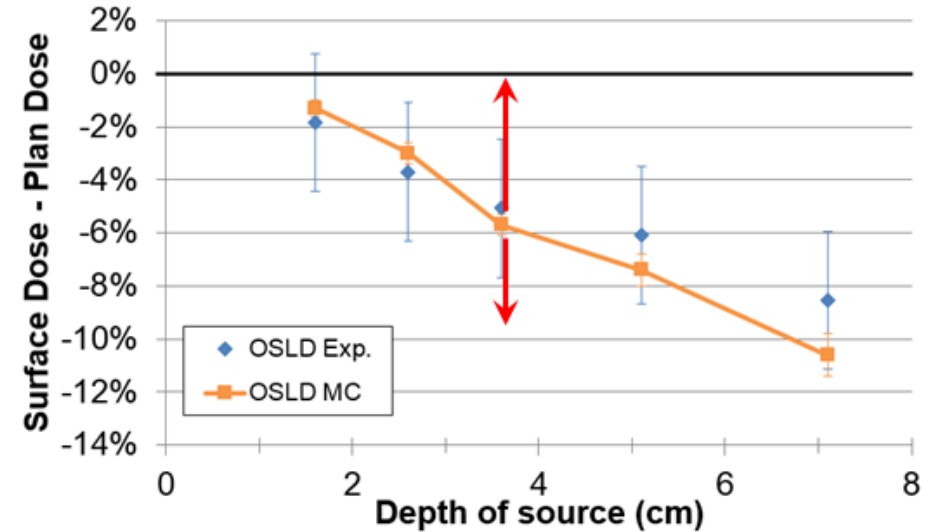
Used EGSnrc Monte Carlo software to re-create OSLD experiment:

- 1) Homogenous water calculation to model TG-43 plan
- 2) OSLD package imbedded in water for calibration
- 3) OSLD package on water surface for surface doses
- 4) Finite water source for skin surface dose



# Monte Carlo Validation

- MC confirmed trends in measured surface dose
- Also revealed trend in true skin dose relative to OSLD measurements
- Results can be used to correct measurement to either:
  - True skin dose or
  - Homogenous-equivalent dose
- Initially correct to homogeneous dose as this is what the planning system provides



# Calculation Worksheet

Raw OSLD reading



<sup>192</sup>Ir calibration



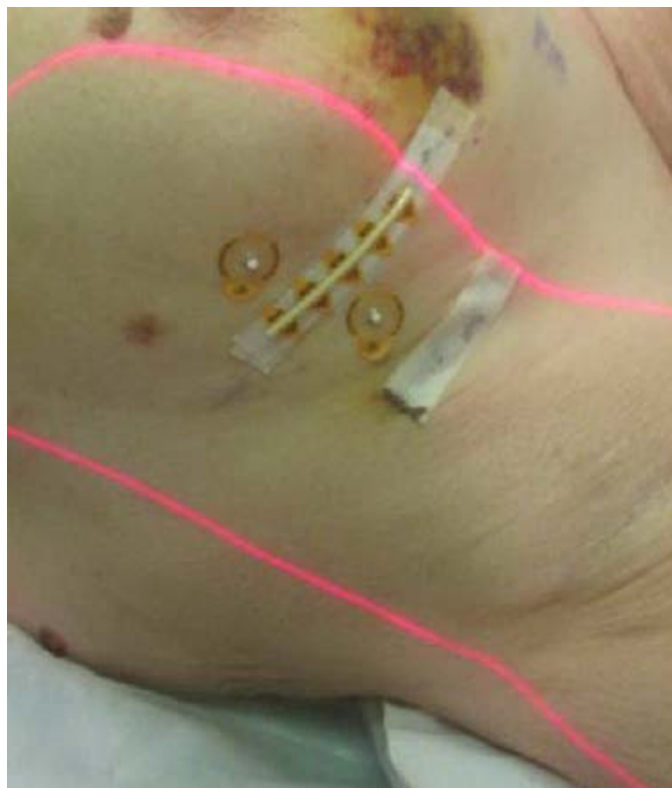
Geometric correction from OSLD to skin (from plan)



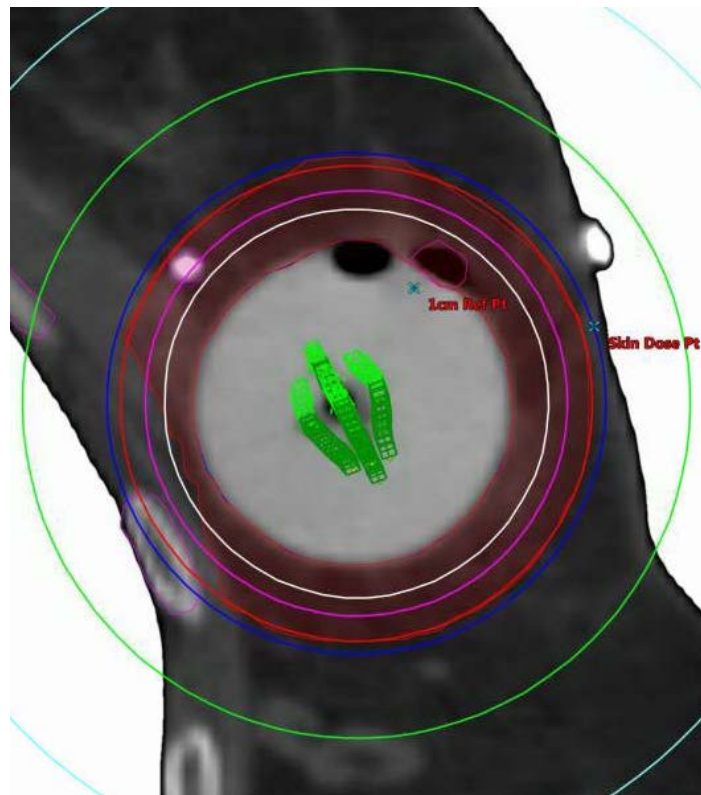
Surface to homogeneous correction from fit to Monte Carlo study

	A	B	C	D	E
1	<b><sup>192</sup>Ir Brachytherapy In Vivo Surface Dosimetry Results</b>				
2	Patient 1				
3					
4	Date: 2017-02-08				
5	Fraction #: 1				
6	OSLD Location: L Breast				
7	Physicist: Jonathon Van Schelt, PhD				
8	<b>Input from BrachyVision</b>				
9	Distance from center of balloon to skin point:	3.4	cm		
10	Planned dose at skin point:	278	cGy		
11	Planned dose 1 mm outside skin point:	262	cGy		
12	<b>Input raw OSLD data</b>				
13	OSLD sensitivity:	0.83			
14	OSLD reader counts, reading 1:	128,421	counts		
15	OSLD reader counts, reading 2:	127,184	counts		
16	OSLD reader counts, reading 3:	127,318	counts		
17	OSLD reader counts, reading 4:	127,663	counts		
18	<b>Dose Calculation</b>				
19	Effective average OSLD counts:	153,791	counts		
20	Dose to water at OSLD from reading:	238	cGy		
21	Geometrically corrected dose to skin surface:	253	cGy		
22	Skin dose corrected to homog. medium:	266	cGy		
23					
24	<b>Results</b>				
25	Skin dose for homogeneous medium:	266	cGy		
26	Uncertainty range:	250-282	cGy		

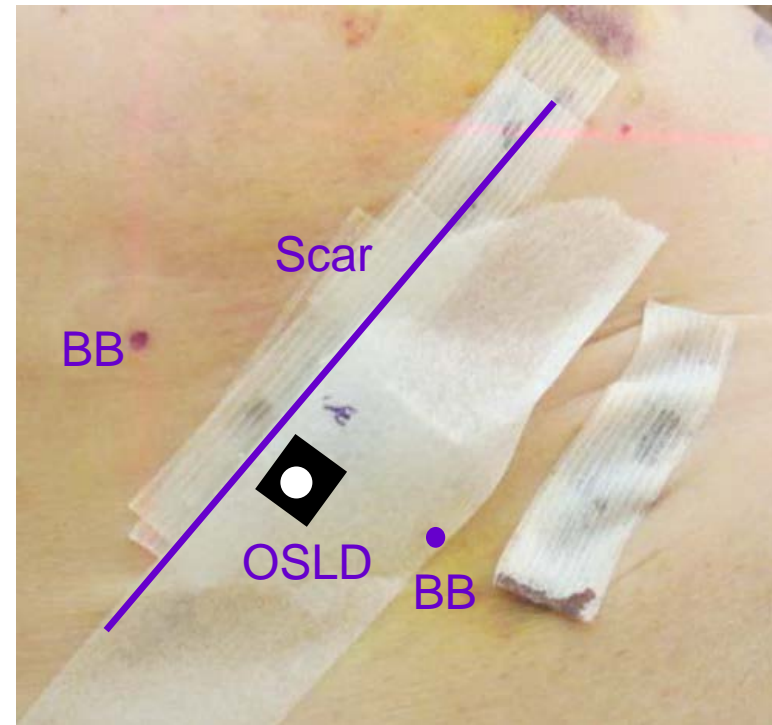
# First Clinical Use



Wire and BBs added around lumpectomy scar at sim



Skin hot spot found in plan



OSLD placed with scar and sim marks as reference

Success! Plan hot spot 278 cGy, measured  $266 \pm 16$  cGy

## *Future Work*

- Accumulate additional data on future patients
  - Fine-tune clinical workflow
- *Upcoming trial: APBI as salvage for failed whole-breast RT*
  - Particularly interested in skin dose for this re-irradiation

Thank you!