Wireless MO*Skin* Dosimetry for In-Vivo Rectal Monitoring During HDR Prostate Brachytherapy

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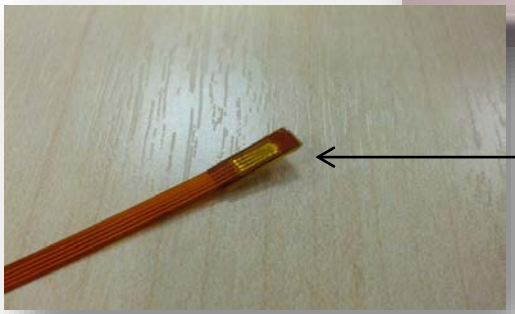
THE ST. GEORGE HOSPITAL — NIL SOUFFRES CELA SUFFIT

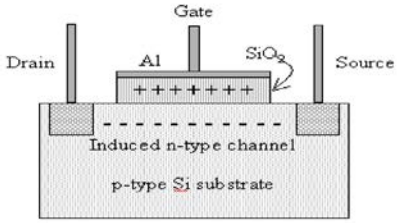
The MO*Skin* Dosimeter

- MO*Skin*™ detector is a novel MOSFET detector prototyped and developed at the Center for Medical Radiation Physics (CMRP), University of Wollongong, Australia.

- **The MO*Skin*™ advantages:**
  - Small physical size, SV less than 1um
  - Can be placed against cavity interfaces
  - Real time read out
  - Can be calibrated using Strontium-90
  - Disposable after use



MO*Skin*™ Detector



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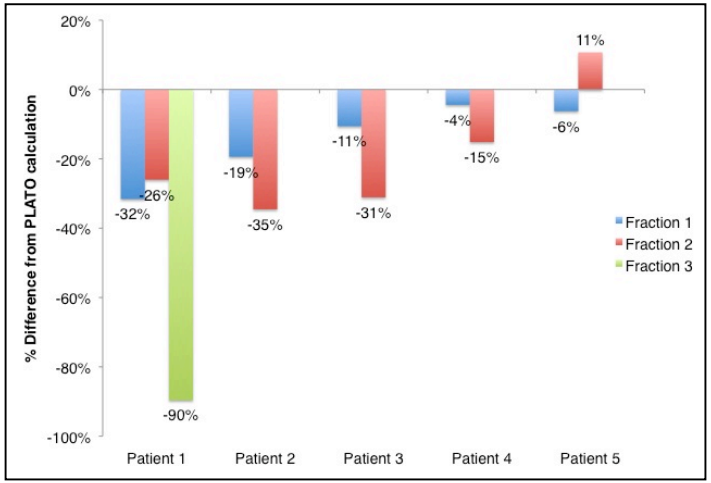
Previous In-Vivo Rectal Measurements (St. G)

- 2007, 2008 – Performed using a prototype MO*Skin* within a sterilisable rubber tube, glued to a MEDRAD rectal balloon (Telisis 5 medical grade adhesive), placed within a condom



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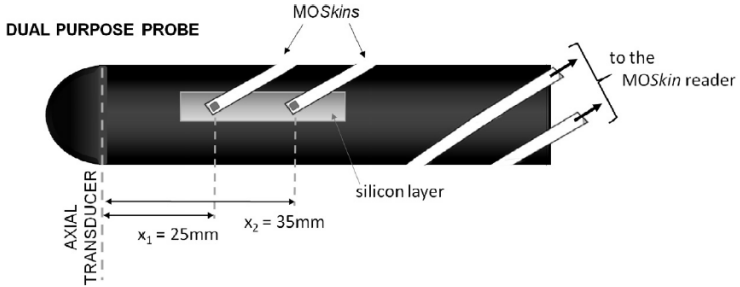
Previous In-Vivo Rectal Measurements (St. G)

- 2010 – Performed using MO*Skin* dosimeters mounted within RadiaDyne rectal balloons during manufacture

- Both trials showed promise, however the accuracy of measurement was limited by the movement of balloons in the rectum
  - Shifting, deflation

Dual Purpose Probe (DPP)

- Developed in collaboration with CMRP, SGCCC and the IRCSS (Milan, Italy)

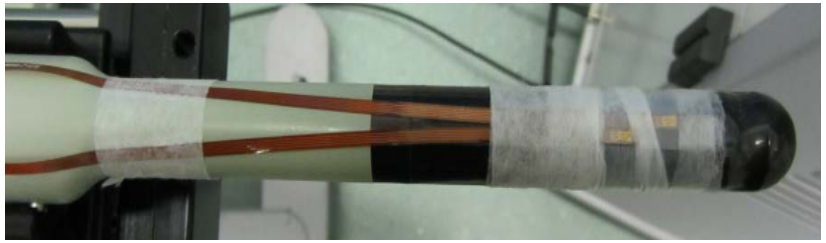


M. Cararra, et al, Radiotherapy and Oncology, 118 (2016) 148-153

- MOSkins mounted on TRUS probe (rigid)
- Constant reference frame between imager (TRUS) and detectors
- Used for HDR prostate brachytherapy and gynaecological procedures (thin rigid probe)

DPP Clinical Use

- In Milan, Italy
- Real time TRUS based HDR prostate brachytherapy
- 18 fractions (36 measurement points)
- The measured doses were compared to
  - Pre-treatment image plan (-2.1% ± 8.3%)
  - Post-treatment image plan (-0.6 ± 4.1%)
- This study showed the delivery needs to be performed within as short a time as possible



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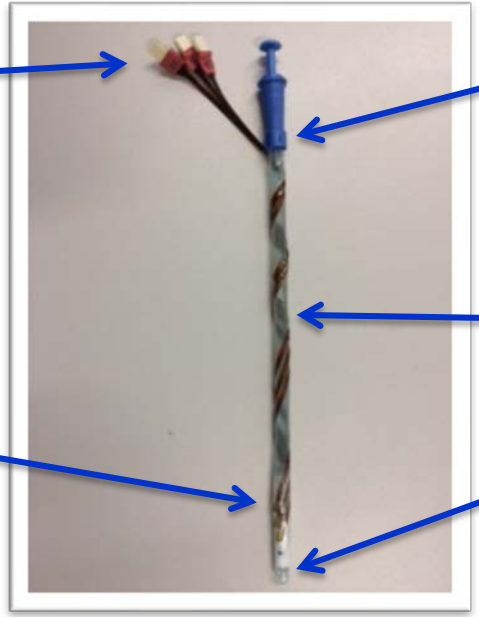
Similarly for Gynaecoligical

- Rectal wall doses were measured for a total of 22 measurements in 9 vaginal HDR brachytherapy fractions, for a total of 3 patients
- 3 detectors were attached to rectal catheter



MO*Skin* pigtails, plugged into reader

Orientation marker

Probe filled with gel

3 MO*Skin* dosimeters
Kapton tails allow for dosimeters to be wrapped around catheter

Radiopaque marker

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New MO*Skin* Reader

- Improved measurement accuracy
  - 0.125 mV minimum signal as opposed to 1 mV
- Short cable connection from MO*Skin* to reader
  - Up to 6 devices at once
  - Battery powered (rechargeable)
- Wireless connection from reader to computer
  - Custom reader software
  - Bluetooth or 434 MHz connection
- Automatic temperature fluctuation compensation
  - Constantly measures leakage current through an on-chip diode
  - Offsets all measurements to account for temperature fluctuations

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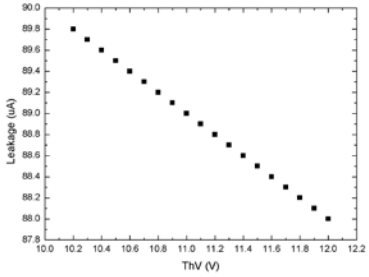
Temperature Calibration

- Performed for every MO*Skin* probe
- Probe placed on an inverted Peltier cooler (to heat it)
- As device cools, a trace of leakage current vs threshold voltage (MOSkin signal) is obtained
- The gradient of this is the temperature calibration
- By constantly comparing the leakage current to the threshold voltage, any changes in threshold voltage due to temperature fluctuation may be separated from the signal induced by radiation



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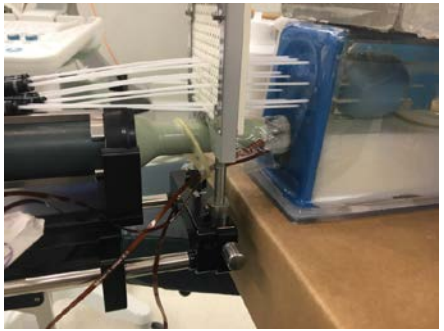
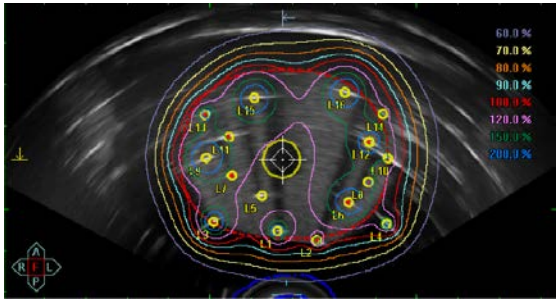
Phantom Trial

- A DPP was created with three MOSkin probes attached to a TRUS
- Designed to span 5cm (base, mid-gland, apex)
- A CIRS prostate phantom was implanted under TRUS guidance
- Real-time TRUS based planning used
- Treatment delivered with MOSkin measurements obtained with the classic reader and the wireless reader





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Phantom Trial

Position	Classic Reader	Wireless Reader
Base (0 mm)	0.6%	3.7%
Mid-Gland (24 mm)	4.3%	3.0%
Apex (50 mm)	2.6%	3.4%

Discrepancies from treatment plan

It was established that the wireless reader would supplant the classic reader with minimal differences in accuracy

Clinical Trials

- Real-time TRUS based planning for HDR Prostate BT introduced at StG CCC Late 2016
  - 2 Fractions, 1 week apart
- MO*Skins* to be used to verify rectal doses
- 4 MO*Skins* mounted to the side of the TRUS probe (1.5cm pitch)
- Probe placed inside TRUS balloon (imaging, hygiene)
- Trials to begin late Feb 2018
- 13 patients, 26 fractions, 104 detectors (6 months)

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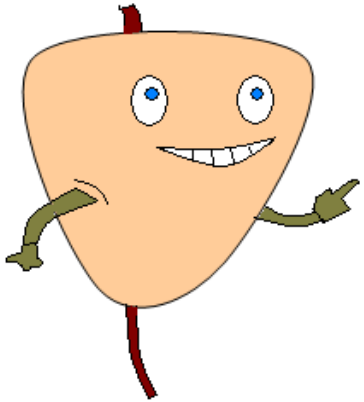
Conclusions



- Development of the MO*Skin* system has progressed to improve
  - Accuracy (better electronics)
  - Useability (wireless, software based acquisition)
  - Stability (temperature correction, lower operating voltage)
- Clinical trials will proceed to
  - Incorporate 4 MO*Skins* onto a TRUS
  - Measure the rectal wall dose during TRUS based HDR BT
  - Physically validate the real-time TRUS based HDR BT procedure at St.G CCC