Applications of Plastic Scintillation Dosimetry for Radiation Oncology:
A Startup Founder Perspective

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2021 Virtual CIRMS Annual Meeting

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From PhD to Entrepreneur

- 2008-2012: PhD in Medical Physics from Laval University (Quebec)
- 2013-2015: Odyssey Fellow at MD Anderson Cancer Center (Houston, TX)
- 2016-2018: Medical Physicist, Researcher and Entrepreneur
- Since 2018: Full-time CEO and co-founder of Medscint inc.

UNIVERSITÉ LAVAL

THE UNIVERSITY OF TEXAS MD Anderson Cancer Center

Making Cancer History®

CHUM

Centre hospitalier de l'Université de Montréal

medscint

Plastic Scintillation Detector (**PSD**)

Probe

Scintillator converting ionizing radiation to light.
Plastic optical guide transmitting light up to the reader.

Reader

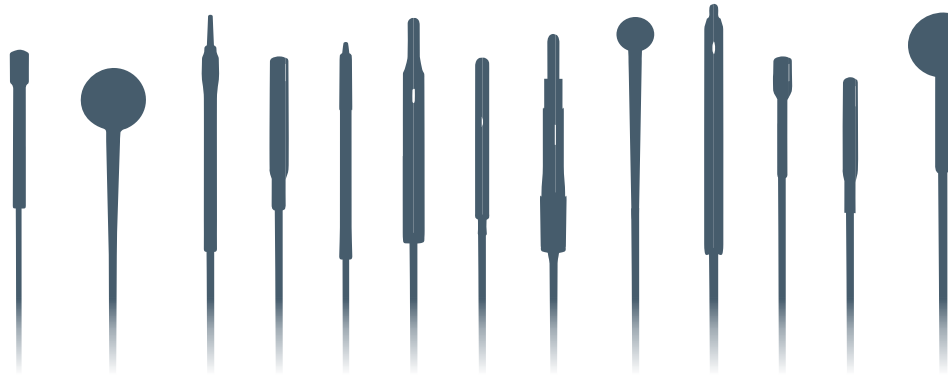
Photodetection module processes and converts light to analog/digital signal.

Software/User Interface

Digital signal processing, visualization and analysis.

The Stem Effect Challenge

Some of the PSD advantages



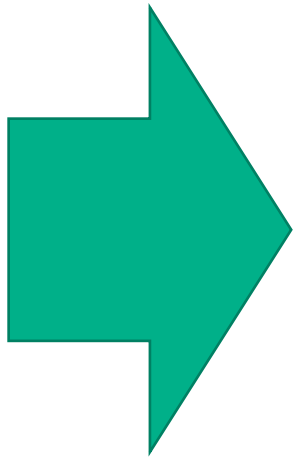
- SUB-MILLIMETRIC SIZE
- MULTI-POINT
- MR-COMPATIBLE
- ENERGY INDEPENDENCE
- ANGULAR INDEPENDENCE
- HIGH DOSE RATE LINEARITY
- WATER-EQUIVALENT MATERIAL
- REAL-TIME DOSIMETRY
- FLEXIBLE PROBE DESIGN
- ROBUST STEM CALIBRATION
- ROBUST TO RADIATION DAMAGES
- LOW DEPENDENCE TO TEMPERATURE

A Growing Interest for PSDs

Pubmed : search for (plastic scintillation detector)

Fields & Applications

- LINAC external beam
- HDR brachytherapy
- MR-Linacs
- Radiosurgery
- Proton & heavy ions therapy
- FLASH radiotherapy
- Radiation Biology
- Veterinary radiation oncology

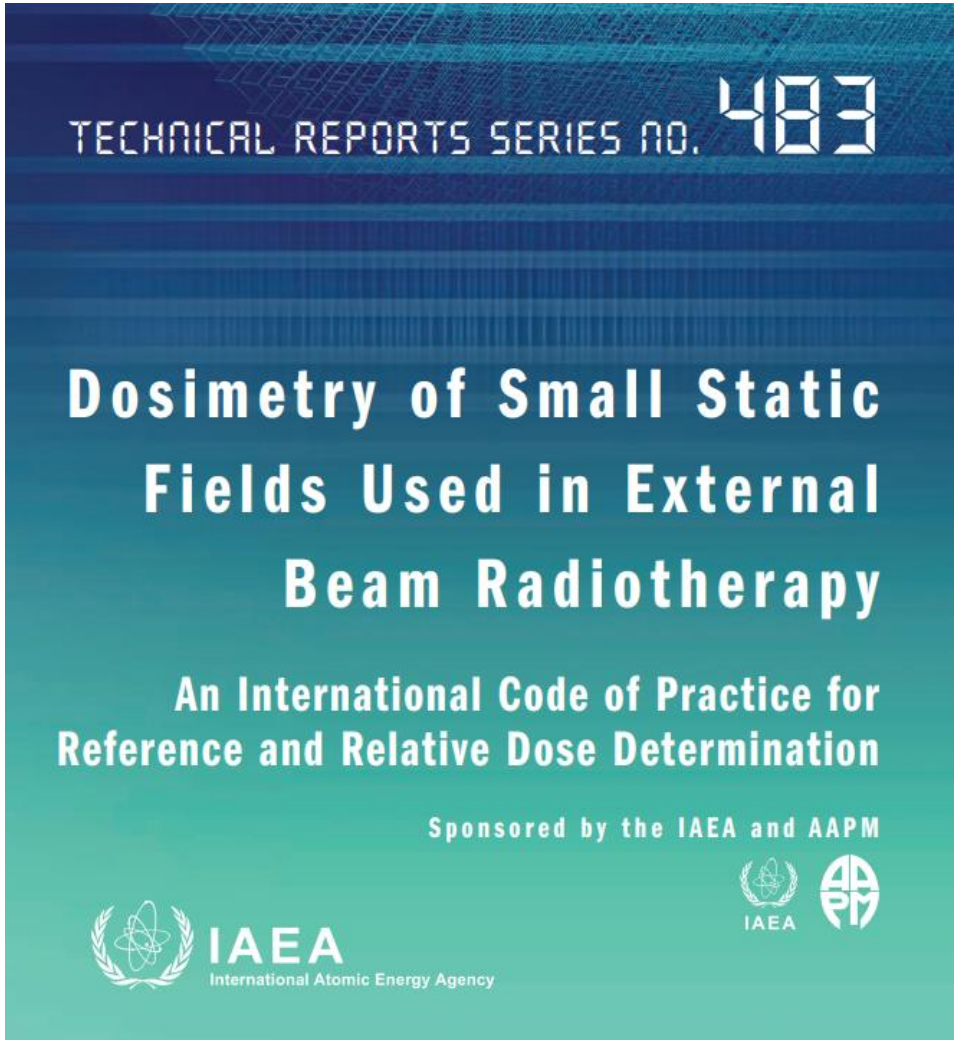


- Research projects
- Quality assurance
- In phantom applications
- Machine/beam characterization
- In vivo dosimetry

Small Field Dosimetry

KEY CHALLENGES

- Volume averaging
- Detector's composition



SUB-MILLIMETRIC SIZE

Detector dimensions are ideal for small fields.

WATER-EQUIVALENT MATERIAL

No perturbation of the radiation field.

ENERGY INDEPENDENCE

Including multiple modalities >100keV

On board MR-imaging LINACs

KEY CHALLENGES

- Change in stem effect
- Effects at the boundaries

Electrons within a MR-LINAC are affected by the magnetic field strength and polarity

Source: https://www.itnonline.com/article/promise-mri-guided-radiation-therapy

MR-COMPATIBLE

Accurate dosimetry even in strong magnetic fields

WATER-EQUIVALENT MATERIAL

No perturbation of the radiation field

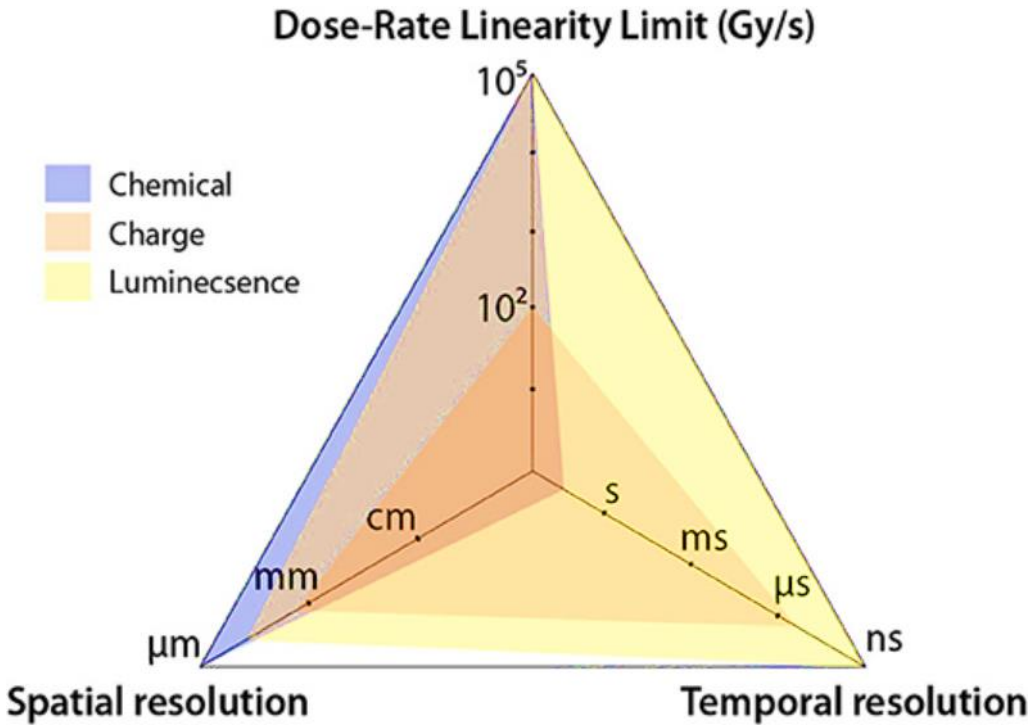
ROBUST STEM CALIBRATION

Complete subtraction of the
Stem components

FLASH Radiotherapy

KEY CHALLENGES

- Ultra-High dose rates
- Fraction of second delivery
- Detectors subject to saturation



Source: Ashraf, MR et al. Dosimetry for FLASH Radiotherapy: A Review of Tools and Role of Radioluminescence and Cherenkov Emission, Frontiers in Physics, 2020 8:328

REAL-TIME DOSIMETRY

Instant dose measurements for dynamic procedures

ROBUST TO RADIATION DAMAGES

Can absorb kGys before seeing significant effects

HIGH DOSE RATE LINEARITY

Linearity high dynamic range

FLASH Radiotherapy

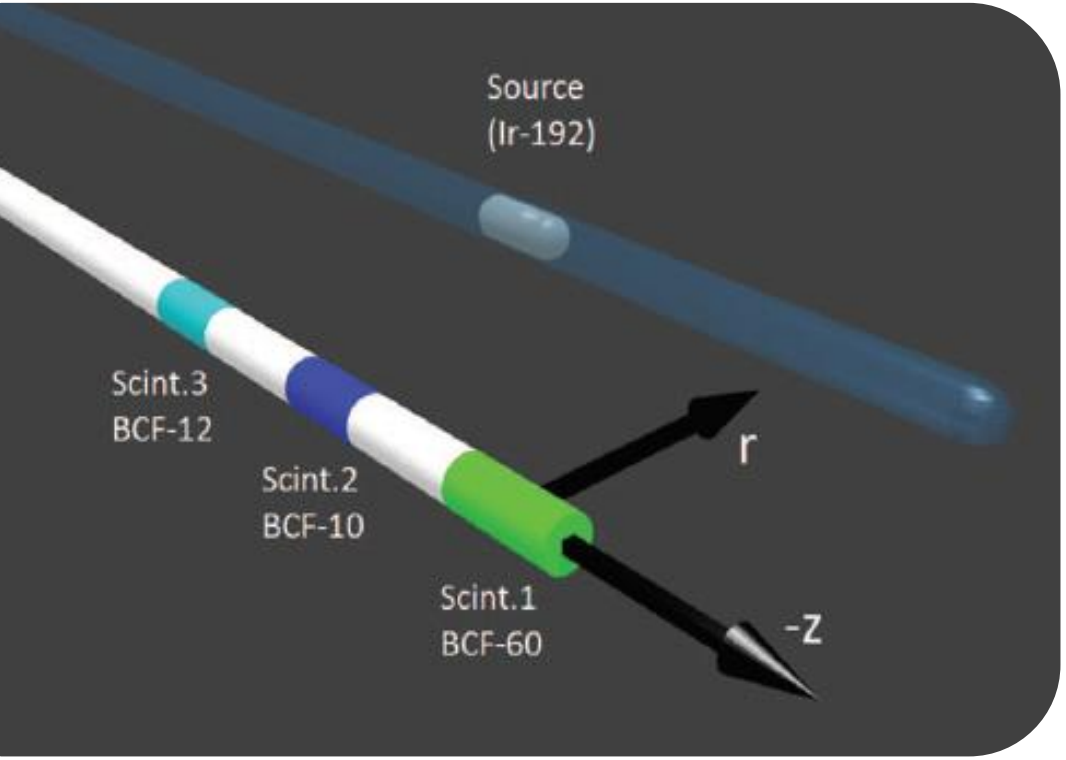
SPOILER ALERT

University of Maryland:
Poirier Y et al, “Novel Plastic Scintillator for Online Dosimetry in Electron FLASH-RT”, work to be presented at AAPM and COMP 2021 annual meetings

HDR Brachytherapy In Vivo Dosimetry

KEY CHALLENGES

- High dose gradients
- Detector vs. source position uncertainty



FLEXIBLE PROBE DESIGN

Can be inserted inside catheters

SUB-MILLIMETRIC SIZE

Accurate dosimetry even in high dose gradients

REAL-TIME DOSIMETRY

Instant dose measurements

MULTI-POINT

Multiple measurements on a single probe

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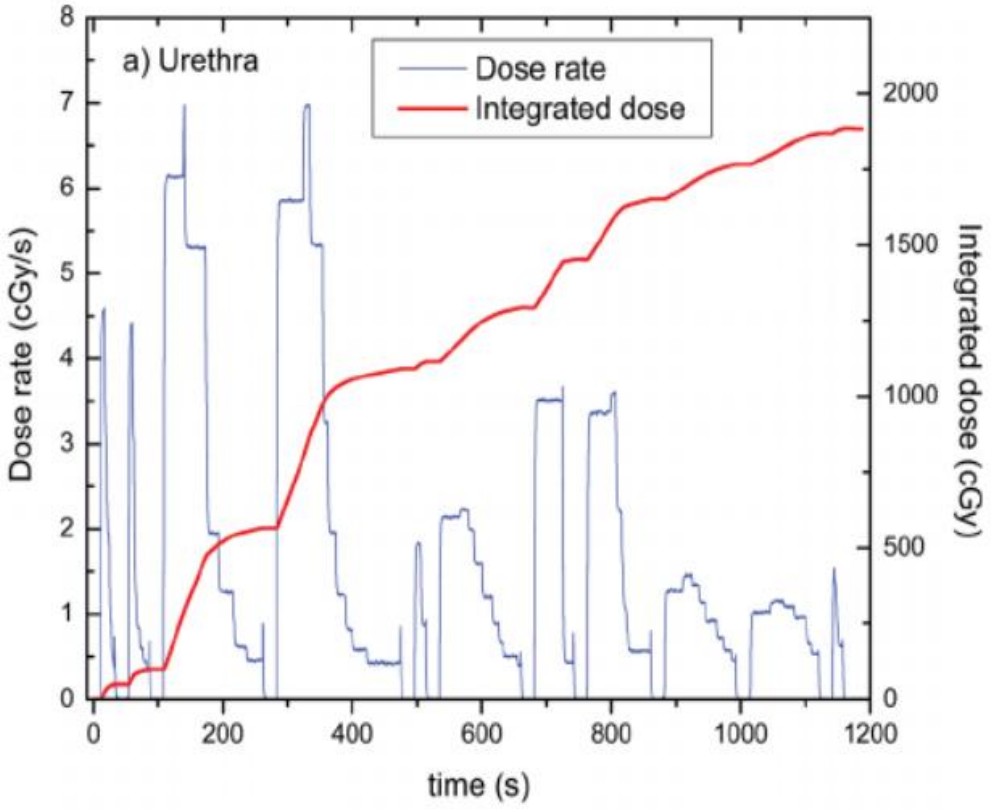

Therriault-Proulx F et al "A phantom study of an in vivo dosimetry system using plastic scintillation detectors for real-time verification of 192Ir HDR brachytherapy" Med Phys. 2011 May;38(5):2542-51.

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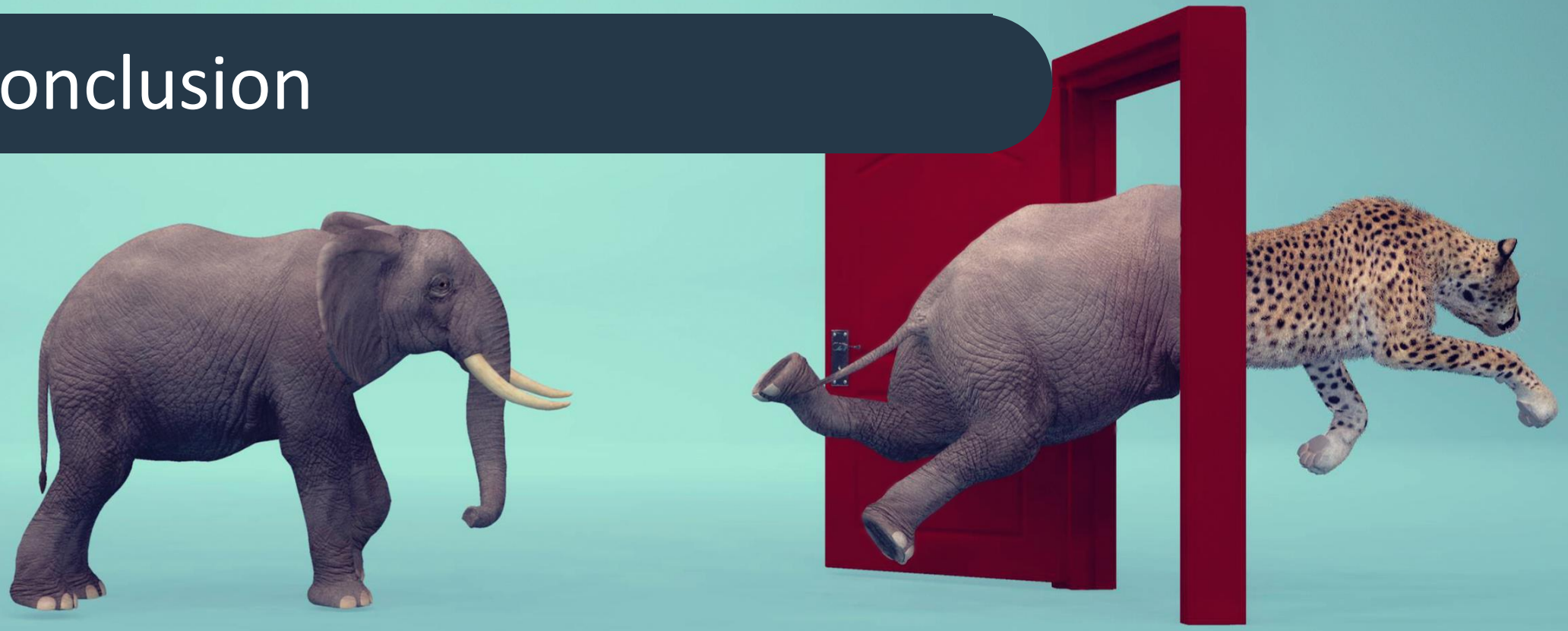
Perspectives for PSDs

- There is a change in paradigm between standard ion chambers and new optical detectors
  - Photonics technologies evolve rapidly
    - PSDs are versatile and fit well within the rapid-prototyping innovation landscape
      - Light spectral information is key to push the limits of PSDs performances

Conclusion



NOW IS A GOOD TIME TO JUMP ON THE PSD TRAIN, STILL PLENTY OF INNOVATING RESEARCH AND CLINICAL PROJECTS TO BE PUSHED FORWARD!

Thank you!

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