





## FIRST APPROACH TO 3D DOSIMETRY VERIFICATION USING LEKSELL GAMMA KNIFE® ICON™

Evelina JASELSKĖ, Linas KUDREVIČIUS, Viktoras RUDŽIANSKAS, Tadas DIDVALIS, Diana ADLIENĖ

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kauno technologijos universitetas



## **POLYMERIZED DOSE GELS IN MEDICINE**

Gel dosimeters are manufactured from radiosensitive chemicals. Dosimetric gels are crosslinked networks of polymers which behave as viscoelastic solids.

<u>These gel dosimeters record the radiation dose distribution in 3D.</u>
<u>Polymer dose gel is nearly human soft tissue equivalent.</u>

Potential applications

Low-energy X-ray; High-linear energy transfer (LET); Proton therapy; Radionuclide therapy; (Boron) neutron capture therapy; Intensity-modulated radiation therapy (IMRT, VMAT); Stereotactic radiosurgery; Radiosurgery with Gamma knife; Brachytherapy dosimetry.







#### **GELS PREPARATION PROCESS**

## •Select an appropriate type of polymer gel:

	Anoxic / Normoxic	Gelatin / Agarose	Acrylamide	N,N' methalyne bis acrylamide	Methacrylic acid	Acrylic acid	Na mathacrylate	4-vinylpyrrolidone	2-hydroxyethyl acrylate	2-hydroxyethyl methacrylate	Ascorbic acid	hydroquinone	Copper(II) sulphate	THPC <sup>1</sup>	THPS <sup>2</sup>
PAG	A	F	•	•				_							
nPAG <sup>3</sup>	N	E	•	•										•	•
PAGAT <sup>4</sup>	N	G	•	•								•		•	
PAGAS	N	G	•	•							•				
MAGIC	N	G			•						•	•	•		
nMAG	N	G			•										•
MAGAS	N	G			•						•				
MCA	Α	G		•	•										
MAGAT	N	G			•									•	
Methacrylate	Α	G		•			•								
VIPAR	Α	G		•				•							
HEA	Α	G		•					•						
HEMA	Α	G		•						•					
ACA	Α	G		•		•									
PRESAGE	N														







## **GELS PREPARATION PROCESS**

### **Preparation:**

The radiation sensitive gel is fabricated and poured into tightly closed vial and left for 24 hours in dark to set.



Irradiation and read-out:

The vial with a gel is exposed to the high energy beam and polymerizes creating regions inhomegeneous physical and optical density.







**DOSE EVALUATION METHODS** 

## Irradiated polymerized dose gels vials could be evaluated using different methods:

- ➤Magnetic resonance imaging;
- ≻Optical imaging;
- Computed tomography;
- ≻Ultrasound;
- >SEM and TEM scanning microscopy;

etc.









#### **POLYMERIZATION CHEMISTRY**





SSD 100cm;

PDD100% at 0.5cm depth





Co-60 source	Ir-192 source				
<b>Teletherapy unit ROKUS-M</b> Activity: 4.28•10 <sup>13</sup> Bq,	HDR Brachytherapy unit MICROSELECTRON V2				
Dose rate: 0.25 Gy/min,	Activity: 0.35•10 <sup>12</sup> Bq,				
Characteristic energies:	Air kerma rate: 0.73 Gy/min,				
$\gamma_1 = 1.17$ MeV,	Characteristic energies:				
$\gamma_2 = 1.34 \text{ MeV}$	$\gamma = 0.37$ MeV,				
	$\beta = 1.454 \text{ MeV}$				
Broad beam geometry;					
Irradiation field 10x10 cm <sup>2</sup>	Point source geometry				

PDD 100% at 1.0 mm (radial distance)







## **IRRADIATION EQUIPMENT**

- 192 Co-60 sources;
- Activity: 195.53 TBq (at loading)
- Dose rate: 3.493 Gy/min (at calibration)
- 8 sectors with 4, 8 and 16 mm collimators;
- Radiological accuracy < 0.5 mm;



- CBCT with 2.5 and 6.3 mGy CTDI preset;
- Energy: 90 kVp, 332 projections, reconstruction volume 224<sup>3</sup> mm;
- Real-time HD motion management (HDMM) system;
- IR camera tracks at 20 Hz, accuracy 0.15 mm, threshold 0.5 3 mm.





## KAUNAS CLINICS GELS IRRADIATION

	I shot	II shot				
Dose rate	3.408 Gy/min					
Prescription	12.0 Gy @ 50%					
Collimator	8	4				
X,Y,Z (mm)	100,130,100	90,120,110				
Dose rate at focus, Gy/min	1.91	2.85				
Time, min	12.12	8.14				
Output factor	0.9645	0.9666				













## CONCLUSIONS

- Polymer gels dosimetry are only one 3D dose distribution method that can be used for indvidual dosimetry in gamma knife therapy.
- nPAG and VIPARnd dose gels are sensitive enough to replicate absorbed dose in three dimension with closely similar shape simulated with gammaplan software.
- Plotted results of T2 (ms) indicated a good agreement estimating the dose response of each gel.
- Getting results enable to assume that VIPARnd dose gels could have better opportunities to replicate abosrbed dose in larger dose range, but more different calculations are required to perform.



# **THANK YOU!**

