

# Thermoluminescence Dosimetry System for Quality Assurance in Ion Radiotherapy

Jan Gajewski

Institute of Nuclear Physics, Kraków, Poland

*Supervisor: Prof. Dr hab. Paweł Olko*

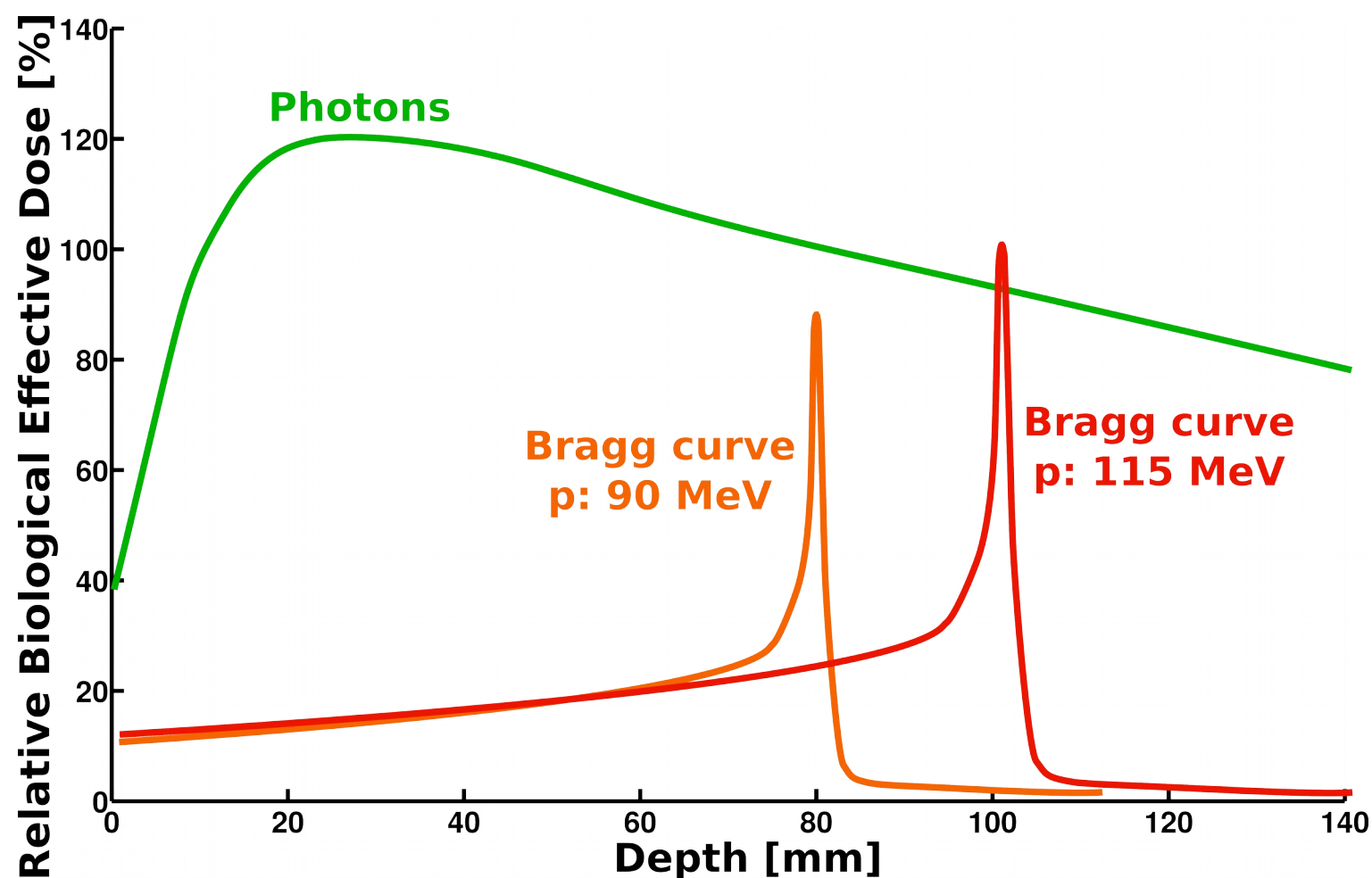
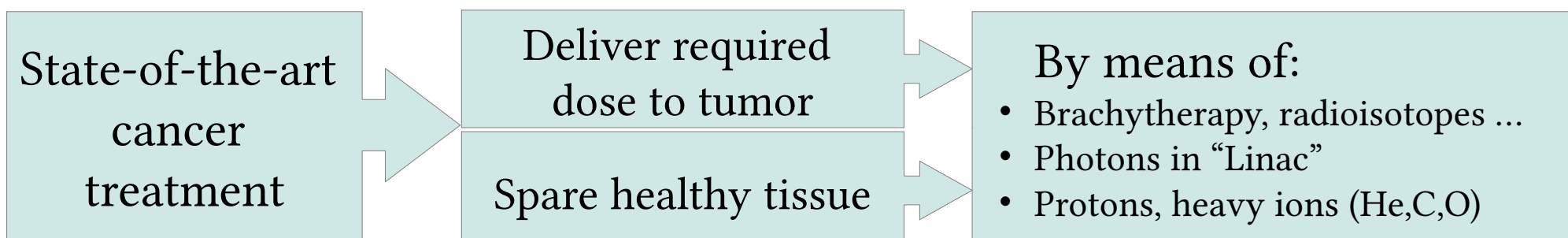
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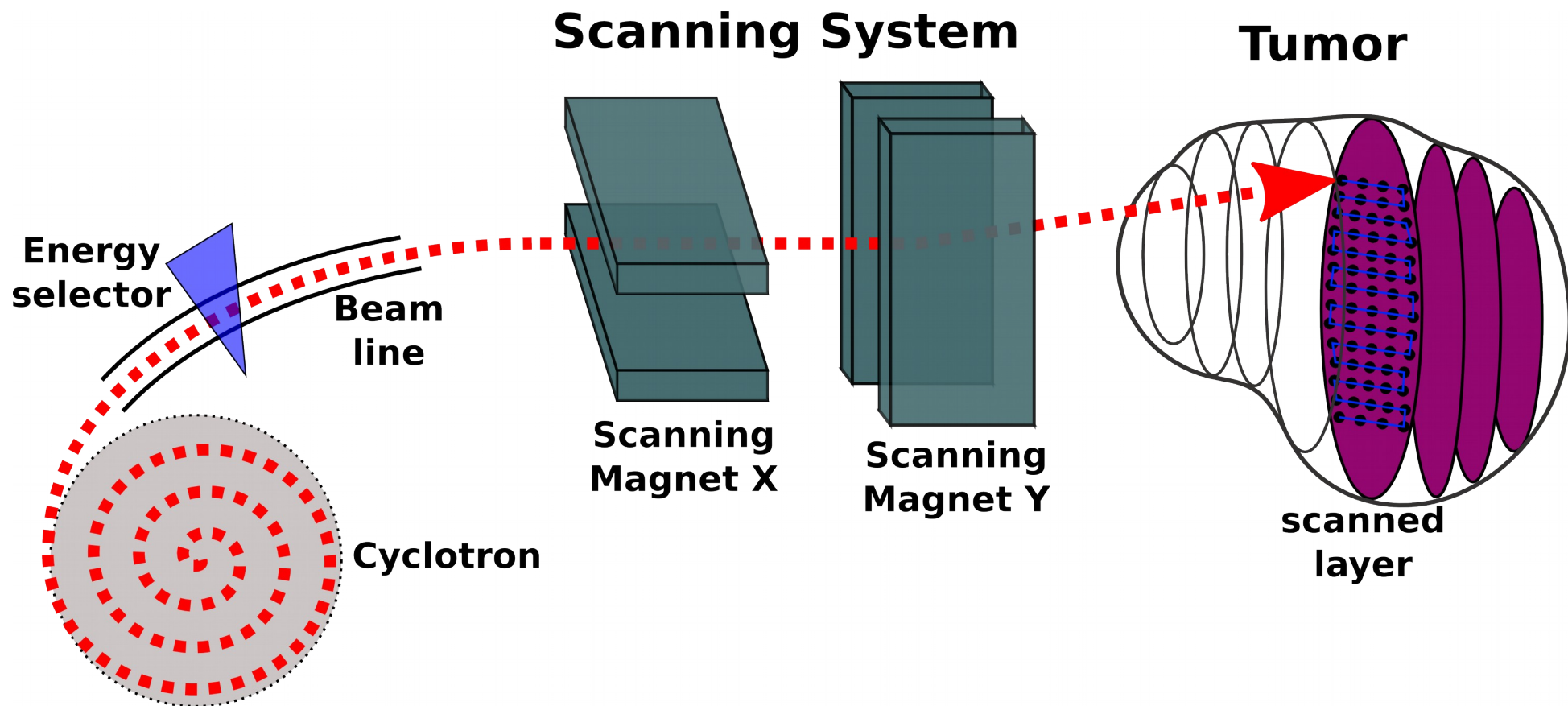
*Kraków, Poland*



# ION THERAPY – WAY OF CANCER TREATMENT

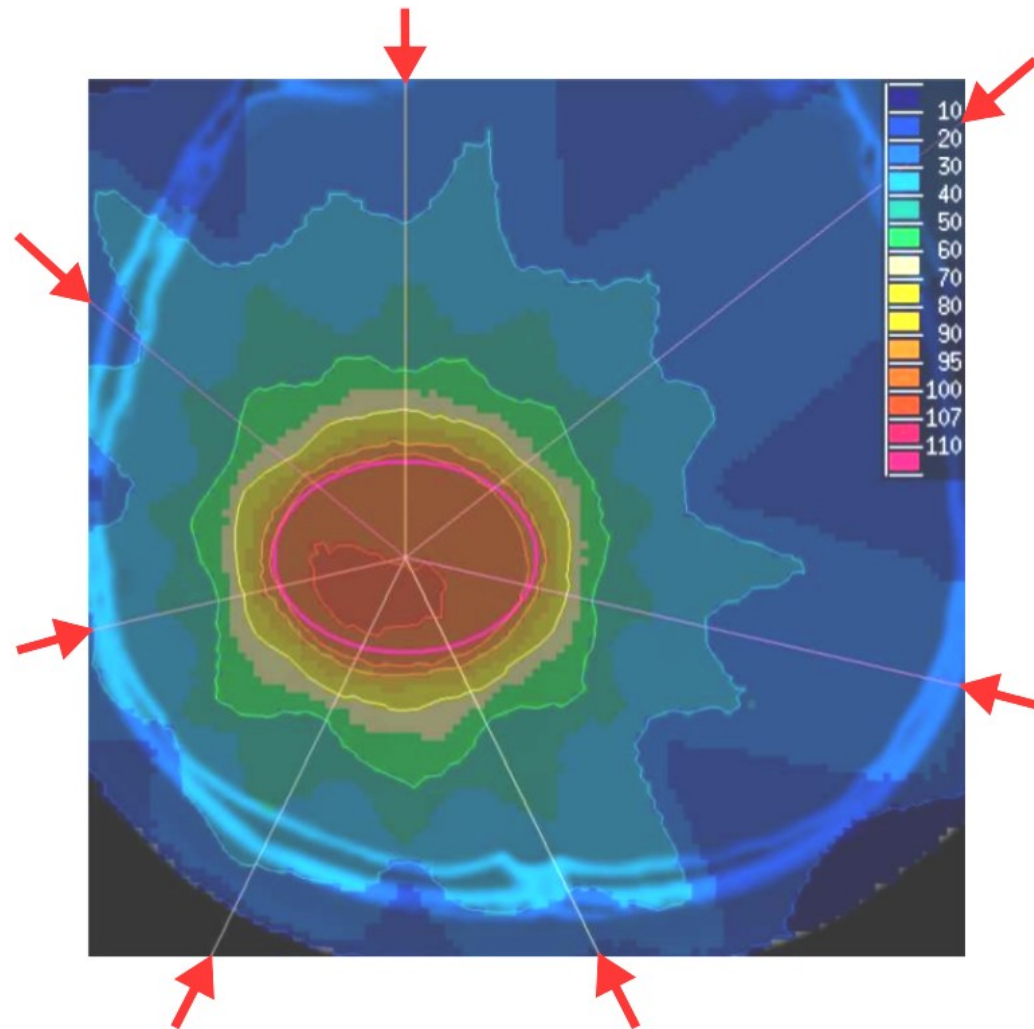


# ION THERAPY – SCANNING SYSTEM

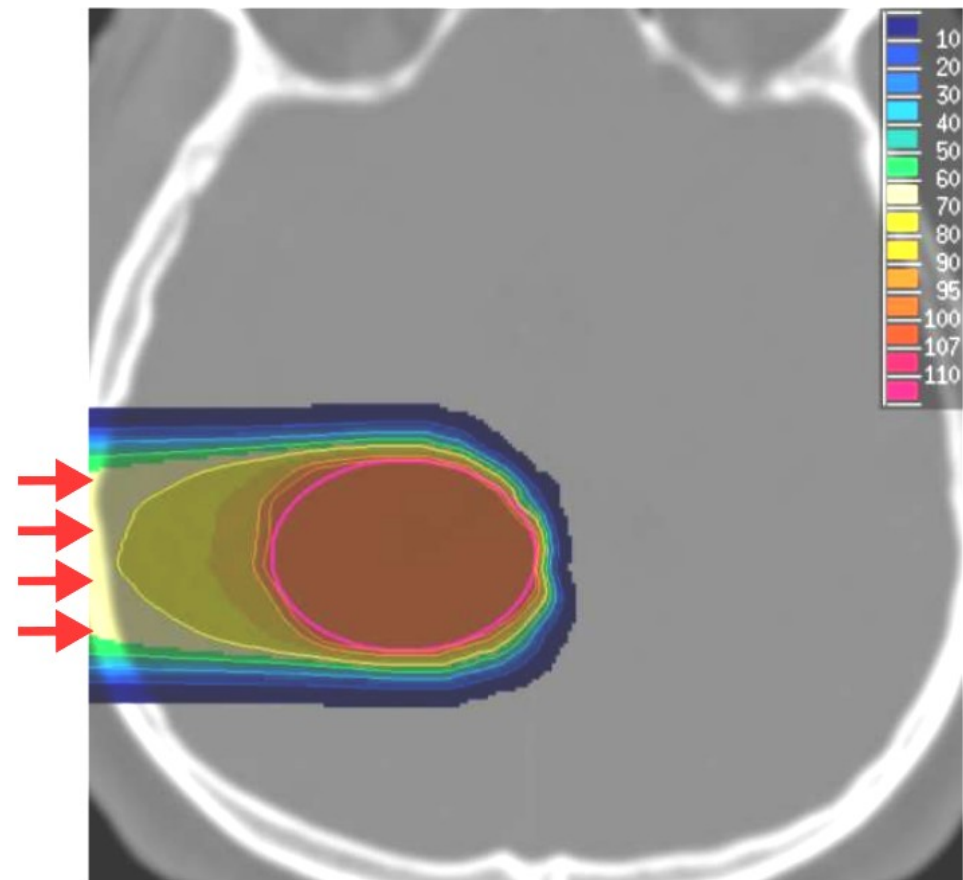


# ION THERAPY VS. CONVENTIONAL THERAPY

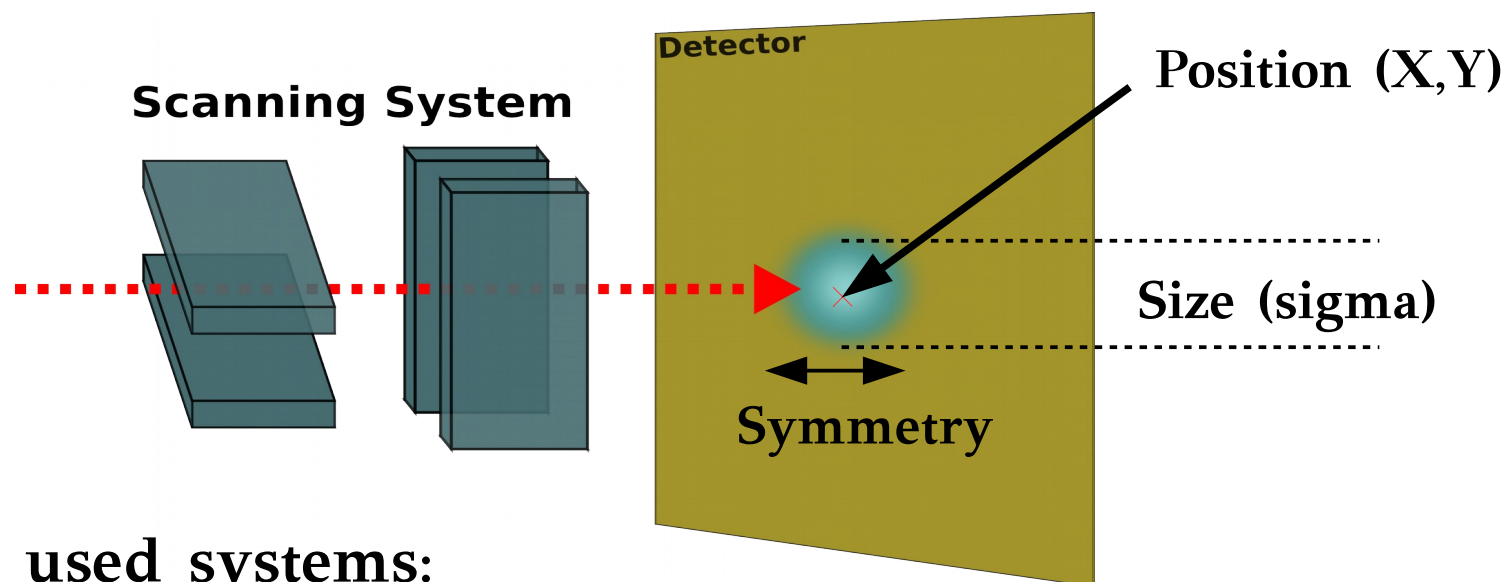
Gamma treatment



Proton treatment

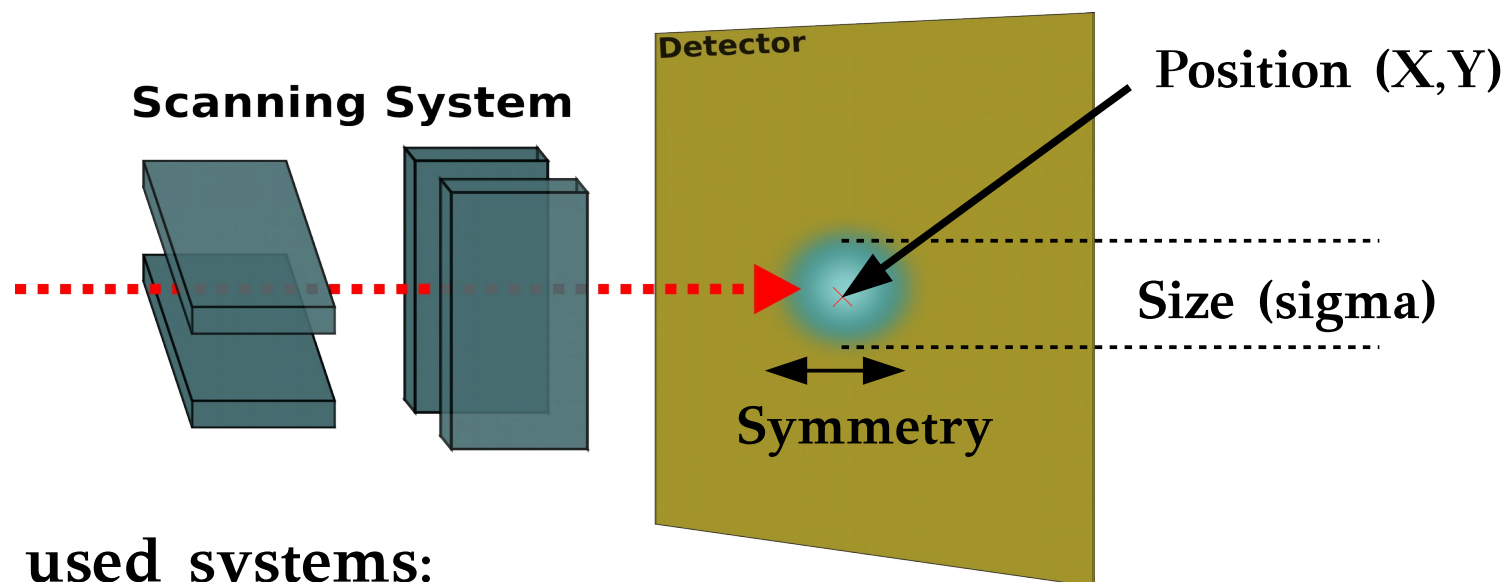


# 2D TLD APPLICATION IN SCANNING BEAM



- Presently used systems:
  - Kodak<sup>®</sup> EDR2
  - Gafchromic<sup>®</sup> EBT2
  - IBA LynX (IBA Dosimetry)
- Weaknesses
  - low resolution
  - disposable
  - non-linear dose response

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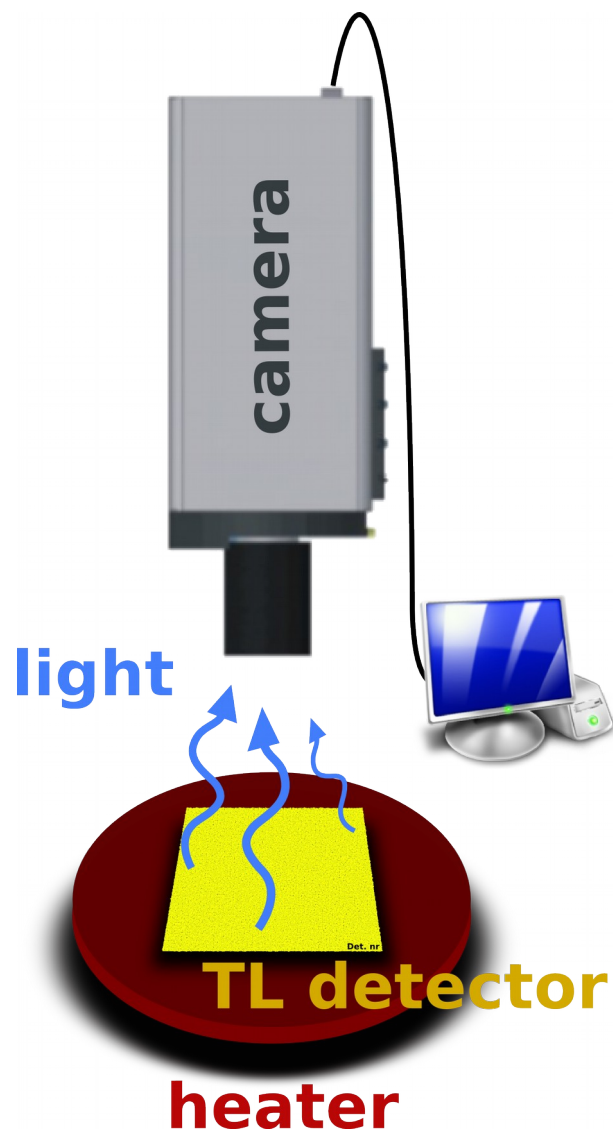
The goal was to develop and test 2D TLD system for measurements of scanning ion beam parameters



# THE PRINCIPLE OF 2D TL DOSIMETRY

Resolution:  
 $1024 \times 1024 \text{ px}^2$   
 (pixel size  $\sim 0.2 \text{ mm}$ )

heater size:  
 $20 \times 20 \text{ cm}^2$



Automated  
 heating and  
 cooling  
 process

easy and  
 safe to use

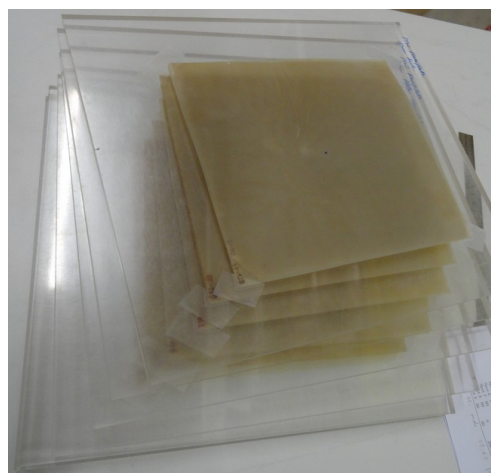
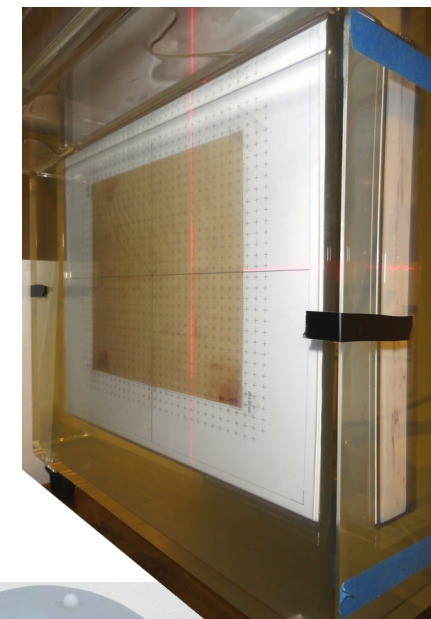
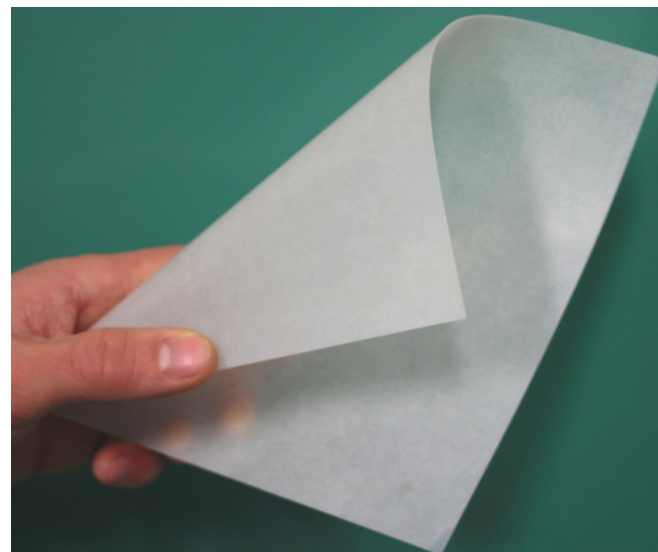
Movable

Developed at IFJ by:  
 Mariusz Kłosowski  
 Łukasz Czopyk  
 Paweł Olko  
 Barbara Marczevska

# 2D TL FOILS

Foil composition:  $\text{LiF:Mg,Cu,P}$  + ETFE (polymer)

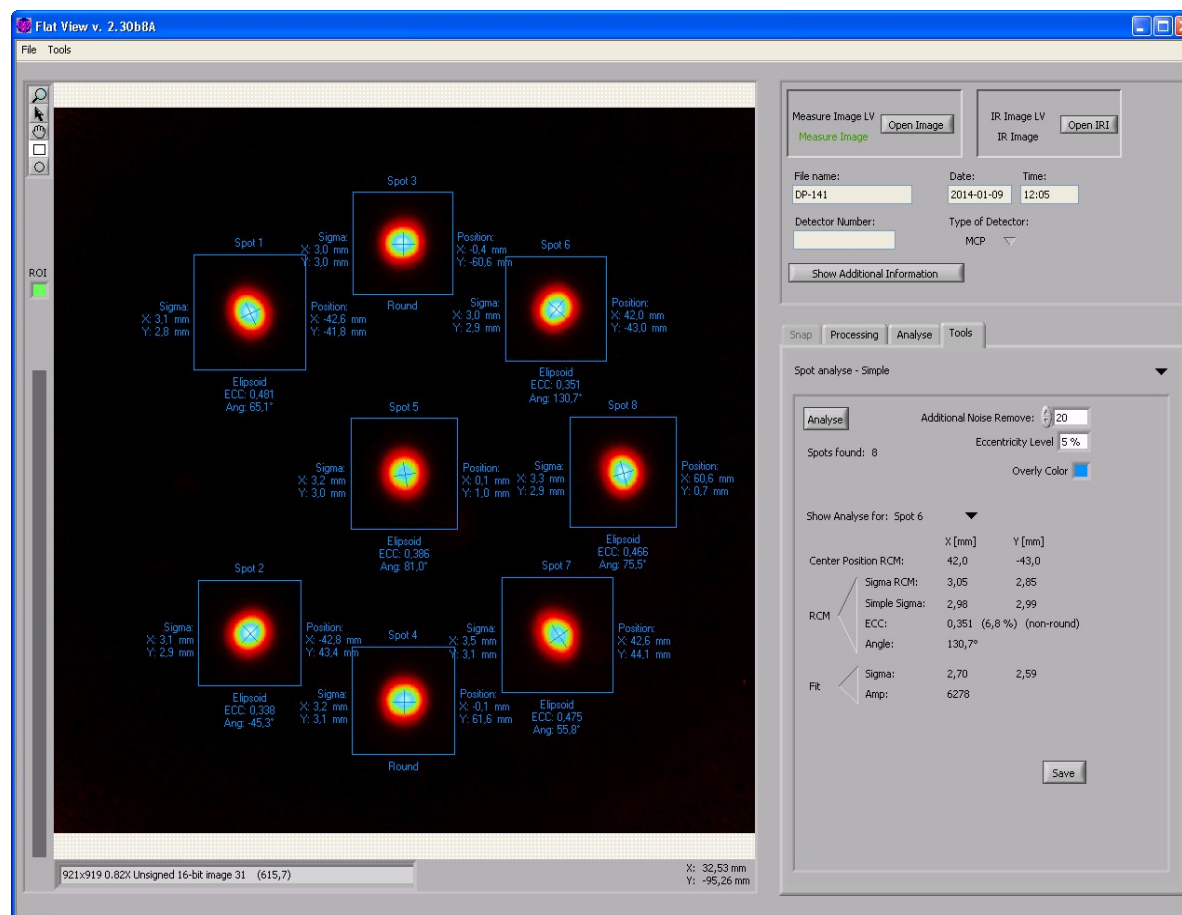
- Water resistant and flexible
- Area up to  $20 \times 20 \text{ cm}^2$
- Thickness 0.3-0.4 mm
- Reusable
- Resolution  $\sim 0.2 \text{ mm}$
- $1\text{mm}_{\text{TLD}} = 1.64\text{mm}_{\text{H}_2\text{O}}$
- $Z_{\text{eff}} = 8.1$





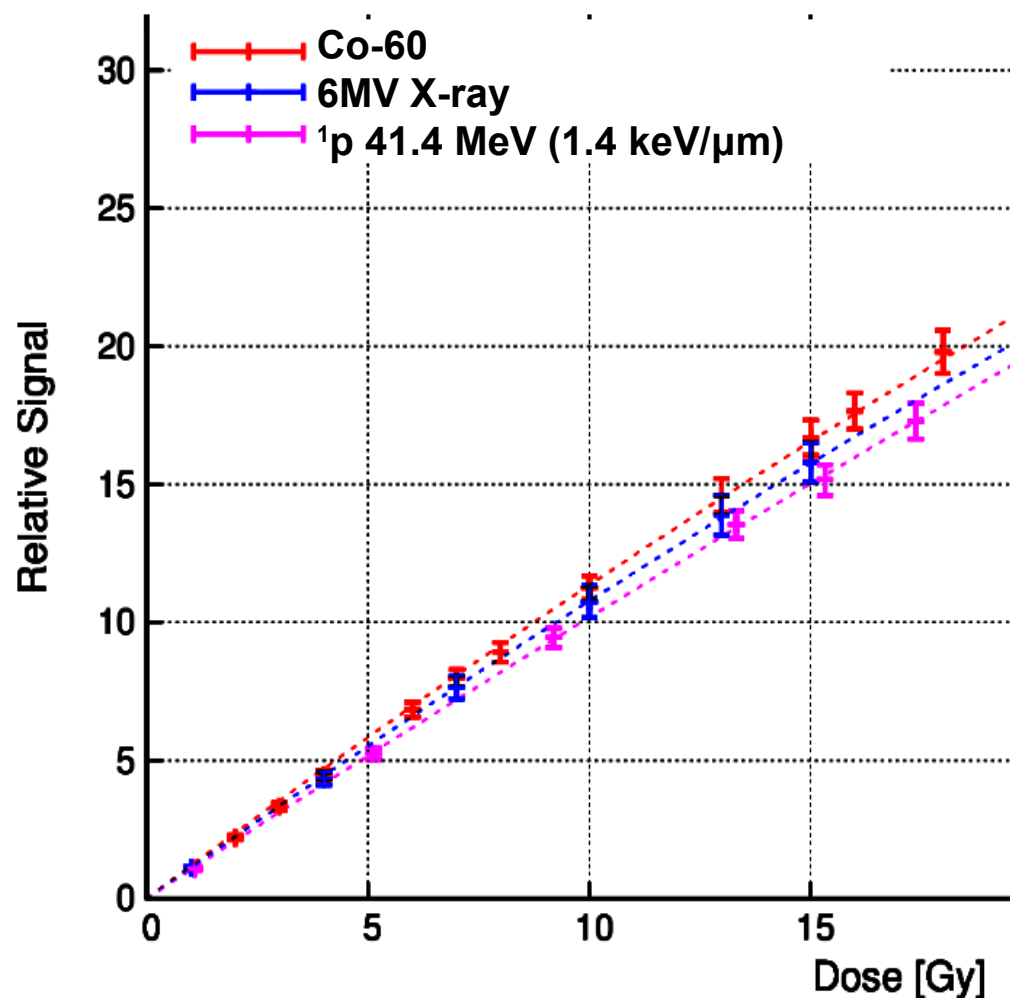
# FLATVIEW – SOFTWARE FOR IMAGE ANALYSIS

- Automatic image acquisition from TLD reader
- Noise and geometrical corrections, additional filters
- Basic analysis:
  - Area histograms
  - Line profiles
- Specific analysis:
  - Circular shapes analysis
  - Spot parameters
  - Individual Reference Image matching

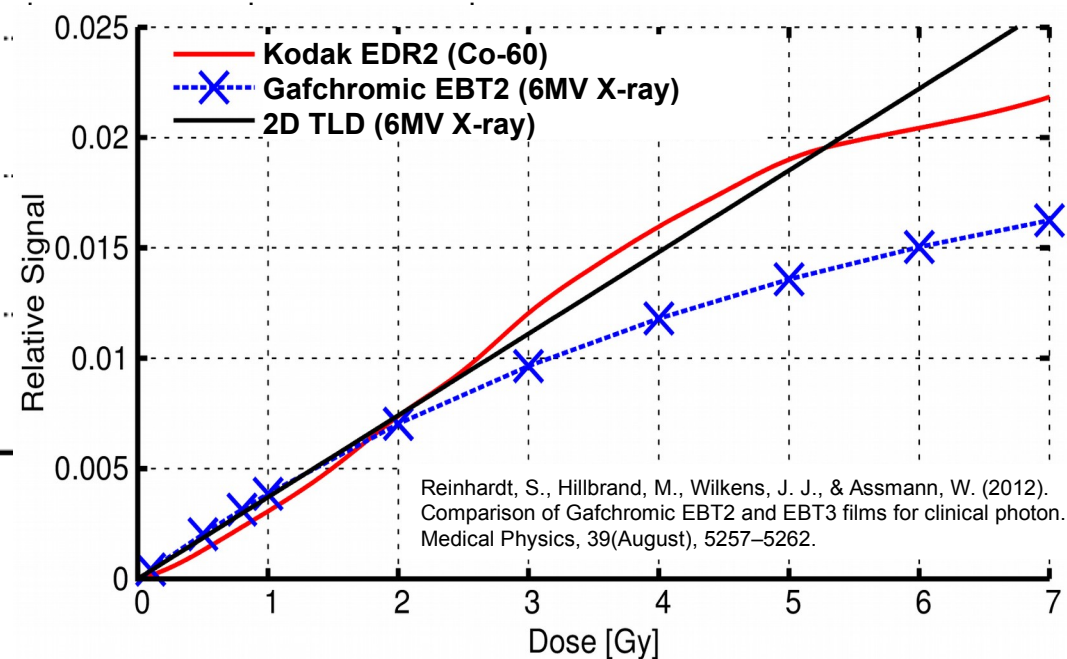


Universal software for image analysis from disparate sources

# DOSE AND BEAM QUALITY RESPONSE



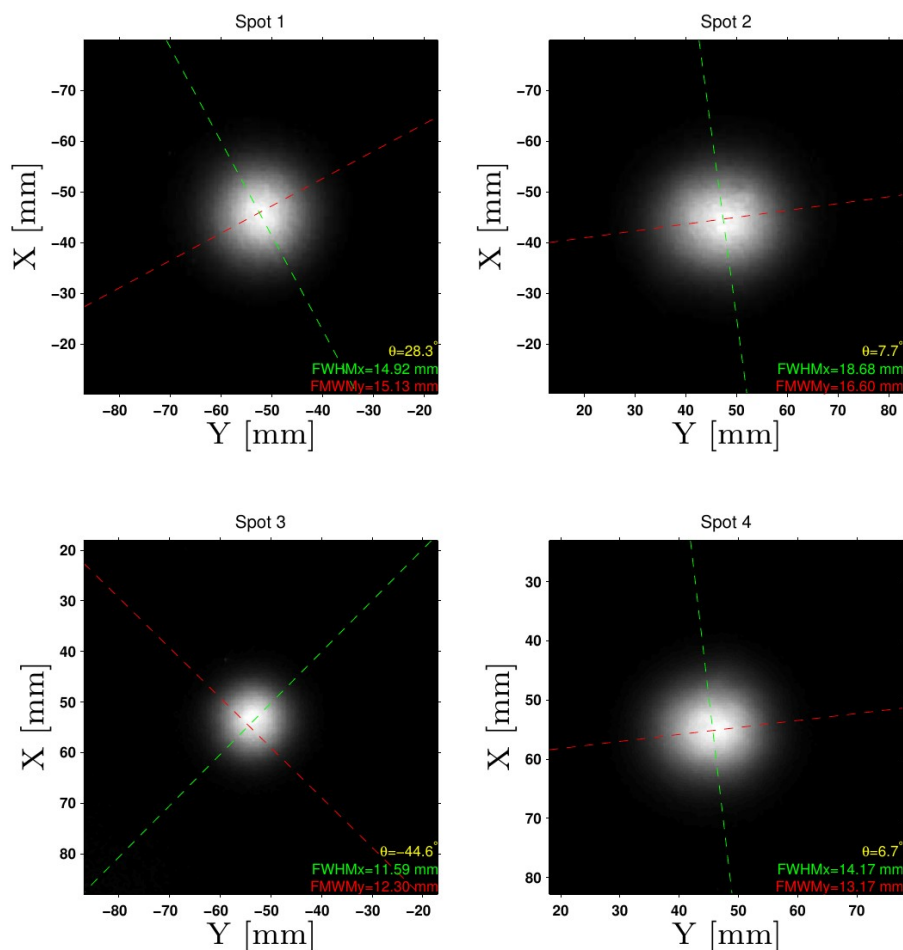
J. Gajewski et al, *The Response of 2D TL Foils After Doses of Co-60 Gamma-Ray, 6MV X-Ray and 60 MeV Proton Beams Applied In Radiotherapy*, Acta Physica Polonica B, vol 6, no. 4, p. 1021.



Reinhardt, S., Hillbrand, M., Wilkens, J. J., & Assmann, W. (2012). Comparison of Gafchromic EBT2 and EBT3 films for clinical photon. *Medical Physics*, 39(August), 5257–5262.

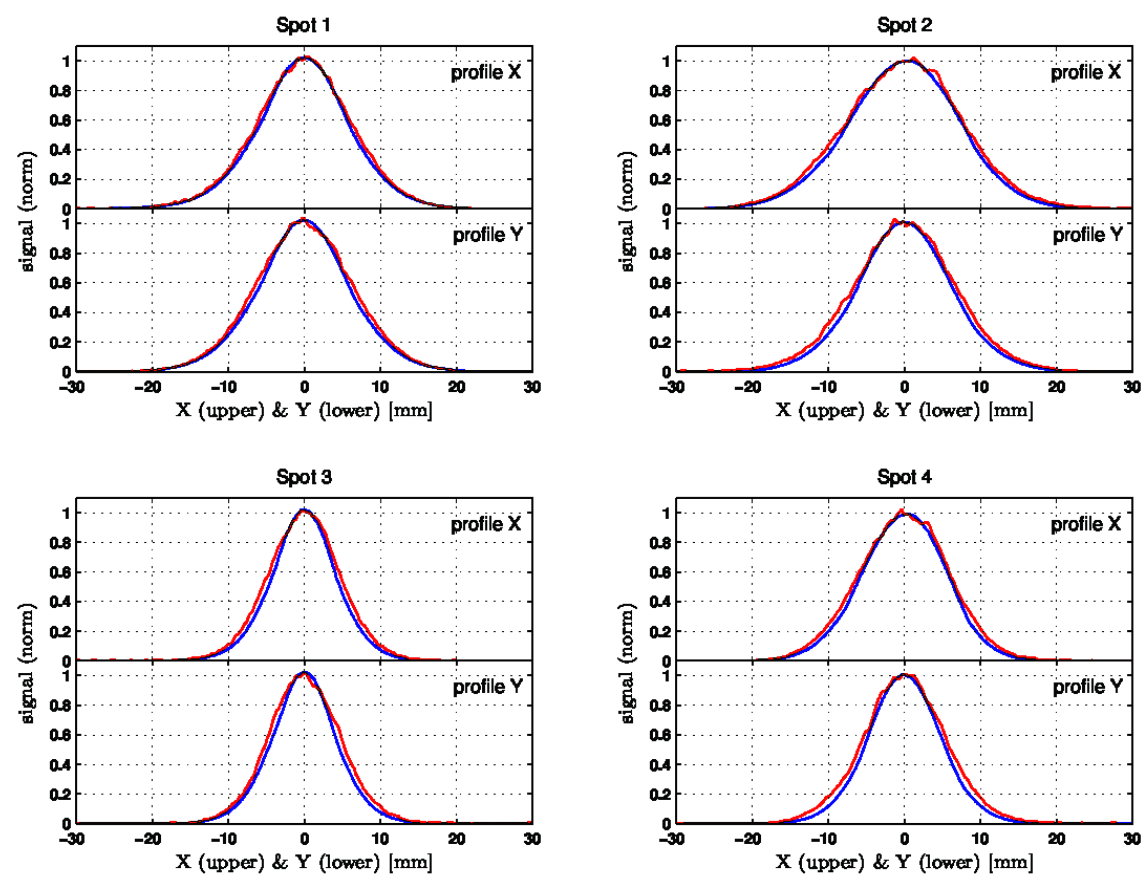
**Dose response of 2D TLD linear up to 20 Gy**

# SPOT MEASUREMENTS IN HEIDELBERG



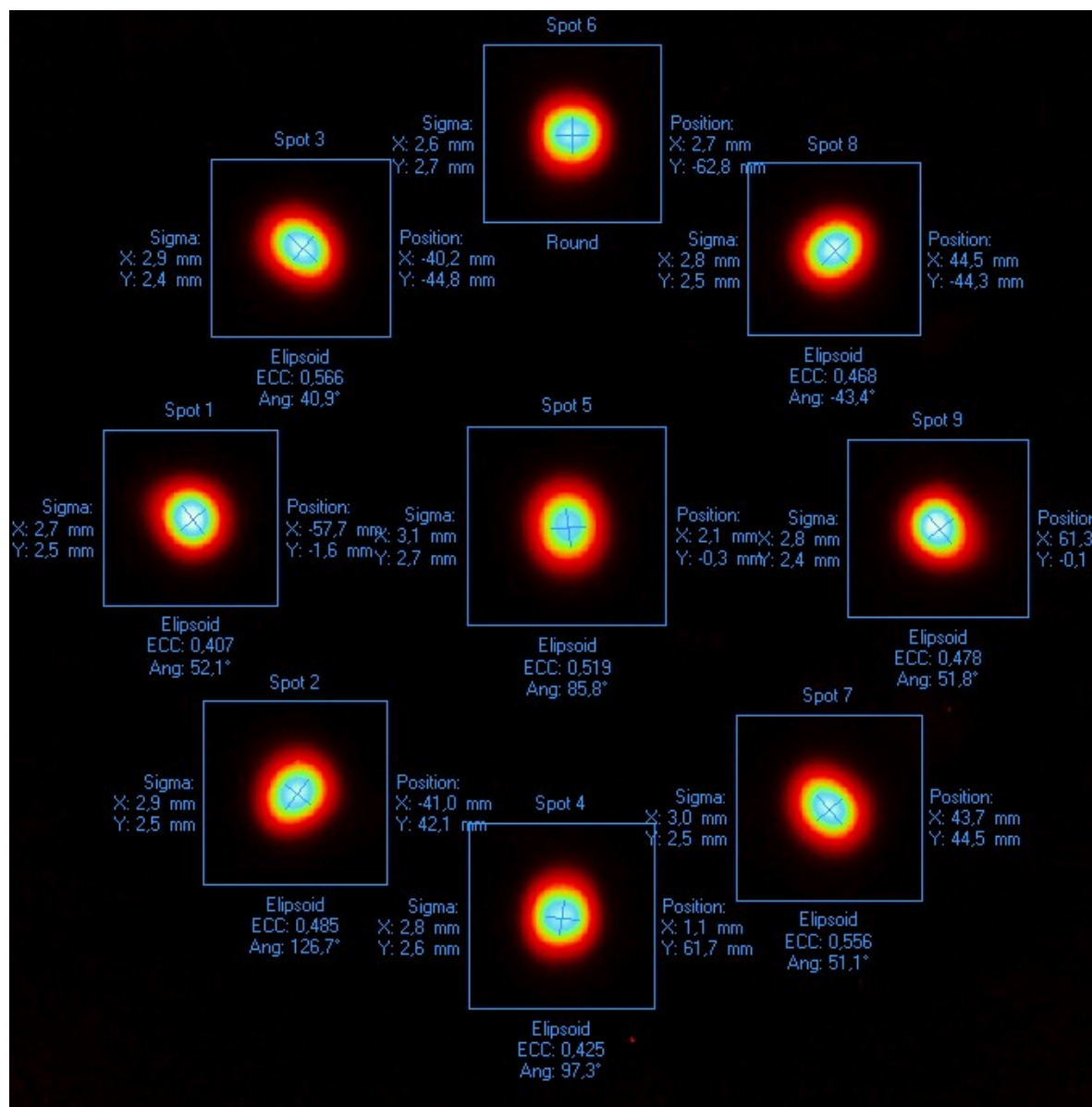
Reference methods:

- Fluka simulations
- Kodak<sup>®</sup> EDR2 films



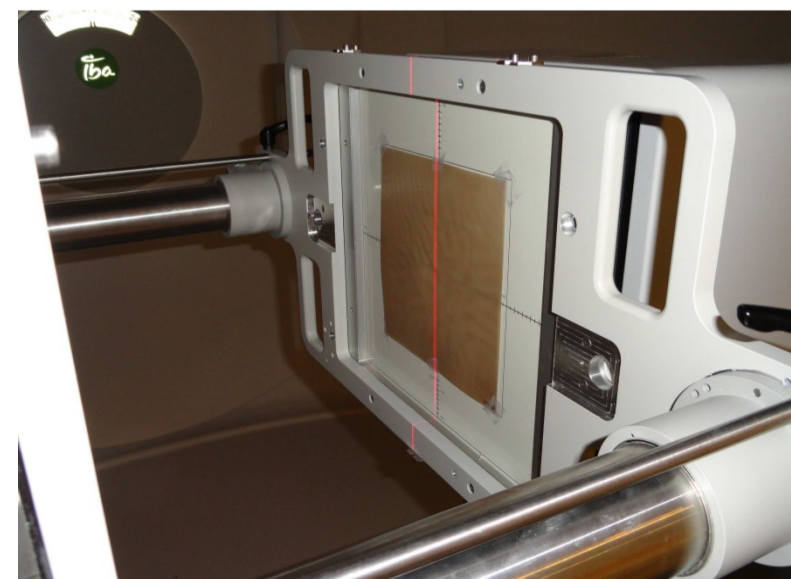
- Spot position measured with 2D TLD agree within 1% with those measured with Kodak<sup>®</sup> ERD2
- Spot sigma measured with 2D TLD agree with sigma measured with Kodak<sup>®</sup> ERD2 within 10%

# SPOT MEASUREMENTS IN PRAGUE



## Reference methods:

- LynX detector



- Absolute spot positions consistent with LynX within 0.1 mm
- Sigma the same within 0.1 mm

# SUMMARY AND PLANS

- **2D TL dosimetry system** has been developed at IFJ PAN
- The measurements made at different particle therapy facilities shown that the 2D TLD system **is suitable for measurements of spot properties**
- **FlatView** software was prepared for **analysis** of images from 2D TLD system. Images from other systems can be analysed (Gafchromic, LynX, OmniPro I'mRT)
- The system was applied in **acceptance tests** of scanning beam in Gantry-1 at Bronowice Cyclotron Center in Kraków
- The system is employed for measuring single spot parameters during the **commissioning** of the scanning beam at Bronowice Cyclotron Center.



# Thank You for Your attention



IBA dedicated Gantry  
with scanning beam delivery system



**INNOWACYJNA  
GOSPODARKA**  
NARODOWA STRATEGIA SPÓJNOŚCI



**UNIWERSYTET  
JAGIELLOŃSKI  
W KRAKOWIE**



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ROZWOJU REGIONALNEGO**



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