



**National Centre  
for Nuclear Research**  
**Świerk**

# IntraLine - a demonstrator of a new mobile linear accelerator for IOERT – development, current state and future plans

Przemysław Adrich and IntraDose Collaboration

[przemyslaw.adrich@ncbj.gov.pl](mailto:przemyslaw.adrich@ncbj.gov.pl)

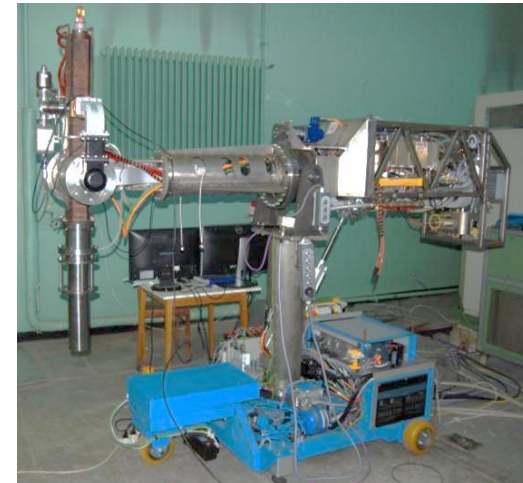
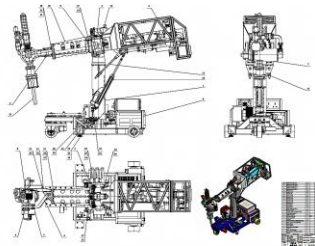
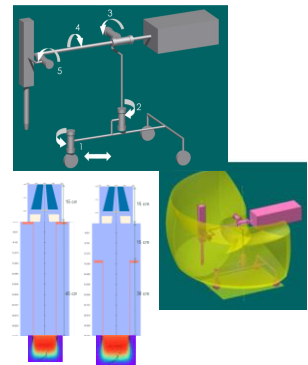
8th International Conference of the ISIORT  
Cologne, Germany, September 25-27, 2014.



# The IntraLine demonstrator

The IntraLine demonstrator is a laboratory prototype featuring:

- an electron linac integrated with a mobile robot,
- 4 – 9 MeV electron beams,
- vast workspace of the therapeutic head,
- 3 – 12 cm circular applicators.



Concepts & models

Technical design

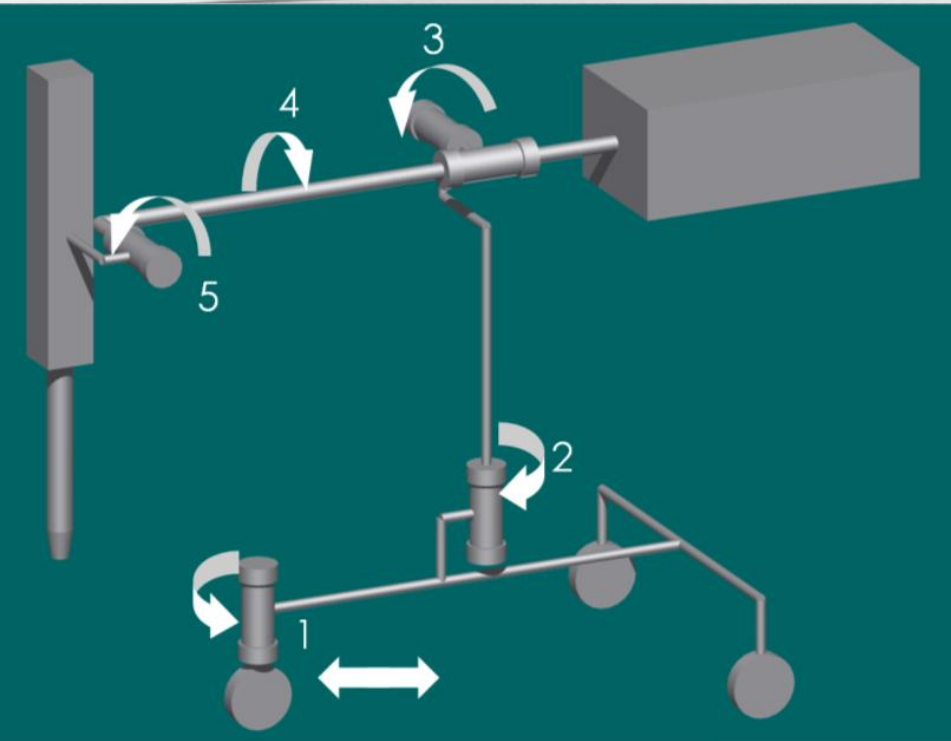
Manufacturing

Assembly & tests

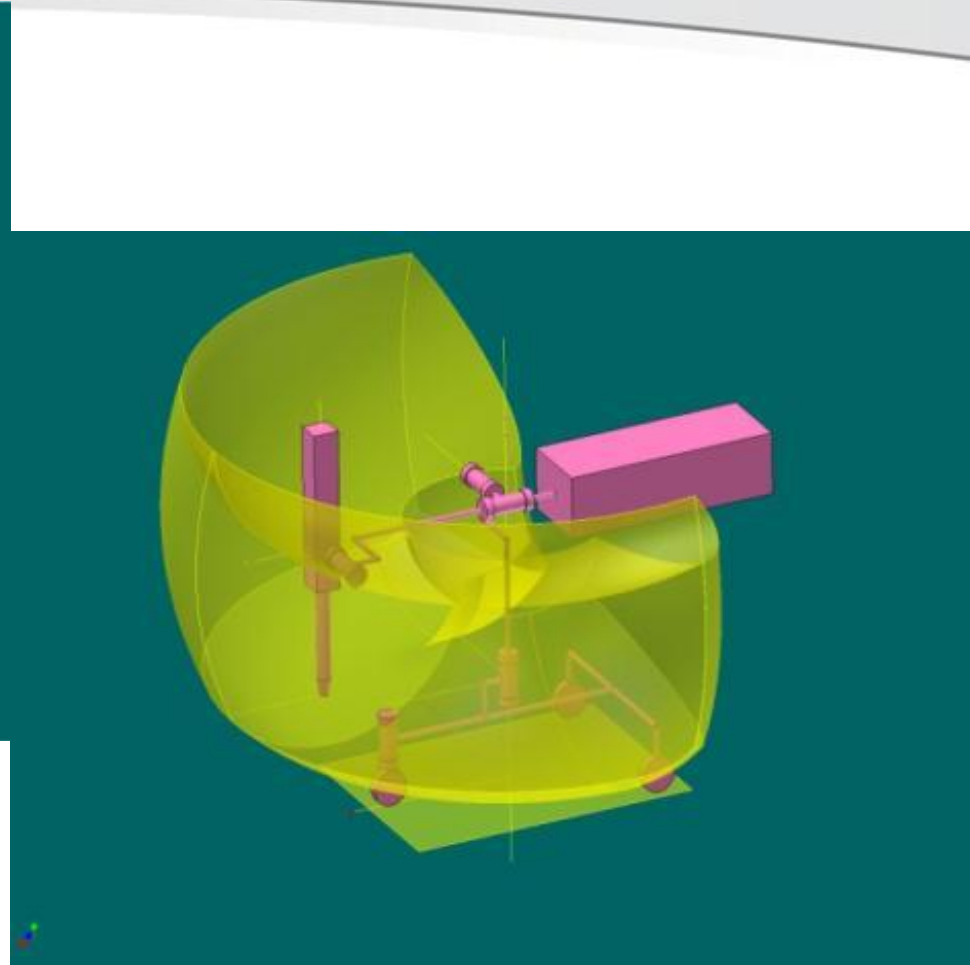


# The IntraLine demonstrator

## Robot mobility



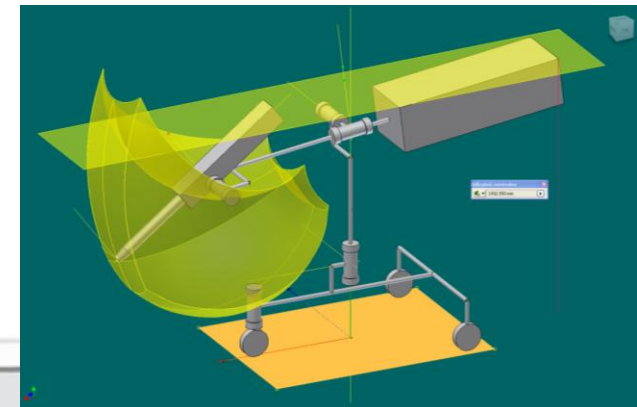
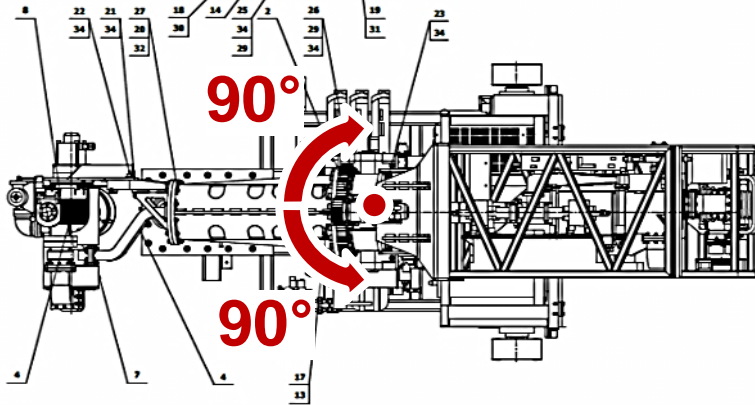
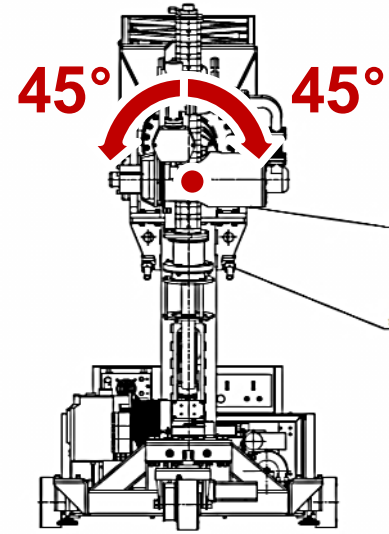
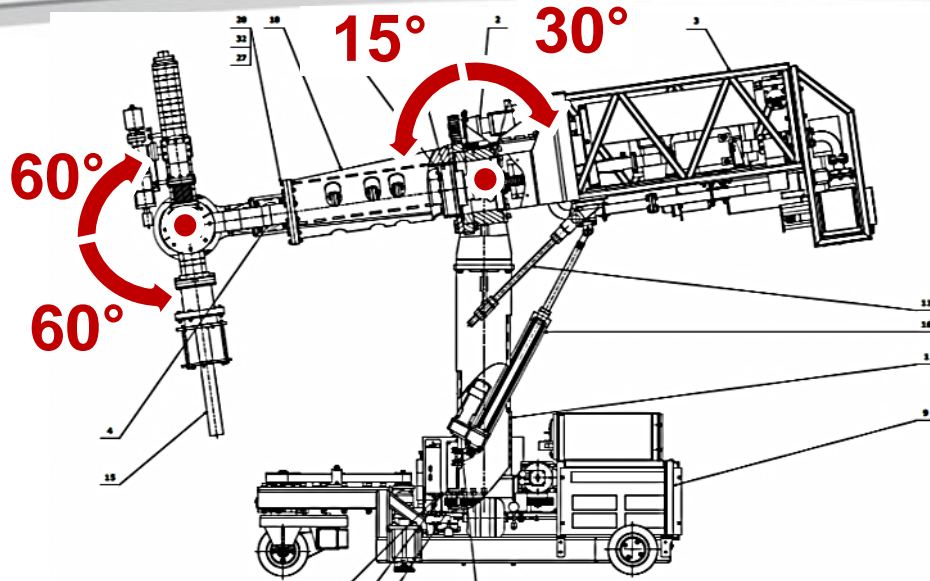
1. Trolley drive and steering
2. Column rotation
3. Crane inclination
4. Crane rotation
5. Head tilt





# The IntraLine demonstrator

## Robot mobility







# The IntraLine robot mobility

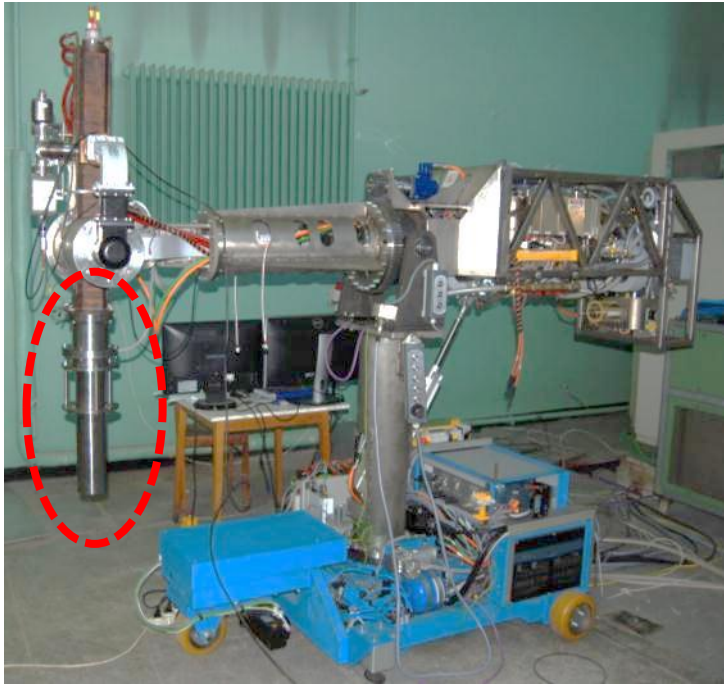




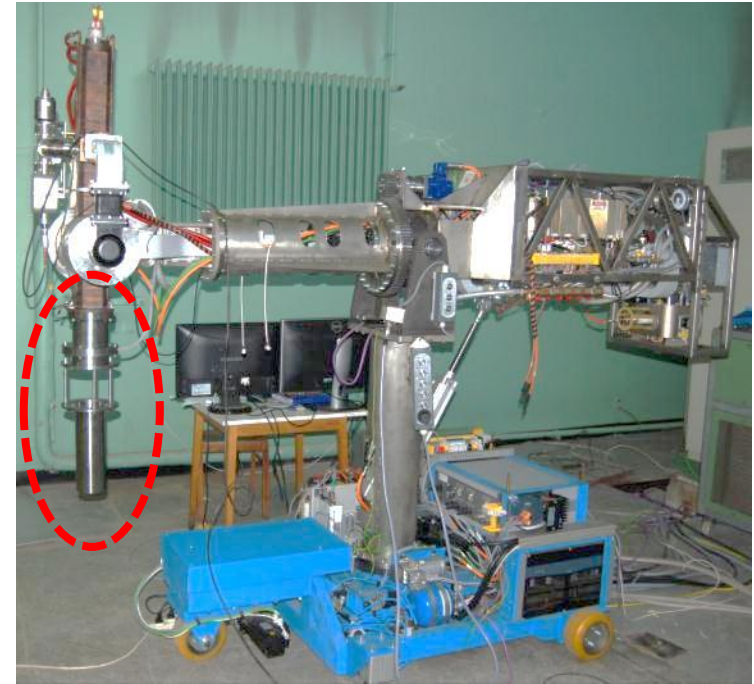
# The IntraLine demonstrator

## Applicator models (demo version)

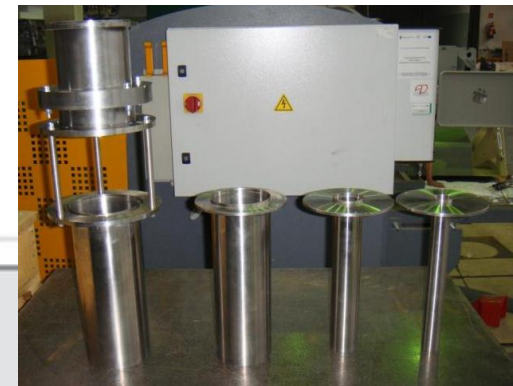
### Hard-docking



### Soft-docking

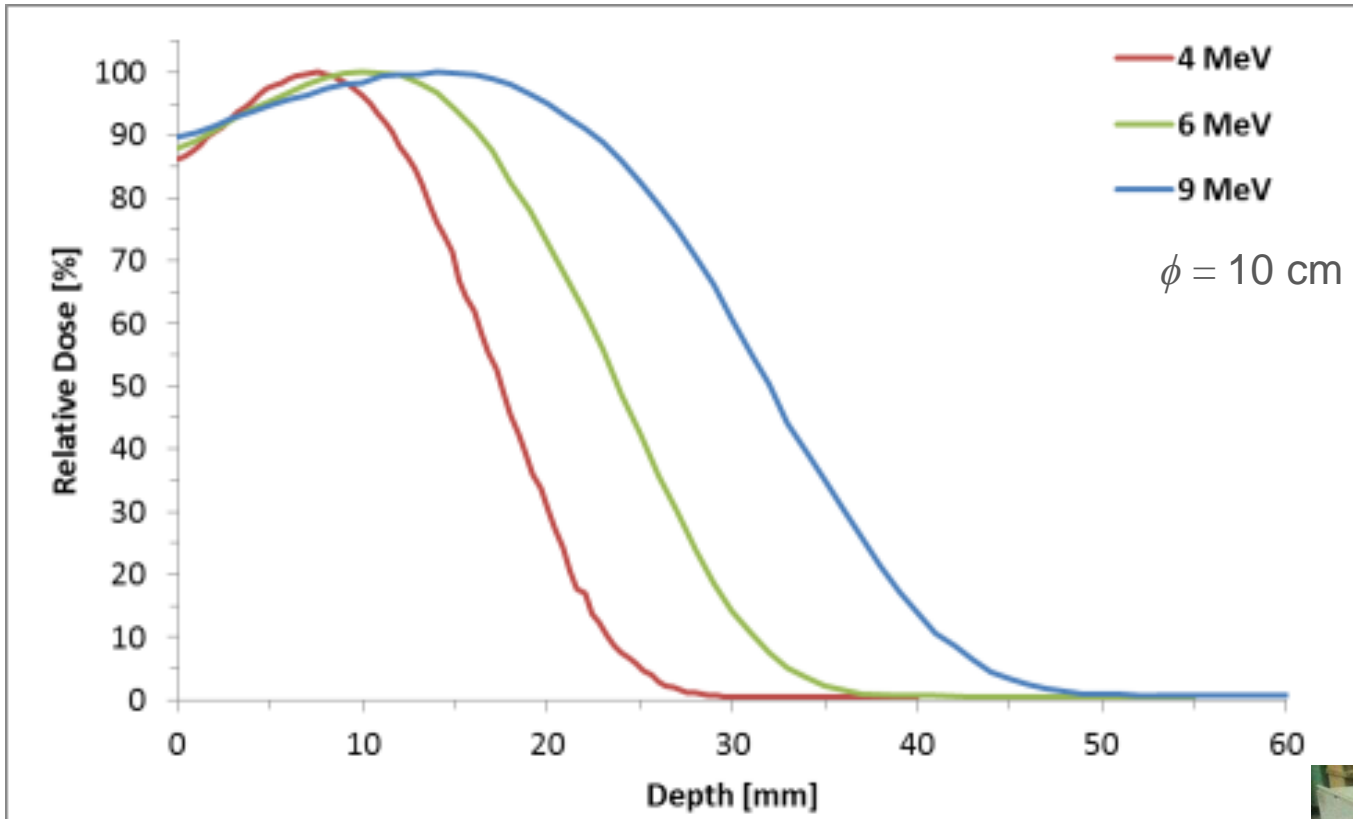


$\phi = 3\text{cm}, 5\text{ cm}, 10\text{ cm}, 12\text{ cm}$   
applicators were manufactured





# Performance hard-docking (preliminary results)



Nominal energy [MeV]	R90 [cm]	R <sub>p</sub> [cm]	E(R <sub>p</sub> ) [MeV]	Surface dose [%]
4	1.1	2.3	4.7	86
6	1.6	3.2	6.5	88
9	2.1	4.1	8.5	90



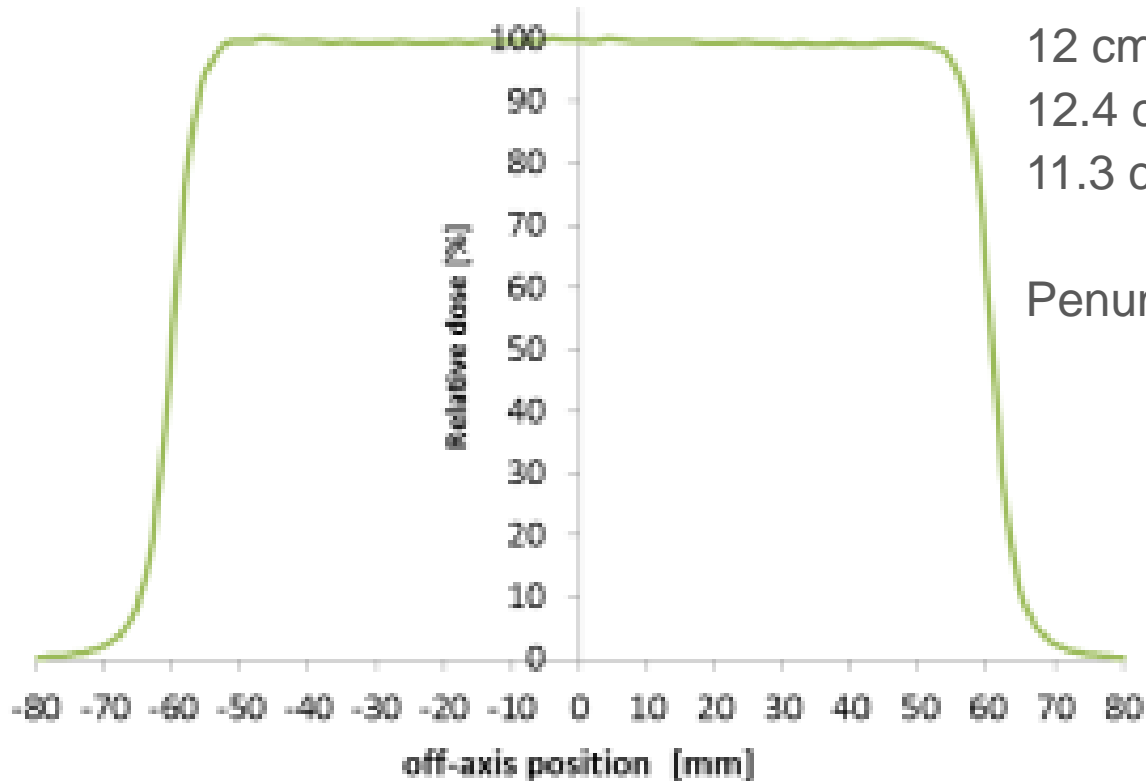


# Performance hard-docking

Ex. large diameter applicator (preliminary results)

$\phi = 12$  cm

**6 MeV**



Field diameter:

12 cm – inner applicator

12.4 cm – outer applicator

11.3 cm – 90% isodose @ SMD

Penumbra = 0.5 cm



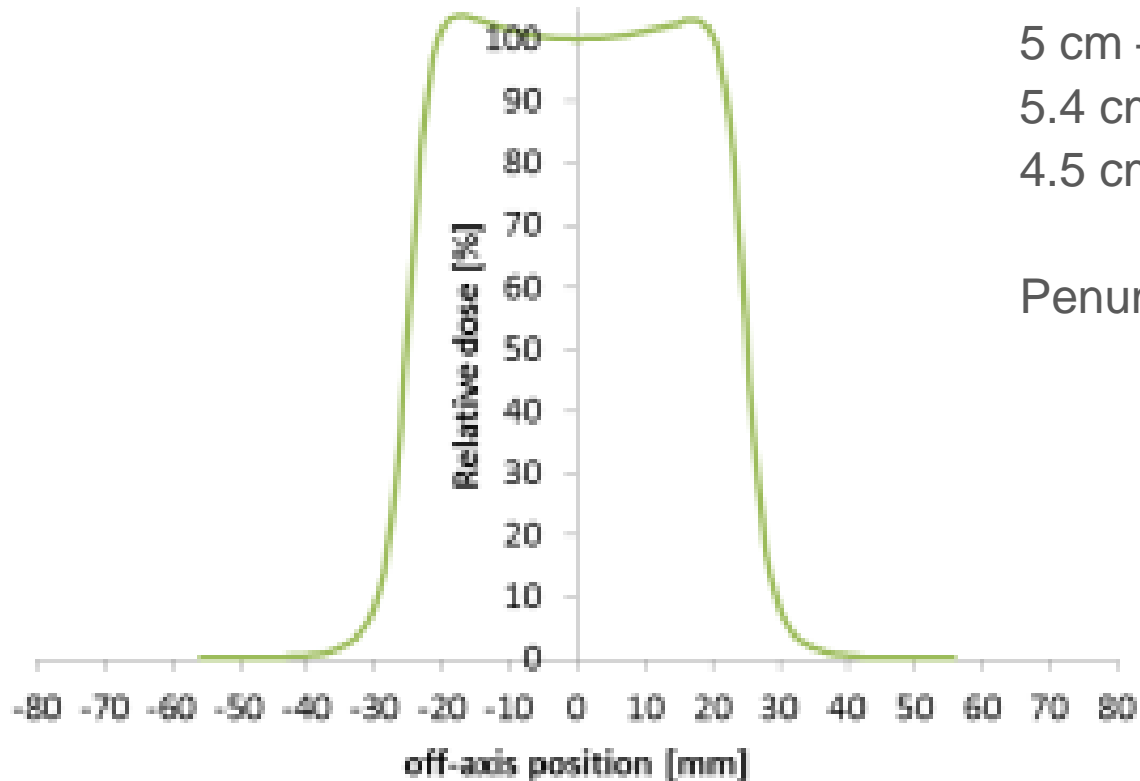


# Performance hard-docking

Ex. small diameter applicator (preliminary results)

$\phi = 5$  cm

**6 MeV**



Field diameter:

5 cm – inner applicator

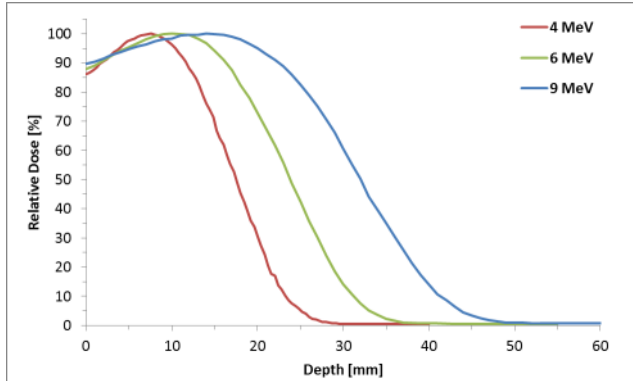
5.4 cm – outer applicator

4.5 cm – 90% isodose @ SMD

Penumbra = 0.5 cm



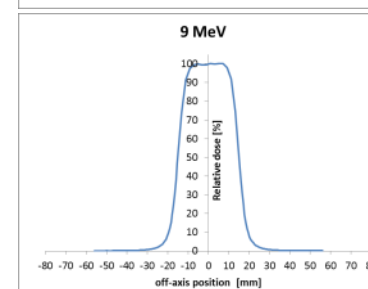
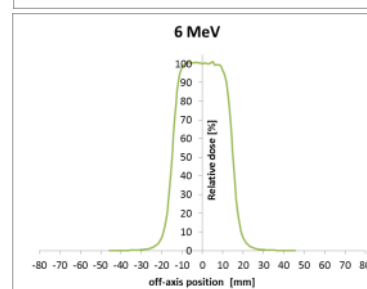
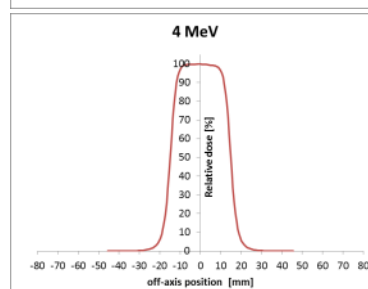
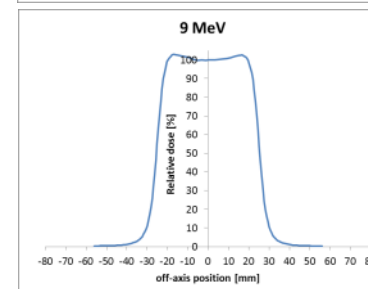
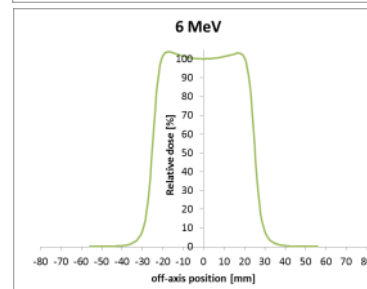
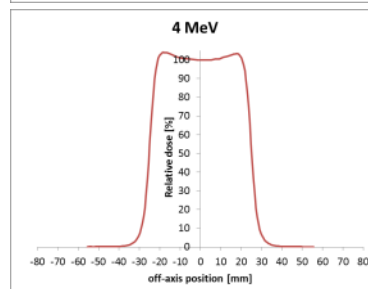
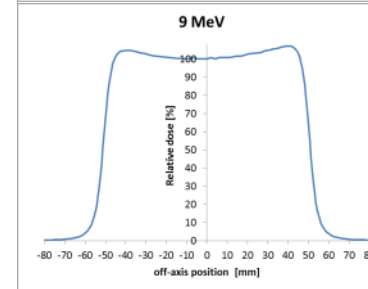
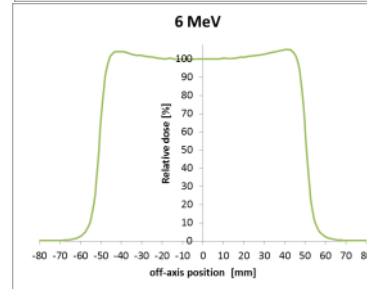
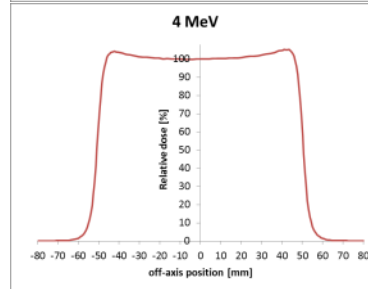
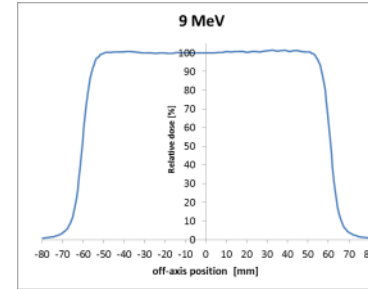
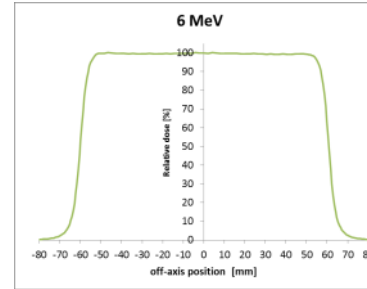
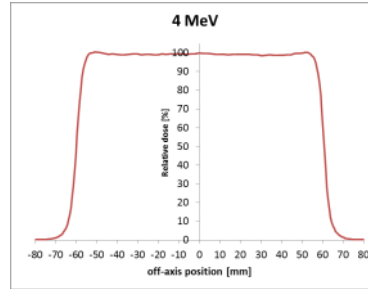
# Performance hard-docking (preliminary results)



Nominal energy [MeV]	R90 [cm]	R <sub>p</sub> [cm]	E(R <sub>p</sub> ) [MeV]	Surface dose [%]
4	1.1	2.3	4.7	86
6	1.6	3.2	6.5	88
9	2.1	4.1	8.5	90

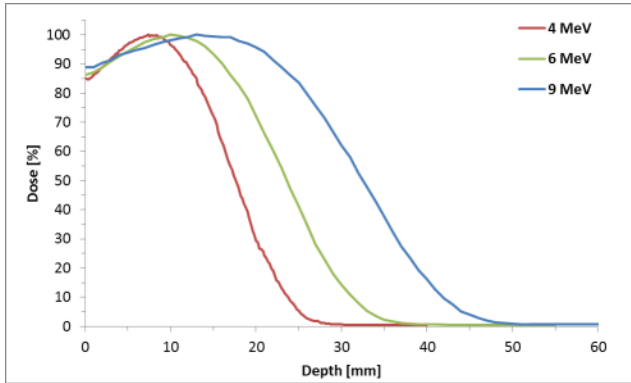
For all fields and beam energies:

- symmetry at SMD < 2%
- flatness < 10%





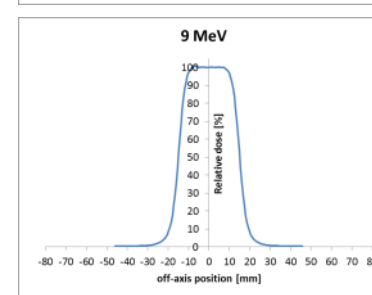
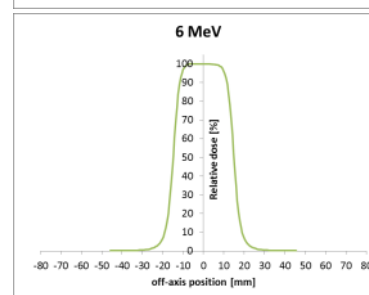
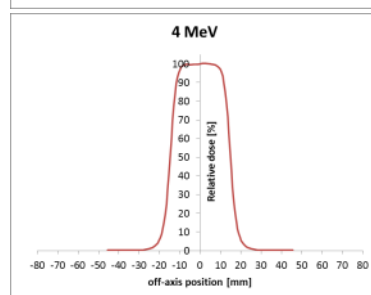
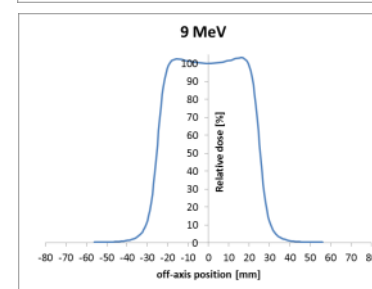
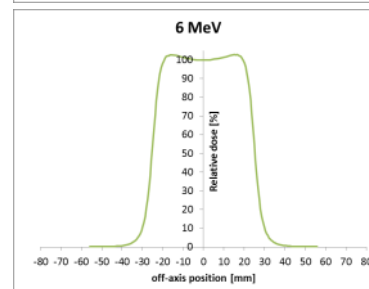
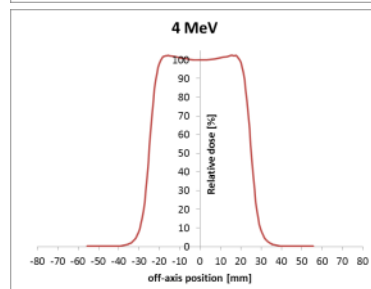
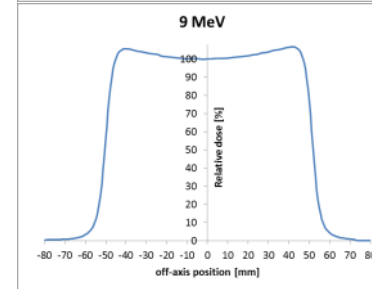
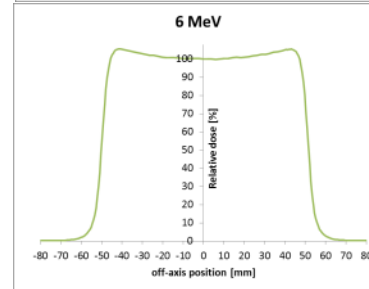
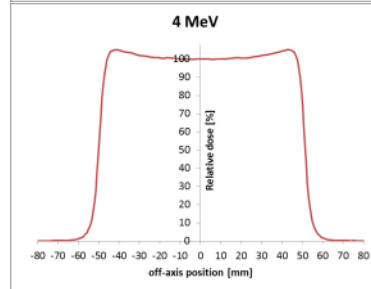
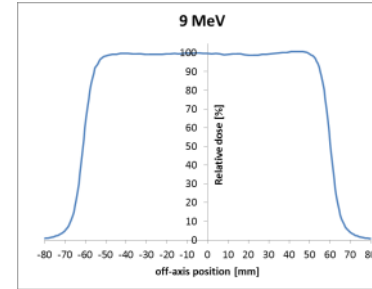
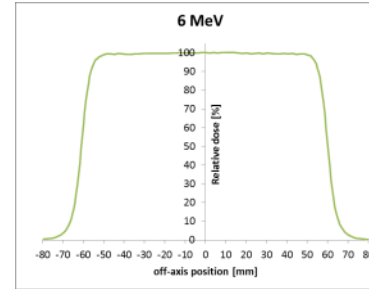
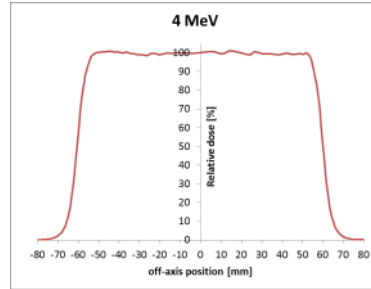
# Performance soft-docking (preliminary results)



Nominal energy [MeV]	R90 [cm]	R <sub>p</sub> [cm]	E(R <sub>p</sub> ) [MeV]	Surface dose [%]
4	1.1	2.3	4.7	85
6	1.6	3.2	6.5	86
9	2.1	4.1	8.5	89

For all fields and beam energies:

- symmetry at SMD < 2%
- flatness < 10%





# Outlook – the IntraDose project

Development towards a preclinical prototype:

- lightweight and highly mobile with vast workspace,
- broader energy range (4 – 12 MeV),
- Intuitive & safe „augmented” applicator docking with user selectable docking scheme (soft- or hard-docking),
- 3 – 12 cm circular applicators (other shapes possible; no bevel),
- user friendly control system,
- planning software.

Ready for certification early 2016.







# Thank you for your attention!



## The team

Przemysław Adrich, Michał Andrasiak, Artur Baczewski, Marek Baran, Andrzej Chmielak, Wojciech Drabik, Rafał Gniadek, Ryszard Grabowski, Kazimierz Gryn, Radosław Hanke, Ewa Jakubowska, Edward Jankowski, Grzegorz Kędziński, Narcyz Kielar, Łukasz Kujawiński, Bronisław Kołodziejcki, Jan Kopeć, Konrad Kosiński, Piotr Kraszewski, Radosław Koziół, Paweł Krawczyk, Ewa Kulczycka, Henryk Lenarczyk, Jerzy Lorkiewicz, Marek Marczenko, Anna Masternak, Michał Matusiak, Bartosz Meglicki, Agnieszka Misiarz, Jerzy Olszewski, Krzysztof Ozon, Marcin Piskorski, Eugeniusz Pławski, Andrzej Polak, Wit Psonka, Małgorzata Rutkowska, Jacek Rządkiwicz, Zbigniew Sienkiewicz, Marcin Staszczak, Kaja Swat, Agnieszka Syntfeld-Każuch, Ryszard Szymański, Marcin Terka, Adam Wasilewski, Jadwiga Wilczek, Marcin Wojciechowski, Marek Wójtowicz, Sławomir Wronka, Anna Wysocka-Rabin, Krzysztof Zalewski, Witold Zawada

## Acknowledgements

This work was supported by the EU Structural Funds, Project No. POIG.01.01-14-012/08-00 and by the National Research and Development Centre under contract no. PBS2/B9/26/2014.