Relative dosimetry for scanned pencil beam proton therapy

Petra Trnková

Outline

- Relative dosimetry:
  - Integral depth dose measurements
  - Phase space definition
- NCS subcommittee for proton therapy

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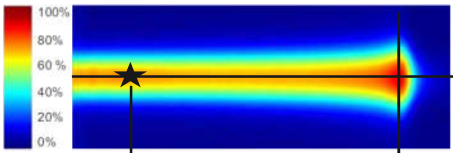
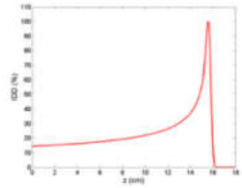
Beam modelling of PBS PT

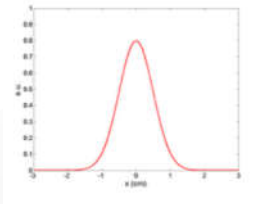


Gillin et al, Med Phys 2010

Integral depth dose curves



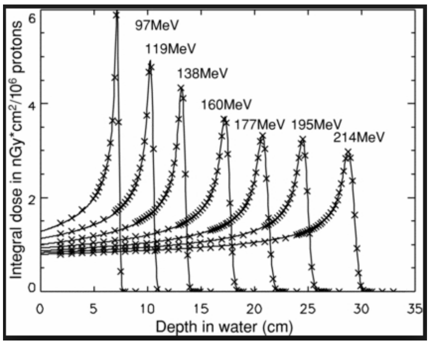
Lateral dose profile



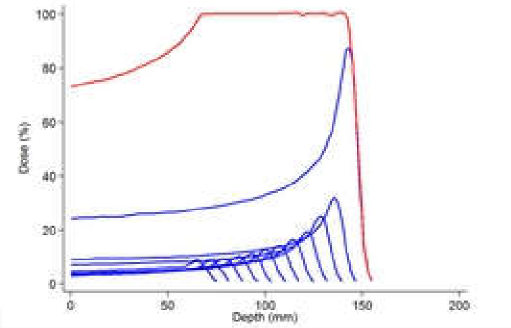
Absolute dose

Integral depth dose curves

Integral depth dose curves



Pedroni et al, PMB 2015



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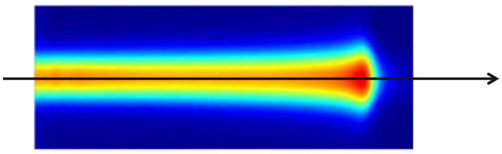
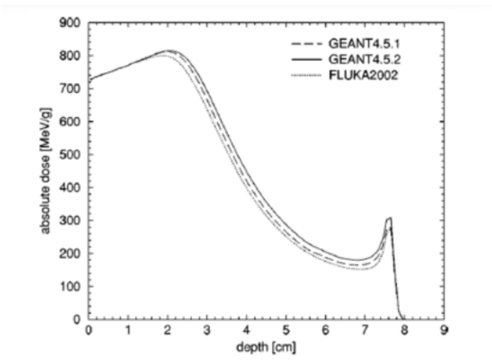
Measurement setup





Fippel and Soukup, Med Phys 2004

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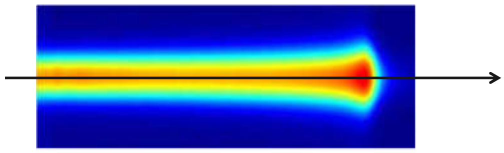
Measurement setup



Courtesy of Ethan Cascio and Martijn Engelsman

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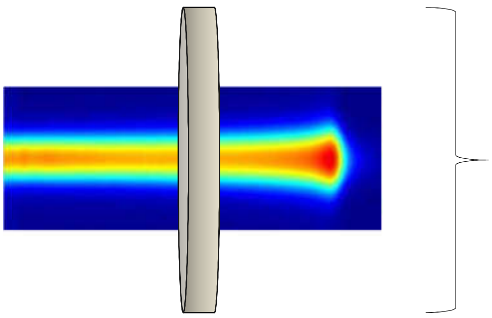
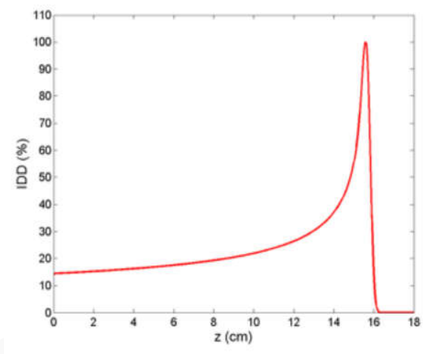
Measurement setup





Courtesy of Carles Gomà

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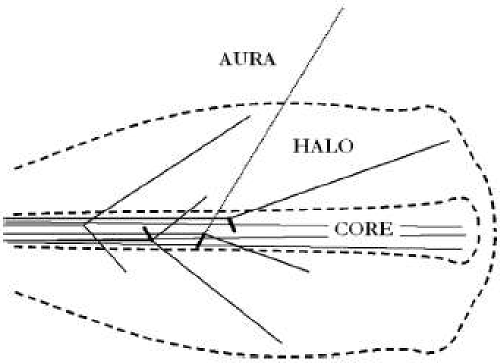
Bragg peak chambers

PTW Bragg Peak Chamber 34070
Diameter 8.16 cm

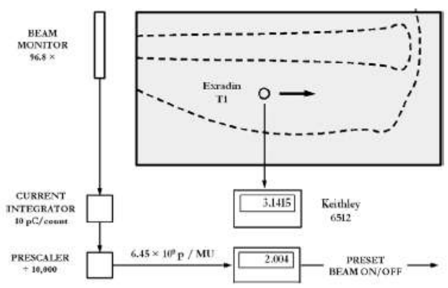
IBA Stingray
Diameter 12 cm

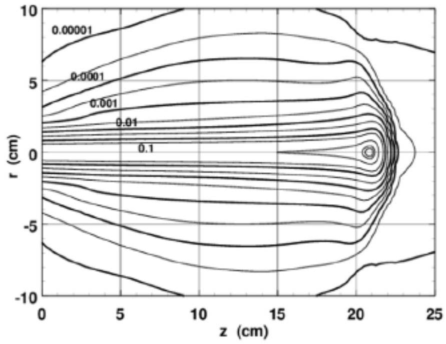
Nuclear halo



Gottschalk et al, PMB 2015

Absolute measurement of the entire halo





Gottschalk et al, PMB 2015

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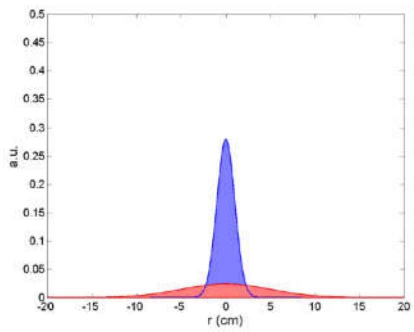
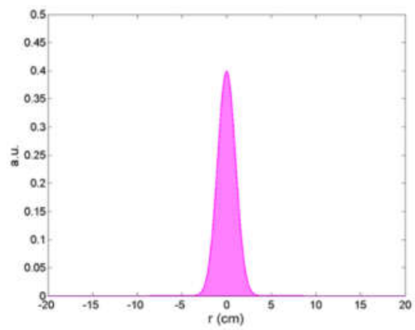
TPS modelling

“reality”



TPS



Courtesy of Carles Gomà

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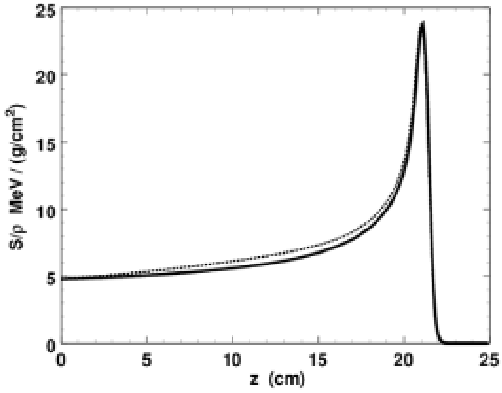
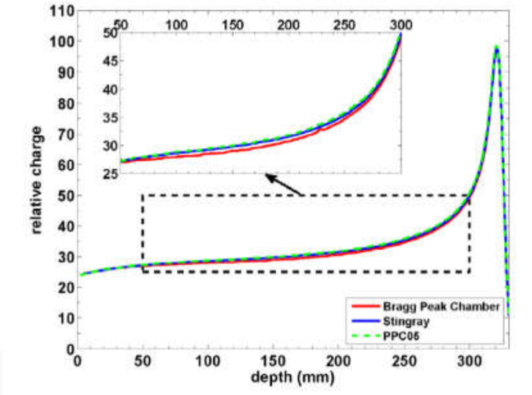
Differences in the IDDs



Gottschalk et al, PMB 2015



Bäumer et al, J App Clin Med Phys 2015

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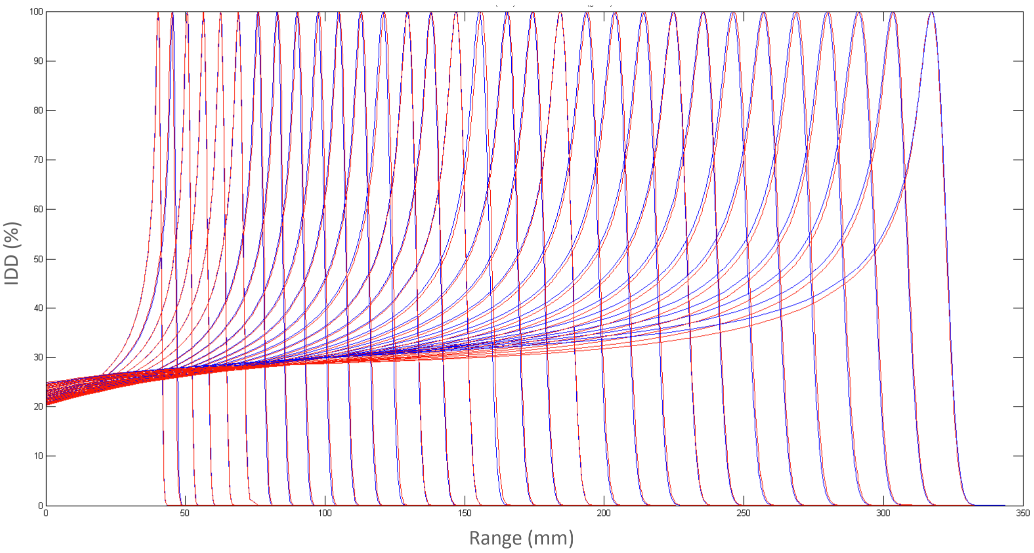
Corrected IDDs (blue) vs. NOT corrected IDDs (red)



Courtesy of Stefano Lorentini

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How to correct?

- Monte Carlo simulations (Fippel& Soukup, Med Phys 2004)
- Analytical calculations (Pedroni, PMB 2005)
- Experimental correction (Anand, MedPhys 2012)
- Golden beam data approach (Classie, PMB 2012)

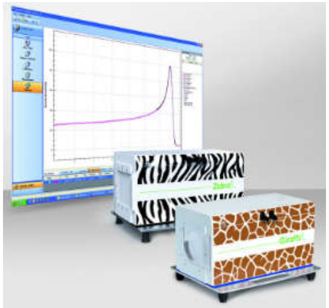
- Create large Bragg peak chambers

- Note: RayStation 6 corrects during the beam modelling

Other measurement devices

- Multi-layer ionization chambers (MLIC)
  - IBA Zebra: 180 independent chambers
  - IBA Giraffe: 180 independent chamber
  - De.Tec.Tor Cube: max 128 independent chambers
- Water column with a reference and measurement chamber
  - PTW Peakfinder: scanning range 35 cm

MLIC



IBA Zebra: Ø 2.5 cm

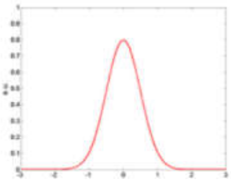
IBA Giraffe: Ø 8.16 cm

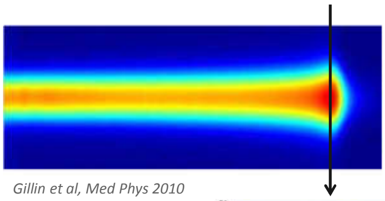
De.Tec.Tor CUBE: 12.7 x 12.7 cm^2

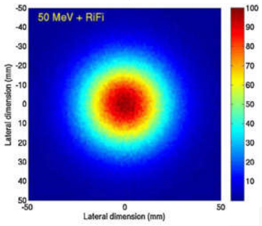
PTW Peakfinder

Phase space definition

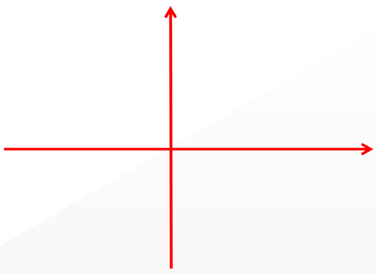
Lateral dose profile

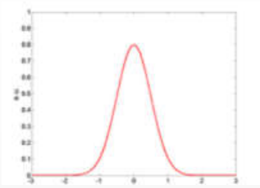



Gillin et al, Med Phys 2010

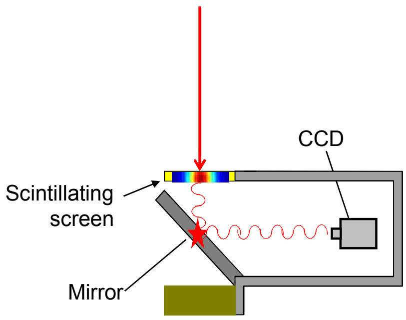


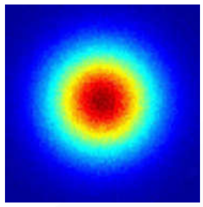
Parodi et al, PMB 2010





Measurement setup



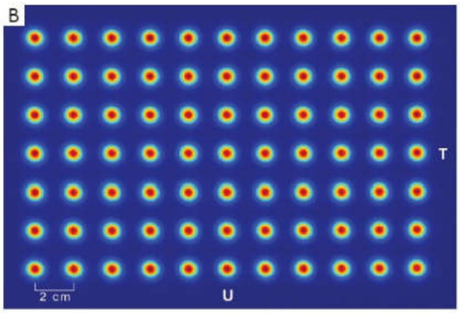


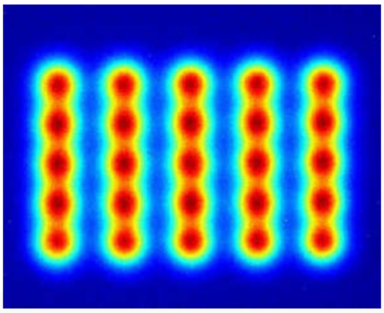
Scintillation screens

IBA Lynx

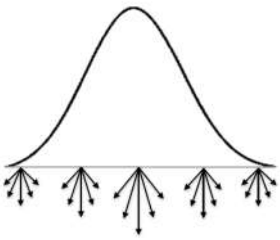
Logos Systems

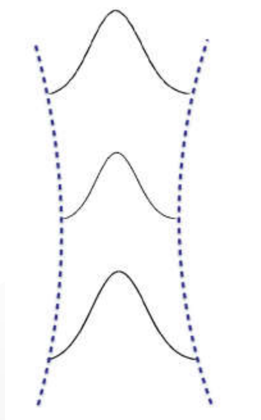
Spot maps





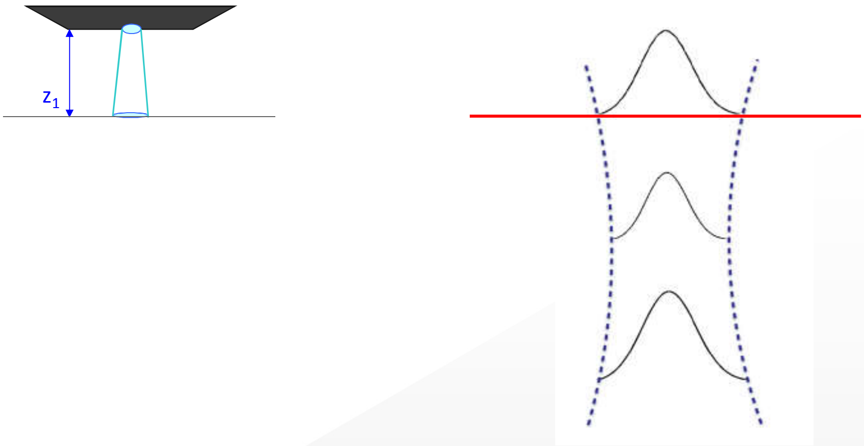
Angular and spatial dose distribution



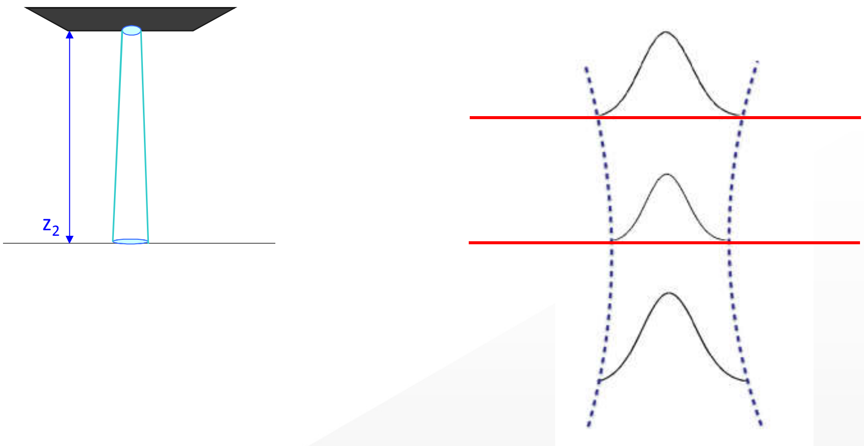


Courtesy of Carles Gomà

Angular and spatial dose distribution



Angular and spatial dose distribution



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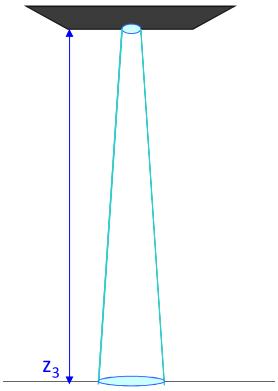
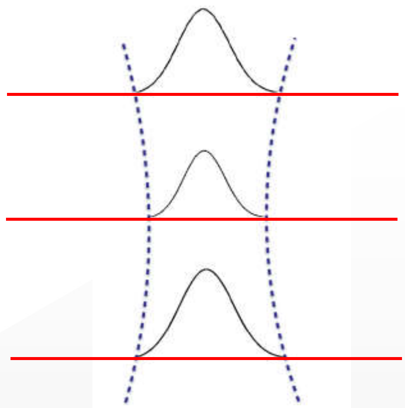
Angular and spatial dose distribution





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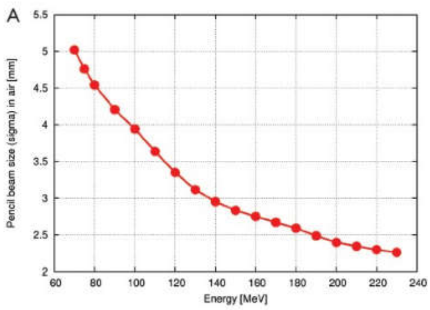
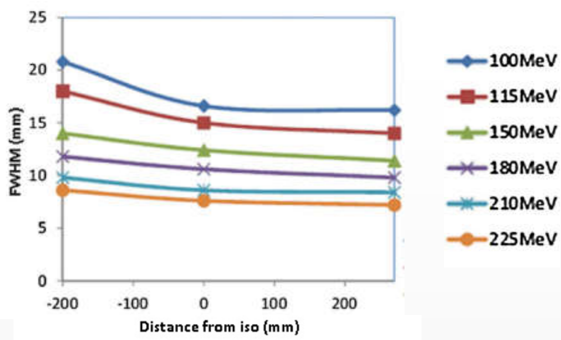
FWHM in-air





Safai et al, Transl Cancer Research 2012

Lin et al, PMB 2013

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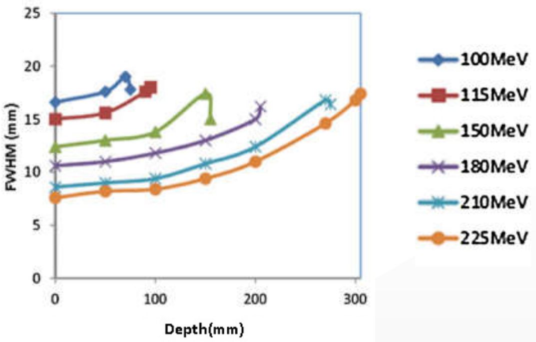
FWHM in water



Lin et al, PMB 2013

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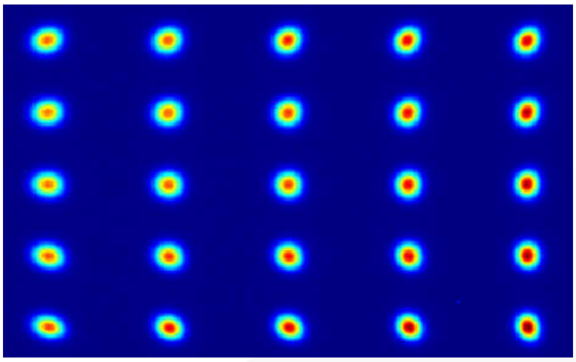
Spot symmetry and ellipticity



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Alternative devices

- Films
- Strip chambers
- Silicon detectors

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NCS subcommittee for proton therapy

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NCS subcommittee for proton therapy

- http://radiationdosimetry.org/ncs/protontherapy
- First meeting: 5.9.2016
- Topics to be covered:
  - Reference dosimetry
  - Single pencil beam specific characteristics
  - Time and space dependent dosimetry
  - Neutron contamination
  - Characteristics of the dosimetry equipment

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Members

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Gloria Vilches Freixas (MAASTRO)

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Thank you for your attention!

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