Performance Assessment of the IEM-CSIC Proton Scanner

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Proton imaging.
A low-dose imaging technique for proton and hadron therapy that improves:

- **Patient positioning** and **proton range verification**
- **Treatment planning** via direct **relative stopping power (RSP) mapping**

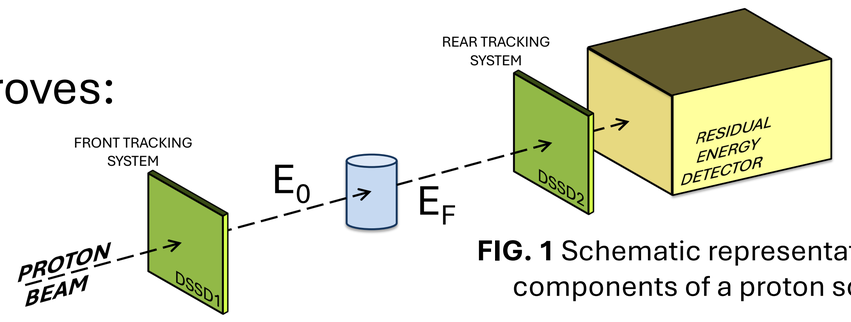


FIG. 1 Schematic representation of the components of a proton scanner.

INTRODUCTION AND MOTIVATION

As proton therapy use is increasing worldwide, **accurate proton range prediction is essential** for the treatment planning. Current treatment planning relies on X-ray imaging to estimate the RSP of tissues.

X-ray imaging	Proton imaging
Indirect RSP estimation	✅ **Direct** RSP measurement
Higher proton range uncertainty [1]	✅ Improved proton **range accuracy**
Higher radiation dose	**Lower** radiation **dose** 👍

Our motivation is to repurpose nuclear detection technologies for medical imaging applications.

Turning research technology into medical innovation

THE SPANISH PROTON SCANNER

- The proton scanner can perform **proton radiography** and **tomography**.
- **Two double-sided silicon strip detectors** (DSSSD) track proton trajectories.
- The **CEPA4 scintillation detector** measures the residual energy of protons.
- It was tested in three campaigns at the Cyclotron Centre Bronowice in Krakow, Poland during 2021 and 2022 [2,3,4].

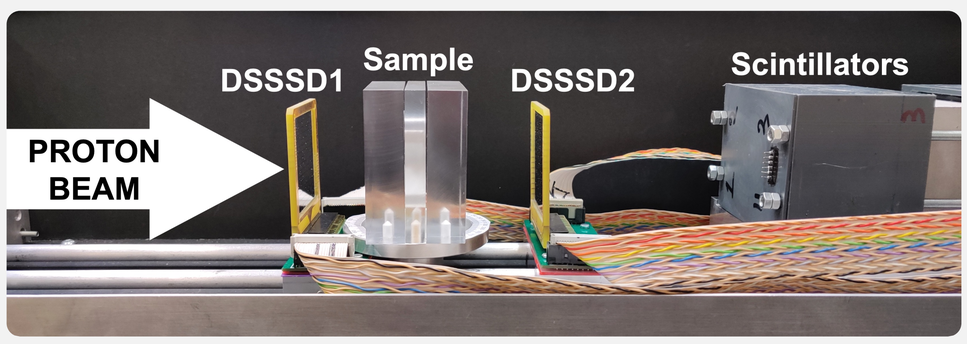
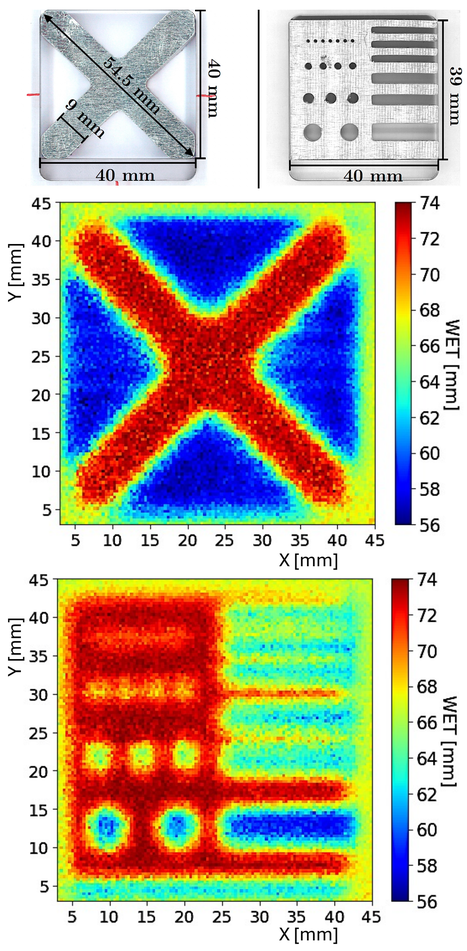


FIG. 2 Setup of the Spanish proton scanner [2].

RESULTS

Proton radiography (pRad)

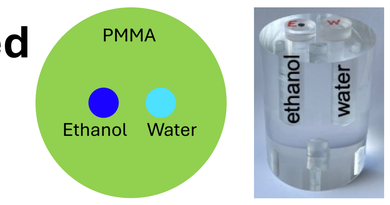
- Nice pRads were obtained which consistently and reliably reproduced the samples.
- Successfully **distinguished** the different **materials** present.
- Resolved structures as small as **2 mm**.
- Determined the **water equivalent thicknesses** (WET), that represent the radiological thickness of the samples.

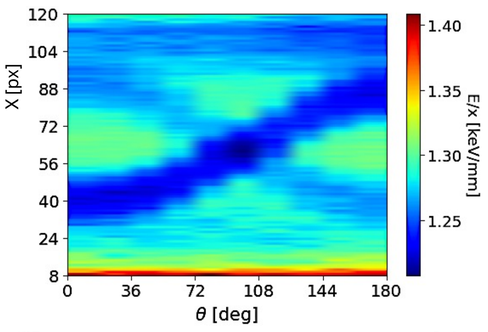


Proton tomography (pCT)

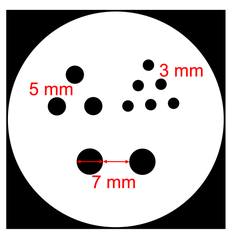
- Tomographic images were obtained using **Filtered Back-Projection** algorithms.
- **RSP** values **in good agreement** with previous works.

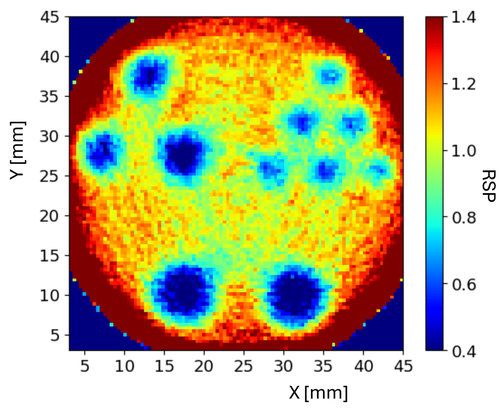
Region	RSP [5] $R_{80\%}$	RSP [6] pCT	RSP [4] This work
Water	1.000(4)	1.00(3)	1.000(5)
Ethanol	0.822(3)	0.82(2)	0.829(7)
PMMA	1.168(5)	1.15(3)	1.158(5)

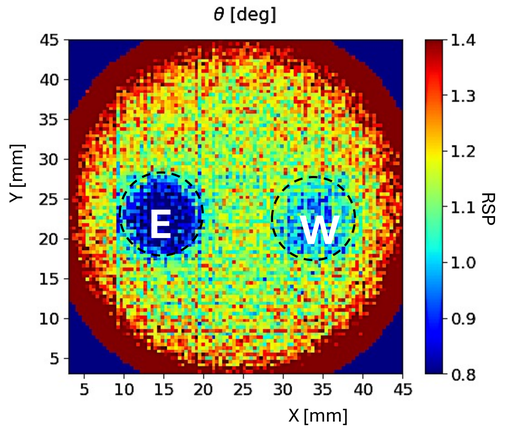




- Resolved structures as small as **3 mm**.







CONCLUSIONS

- pRads and pCT images were obtained using the Spanish proton scanner.
- Spatial resolution **better than 2 mm in pRad** and **better than 3 mm in pCT** with the current prototype.
- **RSP** values **are consistent** with reference values.
- The scanner prototype shows promise for a more accurate RSP mapping while delivering less dose during imaging.

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