### Novel End Station Development: Development of Beam Diagnostics

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### Overview







### Hadron beam therapy



CNAO Synchrotron, image courtesy CNAO.

- Clear healthcare benefits for certain cancer types;
- Significant investment through NHS and private facilities in the UK;
- Optimization of Medical Accelerators (OMA) network identified key R&D challenges:
  - Significant time goes into Q&A
  - New technology solutions needed for novel treatment modalities such as LhARA, FLASH
  - Desirable machine operation modes not currently possible due to lack of noninvasive (online) diagnostics





### **Existing diagnostics**

- + High resolution
- + Reliability
- + Validity
- Interceptive
- Ongoing calibration
- Beam perturbation
- Limited live feedback
- Bunch to Bunch resolution



B. Walasek-Höhne, GSI and G. Kube, DESY S. Giordanengo & M. Donetti, arXiv:1803.00893





### JetDose - Novel diagnostics solution

#### Minimally invasive

- ✓ No beam perturbation
- ✓ Online monitoring
- ✓ Superior error detection

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## Novel treatments and improved operation

- ✓ Enabling technology for LhARA, FLASH and Mini-Beam treatments
- Active machine regulation based on live feedback becomes feasible



# Significantly reduced calibration time

- ✓ No mechanical parts interact with the beam
- ✓ All key parameters monitored remotely
- ✓ Significantly reduced maintenance

N. Kumar, C.P. Welsch, et. al, Physica Medica 73, p 173-178 (2020).

S. Jolly, C.P. Welsch, et al., *"Technical challenges for FLASH proton therapy"*, Phys Med 2020 – Galileo Galilei Award, best paper in 2020

"Non-Invasive Gas Jet In-Vivo Dosimetry for Particle Beam Therapy", contributed talk at IPAC21





### Capitalizing on pioneering STFC-funded technology



#### Gas jet shaping







### Capitalizing on pioneering STFC-funded technology



~3 m

"Gas jet monitor R&D is world leading" – CI SAC (2019)





### Work program



### Deliverables

- Existing gas jet-based online beam monitor will be tested with beam for performance evaluation (Year 1-2);
- Design report and development of the new optimized system for online, non-invasive real time beam dosimetry (Year 3-5);





### Summary

- *JetDose* will apply cutting edge STFC technology to a key healthcare challenge;
- Clearly identified clinical benefits opening opportunities for novel cancer treatment modalities such as LhARA, FLASH and improved ways to operate existing and future facilities;
- Project will be realized by consortium with long-standing collaborative links who are recognized leaders in their respective area;
- Exceptional international network for collaboration and dissemination established through OMA leadership.





# Thank you for your attention





