

# Time-of-Flight PET for Proton Therapy

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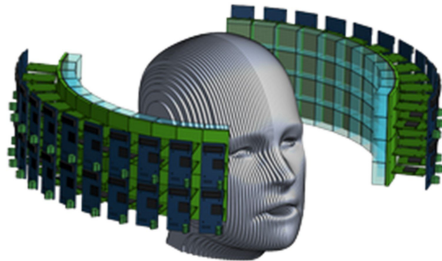
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## Introduction

Proton radiation therapy is a treatment known for delivering precision targeted dosage to tumors while avoiding damage to surrounding healthy tissues, but uncertainty in the proton beam range is a major limiting factor in its effectiveness.

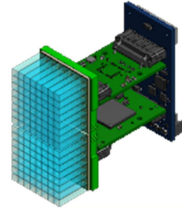
To this end, the Time-of-Flight PET for Proton Therapy (TPPT) Consortium has developed and built a scanner designed to provide in-situ range verification and feedback during proton therapy treatments of head and neck cancer patients. A rendering of this scanner is shown in the figure to the right.



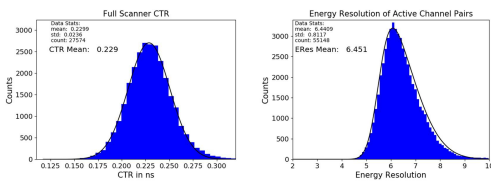
## Scanner Design

This scanner, consisting of two assemblies in the shape of angular sections of a cylinder, is made up of 6144 LYSO crystals ( $3 \times 3 \times 15 \text{ mm}^3$ ) coupled one-to-one to Silicon Photomultiplier (SiPM) arrays. These elements detect coincident gamma photons from positron annihilations resulting from the proton beam (or from radiopharmaceutical tracers) after which tomographic reconstruction can be used to pinpoint the source of the radiation.

All of the readout electronics has been developed by PETSys Electronics specifically for PET scanners. A rendering of a single TPPT module, consisting of two  $8 \times 8$  crystal arrays attached to SiPM arrays and their associated electronics, is shown in the figure to the right.

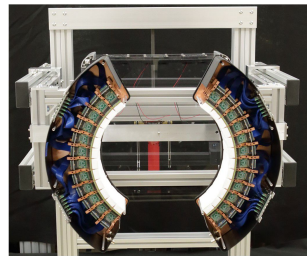


## Scanner Performance



Two important metrics for PET scanner performance are energy resolution and coincidence time resolution, preliminarily shown above for the TPPT scanner.

## Fully Assembled Scanner



## Conclusions and Outlook

The TPPT scanner, now fully assembled (as shown in the above right image), is being calibrated and commissioned in preparation for in-beam studies at the Proton Therapy Center of the MD Anderson Cancer Center (MDACC) in Houston, TX. There, the scanner will be used in conjunction with various anthropomorphic phantoms to assess its performance and validate the scanner design.

