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Developments in the Dedicated Brain PET Imagers Why This is Important

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Hypothesis: Dedicated high performing brain imagers will in a vital way accelerate the development of the cure for dementia, assist with prevention/reversal, as finally safe low-dose early detection accurate molecular screening will become possible. This is the main rationale why scientists and engineers should get involved in this activity. With the beginning of the new era of revolutionary total body dynamic molecular PET Explorer imagers, the previously articulated need to develop dedicated imagers for breast, prostate, heart, etc may slowly disappear, except in the specialized cases in treatment guidance and monitoring, such as in proton therapy. Part of the reason is high cost of the dedicated systems but also an intriguing emerging opportunity that long axial length Explorer PET scanners can be equipped with magnifying inserts that can locally boost the spatial resolution and sensitivity, as per the so-called virtual pinhole concept. However, the exception is the brain imager. The varied asymmetric geometry possible in the head-surrounding designs, still gives an exciting opportunity to the PET imager developers to compete for the best brain imaging PET system. And we are far away from that goal. We all want to produce high quality dynamic molecular PET brain images at as low as practical injected radiation doses, and at low cost. Many new designs are being proposed and being built at this time around the world. These designs mostly fall in two categories: (1) the mini-Explorer cylindrical type and (2) compact helmet type, both with large angular brain coverage assuring high PET detection sensitivity. To further improve sensitivity there is a push now to achieve better than 100 ps or even 50 ps FWHM timing performance. Paul Lecoq from CERN and others from the HEP community formulated the vision/goal of reaching 10 ps FWHM TOF resolution, equivalent to 1.5 mm resolution in space, allowing for non-tomographic open geometry PET imaging. Several groups are working on such concepts, new detection materials, etc. In this race to save lives through better diagnosis, any new ideas from the expert instrumentation community (not only the medical imaging experts) are highly encouraged, as there is expected great impact on brain imaging once such high-performance and robust, economical (dissemination ready) designs are developed. Ideally, brain imagers of the next generation will have high sensitivity and will reach spatial resolution approaching the predicted physical limit due to the positron range and the non-collinearity between the emission directions of the two emitted annihilation photons, of about just over 1 mm FWHM.