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#11-20 Design of a High Energy and High Resolution detector for X-ray computed tomography

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The Nuclear Measurement Laboratory (LMN) at CEA Cadarache in France is developing a high-energy tomograph currently being upgraded to reach energies up to 20 MeV with high dose rates (100 Gy/min). It allows tomographies on massive objects (5 tons, 140 cm diameter) with a millimeter spatial resolution. For the control of absence of cracks, bubbles or defects in the concrete coating of some CEA waste drums, the laboratory needs a "High-Resolution" version of this tomograph. Moreover, it can be used for examination of metal parts produced by additive manufacturing, such as piping parts. Even if several types of detector are available commercially to make high resolution they have drawbacks: some scanners use linear detectors producing one-dimensional images but with high scan times, others use flat panel detectors but there are rapidly damaged by X-ray beam. The purpose of this study is to design an imaging detector able to provide a high spatial resolution on large objects with high dose resistance and scan times of the order of a few hours. This detector is composed of a scintillator, an angle deflecting mirror, and one or more scientific cameras coupled to an optical system. To achieve this design several steps are necessary and will be presented in detail:

- A first step consisted in characterizing the current detection elements of the tomograph such as the camera and its lens via experimental measurements. This allowed us to compare performance of these elements with what exists on the market and to consider a replacement.
- Then we chose the scintillator according to experimental measurements on few scintillators type and a state of the art.
- Next, we optimized the detector configuration to achieve the higher spatial resolution. For example, we can use one camera imaging the whole scintillator, or a coupling of 4 cameras each imaging a quarter of the scintillator.
- The last step was to study the amount and spread of scattered radiation in our design using Monte-Carlo simulations (MCNP6). An optimum to take in account scattered radiation contribution and spatial resolution has been found depending on the configuration and the magnification factor applied to the system.

Through all of these steps, we present the design of a high-resolution detector with a spatial resolution for a contrast at 10% around 250 µm.

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