X-Ray Sources for Fast 3D Tomography Using Laser-Plasma Acceleration

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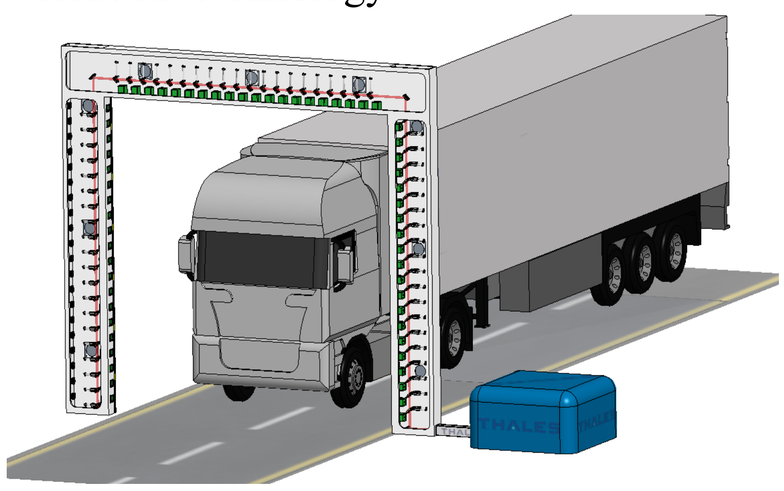
Introduction to Multiscan 3D

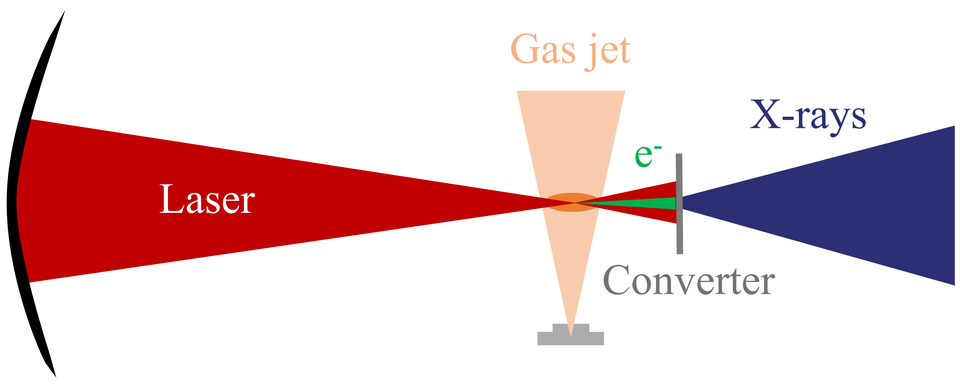
In the context of a projected rising movements of cargo and passengers, Multiscan 3D Project aims to provide a technical solution to create **3D tomography systems** capable of detecting threats invisible with current 2D technology.

Laser-plasma acceleration is a promising method to achieve this goal. Indeed, the laser allows generating **multiple X-ray** sources at **low cost**.



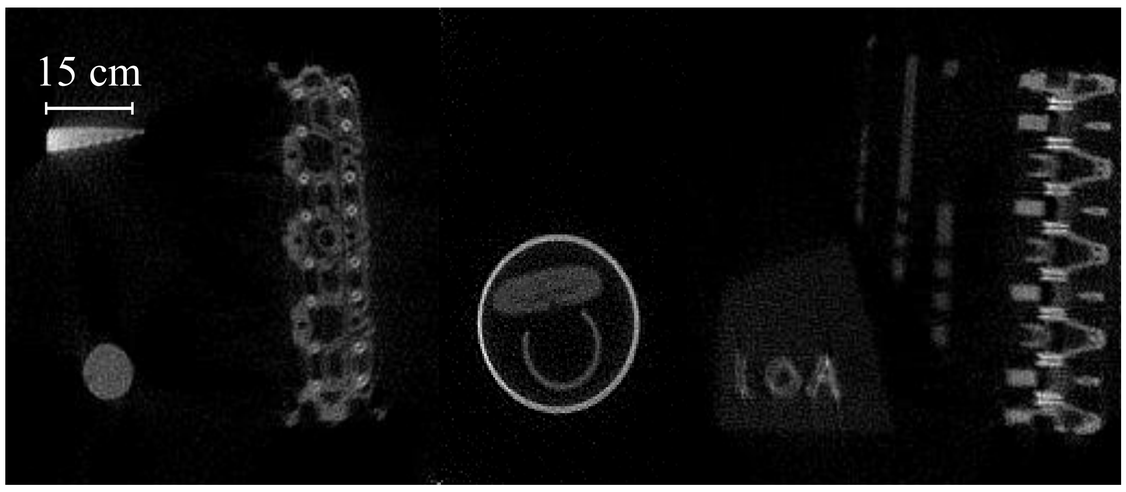
Furthermore, laser-plasma acceleration can produce electron beams with the following characteristics of interest :

- ✓ high charge (> 1 nC)
- ✓ low-energy (< 10 MeV)
- ✓ high divergence



Results

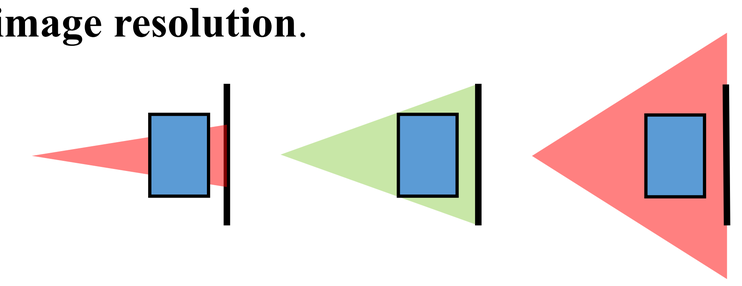
Below are some images taken in the field of the Multiscan 3D Project. Those images demonstrate the capacity of LPA to perform tomography and are encouraging continuing to improve this regime.



Tomography of various objects (Concrete, Motor crankcase…) (150 shot per image and 1 shot per position)

Divergence Issue

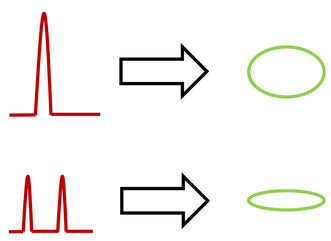
While high divergence is an **advantage to illuminate large objects** like containers, it can also become a drawback when it is too large, as it tends to increase the X-ray source size and **reduce image resolution**.



In regimes such as Multiscan's, charges of the order of few **tens of nC** with divergence of **hundreds of mrad** have already been achieved [1]. This stresses the need to control the divergence while maintaining a high charge.

Contemplated Solution

To address this, we propose using a **train of laser pulses** instead of a single pulse. Each laser pulse will accelerate electrons in its wake, producing a train of electron bunches that achieve the **same overall charge** with **lower divergence**.

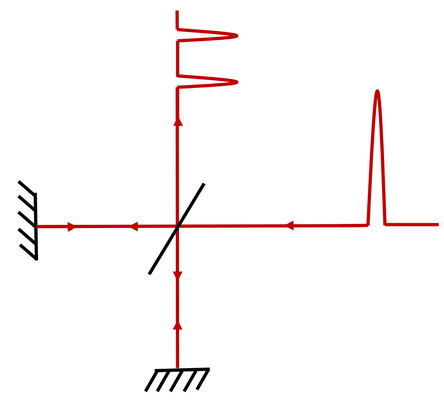


- High charge
- High divergence

- Same overall charge
- Smaller divergence

The first step to a multiple pulse experiment is to split the laser in two. It could be done using a **Michelson interferometer**.

Simulations have already shown that this technique could improve beam divergence [2].



Acknowledgments

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References

[1] L Martelli *et al.* Phys. Rev. Applied 23, 034033 (2025)

[2] I Andriyash, C Thaury, A Flacco, *Pulse-train laser-plasma accelerator,* US patent, 18551791 (2024)