

# Muon scattering tomography with laser-plasma-accelerator-driven muon source

Andi Hektor & Kristjan Pöder et al (MuRay Tech)

In collaboration with:

Sarah Barnes et al (DLR)

Lorenzo Pezzotti (CERN)

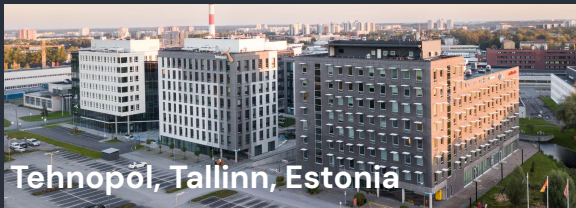
Muographers 2026, Budapest  
June 2, 2026



# The company MuRay Tech

Building the world's first **Muon Beam Imaging** system:

- Laser Plasma Accelerator based muon-ray source
- Detector system for Muography
- AI-based 3D imaging and automated analytics



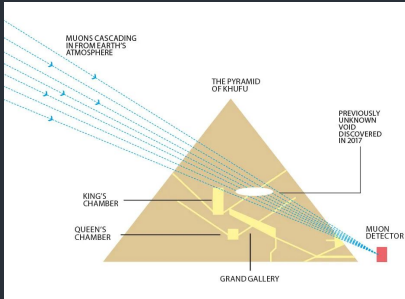
Andi Hektor, PhD  
Co-CEO & Co-founder

Kristjan Pöder, PhD  
Co-CEO & Co-founder



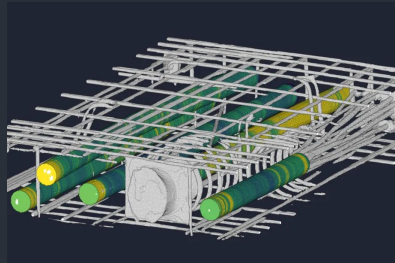
# Muon Tomography with natural radiation muons (cosmic-rays)

Imaging of pyramids:  
R&D from 1970s



**Why muons?**  
Penetrative, sensitive to  
atomic composition, safe

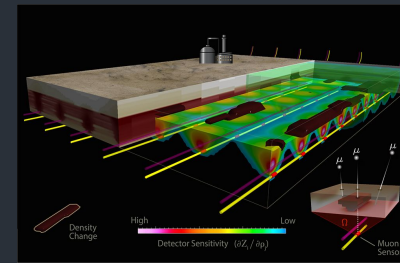
Civil engineering:  
GScan (EE & UK, 2018)



Security & Customs:  
Decision Sciences (US, 2007)



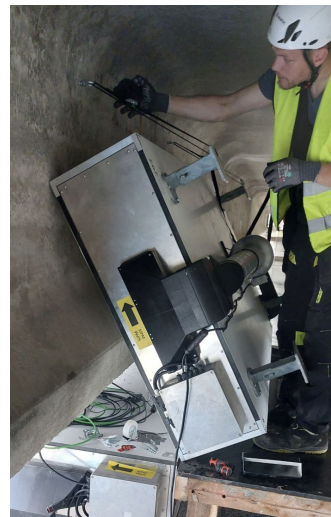
Mining & Geology:  
Ideon (CA, 2013)



# GSCAN

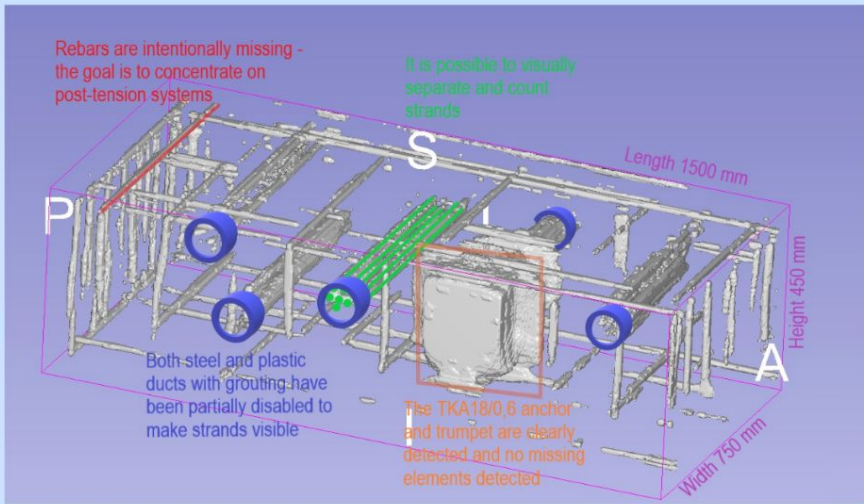
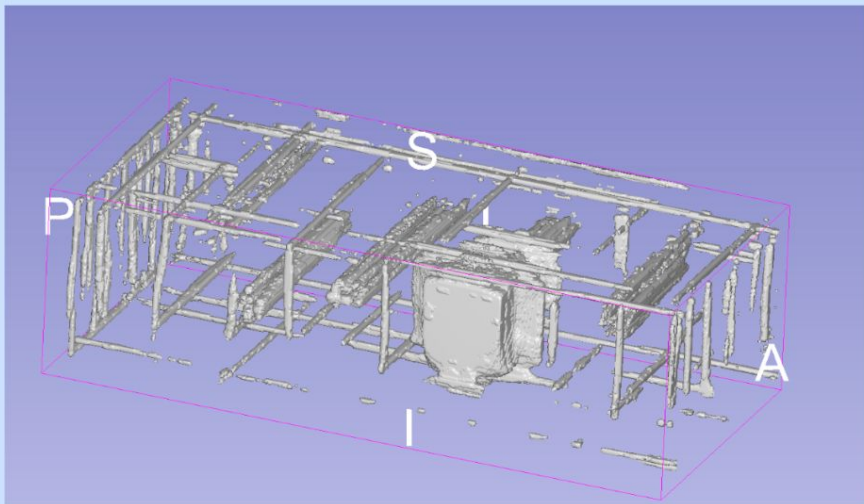
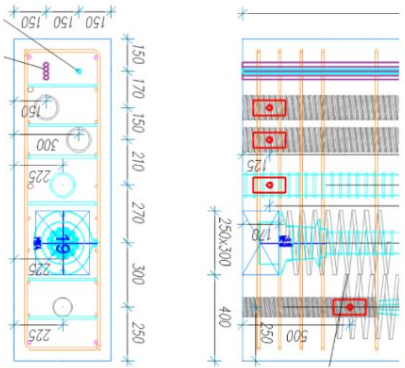
muonFLUX™ Solutions for Non-Destructive Testing and  
Structural Health Monitoring





# Results:

## Moonshot Phase 2

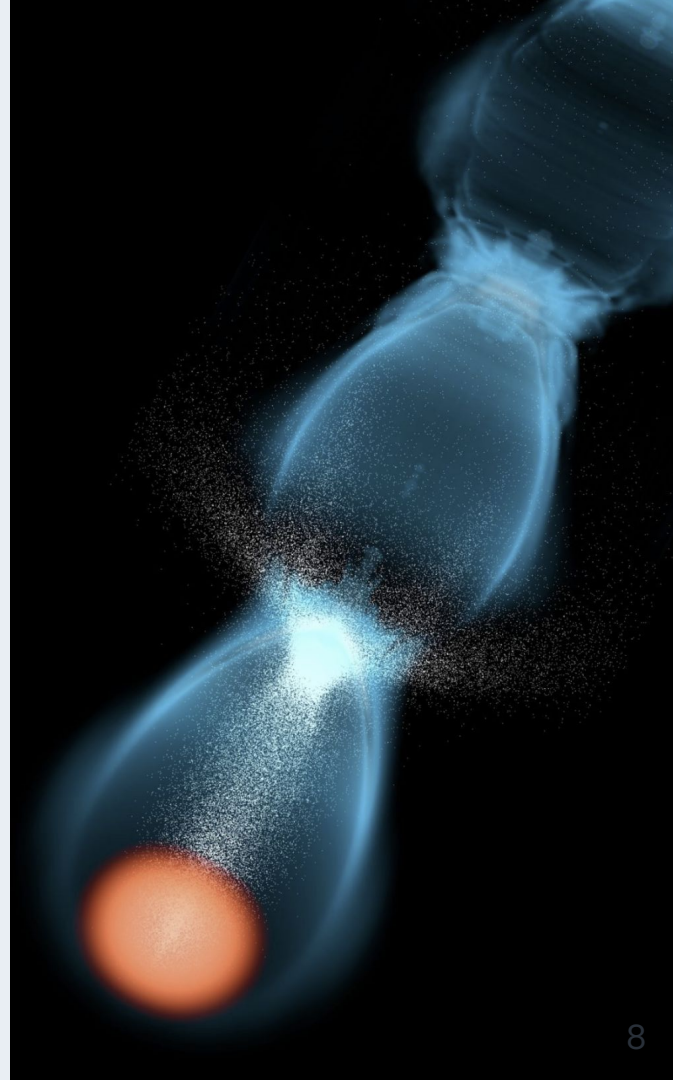


# Why an Artificial Muon Source?

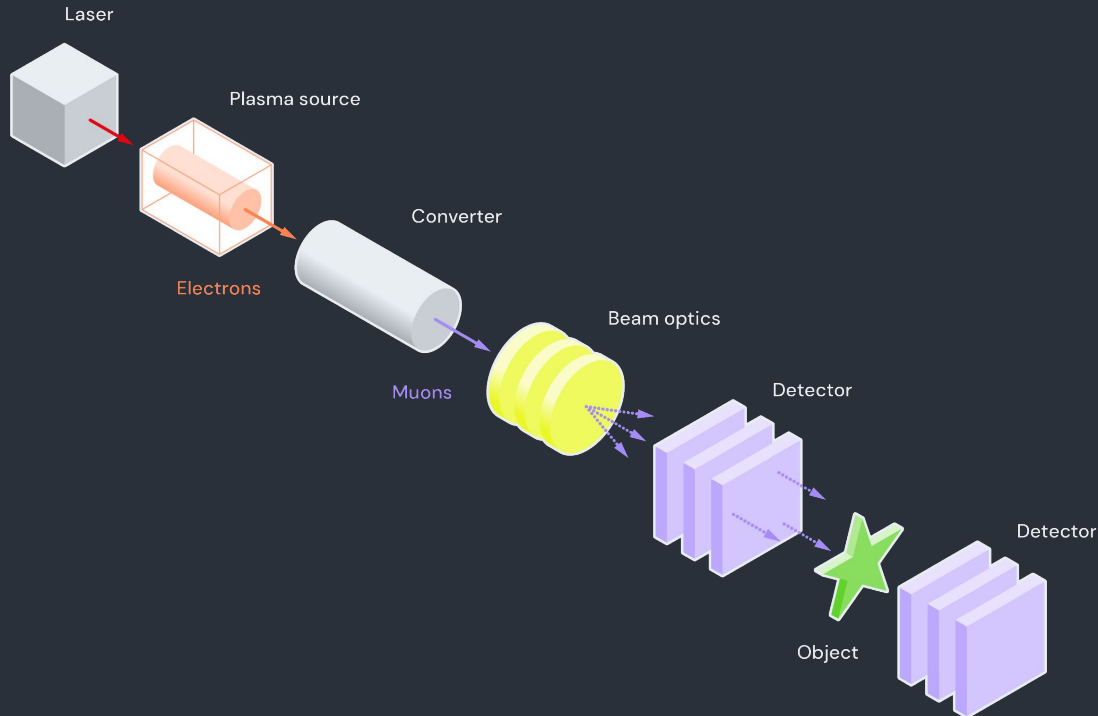
# Cosmic-ray muons *versus* man-made ones

Cosmic-ray based muography is safe and passive, but...

- **Long imaging times:**  
A few mm resolution needs a week of scanning time
- **Low spatial resolutions:**  
It is difficult to achieve  $<1\text{mm}$  resolution
- **Troubles with low-Z materials:**  
Muon scattering angles are small at  $\sim 4\text{ GeV}$

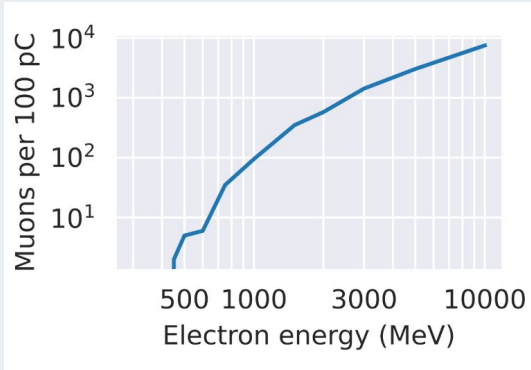
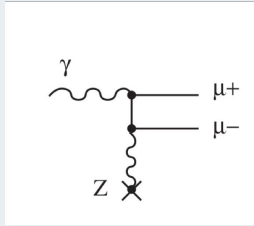


# Muon Beam Imaging: Laser Plasma Accelerator + Muon Tomography

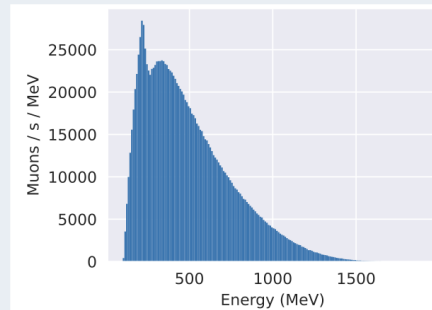
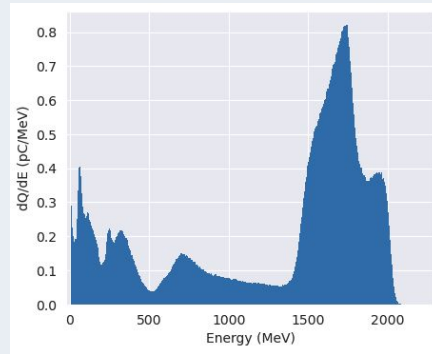


# Laser Plasma Accelerator (LPA) driven muon source

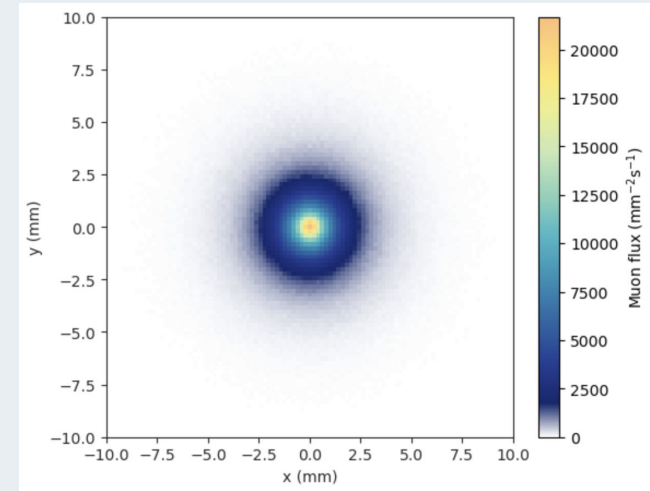
Muons are primarily created by Bethe-Heitler process



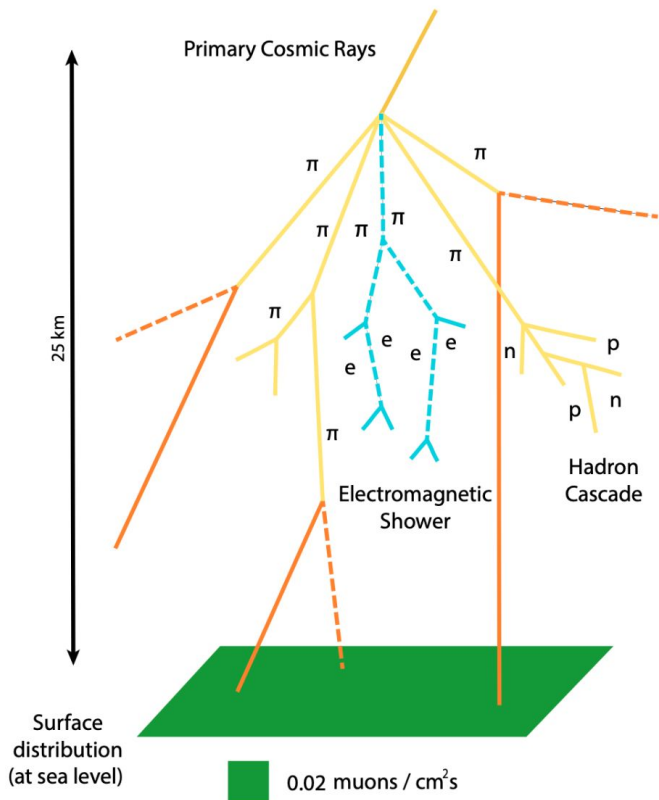
100TW lasers with HOFI-guiding can create 100s pC of charge, which can create 1000s of muons per shot.



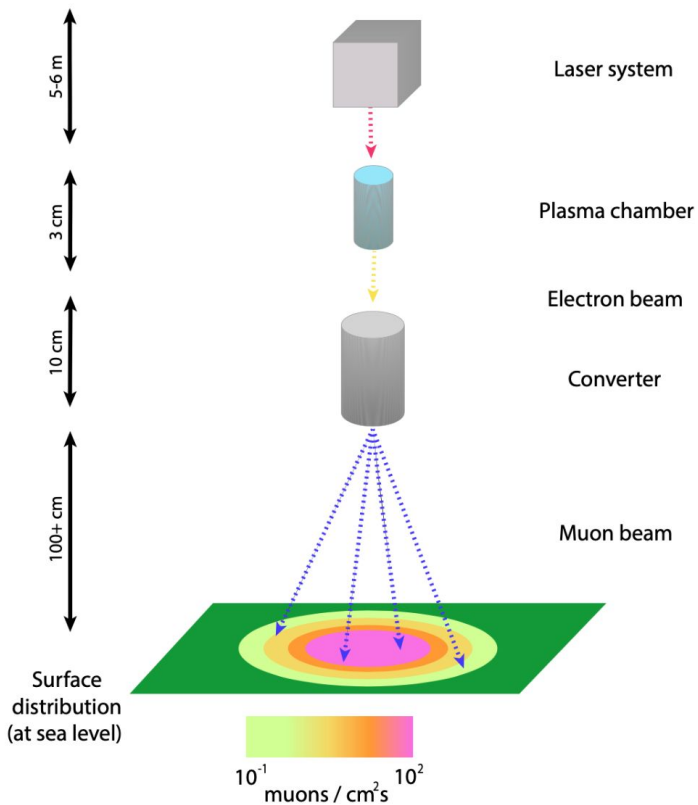
With upcoming 100 Hz laser system, the source could make 100 000s of muons per second



## Natural muon flux

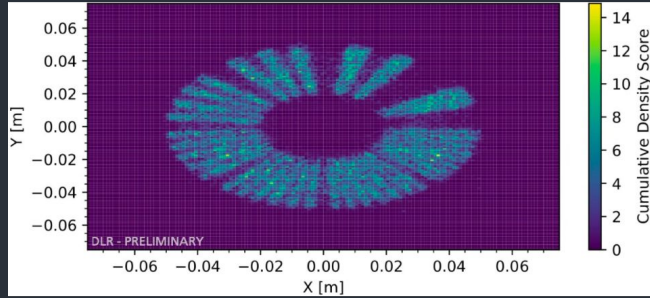


## Artificial muon beam

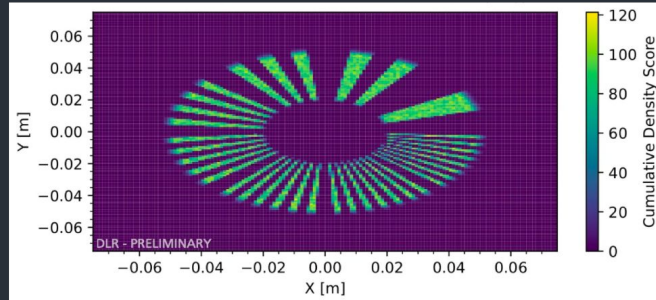
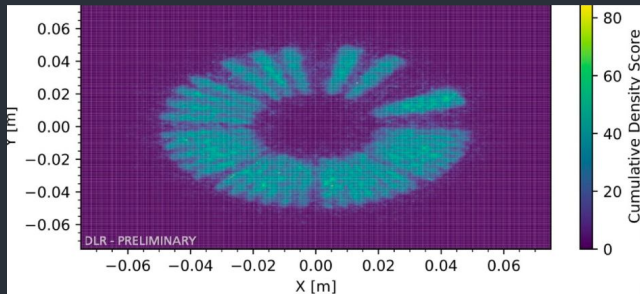
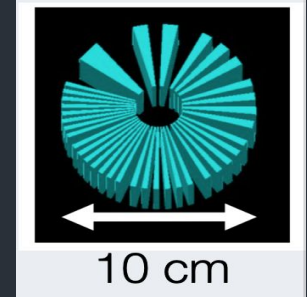
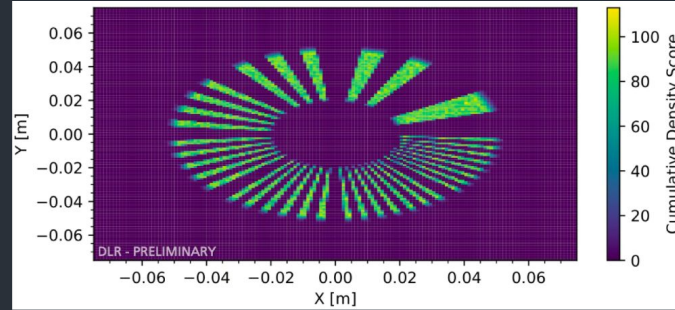


# Muon-Beam-Imaging with LPA-based source

Cosmics: 14 hours

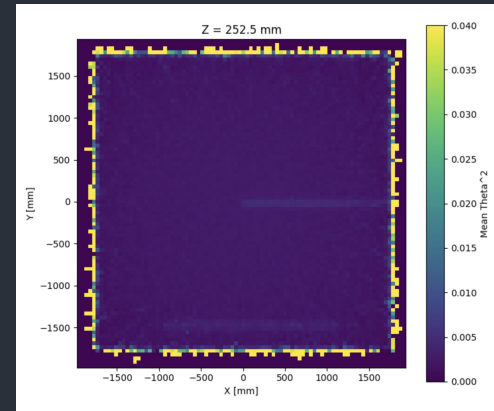
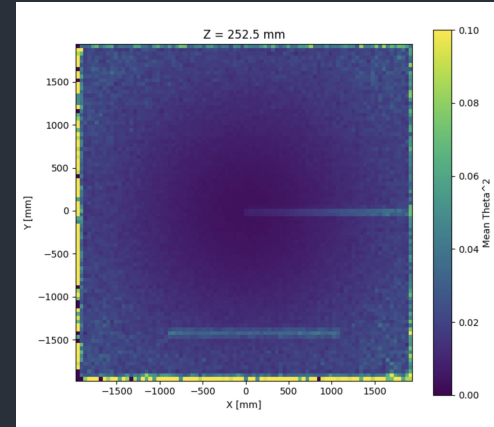
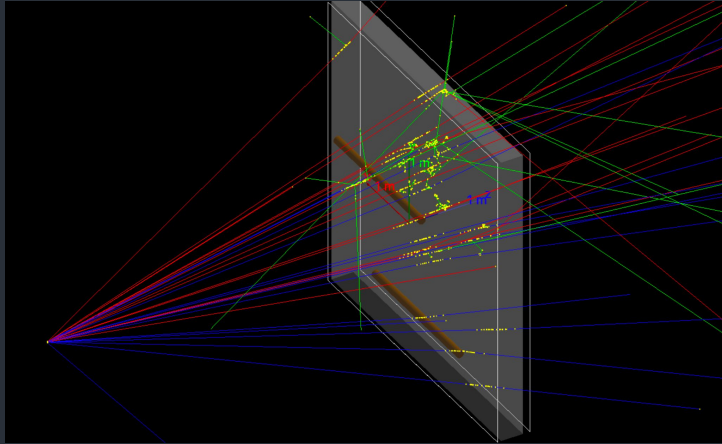


LPA: 1 minute



# Muon-Beam-Imaging with LPA-based source

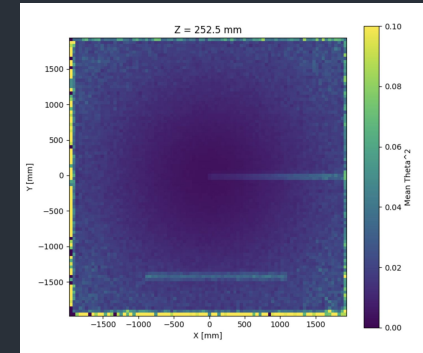
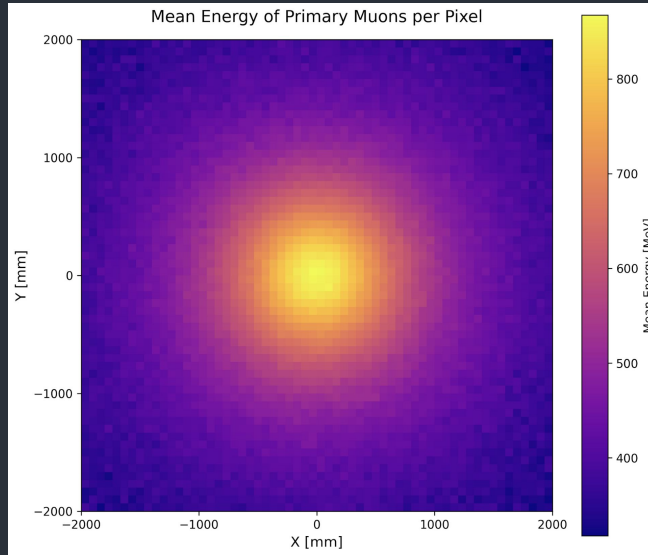
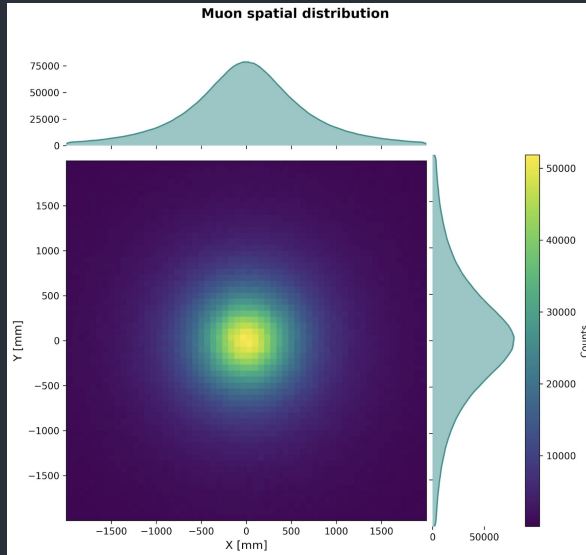
2m x 2m, reinforced concrete,  
Geant4, 20M muons, POCA



In collaboration with L. Pezzotti (CERN)

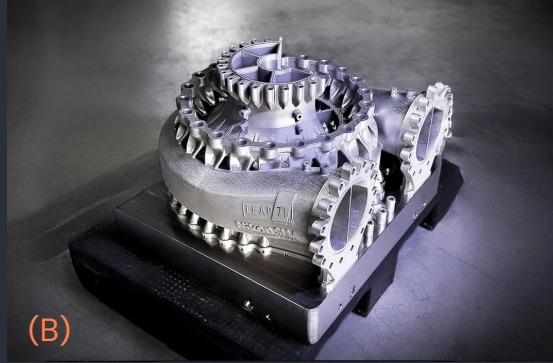
# Muon-Beam-Imaging with LPA-based source

2m x 2m, reinforced concrete,  
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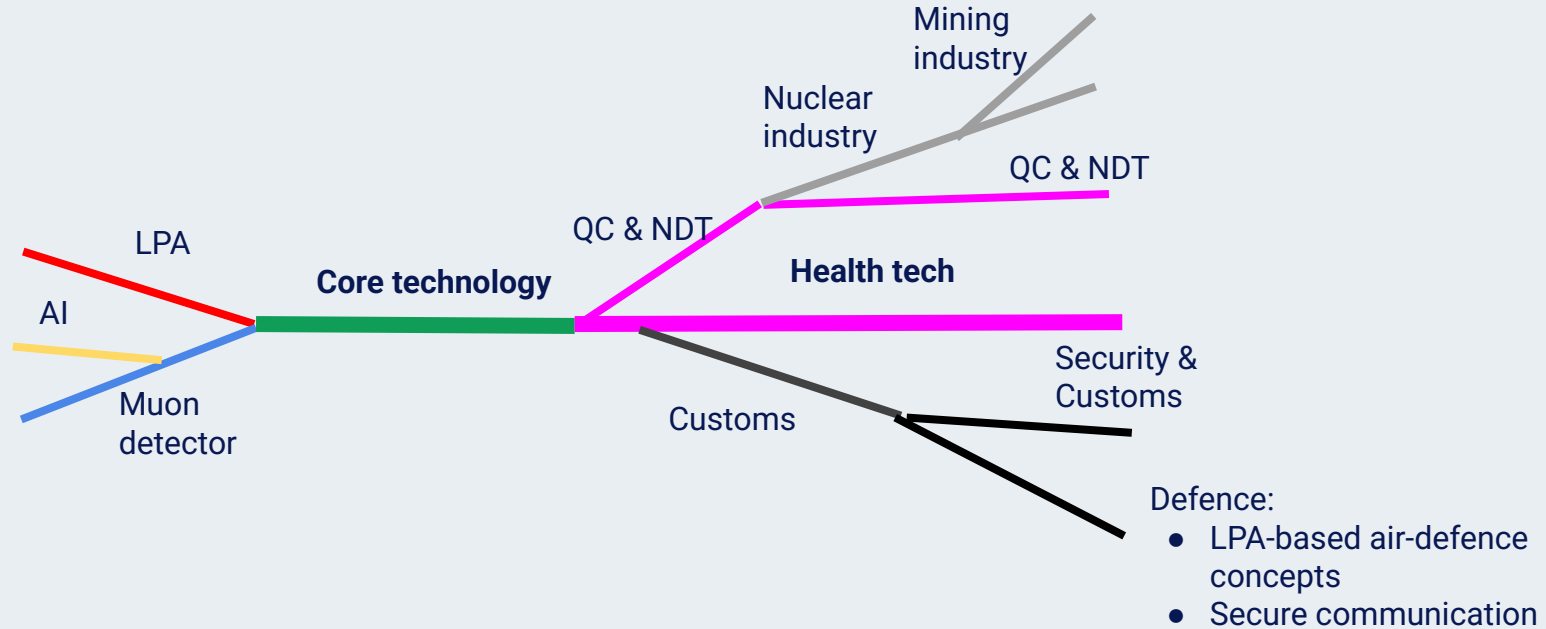
In collaboration with L. Pezzotti (CERN)

# The world of metallic Additive Manufacturing (3D-printing)



- (A) Rocket engine with cooling channels
- (B) Element of the rocket engine
- (C) Gas turbine blades with cooling channels
- (D) World's largest metallic 3D-printer

# Technology vision: The applications



# Summary: Differences between cosmics and MBI

- **Time isolated muons versus pulsating muon beam**
  - The present muography solutions cannot handle 100+ muons per shot (<1ps)
  - Our solution: A scintillator based pixel detector
- **Different energy spectrum**
  - Cosmic-ray muons: the maximum around 4 GeV:  
More suitable for **high-Z materials** and **larger objects**
  - LPA muons: the maximum around 0.5 GeV:  
More suitable **low and medium-Z materials** and **smaller objects**

# Thank you!

- **2026:** Muon source at the DESY PRIMA beamline + early muon detector
- **2027:** Proof-of-Concept projects with industrial partners
- **2028:** First tests with the LPA-based systems
- **2030:** First full-scale product: original LPA + muon detector