Non-intrusive diagnostics for electron density and X-ray emission of plasmas

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Pillar Energy – Spoke 5 / WP5
SAMOTHRACE 2nd Year:
Experimental Prototypes Demo Showcase

SAMOTHRACE PROJECT ECS00000022

March 10th 2025

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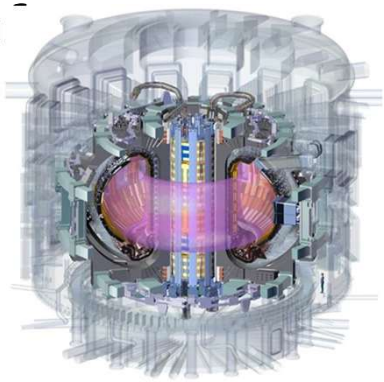
THE PROBLEMS TO BE SOLVED

1 Detectors beyond the state of art for Fusion Plasmas

Innovation addressed: low-cost, robust, extendable and non-intrusive

Why existing solutions fail?

Radiation Damage, Design Constraints
Limited Energy Range



relevant data on market size

number of private fusion companies is growing exponentially!

2 X-ray Sensing Systems for Security

existing solutions suffer of low energy resolution, high false

market estimated at $4.04B. estimated annual increase of 8.9%.

3 In-vivo monitoring of oncological radiotherapy

existing solutions are limited for spatially resolved

market of $3.17–3.65B. Expected growth of around 7% per year.

4 Online sensing for sterilization systems

Non-chemical sterilization of food & packaging

existing solutions are

Segment of $1.67B, expected growth ~15%/year (ref. GMI)

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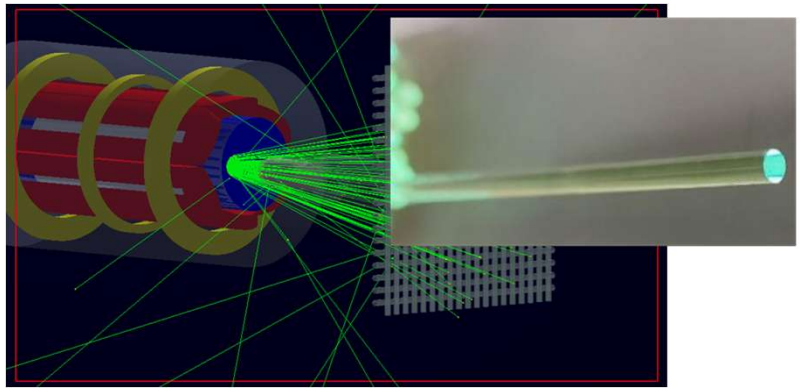
Solutions

1



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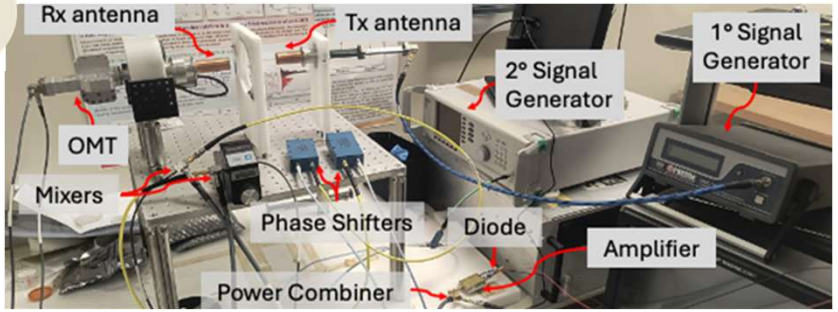
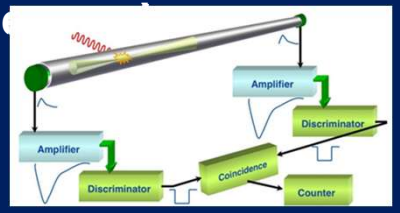
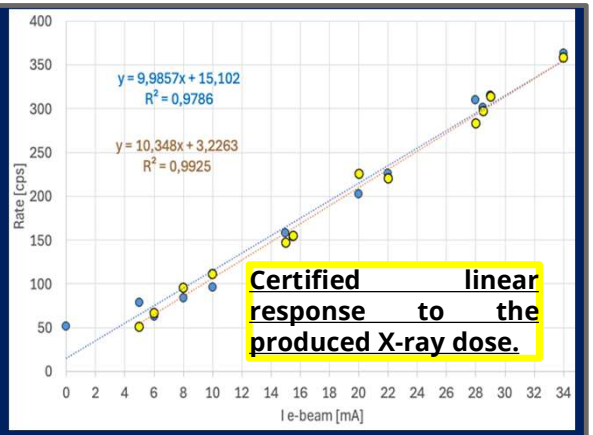
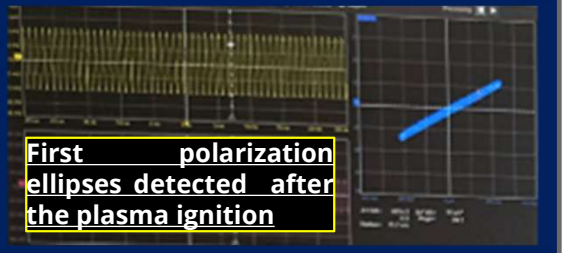


Scintillating Fiber (SciFi) system: Flexible, cheap, extendable, robust, high radiation resistance, non-intrusive **X-ray counter** and **silicon photomultipli**





VESPRI Polarimetric setup: non invasive, scalable, fast superheterodyne method to measure the plasma electron density from the the Faraday rotation.



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SAMOTHRACE DEVELOPMENT PLAN

1 Scintillating Plastic Fibers X-ray Sensors

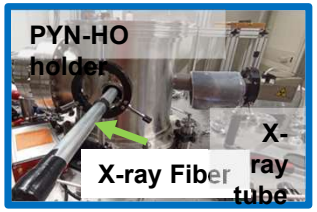
TRL@t_0	Current TRL	Final TRL
2	5	6

Starting point : developed for monitoring radioactive waste using gamma rays (@ ~ 800 keV)

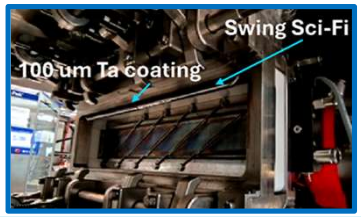
Key Milestones:

1.First Validation: Successful detection of X-ray emissions from plasmas within the 10-35 keV range.

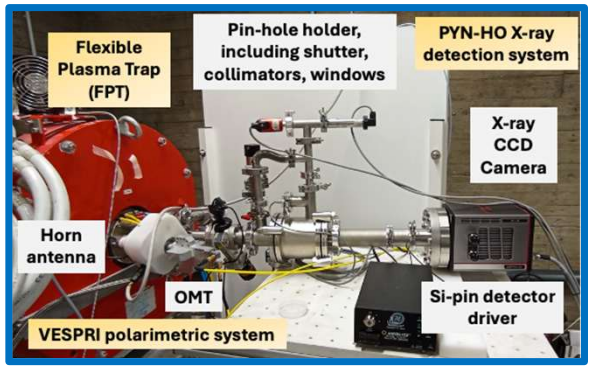
2.Mechanical and Electronic Enhancements



First Validation at LNS through the PYN-HO prototype



First Validation in relevant industrial environment @Tetra Pak site



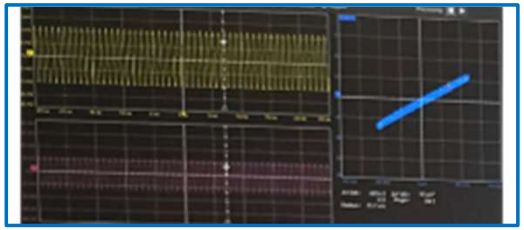
Validation in relevant plasma environment (FPT @LNS, ATOMKI @Debrecen)

2 Full-superheterodyne Polarimeter

Starting Point: Homodyne and VNA Approach: statistical analysis and extensive post-processing limited to 20 GHz.

Key Milestones

- First in-plasma tests on FPT based on two complementary approaches:
  1) Lissajous Figure Detection
  2) Stokes Parameters Determination
- mm-wave components procurement completed



The polarization ellipses detected after the plasma ignition

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NEXT STEP UNDER SAMOTHRACE

Sci-Fi X-ray sensor within the PYN-HO system: Towards a fully-integrated device for complete in-plasma characterization (reliability, long term stability)

Superheterodyne polarimeter: Components ready to be fully-assembled for the in-plasma complete characterization (reliability, long term stability)

TRL@t_0	Current TRL	Final TRL
2	5	**6**

- **Fruitful collaborations** have been established with:
  - **Industrial Partner** (*Tetra PaK*)
  - **Inter-Spoke** (*CNR*),
  - **Worldwide Research Laboratories** (*LPSC-Grenoble, ATOMKI-Debrecen*)

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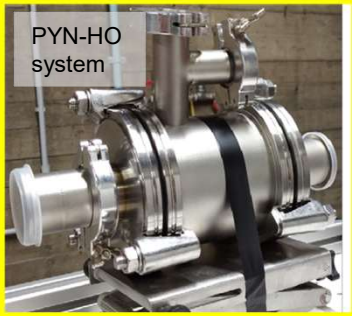
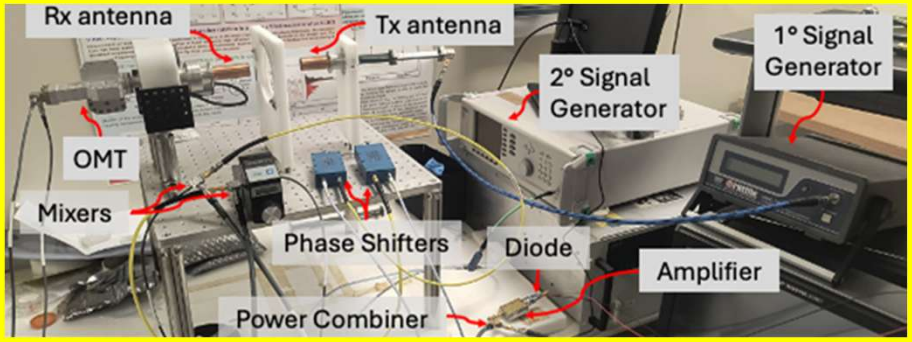
THANK YOU!

VISIT OUR DEMO AT BOOTH N. 21





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