# CVD diamond photodetectors for fusion plasma diagnostics

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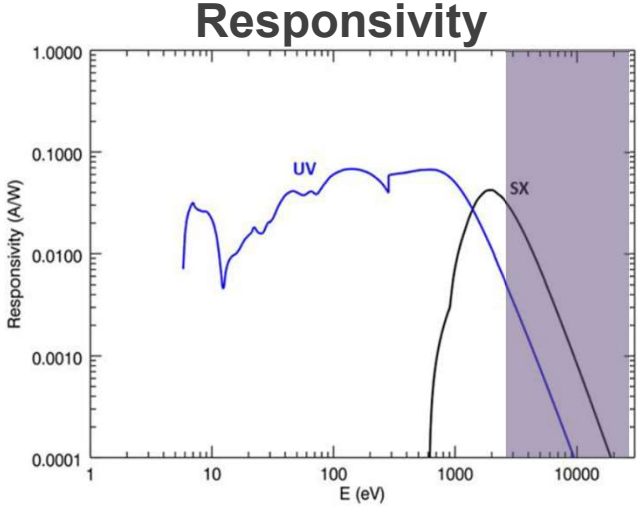
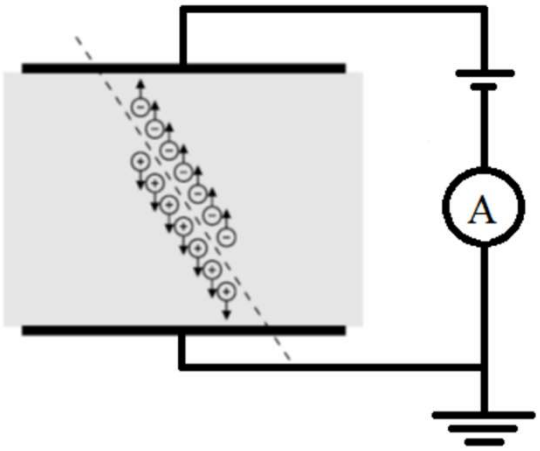
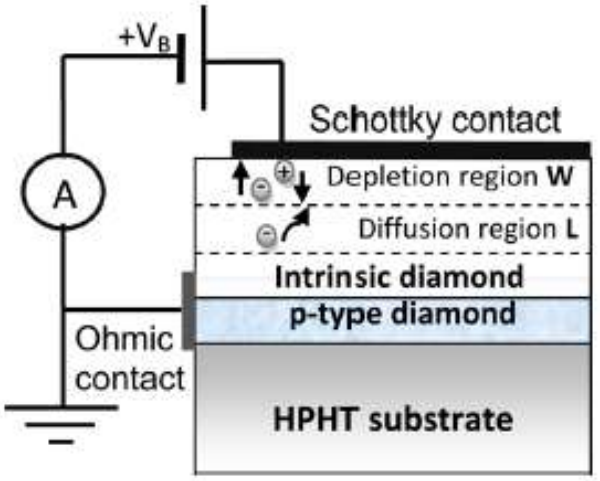
## DIAMOND PHOTODETECTORS

**Diamond features:**
- Good radiation hardness
- Suitable for operation in harsh environments
- High carrier mobility
- Visible-wavelength blindness
- No need of Be windows
- Good S/N



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## 1st DETECTOR INSTALLED @JET → RESULTS

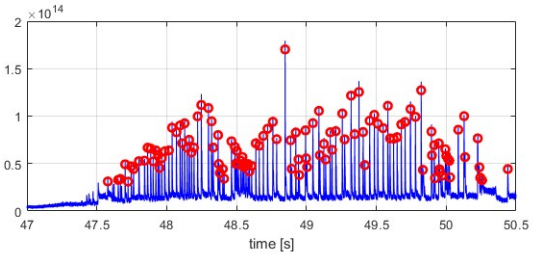
**Edge Localized Modes (ELMs)** = radial plasma bursts hitting the first wall
→ expulsion of particles and energy that need to be controlled

**Diagnostics considered:**

- Pellet Monitoring System
- Beryllium emission line of Spectroscopy
- UV Diamond diagnostics

**Data Analysis:**

1. Detection of signals related to Pellet and ELMs
2. Application of the Spectrogram Cross-Correlation method
3. Classification of the computed signals




- **Diamond UV results more in line with numerical estimation than Spec. Be line**
- **Calculation of triggering time more accurate for Diamond UV signal**
- **Diamond UV line of sight and amplification NOT optimised for ELMs**

*An unsupervised spectrogram cross-correlation method to assess ELM triggering efficiency by pellets*, R. Rossi, **S. Cesaroni**, F. Bombarda, P. Gaudio, M. Gelfusa, M. Marinelli, G. Verona-Rinati. E. Peluso, JET contributors, Appl. Sci. 12, 3681 (2022)

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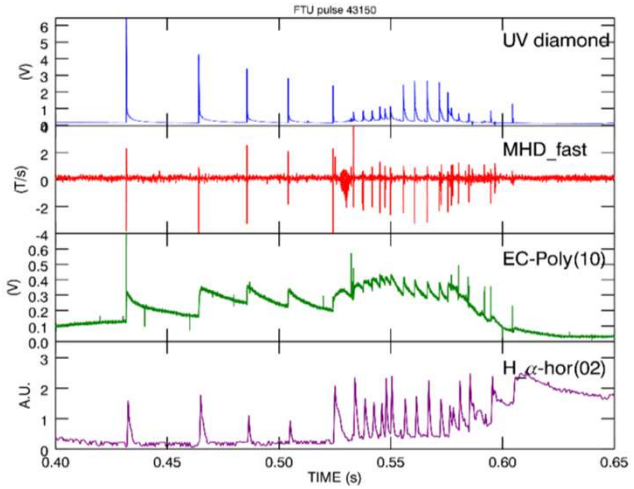
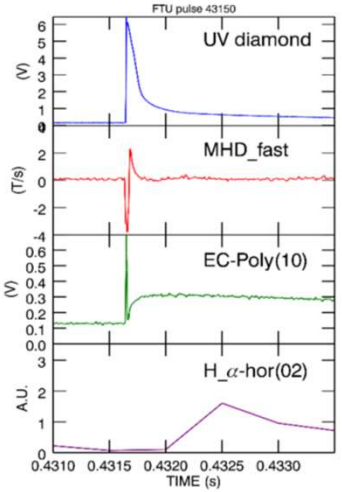
ENEA Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile

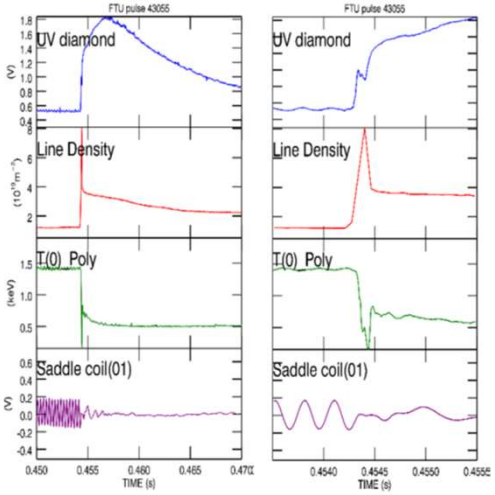
## 2nd DETECTOR INSTALLED @FTU → RESULTS

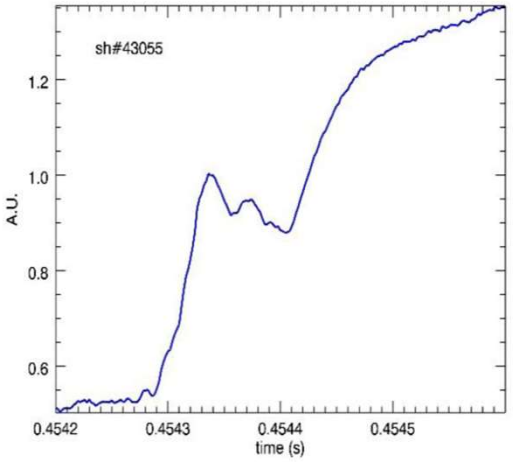
### 1. Anomalous Doppler Instabilities



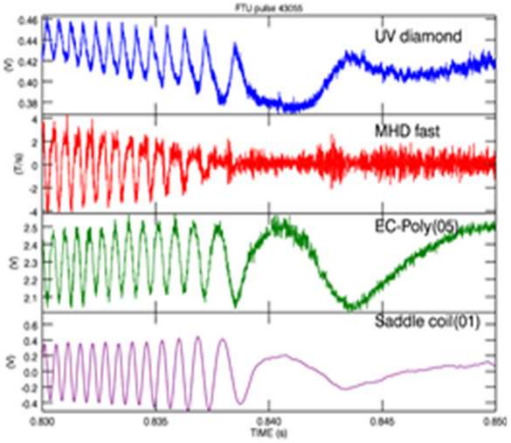



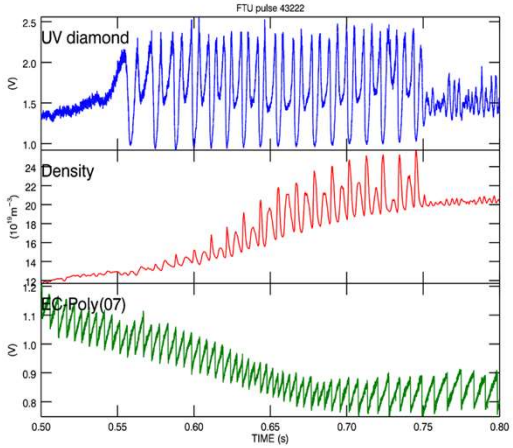

### 2. Pellet ablation



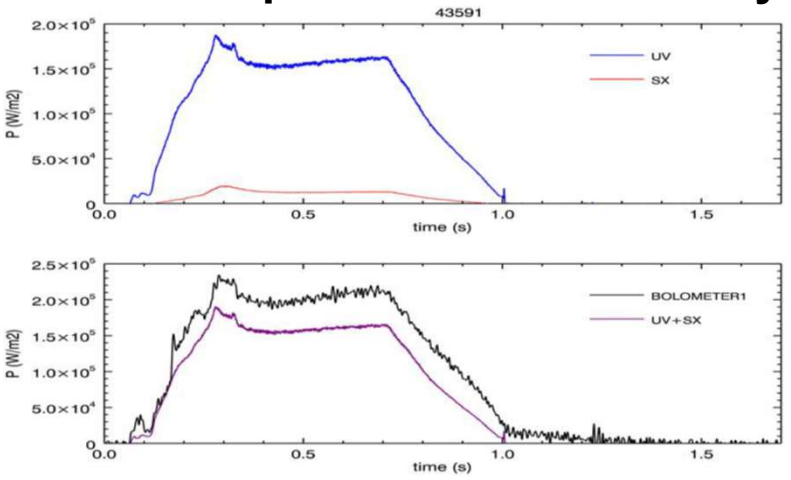




### 3. MHD activity and MARFE




### 4. Comparison with bolometry




*CVD diamond photodetectors for FTU plasma diagnostics*, **S. Cesaroni** et al., Fusion Eng. Des. 166, 112323 (2021)

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25/10/2024
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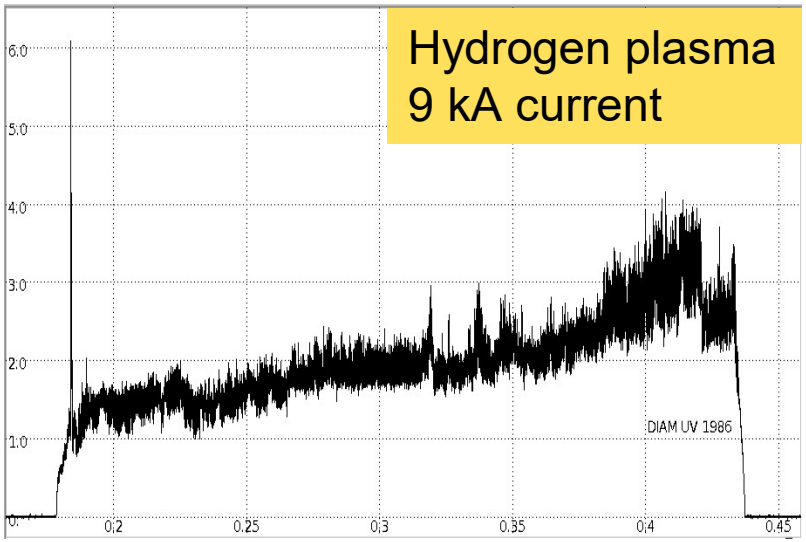
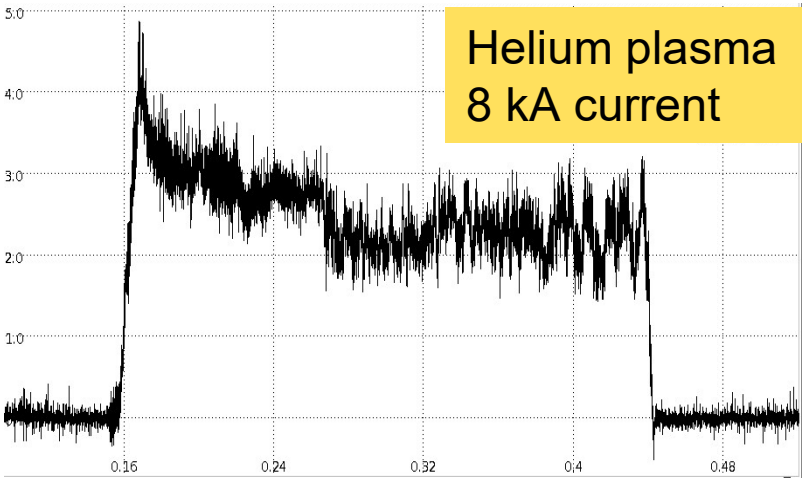
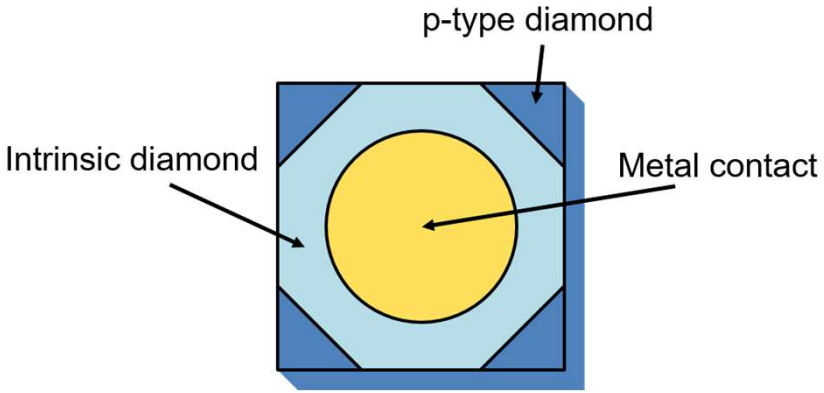
# CVD diamond photodetectors for fusion plasma diagnostics

## 2nd DETECTOR MOVED TO PROTOSPHERA → RESULTS




### A new setup → diamond array

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18:08

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## PUBLICATIONS


- *High temperature response of a single crystal CVD diamond detector operated in current mode*, M. Angelone, **S. Cesaroni**, S. Loreti, G. Pagano, M. Pillon, Nucl. Instr. Meth. Phys. Res. A, vol. 943 (2019)

- *CVD diamond detectors for fast VUV and SX-ray diagnostics on FTU*, F. Bombarda, M. Angelone, G. Apruzzese, C. Centioli, **S. Cesaroni**, L. Gabellieri, A. Grosso, M. Marinelli, E. Milani, S. Palomba, V. Piergotti, G. Pucella, G. Rocchi, A. Romano, A. Sibio, B. Tilia, C. Verona, G. Verona-Rinati, Nucl. Fusion 61 (2021)

- *CVD diamond photodetector for plasma diagnostics on FTU*, **S. Cesaroni**, M. Angelone, G. Apruzzese, F. Bombarda, L. Gabellieri, M. Marinelli, E. Milani, S. Palomba, G. Pucella, A. Romano, C. Verona, G. Verona-Rinati, C. Centioli, A. Grosso, V. Piergotti, G. Rocchi, A. Sibio, B. Tilia, Proceedings of the 47th EPS Conference on Plasma Physics, ref. P5.1003 (2021)

- *CVD diamond photodetectors for FTU plasma diagnostics*, **S. Cesaroni**, M. Angelone, G. Apruzzese, F. Bombarda, L. Gabellieri, M. Marinelli, E. Milani, S. Palomba, G. Pucella, A. Romano, C. Verona, G. Verona-Rinati, C. Centioli, A. Grosso, V. Piergotti, G. Rocchi, A. Sibio, B. Tilia, Fusion Eng. Des. 166, 112323 (2021)

- *Helium doped plasmas on FTU*, C. Mazzotta, **the FTU team and collaborators**, Proceedings of the 28th IAEA Fusion Energy Conference (2021)

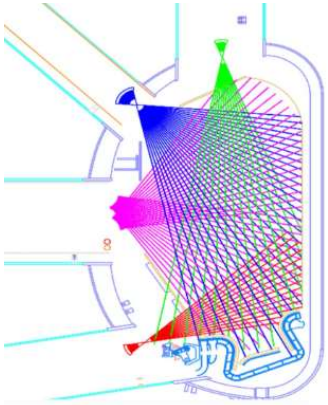
- *Overview of the FTU results*, G. Pucella, **the FTU team and collaborators**, Nucl. Fusion 62 042004 (2022)

- *An unsupervised spectrogram cross-correlation method to assess ELM triggering efficiency by pellets*, R. Rossi, **S. Cesaroni**, F. Bombarda, P. Gaudio, M. Gelfusa, M. Marinelli, G. Verona-Rinati. E. Peluso, JET contributors, Appl. Sci. 12, 3681 (2022)

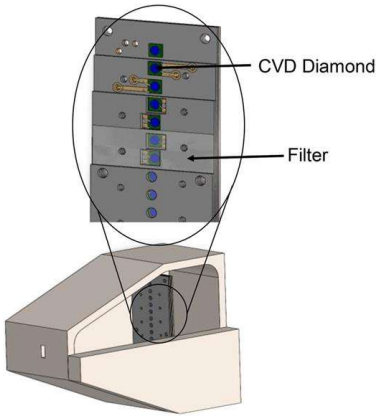
# PhD graduation in June 2022


...what happened after that?

# Outcomes of this PhD work

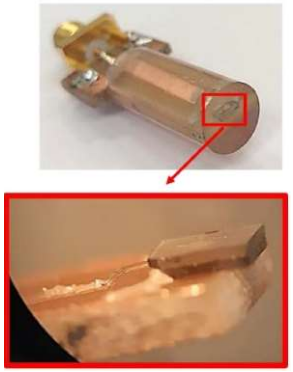


- Diamond Tomographic System for DTT
  S. Palomba, SOFT24 conference




- SX Tomographic System for SPARC

S. Normile et al., Rev. Sci. Instrum. 95, 093102 (2024)



- New detector layout → LAT layout

S. Cesaroni et al., Fus. Eng. Des. 197, 114037 (2023)

- CAEN developed a multichannel amplifier for diamond arrays

Poster presented on Monday 21st October, this conference

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## CONCLUSIONS

**CVD diamond photodetectors result to be:**

- Suitable for harsh environments
- Easy to handle and compact in their layout
- Highly reliable, highly performing

**Specific purpose oriented installations:**

- In arrays for core e/o divertor tomography/bolometry systems
- To monitor fast events occurring at the edge (ELMs, MARFEs, plasma-wall interactions)
- For identification of MHD instabilities in the plasma core
- For Pellet ablation diagnostics

**R&D program for the development of diamond based tomography/bolometry system:**

- Further tests on multichannel amplifier developed by CAEN
- Test diamond detector in LAT layout using a monochromatic calibrated source at a synchrotron facility
- Install diamond detector arrays inside operating tokamaks

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