

Results of the 32nd Joint Russian-German Workshop on ECRH and Gyrotrons

Organised by the Institute of Applied Physics, RAS, Nizhny Novgorod, Russia
December 23, 2020 (Virtual Meeting)

This meeting of the Russian-German Network for “Millimeter- and THz-Sources and Applications” was the 32nd Workshop in sequence, which was originally organized according to the plan (01DJ15002) of the International Educational and Scientific Cooperation with Russia in the field of Application of High-Power Microwaves of the Bundesministerium für Bildung und Forschung (BMBF). The following research institutions were represented at the workshop: Institute of Applied Physics Russian Academy of Sciences (IAP, Nizhny Novgorod), GYCOM (Nizhny Novgorod), Kurchatov Institute (KI Moscow), Karlsruhe Institute of Technology (KIT, Karlsruhe), Institut für Grenzflächenverfahrenstechnik und Plasmatechnologie der Universität Stuttgart (IGVP, Uni Stuttgart), Max-Planck-Institut für Plasmaphysik (IPP, Garching and Greifswald). Due to the COVID-19 pandemic and the related travel restrictions in 2020, the workshop was held virtually via the internet. About 32 participants (almost half of them being young scientists) were attending the Workshop sessions. 12 reports were presented and discussed.

All the most relevant theoretical and experimental collaboration activities of the Network were reviewed, the goals, which have been already reached were identified, the state-of-the-art of the various topics was thoroughly discussed and updated goals were defined. Many aspects of high power microwave sources (gyrotrons) and their applications to the fusion programme as well as additional applications were discussed. Among them, the following theoretical and experimental items giving or promising remarkable progress in the fields are to be distinguished:

1. ECRH RF Sources (Gyrotrons)

- KIT developments during 2020 (KIT)
- Development of master oscillator for frequency locking of a complex of megawatt level microwave sources (IAP)
- Progress in 170/204 GHz coaxial development (KIT)

- Concept of double-harmonic megawatt-level gyrotron for plasma heating in spherical tokamaks (IAP)
- Progress on multi-stage collector development (KIT)
- Gyrotron frequency multiplication (IAP)
- Progress on advanced systems and tools (KIT)

2. Plasma Applications, Experiments and Systems

- Conversion of carbon dioxide in a microwave plasma torch sustained by gyrotron radiation at frequency of 24 GHz at atmospheric pressure (IAP)
- Characteristics of ECRH-plasmas at the W7-X stellarator (IPP)
- Performance of the multi-frequency ECRH system at ASDEX Upgrade (IPP)
- Advanced ECRH components for ITER: Fast switches and reflector gratings (IGVP)
- Current status of tokamak T-15MD (KI)

4. Summary and Conclusions

Both delegations note the remarkable progress achieved in the areas of ECRH and ECCD experiments, the generation of high power microwaves up to THz frequencies and their related applications. In particular, the delegations are highlighting the following achievements:

1. First demonstration of successful frequency locking of high-power gyrotrons (IAP, GYCOM).
2. Versatile use of the world's most powerful ECRH systems for plasma experiments on ASDEX Upgrade and W7-X (IPP).
3. Successful experiments with a 1.5 MW 140 GHz short-pulse prototype gyrotron for upgrade of the W7-X ECRH system (KIT).
4. Application of gyrotron radiation for the conversion of carbon dioxide at atmospheric pressure (IAP).

All parties are fully satisfied with the fruitful technical discussions which have led to an extensive exchange of knowledge in the different fields of high power microwaves. All parties express their wish for further exchange of knowledge and further strengthening of the collaboration between the different institutes. All Parties expressed their wish to extend the collaboration with respect to new applications

The 33rd Joint Workshop in May-June 2021 should be conducted by IPP Greifswald.

Prof. H. Zohm (Co-Chairman, IPP)

Prof. A. Litvak (Co-Chairman, IAP)