The GOLEM tokamak bibliography

The tokamak GOLEM team

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Official GOLEM Articles

Abbasi et al.: Plasma diagnostics using fast cameras at the GOLEM tokamak **Abbasi-2023-FUSENGDES23**

S. Abbasi et al. "Plasma diagnostics using fast cameras at the GOLEM tokamak". In: *Fusion Engineering and Design* 193 (2023), p. 113647. ISSN: 0920-3796. DOI: https://doi.org/10.1016/j.fusengdes.2023.113647. URL: https://www.sciencedirect.com/science/article/pii/S0920379623002302.

Abstract: Tomographic inversion of radiation determines spatial distribution of tokamak plasma radiation sources using line integrated plasma projections data. For measurements of the projections, fast visible radiation matrix cameras became broadly applied on tokamaks in recent past. These novel cameras opened new possibilities in high temperature plasma studies. The GOLEM tokamak of the Czech Technical University in Prague strives to implement up-to-date diagnostics with enhanced temporal and spatial resolution. Therefore, a novel diagnostic system of two crossed monochrome cameras Photron FASTCAM MINI UX50 was integrated into the GOLEM diagnostics. The proposed contribution will detail their novel port mounts (vertical and horizontal) at the GOLEM tokamak which have been designed so that additional optical measurements of the plasma core (e.g. plasma spectroscopy) is possible. As the main purpose of this study, we shall focus in particular on the frame rate potential which is high enough to make detection and observation of highly transient phenomena in the GOLEM plasmas possible. Progress in solving specific challenges of the ill-conditioned tomographic inversion via the algorithm optimization and testing for the GOLEM tokamak will be presented together with the first tomographic results.

Mácha et al.: Spontaneous formation of a transport barrier in helium plasma in a tokamak with circular configuration **Macha-2023-NuclFus**

Petr Mácha et al. "Spontaneous formation of a transport barrier in helium plasma in a tokamak with circular configuration". In: *Nuclear Fusion* (Aug. 2023).

Abstract: We report on the first experimental observation of a spontaneously formed transport barrier in the tokamak with a circular configuration in helium plasmas. There was no external polarization of the plasma by electric field or other technique to form the barrier as it is typically used in tokamaks with circular plasma. In general, the transport barriers play an important role in plasma confinement especially in tokamaks with divertor configuration. In our experiments, we clearly observe distinct characteristics of a transport barrier, including a steep gradient of the electron temperature and an enhanced radial electric field along with the change in the plasma potential, floating potential, and electron temperature fluctuation. The electron temperature and the plasma potential are obtained by a combination of the ball-pen and Langmuir probe measurements with high temporal resolution on a shot-to-shot basis. This first experimental observation of the spontaneously formed transport barrier might bring new possibilities to obtain a fusion-relevant study of the edge plasma parameters and transport in helium plasmas even on small tokamaks.

Sarancha et al.: Remote Plasma Physics Research and Teaching by Example of Turbulence Study at the University-Scale Tokamak GOLEM **Sarancha-2023-FST**

G. Sarancha et al. "Remote Plasma Physics Research and Teaching by Example of Turbulence Study at the University-Scale Tokamak GOLEM". In: *Fusion Science and Technology* 79.4 (2023), pp. 432–445. eprint: https://doi.org/10.1080/15361055.2022.2148842. URL: https://doi.org/10.1080/15361055.2022.2148842.

Abstract: AbstractThe university-scale tokamak GOLEM provides a unique opportunity to perform remote thermonuclear experiments [V. Svoboda, J. Fusion Energy, Vol. 38, Part 2, p. 253 (2019)]. Undergraduate plasma physics students from three universities—Moscow Institute of Physics and Technology (National Research University), RUDN University, and National Research Nuclear University MEPhI—carried out joint remote experiments to train in tokamak operation and to study topics relevant for mainstream fusion research such as plasma start-up, comparison of hydrogen versus helium plasma characteristics, electrostatic and electromagnetic turbulence, long-range correlations, etc. New observations of the long-range correlations between low-frequency (¡50 kHz) quasi-coherent electrostatic and magnetic oscillations identified as m = 2 mode with several techniques were done, as well as of the broadband (¡250 kHz) magnetic oscillations resolved in frequency and wave vector in helium and hydrogen plasmas. The presence of broadband electrostatic and broadband magnetic turbulence has also been established at the plasma edge.

Cerovsky et al.: Progress in HXR diagnostics at Golem and COMPASS tokamaks **Cerovsky-2022-JINST**

J. Cerovsky et al. "Progress in HXR diagnostics at Golem and COMPASS tokamaks". In: *Journal of Instrumentation* 17.01 (Jan. 2022), p. C01033. DOI: 10.1088/1748-0221/17/01/c01033. URL: https://doi.org/10.1088/1748-0221/17/01/c01033.

Abstract: Scintillation detectors are widely used for hard X-ray spectroscopy and allow us to investigate the dynamics of runaway electrons in tokamaks. This diagnostic tool proved to be able to provide information about the energy or the number of runaway electrons. Presently it has been used for runaway studies at the Golem and the COMPASS tokamaks. The set of scintillation detectors used at both tokamaks was significantly extended and improved. Besides NaI(Tl) (2 x 2 inch) scintillation detectors, YAP(Ce) and CeBr3 were employed. The data acquisition system was accordingly improved and the data from scintillation detectors is collected with appropriate sampling rate (approx. 300 MHz) and sufficient bandwidth (approx. 100 MHz) to allow a pulse analysis. Up to five detectors can currently simultaneously monitor hard X-ray radiation at the Golem. The same scintillation detectors were also installed during the runaway electron campaign at the COMPASS tokamak. The aim of this contribution is to report progress in diagnostics of HXR radiation induced by runaway electrons at the Golem and the COMPASS tokamaks. The data collected during the 12th runaway electron campaign (2020) at COMPASS shows that count rates during typical low-density runaway electron discharges are in a range of hundreds of kHz and detected photon energies go up to 10 MeV (measured outside the tokamak hall). Acquired data from experimental campaigns from both machines will be discussed.

Kulkov et al.: Detection of runaway electrons at the COMPASS tokamak using a Timepix3-based semiconductor detector **Kulkov-2022-JINST**

S. Kulkov et al. "Detection of runaway electrons at the COMPASS tokamak using a Timepix3-based semiconductor detector". In: *Journal of Instrumentation* 17.02 (Feb. 2022), P02030. DOI: 10.1088/1748-0221/17/02/p02030. URL: https://doi.org/10.1088/1748-0221/17/02/p02030.

Abstract: Runaway electrons are considered dangerous for the integrity of tokamak vacuum vessels. To secure the success of the future tokamak-based machines, reliable diagnostics and mitigation strategies are necessary. The COMPASS tokamak supported the research of runaway electron physics via regular experimental campaigns. During the last two experimental campaigns dedicated to runaway electrons, a semiconductor detector with a Timepix3 readout chip, Si sensor, and the SPIDR readout system was tested. Time evolution signals, energy measurements, and sensor snapshots collected with the Timepix3-based detector are presented.

Sarancha et al.: Magnetic turbulence and long-range correlation studies in the Golem tokamak **Sarancha-2021-JPCS**

G Sarancha et al. "Magnetic turbulence and long-range correlation studies in the Golem tokamak". In: *Journal of Physics: Conference Series* 2055.1 (Oct. 2021), p. 012003.

Abstract: The small university-scale tokamak Golem equipped with the electric and magnetic probes becomes a test bench for studying the plasma turbulence and Zonal Flows, which are the essential processes affecting the plasma confinement. The broadband ($f_{BB} < 250$ kHz) magnetic turbulence was detected for the first time using the Mirnov probes. The two-dimensional (frequency–wavelength) Fourier power spectra $S(k, f)$ of the magnetic turbulence indicate the turbulence poloidal propagation. The long-range correlations (LRC) between the signals of magnetic and electric probes installed at different toroidal cross-sections were detected in the low-frequency range ($f_{LRC} < 60$ kHz), which is similar to the plasma potential LRC range observed in other devices.

Sarancha et al.: Hydrogen and helium discharges in the Golem tokamak **Sarancha-2021-VANT**

G.A. Sarancha et al. "Hydrogen and helium discharges in the Golem tokamak". In: *Problems Of Atomic Science And Technology, Ser. Thermonuclear Fusion* 4 (2021), pp. 92–110.

Abstract: The helium plasma properties and confinement remain an important area of research in modern fusion devices. This work is dedicated to the helium plasma initiation and control in a small-scale tokamak Golem compared to hydrogen plasma. Helium and hydrogen plasmas are comprehensively compared and the optimum operational conditions for the start-up are found. Long-range correlations between lowfrequency (< 50 kHz) electrostatic and magnetic oscillations are found, as well as broadband (< 250 kHz) magnetic oscillations resolved in frequency and wave vector in helium plasma.

Siusko et al.: Breakdown phase in the Golem tokamak and its impact on plasma performance **Siusko-2021-UJP**

Y. Siusko et al. "Breakdown phase in the Golem tokamak and its impact on plasma performance". In: *Ukrainian Journal of Physics* 66.3 (2021), pp. 231–239. URL: https://ujp.bitp.kiev.ua/index.php/ujp/article/view/2020180.

Abstract: The effect of the breakdown phase on subsequent plasma parameters was investigated remotely in Golem tokamak. The dependence of breakdown voltage and the breakdown time versus the time delay between the trigger of the toroidal magnetic field B t and the trigger of toroidal electric field E t for different groups of the pressure magnitudes is built. The performed ex- periments have shown that for Golem tokamak the shorter is temporal delay - the better mean plasma parameters are obtained. In addition, the breakdown phase was discussed more detailed. In the discussion the analysis of the avalanche phase of the breakdown was made. The dominant mechanism of particle loses during avalanche phase, future steps, tasks were discussed and set.

Gryaznevich et al.: Contribution of joint experiments on small tokamaks in the framework of IAEA coordinated research projects to mainstream fusion research **Gryaznevich-2020-PST**

M. Gryaznevich et al. "Contribution of joint experiments on small tokamaks in the framework of IAEA coordinated research projects to mainstream fusion research". In: *Plasma Science and Technology* 22.5 (Mar. 2020), p. 055102. DOI: 10.1088/2058-6272/ab6d4d. URL: https://doi.org/10.1088%2F2058-6272%2Fab6d4d.

Abstract: Joint experiments (JEs) on small tokamaks have been regularly performed between 2005 and 2015 under the framework of the International Atomic Energy Agency (IAEA) coordinated research projects (CRPs). This paper describes the background and the rationale for these experiments, how they were organized and executed, main areas of research covered during these experiments, main results, contributions to mainstream fusion research, and discusses lessons learned and outcomes from these activities. We underline several of the most important scientific outputs and also specific outputs in the education of young scientists and scientists from developing countries and their importance.

Novotny et al.: Runaway electron diagnostics using silicon strip detector **Novotny-2020-JINST**

L. Novotny et al. "Runaway electron diagnostics using silicon strip detector". In: *Journal of Instrumentation* 15.07 (July 2020), p. C07015. DOI: 10.1088/1748-0221/15/07/c07015. URL: https://doi.org/10.1088%2F1748-0221%2F15%2F07%2Fc07015.

Abstract: We present a proof-of-principle measurement of runaway electrons in a small tokamak using a silicon strip detector. The detector was placed inside the diagnostic port of the tokamak vessel and detected the runaway electron signal directly. The measured signal was compared to the signal provided by other tokamak diagnostics, especially the hard X-ray scintillation detector, which detects secondary photons created by interaction of accelerated electrons with tokamak walls (indirect detection of runaway electrons). The preliminary results show that when not saturated, direct detection with a segmented silicon strip detector provides promising new diagnostic information including spatial and temporal distribution of the runaway electron beam, and the measurement results are in good agreement with hard X-ray measurements with a scintillation detector.

Dhyani et al.: Study of Runaway Electrons in Golem Tokamak **Dhyani-2019-JINST**

P. Dhyani et al. "Study of Runaway Electrons in Golem Tokamak". In: *Journal of Instrumentation* 14.09 (Sept. 2019), pp. C09029–C09029. DOI: 10.1088/1748-0221/14/09/c09029. URL: https://doi.org/10.1088%2F1748-0221%2F14%2F09%2Fc09029.

Abstract: High loop voltage and low-density plasma discharges at the Golem tokamak present favorable conditions for the study of the runaway electrons (RE). A probe is being designed and developed for the spectral measurement of the RE energy inside the last closed flux surface of Golem tokamak plasma. Design of the probe is based on simulation results of the FLUKA code that estimates the energy absorbed by the scintillating crystals and filters of various densities. In the simulations, graphite, stainless steel and molybdenum were tested to filter the supra-thermal electrons. Since having different light yield, YSO (Y2SiO5:Ce), NaI(Tl) and plastic (EJ-200) scintillating crystals were chosen for the simulations.

Stockel et al.: Operational Domain in Hydrogen Plasmas on the Golem Tokamak **Stockel-2019-JOFE**

J. Stockel et al. "Operational Domain in Hydrogen Plasmas on the Golem Tokamak". In: *Journal of Fusion Energy* 38 (Mar. 2019), pp. 253–261. ISSN: 1572-9591. DOI: 10.1007/s10894-019-00215-7.

Abstract: A series of discharges in hydrogen were performed in two experimental sessions. The vessel was not conditioned before the first session, while inductive heating of the vessel and cleaning glow discharge were applied before the second session. Experimental results from both sessions are compared, and optimum operational conditions for the majority of key plasma parameters are determined. It is found that plasma performance with a properly conditioned vessel is significantly better, as expected. In particular, a noticeable increase of discharge duration, and of the electron temperature is observed.

Svihra et al.: Runaway electrons diagnostics using segmented semiconductor detectors **Svihra-2018-FUSENGDES**

Peter Svihra et al. "Runaway electrons diagnostics using segmented semiconductor detectors". In: *Fusion Engineering and Design* 146 (2019). SI:SOFT-30, pp. 316–319. ISSN: 0920-3796. DOI: https://doi.org/10.1016/j.fusengdes.2018.12.054. URL: https://www.sciencedirect.com/science/article/pii/S0920379618308196.

Abstract: A novel application of strip and pixel silicon radiation detectors for study and characterization of run-away electron events in tokamaks is presented. Main goal was to monitor runaway electrons both directly and indirectly. The strip detector was placed inside the tokamak vacuum chamber in order to monitor the run-away electrons directly. Whereas the pixel detector was placed outside the tokamak chamber behind a pin hole for monitoring the run-away electrons indirectly via radiation produce by interaction of the electrons with the plasma facing material. Results obtained using the silicon detectors are compared with already existing diagnostic methods consisting of scintillation devices detecting X-rays and photo-neutrons, providing the same results in the observable comparisons. Tests with the pixel detector proved that the pinhole camera is able to extract spatial information of interaction point (a place where the runaway electrons hit on the facing material) and the strip detectors indicate presence of additional signal from throughout the discharge. The performed experiments are innovative, illustrating possible development of new and easy to use diagnostic method.

Grover et al.: Remote operation of the Golem tokamak for Fusion Education **Grover-2016-FUSENGDES**

O. Grover et al. "Remote operation of the Golem tokamak for Fusion Education". In: *Fusion Engineering and Design* 112 (2016), pp. 1038–1044. ISSN: 0920-3796. DOI: 10.1016/j.fusengdes.2016.05.009.

Abstract: Abstract Practically oriented education in the field of thermonuclear fusion is highly requested. However, the high complexity of appropriate experiments makes it difficult to develop and maintain laboratories where students can take part in hands-on experiments in this field of study. One possible solution is to establish centres with specific high temperature plasma experiments where students can visit such a laboratory and perform their experiments in-situ. With the advancements of {IT} technologies it naturally follows to make a step forward and connect these with necessary plasma physics technologies and thus allow to access even sophisticated experiments remotely. Tokamak Golem is a small, modest device with its infrastructure linked to web technologies allowing students to set-up necessary discharge parameters, submit them into a queue and within minutes obtain the results in the form of a discharge homepage.

Svoboda et al.: Remote operation of the Golem tokamak with hydrogen and helium plasmas **Svoboda-2016-JPCS**

V. Svoboda et al. "Remote operation of the Golem tokamak with hydrogen and helium plasmas". In: *Journal of Physics: Conference Series* 768.1 (2016). DOI: 10.1088/1742-6596/768/1/012002. URL: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84996848706&doi=10.1088%2f1742-6596%2f768%2f1%2f012002&partnerID=40&md5=e2758016f6bdd51be8c02e6f972a374e.

Abstract: The Golem tokamak was operated remotely via Internet connection during the 6th International Workshop and Summer School on Plasma Physics. Performances of hydrogen and helium discharges are compared in this paper. It is found, at similar vacuum conditions, that helium discharges are shorter but the breakdown of the working gas can be quite easily achieved at almost the same loop voltage. The plasma current in helium discharges is slightly lower than in the case of hydrogen. Turbulent fluctuations of the floating potential measured by means of an array of Langmuir probes reveal a noticeably different character in the two discharges.

Gryaznevich et al.: Contribution to fusion research from IAEA coordinated research projects and joint experiments **Gryaznevich-2015-NuclFus**

M. Gryaznevich et al. "Contribution to fusion research from IAEA coordinated research projects and joint experiments". In: *Nuclear Fusion* 55.10 (2015), p. 104019. DOI: 10.1088/0029-5515/55/10/104019.

Abstract: The paper presents objectives and activities of IAEA Coordinated Research Projects 'Conceptual development of steady-state compact fusion neutron sources' and 'Utilisation of a network of small magnetic confinement fusion devices for mainstream fusion research'. The background and main projects of the CRP on FNS are described in detail, as this is a new activity at IAEA. Recent activities of the second CRP, which continues activities of previous CRPs, are overviewed.

Markovic et al.: Development of 3D ferromagnetic model of tokamak core with strong toroidal asymmetry **Markovic-2015-FUSENGDES**

T. Markovic et al. "Development of 3D ferromagnetic model of tokamak core with strong toroidal asymmetry". In: *Fusion Engineering and Design* 96-97 (2015), pp. 302–305. ISSN: 0920-3796. DOI: 10.1016/j.fusengdes.2015.03.041. URL: http://www.sciencedirect.com/science/article/pii/S0920379615002100.

Abstract: Abstract Fully 3D model of strongly asymmetric tokamak core, based on boundary integral method approach (i.e. characterization of ferromagnet by its surface) is presented. The model is benchmarked on measurements on tokamak Golem, as well as compared to 2D axisymmetric core equivalent for this tokamak, presented in previous work. Linearized model well describes quantitative characteristics of {BR} field, generated by poloidal field coils located close to core central column, and distorted by ferromagnet. A discrepancy is seen between linearized form of model for {BR} field generated by coils under the transformer limbs and the measurements. Future work will thus include implementation of the non-linearity effects in order to further investigate this issue.

Svoboda et al.: Remote operation of the vertical plasma stabilization @ the Golem tokamak for the plasma physics education **Svoboda-2015-FUSENGDES**

V. Svoboda et al. "Remote operation of the vertical plasma stabilization @ the Golem tokamak for the plasma physics education". In: *Fusion Engineering and Design* 96-97 (2015), pp. 974–979. ISSN: 0920-3796. DOI: 10.1016/j.fusengdes.2015.06.044. URL: http://www.sciencedirect.com/science/article/pii/S0920379615300740.

Abstract: Abstract The Golem tokamak at the Czech Technical University has been established as an educational tokamak device for domestic and foreign students. Remote participation in the scope of several laboratory practices, plasma physics schools and workshops has been successfully performed from abroad. A new enhancement allowing understandable remote control of vertical plasma position in two modes (i) predefined and (ii) feedback control is presented. It allows to drive the current in the stabilization coils in any time-dependent scenario, which can include as a parameter the actual plasma position measured by magnetic diagnostics. Arbitrary movement of the plasma column in a vertical direction, stabilization of the plasma column in the center of the tokamak vessel as well as prolongation/shortening of plasma life according to the remotely defined request are demonstrated.

Gryaznevich et al.: Progress in application of high temperature superconductor in tokamak magnets
Gryaznevich-2013-FUSENGDES.pdf

M. Gryaznevich et al. "Progress in application of high temperature superconductor in tokamak magnets". In: *Fusion Engineering and Design* 88.9-10 (2013), pp. 1593 –1596. ISSN: 0920-3796. DOI: 10.1016/j.fusengdes.2013.01.101. URL: http://www.sciencedirect.com/science/article/pii/S0920379613001117.

Abstract: It has long been known that high temperature superconductors (HTS) could have an important role to play in the future of tokamak fusion research. Here we report on first results of the use of HTS in a tokamak magnet and on the progress in design and construction of the first fully-HTS tokamak.

Markovic et al.: Evaluation of applicability of 2D iron core model for two-limb configuration of Golem tokamak
Markovic-2013-FUSENGDES

T. Markovic et al. "Evaluation of applicability of 2D iron core model for two-limb configuration of Golem tokamak". In: *Fusion Engineering and Design* 88.6-8 (2013), pp. 835 –838. ISSN: 0920-3796. DOI: 10.1016/j.fusengdes.2013.02.142. URL: http://www.sciencedirect.com/science/article/pii/S0920379613002573.

Abstract: This paper presents evaluation of applicability of 2D iron core model for highly non-axisymmetric two limb configuration of Golem tokamak (former CASTOR). Presented results explain the long-term discrepancy between measured magnitudes of external poloidal field and those calculated by air-core approach on this tokamak. The model has been applied to two poloidal planes at different toroidal angles in the vacuum vessel region and has shown that close to central column of the transformer, it is possible to correct for 3D effects by variation of chosen dimensions of axisymmetric iron core model. Satisfactory agreement of the 2D model results with the measured distribution of {BR} field component was achieved.

Odstrcil et al.: Low cost alternative of high speed visible light camera for tokamak experiments **Odstrcil-2012-RSI**

T. Odstrcil et al. "Low cost alternative of high speed visible light camera for tokamak experiments". In: *Review of Scientific Instruments* 83.10, 10E505 (2012). DOI: 10.1063/1.4731003. URL: http://scitation.aip.org/content/aip/journal/rsi/83/10/10.1063/1.4731003.

Abstract: We present design, analysis, and performance evaluation of a new, low cost and high speed visible-light camera diagnostic system for tokamak experiments. The system is based on the camera Casio EX-F1, with the overall price of approximately a thousand USD. The achieved temporal resolution is up to 40 kHz. This new diagnostic was successfully implemented and tested at the university tokamak GOLEM (R = 0.4 m, a = 0.085 m, BT ¡ 0.5 T, Ip ¡ 4 kA). One possible application of this new diagnostic at GOLEM is discussed in detail. This application is tomographic reconstruction for estimation of plasma position and emissivity.

Svoboda et al.: Multi-mode Remote Participation on the Golem Tokamak **Svoboda-2011-FUSENGDES**

V. Svoboda et al. "Multi-mode Remote Participation on the Golem Tokamak". In: *Fusion Engineering and Design* 86.6-8 (2011), pp. 1310–1314. ISSN: 0920-3796. DOI: {10.1016/j.fusengdes.2011.02.069}.

Abstract: The Golem tokamak (formerly CASTOR) at Czech Technical University is demonstrated as an educational tokamak device for domestic and foreign students. Remote participation of several foreign universities (in Hungary, Belgium, Poland and Costa Rica) has been successfully performed. A unique feature of the Golem device is functionality which enables complete remote participation and control, solely through Internet access. Basic remote control is possible either in online mode via WWW/SSH interface or offline mode using batch processing code. Discharge parameters are set in each case to configure the tokamak for a plasma discharge. Using the X11 protocol it is possible to control in an advanced mode many technological aspects of the tokamak operation, including: i) vacuum pump initialization, ii) chamber baking, iii) charging of power supplies, iv) plasma discharge scenario, v) data acquisition system.

Conference proceedings

Cerovsky et al.: Runaway electron studies via HXR spectroscopy at Golem, COMPASS and TCV
CerovskyECPD23

J. Cerovsky et al. "Runaway electron studies via HXR spectroscopy at Golem, COMPASS and TCV". In: *European Conference on Plasma Diagnostics*. Rethymno, Apr. 2023. URL: http://golem.fjfi.cvut.cz/wiki/Presentations/Conferences/ECPD/5th_Rethymno_2023/poster.pdf.

Abstract: The research on runaway electrons in tokamaks continues to be important for safe and reliable operation of large fusion devices due to the potential risk of impact of so called runaway electron beams on plasma facing components which could cause a serious damage and lead to putting the machine out of operation. In order to investigate the properties of runaway electrons and provide useful information about their behavior under different experimental conditions (e.g. efficiency of various mitigation techniques or exploration of runaway electrons free regimes) many dedicated diagnostics has been utilized. One way of inferring features of runaway electrons is a measurement of their bremsstrahlung radiation which is generated by collisions with plasma ions or by their impact on the first wall when runaway electrons are deconfined and lost. Recently, diagnostic capabilities at GOLEM [1] were upgraded by installation of two scintillation detectors with CeBr3 crystals (1" x 1"), which were also successfully tested during