Akademie věd České republiky
Strategie AV21
Špičkový výzkum ve veřejném zájmu

MODELLING SMART GRIDS 2019

Statistical Modelling and Optimization

Akademie věd České republiky

SMO workshop

Thursday September 19, 2019
TUL, Studentská 2, Liberec, building G, room 305

Energy Day 2019

Friday September 20, 2019
TUL, Studentská 2, Liberec, building G, room 305

System Modelling

Saturday September 21, 2019
Czech Technical University, Karlovo nám. 13, Praha 2
metro B Karlovo náměstí

CAAT

General programme

Thursday, September 19, 2019

9:30	Registration
9:55 – 10:00	Opening
10:00 – 11:50	Statistical modelling and optimization I
11:50 – 13:00	lunch
13:00 – 17:00	Statistical modelling and optimization II

Technical University of Liberec, Studentská 2, Liberec GPS 50.7730561N, 15.0744136E

20:00 Informal discussion meeting *Future of energetics I*, U Uhlířů, Liberec - Kryštofovo údolí 126
GPS 50.7684517N, 14.9347325E

Friday, September 20, 2019

8:00	Registration
8:40 – 8:45	Opening
8:45 – 13:35	Energy day 2019: Keynote and invited lectures
13:35 – 14:00	lunch
14:00 – 16:00	Energy day 2019: Round table discussion
16:00 – 16:30	Conclusions of the Round table discussion

Technical University of Liberec, Studentská 2, Liberec GPS 50.7730561N, 15.0744136E

Saturday, September 21, 2019

8:45	Registration
8:55 – 9:00	Opening
9:00 – 14:30	System modelling

Czech Technical University, Faculty of Mechanical Engineering, Karlovo náměstí 13, Praha 2, building A, room 312
GPS 50.0762364N, 14.4190333E, metro line B station Karlovo náměstí

Book of Abstracts:

Keynote Lectures

Jaap Baarsma
The implementation of Solar Energy in the Netherlands and the implications on the grid

Holland Solar, The Netherlands
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J.P. (Jaap) Baarsma, is a President of Holland Solar, the Dutch association for solar energy. After a career in water management and politics, since 2003 is active in renewable energy. Currently he is senior adviser for a group of 40 mid-sized electrical engineering companies basically in the transition to renewables in their companies.

As President of Holland Solar he is very active in the Dutch policy in respect to renewable energy. There will come a new agreement between all stakeholders in the Netherlands for the energy transition. The aim is to reduce ther CO2 emissions in 2030 with 49%. The pitch of Holland Solar in this agreement is to have in 2030 of all necessary energy 15 % out of solar energy, mainly solar-PV. It is inevitable that this transition needs also storage of electricity. The fast development of electrical cars in the Netherlands can be of great help in this storage challenge.

Daneš Burket
Výzvy pro energetiku 21. Století

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Během přednášky se soustředím na následující otevřené problémy spojené s energetikou nejenom u nás.

- Jak bude energetika reagovat na výzvy, které před ní stojí v 21. století?

- Jak naplníme klimatické cíle, které si stanovila Evropská unie? Jsou tyto cíle splnitelné a za jakých podmínek?
- Jak se bude měnit energetický mix?
- Je v tomto mixu místo pro velké energetické zdroje a jaká bude role decentralizované energetiky?
- Jak bude vypadat energetika v budoucnu a jaké nové technologie můžeme očekávat?

Daneš Burket has been working for a long time in NPP Dukovany on different levels. Since 2006 he is a head of the research and development in CVŘ ŘEŽ, a research organization concentrated on research, development and innovation in the energy sector, primarily nuclear. Since 2010 he is President of the Czech nuclear society, a voluntary nonprofit society aimed at effective exchange of experience in peaceful usage of nuclear energy.

Z. Hlávka (jointly with M. Hušková and S.G. Meintanis)
One- and two-sample monitoring of complex stochastic systems

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We review classical one-sample approach to on-line monitoring within the framework of multidimensional time series and then propose its two-sample modification. The new method is based on empirical characteristic function and the proposed test statistic is easy to compute even in high dimension. We obtain asymptotic results covering wide range of dependencies both within and between the two multivariate time series. In the simulation study, covering also autoregressive and GARCH processes, critical values are calculated by bootstrap. We describe an application to a real data-set from the financial sector and some possible extensions to on-line monitoring of offshore wind turbines.

Z. Hlávka is associated professor of statistics at the Charles University of Prague. He is author of many papers and books published by prominent publishing houses. He is specialized especially in multivariate statistics, computation, change point detection and applied statistics.

Ivan Mizera
Resistance and robustness: the case for the conservation of outliers in time series

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Various examples, among others from deregulated electricity markets, prompt for methods that are not derailed by outlying observations - so-called resistant, or more technically, robust methods. At the same time, however, such methods are not to merely dismiss outliers as gross errors, because the latter may be completely valid data. A special topic focused on are autoregressions, in particular, suitable alternatives for estimating not only central, but also quantile predictions. Apart from existing methods, new methods, based on so-called regression depth, are proposed and studied.

Ivan Mizera graduated in Bratislava and continued his studies in Praha. Since 2000 he is a full professor with tenure at the University of Alberta (Edmonton, Alberta, Canada), where he works until now. Since recently he serves as the Head of the Statistics Division of the Department of Mathematical and Statistical Sciences. During his sabbatical and other leaves he accomplished long-term visits of the University of Illinois at Urbana-Champaign, University of California Davis, University of Chicago, University of Melbourne, Rutgers University, Columbia University at New York, Charles University, and others. His past and recent research involves statistical and data science methodology, in particular in nonparametric function and density estimation, shape-constrained methods, empirical Bayes prediction, regularization of inverse problems, quantile regression, data depth, and robust statistics.

Michal Postránecký
Twin city – virtual twin

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Prezentace představuje Centrum Města Budoucnosti (Center of City of the Future), které je součástí Českého institutu informatiky, robotiky a kybernetiky, ČVUT Praha. Je to sdružení partnerů tvořících platformu propojující akademickou, komerční a municipální sféru. “Virtuální dvojče”, nebo-li “Virtual Twin” je pojem, který se velmi často užívá v konceptu nazvaném Průmysl 4.0. Užívá se pro simulaci procesů v rámci celého životního cyklu nového produktu, pro zobrazení a ovládání všech vazeb, monitorování funkčnosti všech jeho částí, zobrazování dat, a řízení jednotlivých operací. Stejným způsobem jej lze aplikovat při systémovém pohledu na urbanistické struktury, jako jsou města, celé regiony a v nich umístěné systémy technické infrastruktury.

Jedním z hlavních projektů v rámci Centra Města Budoucnosti je vytvoření teoretických modelových případů “virtuálního dvojčete” na úrovni ulice a náměstí, konkrétně Jugoslávských partyzánu a Vítězného náměstí, s napojením na takzvanou inteligentní budovu CIIRC. Dále vytvoření podobného modelu na úrovni menšího města, nebo jiné infrastructure, jako je významný průmyslový závod či logistické centrum. Dalším z připravovaných projektů je předpokládané zobrazení základních vazeb a procesů na úrovni celého regionu ve spolupráci se

Středočeským krajem. Největším z těchto modelů by mělo být zobrazení takzvané Open urban lab v Muskatu a funkčnost procesu takzvané “Smart biotic pump” na konkrétním území v Ománu..

Pro zobrazení těchto struktur, dějů a procesů je možné použít různé druhy zobrazovacích metod. V CCF se zaměřujeme v na augentovanou realitu zobrazovanou pomocí brýlí hololense, která umožňuje trojrozměrný zobrazení nad fyzický modelem a v lepším případě nad digitální dotykovou obrazovkou metofdou, kterou vyvinul jeden z partner CCF Pocket Virtuality. Tyto zobrazovací metody jsou napojitelné na rozličné simulační modely i na vstupy s takzvanými živými daty.

Michal Postránecký je vedoucím Centra města budoucnosti CIIRC. Hlavním cílem je vytvořit širokou odbornou platformu na neutrální akademické půdě, která sdruží subjekty s inovativními produkty, službami a jinou činností, za účelem podpory pozitivního rozvoje existující urbanistické infrastruktury s důrazem na města, jako přirozená gravitační střediska regionů, ve kterých se nachází i ostatní urbanistické struktury, které tato města spojují (dopravní stavby, energetická liniová infrastruktura, plynovod...) nebo vytvářejí samostatné urbanistické celky ve "volné" krajině (zemědělský závod, výrobní podnik, logistická centra, elektrárny, přehrady, doly, ...). Ve středu zájmu je rovněž stav celé společnosti směřující díky novým technologiím k významným změnám ve svém chování i způsobům řízení společnosti a participace na tomto řízení.

Ján Štuller

Myths about the nuclear power program which are not true

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Ján Štuller graduated from the Czech Technical University in Prague. His work has been for 35 years related to the nuclear technology, primarily focused on development of nuclear power program and safety of NPPs. He contributed to creating nuclear regulatory infrastructure in the Czech Republic and promoted international cooperation in nuclear safety and nuclear applications worldwide - specifically in Central and East Europe and Central Asia.

Among others, he was Chairman of the Czech nuclear regulatory authority; Chief Nuclear Safety Inspector with the task to build up and consolidate nuclear regulatory framework in the Czech Republic; a special Assistant to the Director General of IAEA, senior nuclear energy expert supporting the Czech Permanent Mission in Vienna during the Czech presidency of the EU; director of the Department for nuclear safety assessment; Special Envoy for Nuclear Energy coordinating activities related to preparing the

construction of new nuclear power plants in CZ, etc. Currently, he serves the Ministry of Industry and Trade of the Czech Republic as the Advisor for nuclear energy.

Invited and contributed presentations

Jaromír Antoch

Charles University, Faculty of Mathematics and Physics, Prague
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Modelling “standard” profiles of atmospheric radiation

After each radiation problem, nothing to say “disaster", no matter whether real or not, all mass media are full of papers entitled:
XXX nuclear power plant possibly caused a radioactive problem;
XXX says that radiation levels spiked after mysterious rocket test accident, etc.
A natural question arises how it is with the radioactivity around us.

In the Czech Hydrometeorological Institute there exists a unique set of meteorological measurements consisting of the values of vertical atmospheric levels of beta and gamma radiation. An important task required by the meteorologists is assessment of a upper confidence bound for the beta and gamma counts that might be used for warning purposes.

The primary goal of our talk is to improve understanding of the distribution of environmental radiation based on the measurements of the vertical radioactivity profiles by a sonde system. To that purpose we use a nonlinear quantile regression, which is gradually evolving into a comprehensive approach to the statistical analysis of linear and nonlinear response models for conditional quantile functions.

It is well known that the calculation of the nonlinear regression quantiles is from the computational point of view a very complicated problem. Therefore, we will show under which assumptions the quantiles can be calculated in much simpler way directly from the estimated intensity of observed radioactivity process without the need of numerical iterations. The last part of our talk will concentrate on a combined approach to the quantiles when we have available a parametric model, and when the quantiles are estimated from the corresponding residuals either nonparametrically or parametrically.

Modelling and detection of instabilities in panel type data

The detection of (structural) breaks or the so called change point problem has drawn increasing attention from both the theoretical and applied fields. Much of the existing research concentrates on the detection of change points and asymptotic properties of their estimators in panels the number of panels, as well as the number of observations in each panel are large. In the lecture we pursue a different, and more practically usable approach, namely, number of panels grows while time horizon is fixed. We will illustrate the obtained results on real examples.

Jaromír Antoch is professor of statistics at the Charles University of Prague. He is author of many papers and books published by prominent publishing houses. He is specialized especially in simulations, robust statistics, change point detection and applied statistics. He served, among others, as President of the International Association for Statistical Computing, member of the Council of the International Statistical Institute, President of the Czech Statistical Society, etc.

Hynek Beran
Optimization of energetic systems

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Current energetic situation is a great challenge to develop new strategy of energy system control and optimization based on Energy 3.0 (i.e. automatization and optimization in the infrastructure) and Energy 4.0 principles. The main features are:

a) Significant part of the system control must be in the embedded structure cooperating with the central system.
b) In the time of deficit, the system must not provide “rolling blackout”. It should be designed to distribute the energy to intelligent infrastructures, which can regulate themselves, and it has to communicate with their requests, not only to switch them off.
c) The origin of the above mentioned tasks is primarily technological. They are sophisticated control tasks. New methods are to be used for such system (predictive control, multi agent, etc.).
d) On the other hand, both the legislative rules (unbundling) and the possibility of both market and distribution tariff motivation must be taken into account.

Marek Brabec
Power plant turbine rotor health monitoring via BTT and statistical modeling

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We present a statistical modeling framework for detailed analysis of blade-tip-timing (BTT) data from vibro-diagnostic measurements. The data consist of times when individual blades of a large turbine pass sensors mounted on the turbine circumference. Our model is a time-varying extension of the traditional spectral-based approach. It builds on a generalized additive model (GAM) with splines. Penalized time-varying components are used to test whether the coefficients of important trigonometric terms are constant. If they are not, their trajectory is extracted and time-varying amplitudes and phases are derived. We demonstrate how this is useful for practical turbine rotor health monitoring. This work is supported from the Strategy AV21 of the Czech Academy of Sciences (program "Účinná přeměna a skladování energie").

Marek Brabec is leading scientific worker at the Institute of Computer Science of the Czech Republic. He is author of many papers published by prominent publishing houses. He is specialized in statistical modelling.

Ivo Bukovský

Czech Technical University, Prague, Czech Republic
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Some less conventional methods of non-stationarity evaluation and monitoring with prospects for machine learning

The goal of the talk is to present and to rise discussion on some less common methods and ideas for non-stationarity evaluation and monitoring of dynamical systems (here with focus on time series), and possible connotations of these methods to machine learning will be discussed. The talk will introduce the problem of multiscale analysis of non-stationarity of dynamical behavior (e.g. variance fractal dimension trajectory). Then the attention will be drawn toward the recurrence plot and its multi-scalability
and toward its potentials for neural networks. In the end, the concept of Learning Entropy for learning systems will be recalled and its potential for non-stationarity monitoring will be discussed.

Usage of learning entropy in novelty detection

Novelty detection means identification of unusual behavior of processes we are monitoring. The term “novelty” in this case means something new in the process behavior different from an existing progress, ie, data that is new and does not occur regularly or data that is simply different from the rest. During the lecture will be introduced a bridge between Learning Entropy, recently introduced as a novel concept of a no probabilistic information measure for the learning process of incremental learning systems and a classical multivariate SPC framework for sequential online change point detection. Using multivariate SPC methods, we are able to quantify and detect unusual learning effort—hence the change of underlying proces behavior—during the process monitoring without any consideration for the underlying process.

Ivo Bukovský is associate professor at the Czech Technical University in Prague. Currently he serves as the head of Department of Instrumentation and Control Engineering. Artificial intelligence, higher order neural networks, time series analysis and prediction, and nonlinear adaptive control multi-scale analysis belong to his main areas of interest.

Eliška Cézová

Economic design of zone diagrams

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The economic design of the control chart in an integrated model will be treated. During the regulation it is assumed that the production process is regularly maintained within the planned preventive maintenance schedule. Four different scenarios may arise in regulation we describe here how these scenarios translate into the economic design of the control chart. The lecture focuses mainly on the zone-type control diagram.

Eliška Cézová is assistant professor at the Czech Technical University in Prague. She is specialized in statistical process control and metrology.

Michal Černý

Optimization problems when encountering big data

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We will discuss the problem of the analysis of big data which often need representation in streams. Here it is necessary to design of procedures taking into account the computational restrictions of the data model – the inability to store the whole dataset and the inability to access data point(s) repeatedly. Therefore, we will concentrate on the partial identification of models when data from, e.g., energetic markets, such as price generating processes which are not directly observable, but only intervals enclosing the variables of interest are available, and we only have partial information about the conditional distribution on the intervals. We will show that if the data are specific either due to streaming or due to the fact that parameters of distributions are partially identified, then it is necessary to take these phenomena into account within the optimization methodology.

Michal Černý is professor at the Czech University of Economics in Prague. He is specialized in optimization and computational complexity. He is an author of many books about identification, optimization and computational complexity. He successfully leads many large projects.

Gejza Dohnal

Czech Technical University, Prague, Czech Republic
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Optimal inspection time

We consider sequential detection scheme represented by a control chart of Shewhart type. In the classical approach, times between inspections (TBI) are of the same length. In some situations, especially when each inspection is relatively expensive, and the loss when a failure occurs is very high, we would like to optimize a number of inspections with respect to failure time distribution. It means to increase TBI when the failure is unlikely and to decrease TBI if the probability of failure increases. In
this contribution, we use a Bayes approach to optimize TBI given knowledge of the failure distribution.

Bayesian detection schemes

The knowledge of probabilistic behavior of the time to failure in monitored process allows us to use adaptive control charts of Shewhart's type for efficient statistical process control. In the contribution, a new algorithm for enumeration of optimal interval length between successive inspections is developed. This optimal policy leads to minimal control costs.

Gejza Dohnal is professor at the Czech Technical University in Prague. He is specialized in statistical process control, reliability, quality control, and statistical applications. He successfully leads many large projects, let us mention REQUEST among others.

Zdeněk Fabián
Information under the uncertainty

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Among the key statistical problems since the beginning of statistics belong:

- What amount of information carries one item taken from a continuous distribution (relative to other possible values)?
- What is the mean information of a continuous distribution?

It is well known that Fisher information carries information only about a parameter involved and as mean uncertainty is usually considered the continuous equivalent of Shannon's entropy, i.e. the differential entropy. However, its value can be negative! A natural question arises, namely: *Does it have any sense and is it eligible to extrapolate theory developed for discrete models to continuous models with infinite support?* In our contribution we provide unexpected solution, namely, mean information of continuous models is extended Fisher information, and the mean uncertainty is its reciprocal value.

Zdeněk Fabián is scientific worker at the Institute of Computer Science of the Czech Republic. He is specialized in information theory, modelling uncertainty and the use of artificial intelligence in data analysis and modelling.

Lenka Kosková-Třísková
Building as a source of an information - sensors in smart buildings

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Based on the sensed information the smart house should be energy efficient with heating, lightning, air conditioning and other systems automated as much as possible. The question is what is to be sensed and how do it to keep the smart house also cost efficient, comfortable to use with acceptable privacy level for the house inhabitants. The presentation gives an actual overview of the current sensors systems in the smart houses and possible application regarding the target house systems.

Lenka Kosková-Třísková is Assistant professor at Institute of New Technologies and Applied Informatics of Technical University in Liberec, responsible for lectures in Automata and language theory, Operational systems classes, Complexity and computability, Single board computers, Compilers. Among her research topics belong embedded operating systems and its applications, IoT systems; applied machine learning and AI (geophysics), among others.

Čeněk Jirsák

Parallel redundancy with continuously deteriorating components

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The main topic of the presentation is a generalization of a well-known *k* out *n* model and finding an optimal control for such a system. The problem is industrially motivated. Recall that the *k* out *n* model is a reliability model with parallel redundancy where the system of *n* identical components is functional when at least *k* out of them are functional. These components are either working (functional) or failed. In our model we consider the components to degrade continuously rather than just switching from working to failed at certain point. Then condition for at least *k* functioning components can be fulfilled by a smaller number of lesser deteriorated components or with a larger number of more deteriorated components. The idea is that the *k* does not have to be anymore an integer, so we can have a system 2.5 out of 3, etc. The output of each component can be controlled. A component running on full capacity delivers more output but also deteriorates faster. The condition now means that the system should deliver the combined output of new components running on full capacity. When the components are too worn out to fulfill the condition, (at least) one of them must be replaced with a new one. An optimal control is such a control that minimizes the average number of replacements per time unit on an infinite time horizon. We can now prove optimality for a control in k out of n model with linear dependencies. The general case hopefully works analogously, however, it still lacks a complete proof.

Čeněk Jirsák is a PhD student on TUL under supervisor Professor Miroslav Koucký. He graduated in probability and mathematical statistics and is now focusing on applications in reliability theory.

Václav Pokorný
System management in practice

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System management systems offer typically complex solutions for the energy administration on one hand and securing energetical needs in a long-term horizon. Emphasis is usually on the long term ahead prediction of the energy consumption and prediction of the development of the market. In the lecture we will concentrate on selected economical and technical aspects needed for its successful running and administration and illustrate it on the real example.

Václav Pokorný is a PhD student at the Czech Technical University in Prague.

Vladimír Wágner
South Korean power energetics

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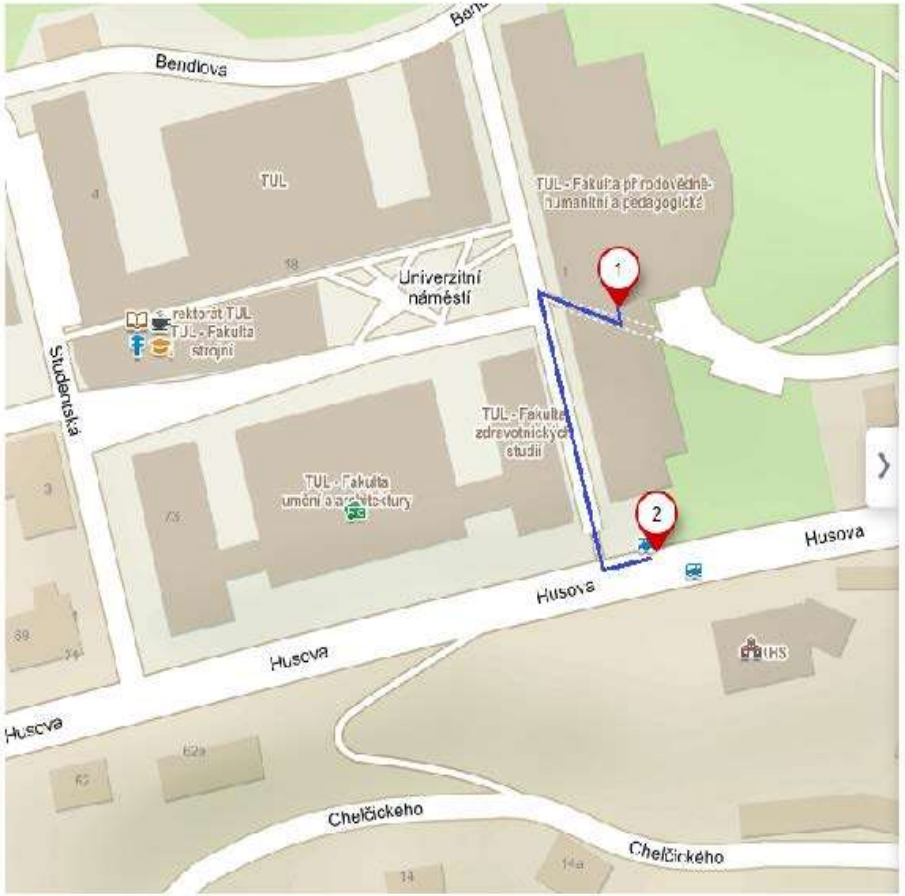
Since recently in the Czech Republic increased, both economically and politically, an interest concerning the construction of new blocks of nuclear power plants. Among the eventual suppliers is South Korea, where the development of the nuclear energetics has an interesting progress and, currently, quite considerable potential. South Korea developed its own reactor of the third generation, and successfully exports them abroad. All this is a reason why it is interesting to take a look on the south Korean nuclear energetics and technologies in more details and, especially, in a context of other offers for Dukovany NPP.

Vladimír Wágner joint Nuclear Physics Institute of ASCR just after ending of his university studies of nuclear physics on Faculty of Mathematics and Physics of Charles University. He was member of group which studied nuclear structure using nuclear spectroscopy methods up to 1990 and now he is member of Relativistic Heavy Ion Group. He made his diploma and Ph.D. thesis dealing with a structure of deformed nuclei at this institute. Presently he is studying mainly hot and dense nuclear matter. Such matter is for example inside neutron

stars or is produced during supernovae explosion. Small volume of such matter is possible produce by collision of heavy nuclei accelerated to the very high energy (nucleus velocity near to the velocity of light). He is involved also to the studies of possible application of relativistic proton reaction with thick target for neutron production and using of obtained neutron field for transmutation of radioactive waste.

Strategy AV21

Top research in the public interest" is the motto of the new strategy of the Czech Academy of Sciences, which presents itself more strongly as an institution whose primary mission is high quality research focused on the problems and challenges faced by contemporary society. Topics such as the **future of energy in the Czech Republic**, public health or the quality of public policies involve complex sets of problems, the solution of which requires broad-based interdisciplinary research. The Czech Academy of Sciences has therefore adopted Strategy AV21 based on a set of coordinated Research Programmes utilizing interdisciplinary and inter-institutional synergies in order to identify the problems and challenges of our time and to harmonize the efforts of research institutes of the Czech Academy of Sciences towards their solutions. Concise information concerning the topics concerning energy will be presented.



1 **G312 - Venue**
50°46'23.206"N, 15°4'34.305"E
50.773136°N, 15.076181°E

2 **"Technicka univerzita" bus stop**
Bus number: 15, 19, 29, 91

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