Control Sheet Cosylab's Newsletter

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Table of Contents

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ICALEPCS Lifetime Achievement Award for Shin-ichi Kurokawa

By : M . PLEŠKO (COSYLAB)

Dr. Shin-ichi Kurokawa receives award from Christopher Marshall, Chair of ICALEPCS2013.

Dr. Shin-ichi Kurokawa, Professor Emeritus of KEK and Vice-President of Cosylab, has been honoured with the ICALEPCS Lifetime Achievement Award for his contributions to "initiation, growth, reinforcement and management of the ICALEPCS series of conferences" at the occasion of the 14th ICALEPCS held in San Francisco on October 6-11, 2013.

At the Award Ceremony, Roland Müller, Chair of the ICALEPCS Executive Committee stated that: "the ICALEPCS Lifetime Achievement Award is meant to honor individuals who throughout their careers have made invaluable and lasting contributions to the field of control systems for large experimental physics facilities. The aim of the ICALEPCS Lifetime Achievement Award is to recognize those who through their vision, leadership, technical excellence, and willingness to think beyond a single laboratory or even a country have influenced the international practice of control system development."

"This year tribute is given to the initiators and shapers of this conference: The biennial "International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS)" itself. The nomination is intended to recognize the people who formed the event we are enjoying right now. It should honor those recognized as main contributors to the initiation, growth, reinforcement and management of the ICALEPCS series of conferences", Müller continued.

The 2013 Awards were specifically for acknowledging the main contributors to the foundation and growth of ICALEPCS allowing it to become as we know it today. The first pre-ICALEPCS workshop in 1985 was initiated by Peter Clout and was held in Los Alamos, U.S.A. Shin-ichi Kurokawa was the first representative from an Asian institute that participated in the pre-ICALEPCS workshop and the first ICALEPCS conference (Villars-sur-Ollon, Switzerland, 1987). With Kurokawa's initiative and with strong support from CERN's Axel Daneels it was decided at this stage to include Asia and Europe with America in all follow-up events. Clout, Kurokawa and Daneels were honoured for their roles in the initiation of ICALEPCS.

Other awardees during the 2013 conference were Dave Gurd, Daniele Bulfone and Ryotaro Tanaka who were honoured for their roles in drawing up the charter that guides organisers of future ICALEPCS events as to the spirit and logistics of each event.

Lifetime Achievement Awardees at the 2013 ICALEPCS Conference (from left): Ryotaro Tanaka, Daniele Bulfone, Dave Gurd, Shin-ichi Kurokawa, Peter Clout. Axel Daneels also received the award, but was not present at the Award Ceremony.

Cosylab Enters the House of Experiments

By : FRANK AMAND (COSYLAB)

> »It is meant for the curious. For the people who can admit that they still don't know everything.«
>
> - **Dr. Miha Kos**, Director, House of Experiments

Cosylab has become one of the sponsors of the Hiša Eksperimentov (House of Experiments) [1], the science center in Ljubljana, Slovenia. Hiša Eksperimentov (pro.: hee-sha experi-ment-owe) (HE) not only focusses on hands-on exhibits from physics, chemistry, engineering, medicine, geography, biology, mathematics and any other subject that has something interesting, but also hosts regular talks for the public, demonstrations, interactive science shows, shows at international science festivals, and an annual out-door science festival in summer. Cosylab will be sponsoring HE for the next two years.
Control Sheet spoke to physicist, Dr. Miha Kos, Director of HE, to get a behind-the-scenes feel for what goes into setting up and maintaining a science center.

Control Sheet: Miha, can you tell us how Hiša Eksperimentov came about?
MK: My father studied 2 years of physics, and later became an artist, but he encouraged experimenting. I did my Ph.D. in physics and while I was doing a post-doc in the U.S., I was sharing some of these experiments with my colleagues and they recommended that I visit the Exploratorium in San Francisco. I visited with my kids in 1995 and realized that this was what I had always wanted. When I got back to Slovenia, I started to collect the critical mass of people necessary to get a science center off the ground. In 1996 we established a Foundation, the legal entity behind HE and we started building exhibits and did shows around Slovenia. We have been in the current location from 2000, with 500 m2 for exhibition space, offices, workshop -- we even use the ceiling!

Control Sheet: Whenever anyone hears "Science Centre" they think "hands-on". Tell us something about the hands-on exhibits.
MK: All hands-on exhibits are built in HE, in our workshop. Most ideas are our own, but others were obtained from other science centers. The understanding amongst science centers is that we can use each other's ideas, but we have to improve upon them. In general, the exhibits are not patented. There is however one exhibit (Sweet-o-bike) that we developed which is being patented.
Sweet-o-Bike interactively explains principles behind diabetes and it was developed collaboratively with a medical doctor. Activities involve Sweet-o-bike to teach children about diabetes as there are already children that visit that have Type 1 diabetes. With this exhibit, schools receive questionnaires 3 months after the visit to check how much of the what was taught is still remembered. Two exhibits were built, one for HE and one for the doctor's practice where it is being used for patient education.
Some of our experiments are online so you can try them out for yourself when HE is closed or you are not in Ljubljana. [4].

Control Sheet: Where did the idea for HE's own science festival come from?
MK: The original science festival in Ljubljana (which is still running) is more of a show case of the work that researchers at the different institutes in Slovenia are doing. There are mostly posters with some exhibits. This didn't fit my view of what a science festival should be and the "Znanstival" (sciencetival) [2] was born. The "Znanstival" is a 4-day open-air science festival that is held on the bridges and squares in the Ljubljana city center. The "Znanstival" brings HE directly to the people, including crossing the Ljubljanica River by bicycle [3] and riding on a wagon with wheels shaped like the HE logo [5]. HE invites the best science show-men from countries like US, UK, Poland, Israel, France, Denmark, Finland, and Italy.

> (HE)...started with the aim of increasing a child's interest in science and this is what we thought was the mission. Through experience, I found that it is something different and something bigger than we are doing. We are promoting learning. It's making people fall in love with learning. Promoting the interest in acquiring knowledge. I'm very much against the sentence that many science centers use: "Science is fun". Science is not fun. It's a lot of work, ... but learning can be fun. Learning can be a hobby. It's the best hobby that you can say everyday: "Today I learnt this."
>
> -Dr. Miha Kos, Director, House of Experiments

Control Sheet: You also host competitions for high school pupils.
MK: One of the popular competitions that HE hosts is called Elastomobiles. Participants are given two rubber bands and they are required to build a vehicle of their design that is powered with only the two rubber bands. The 40 or so participants get to test their design at the Ljubljana

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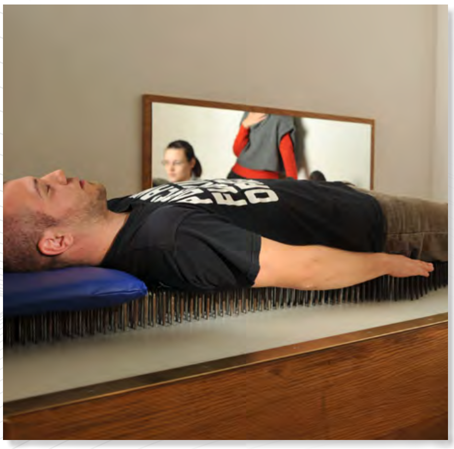
athletic track where the winner is the vehicle that travels the furthest while carrying a weight.
Another competition which we are planning is for participants to build a build a box that is locked with a combination lock. The box must contain some physics that helps to find the numbers to unlock the safe.

Control Sheet: What other activities to you have?
MK: Science Adventures are interactive lectures on specific topics with experiments. The Adventures last between 30 to 45 minutes and audience participation is encouraged. Science Adventures are generally held on the weekends, when HE is open to the public. We also take our Science Adventures on tour as part of the activities known as "Reach Outreach" when we visit villages in Slovenia where there is only one or two primary schools. We have three Science Adventures, one for primary school children, one for teachers and one for the general public.
We visit kindergartens and we often get feedback that the children start experimenting for themselves. We host Science Fairy Tales which combines fairy tales with science. For example, Cinderella is not just a girl who is waiting to be rescued by the Prince, but uses science to complete the tasks that her step-mother gives her so she can go to the ball.
We host talks for the public to describe the science behind current events, e.g. Fukushima Daiichi nuclear disaster. We are also invited to perform at science festivals in other countries (e.g. Israel, Finland).

Control Sheet: Ljubljana has a multi-cultural population. How do you handle visitors that don't speak Slovene?
MK: We support Slovene, English, Italian, Croatian, German and French. The first 4 languages are supported on an audio-guide accessible on your mobile phone. Dial a number to connect to the system, then when you are at an experiment, type in the number of the experiment to hear a description of the experiment. This service is free to customers of the mobile company that has sponsored it. If you are not a customer of that particular mobile company, then there are printed manuals in the language of your choice.



Control Sheet: We know you charge an entrance fee, but that is only €6. What are HE's other funding sources?
MK: There is no permanent source of funding. Currently our funding comes from one of three sources: projects (EU, State, Municipal), entrance fees and sponsors.

Control Sheet: How many visitors do you have each year?
MK: There are between 25 000 and 30 000 visitors each year, ranging from kindergarteners to associations of the elderly. There is no age limit!

Control Sheet: How many staff do you have?
MK: There are 7 full-time staff members. Everyone pitches in where the help is needed. There are also many demonstrators! Demonstrators come from all faculties at the University at Ljubljana (psychology, medicine, physics). Two most important things that are looked for in a demonstrator are that they must be communicative and they must be able to admit when they don't know something.

Control Sheet: How often to you get new experiments and how often should visitors visit HE?
MK: There are 4 to 5 new experiments per year, so you should definitely visit at least once per year! We have kids (with an annual ticket) that visit every second week, because they always find something new.

REFERENCES

[1] http://www.he.si/
[2] http://www.znanstival.si/ (in Slovene)
[3] http://www.youtube.com/watch?v=aF-HPoW9hsM
[4] http://www.he.si/index.php?option=com_content&task=view&id=121&Itemid=166
[5] http://www.youtube.com/watch?v=MztEKh-LJO4

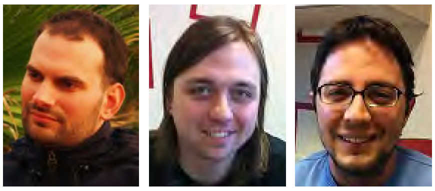
ABOUT THE AUTHOR

***Frank Amand**, Belgian, joined Cosylab in 2011. Previous work experience includes 12 years with Royal Philips in Belgium and the Netherlands in a variety of software engineering related roles. His technical expertise lays in the domain of human-computer interaction, GUI design and usability. He is currently Cosylab's Head of Marketing.*

Photos: courtesy of House of Experiments

ISSN: 1855-9255

Application of ITER CODAC for Plasma Control



By : Klemen Žagar (Cosylab), Bor Marolt (Cosylab), Aldo Rovandi (CREATE), Frank Amand (Cosylab)

CODAC [1] (Control, Data Access and Communication) is ITER's main control system for operating the tokamak and is based on the EPICS (Experimental Physics and Industrial Control System) infrastructure. CODAC will be used for the integration of ITER's plant systems, including diagnostics and actuators, and will need to interact with the Plasma Control System (PCS).

Previously, we described the development of a tokamak simulator plug-in for the CODAC core system [2] that simplified the process of changing tokamak models or simulation environments. This article describes extensions to that work where we have transferred the control laws from the Simulink environment to CODAC (C code running within EPICS IOCs) which allows real-time validation of actual implementations of control law algorithms.

In order to demonstrate that CODAC can be used for real-time plasma control, we developed an EPICS device support that provides a runtime environment for executing control law algorithms in a simulated plant and plasma control environment. EPICS then supervises and configures the control law, but the control law itself runs in real-time.

The Simulink Model

A linearized model of a plasma shape controller with vertical stabilization around a chosen equilibrium, together with corresponding control laws were used as the basis for the work. The original Simulink model was manually converted to C to improve processing times, but this conversion process proved to be time consuming and error prone. However, the comparison between signals from the EPICS and Simulink models show a good correlation between the models (Figure 1).

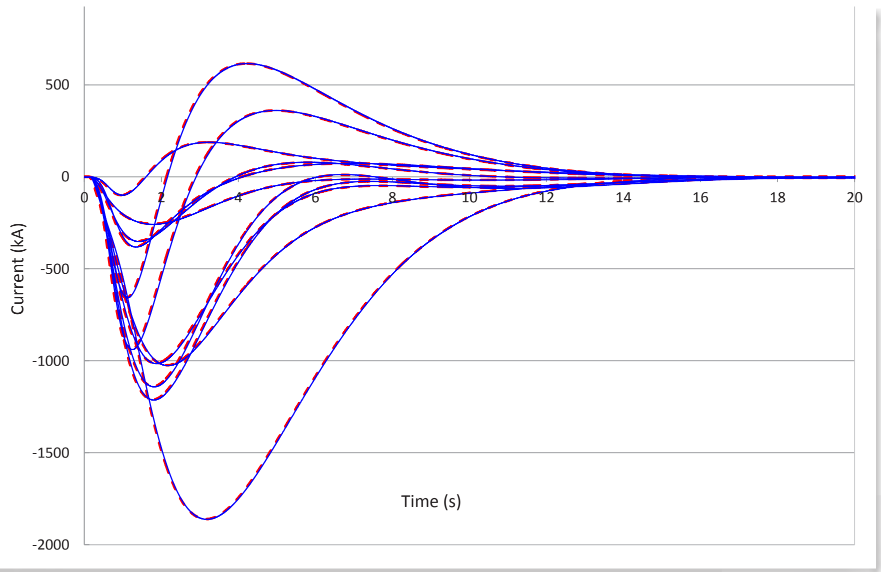


Figure 1: Results of the validation of the Simulink and C/EPICS models for plasma behaviour and control laws for in-vessel coil control signals.

Results

ITER plasma control system loop is likely to run at 2 kHz (500 µs). The latency budget for a two-hop communication is capped at 100 µs. In order to minimize communication latency, the effects of priority and affinity of the plasma control thread, the plant system thread and network interrupts were investigated. Latencies were measured between just before the plant system started the simulation and ended when the plant system received notification that the simulation was complete. Two Linux Kernel versions were used: a regular kernel (version: 2.6.32-279) and a real-time kernel (MRG-R version: 3.0.9). All tests were run on an unloaded system. [4]

Figure 2 shows the distribution of latency depending on optimization method that was applied. In plot 2, the CPU isolation was used to isolate the real-time load on a particular core, and move all the other load on the other cores. Compart to the non-optimized case of Plot 1, with this approach the average latency decreases, as does the spread (standard deviation), even though a non-real-time kernel was still used. Using the real-time kernel in addition to isolation further improves the average case (Plot 3). If, furthermore, the network card's interrupt handlers are configured to run on the same core as the real-time load, the latency drops further (Plot 4). The total reduction of average latency was from 140 µs down to 90 µs.

Conclusions

With this work, we have proven two things: 1) the ITER CODAC infrastructure is suitable for implementing real-time distributed control loops meeting ITER's foreseen latency requirements and 2)

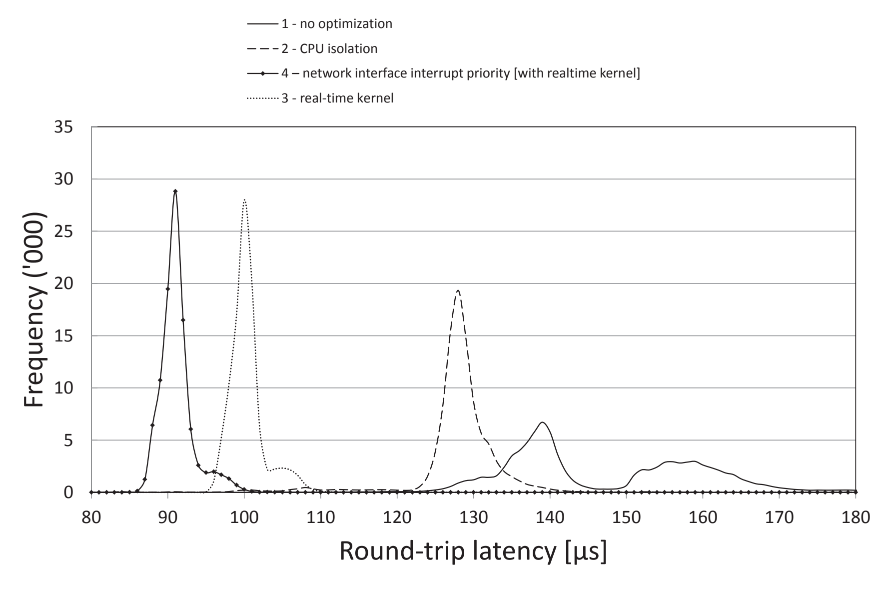


Figure 2: Effects of optimization on communication latency.

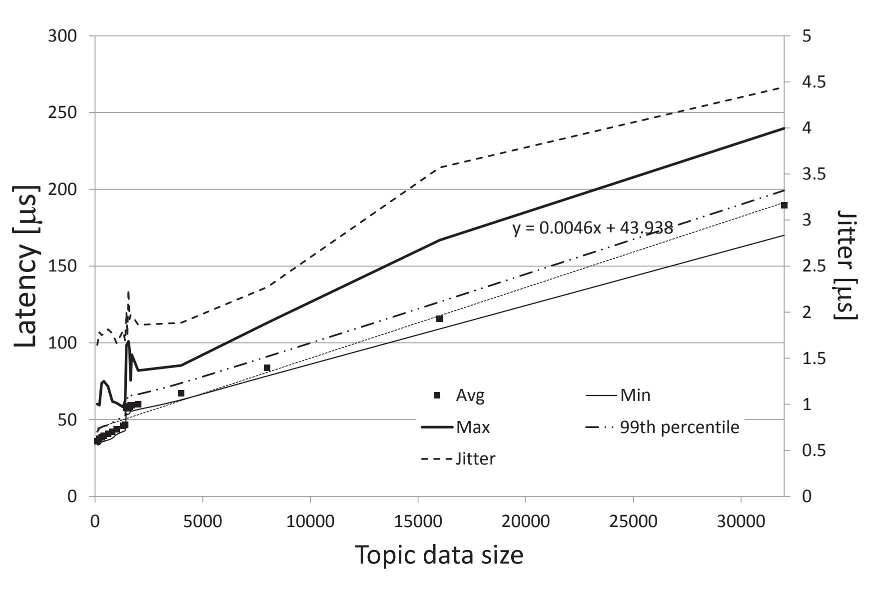


Figure 3: Latency as a function of data size shows that the slope of the curve that is fit to the average latency data is approximately 1.7Gps, which leaves significant room for improvement to achieve the 5 Gbps limit of the two-hop system.

EPICS can also be used to implement plasma control algorithms.
We have also identified potential for improvements: 1) the manual translation of Simulink models to C was proven to be time consuming, therefore we propose that this process is automated and 2) a lightweight C framework bridging the gap between control law programming and EPICS should be designed to facilitate development of the many control law building blocks that will constitute the ITER plasma control system.

Acknowledgements

This project was funded by the Competence Center for Advanced Control Technologies (CCACT). Cosylab is a CCACT [3] participating company, together with many Slovenian research institutions and engineering firms. The Competence Centre for Advanced Control Technologies is partly financed by the Republic of Slovenia, Ministry of Education, Science and Sport and European Union, European Regional Development Fund.

REFERENCES

[1] ITER CODAC (https://www.iter.org/org/team/chd/cid/codac)

[2] D. Groselj and K. Žagar, Development of a Tokamak Simulator plug-in for the CODAC Core System, Control Sheet No. 13, December 2012 (http://www.cosylab.com/our_newsletter_control_sheet/)

[3] Competence Center for Advanced Control Technologies (http://www.kcstv.si/en/)

[4] Klemen Zagar, Mark Pleško, Daniel Grošelj, Gianmaria De Tommasi, Giuseppe Ambrosino, Aldo Rovandi, Samo Gerkšič, Application of ITER CODAC for Plasma Control, Presented at the 9th IAEA Technical Meeting on Control, Data Acqusition, and Remote Participation for Fusion Research, 6-10 May 2013, Hefei, China (http://tm2013.ipp.ac.cn/)

ABOUT THE AUTHORS

***Klemen Žagar**, Slovenian, joined Cosylab in 1999 and started as a software developer. From there he continued as a software and systems architect and is now Chief Technology Officer. His professional interests are distributed control systems, real-time and networking. In his spare time, he enjoys hiking, cycling and running.*

***Aldo Rovando,** Italian, worked at Cosylab for 6 months as an Erasmus student. In May 2013, he received a diploma in automation and robotics engineering in Naples. Since September 2013, he has been working as a consultant engineer for Altran spa. His professional skills are focused on control systems and software. During leisure time he likes playing waterpolo and traveling.*

***Bor Marolt**, Slovenian, received his degree in Physics from University in Ljubljana, Faculty of Mathematics and Physics in September 2012. Later that year he joined Cosylab and has, since then, been working as a developer on different projects for ITER, PSI, KIT.*
His hobbies include playing guitar and tennis.

On-Site Beam Diagnostics Support @ MedAustron



By : SAMO TUMA (COSYLAB), MATEJ KLUN (COSYLAB), MATJAŽ REPOVŽ (MEDAUSTRON)

MedAustron is one of the most advanced facilities for ion beam therapy and research in Europe. It is a synchrotron based accelerator complex that will be used for cancer treatment as well as for medical and non-medical physics research, and is situated in Wiener Neustadt, Austria. The first patient treatment is foreseen by the end of 2015, and installation and commissioning of the particle accelerator is already well under way.
Cosylab has been working with MedAustron since 2010 and has contributed a significant amount of development on the MedAustron accelerator core control system, MACS [1]. Currently, Cosylab is also actively involved with development of equipment related to beam delivery. Due to this successful collaboration between EBG MedAustron and Cosylab, EBG MedAustron requested expert on-site support to help with the ongoing development and integration of Beam Diagnostics (BD) equipment.

Beam Diagnostics at MedAustron

In ion beam cancer therapy, the characteristics of the beam are critical to successful treatment. To make sure that the particle beam delivered to the patient meets the specified requirements, the beam needs to be diagnosed first. For that purpose there are around 150 Beam Diagnostics (BD) devices installed along the length of the accelerator that measure various beam properties like:

- beam current intensity
- beam position
- beam profile
- beam emittance

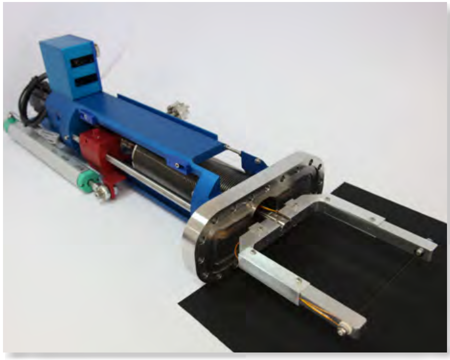
These monitors together are the operators "senses" on the particle beam along the accelerator. The BD devices in the accelerator are arranged into Low Energy Beam Transfer (LEBT), Medium Energy Beam Transfer (MEBT), Synchrotron ring (SYNC) and High Energy Beam Transfer (HEBT) monitors. Currently only the LEBT and MEBT monitors are operational and are being commissioned.

Low Energy Beam Transfer Monitors

The LEBT transports a continuous beam, currently from one of the three Ion Sources, to the entrance of the LINAC section, where the beam is focused and accelerated further, to ~7MeV/u.
In the LEBT beam current intensity is (destructively) measured with Faraday Cups (FC). FCs can be moved in and out of the beam using a pneumatic motion system. Faraday Cups have a so called repeller ring that can be biased to negative potential up to -1kV in order prevent the secondary electron emissions, caused by particles hitting the cup. Without high voltage, these secondary electrons would escape and the intensity measurement would not be precise.

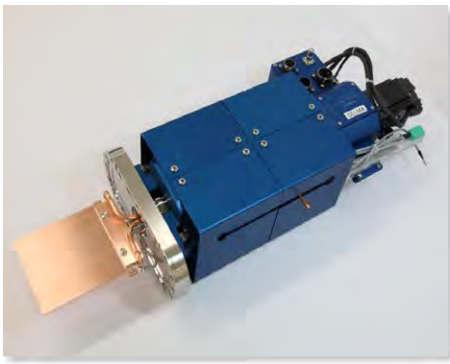
Faraday CUP

For beam position and profile measurements in the LEBT, a Wire Scanner monitor is used. A Wire Scanner is a device comprised of a 0.1 mm tungsten wire that moves through the continuous (non-pulsed) beam at a speed up to 300 mm/s thus measuring the beam's position and profile along its path.



Wire Scanner

Another important property of a charged particle beam is its emittance. At MedAustron, this is effectively measured using a synchronous measurement of the beam profile (using Wire Scanners) and moving Slit Plates around the beam coordinate system.
Slit Plates are 2 mm thick chamfered copper plates, which are accurately moved in steps (to a maximum deviation of 100 μm) and just like the Faraday Cup's repeller rings, they may also be biased to a high potential using the high voltage system.

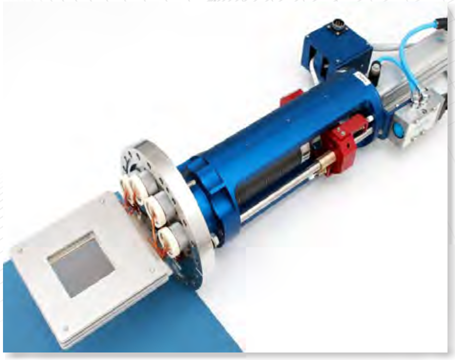


Slit

ISSN: 1855-9255

Medium Energy Beam Transfer Monitors

The MEBT line starts after the Linac, where the beam is pulsed (30 µs pulses nominally) with the beam energy reaching 7 MeV/nucleon. Besides acceleration, the purpose of the MEBT is to shape and prepare the beam for injection into the Synchrotron (current task of the commissioning team). In the MEBT the same beam properties as in the LEBT are measured using similar methods. However, since the beam is pulsed, all measurements have to be synchronized to the passing of a beam pulse.



PGX

Faraday Cups are used once more to monitor the beam's intensity. Additionally they may be used to calibrate the AC transformers. Slit Plates are used to shape the beam and for the measurement of the beam emittance together with the profile monitors. Beam profile measurements will be done using Profile Grid monitors, made of 64 x 64 tungsten wires and covering ~64x64 mm^2 of area in the beam coordinate system.

Since the accelerator may produce higher intensities than those required for cancer treatment, an energy degrader will be used that will attenuate the beam's intensity according to the treatment plan.

On-Site Support

Cosylab's on-site support to the Beam Diagnostics Group included maintenance, upgrades, development and integration of the beam measurement devices, as well as writing up the necessary documentation for those devices.

As with previous work for MedAustron, Cosylab worked closely with the control system and commissioning teams, to provide the necessary support for operators using the machine. This included design and development of a graphical user interface (GUI) framework, which not only allows the user to interact with the Front End Controllers, but also provides functionalities like data analysis, logging, window manager and data visualization. This framework allows development of future GUIs to be speeded up significantly.

REFERENCES

[1] J. Gutleber, A. Brett, R. Moser, M. Marchhart, C. Torcato de Matos, J. Dedic The MedAustron Accelerator Control System, In Proceedings of ICALEPCS2011, held 10-14th October 2011, Grenoble, France. (http://accelconf.web.cern.ch/AccelConf/icalepcs2011/papers/mobaust03.pdf)

ABOUT THE AUTHORS

Samo Tuma, *Slovenian, joined Cosylab in October 2012 as a software engineer, then spent most of his time working on the MedAustron project. His current role is that of a senior software/hardware engineer, interested in a good game of basketball or a bite into a chilly pepper!*

Matej Klun, *Slovenian, joined Cosylab in February 2011 as a software/hardware engineer. Currently he is in the role of a senior systems architect, but when there is time left he enjoys a pint of his own home-made beer.*

Matjaž Repovž, *Slovenian, joined MedAustron in September 2010 as a senior engineer developing electronics for the Beam Diagnostics Team. Currently he is the Head of Beam Diagnostics. He likes to spends his free-time socializing with a glass of wine or a pint of beer.*

Photos by: Adam György

Accelerator and Treatment Rooms

Beam Diagnostics Team (from left): Fadmar Osmić, Matjaž Repovž, Samo Tuma, Adam György, Jacques Bosser, Stefan Schwarz, Anton Kerschbaum, Manuel Fürtinger, Jose Sanchez Arias

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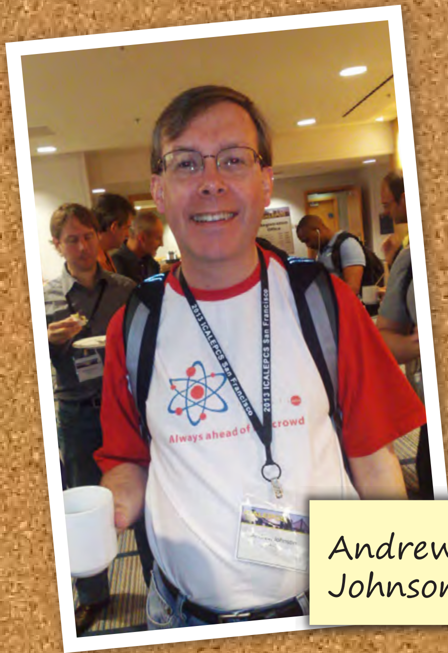
COSY T-Shirts

Spotted at ICALEPCS2013

Michael Davidsaver



Andrew Johnson

Franck DiMaio

Rok Šabjan

Marty Kraimer

COSYLAB
CONTROL SYSTEM LABORATORY

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31.12.2013

As 2013 comes to a close, we say "Thank You!" to all our friends. It has been our pleasure to help you reach your goals during this past year, and we look forward to working with you again in the New Year. To our future customers, may 2014 bring new opportunities for us to work together.

We wish you an ingenious 2014!

The Team at Cosylab

http://www.cosylab.com/ny2014/

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