COMPUTE Travel Grant – Application Form

COMPUTE travel grants are announced biannually for PhD-related travels up to one year *after* the deadline. Only PhD students at the Faculty of Science enrolled in COMPUTE can apply. The maximum amount given to one student over a two-year period is SEK 20 000. Only actual costs will be reimbursed, even if a larger sum has been granted based on the estimate in the application. Successful applicants may be asked to present the conclusions from their travel at a future COMPUTE event.

The application should consist of this form (signed), the actual application document (max 2 pages), an itemised cost estimate (including financial support from other sources, e.g. the department), a CV (max 2 pages), and a list of publications. The document should contain:

- Short description of the PhD project, aimed at a general science audience
- Details of the travel and its relevance to the PhD education
- List of the COMPUTE activities that the PhD student has taken part in

The application should be sent to Magnus Ullner, Theoretical Chemistry, HS 1 by Feb. 21, 2014. Questions should be directed to magnus.ullner@teokem.lu.se and joachim.hein@math.lu.se.

Name: Oleksandr Viazlo

Department: Department of Physics, Particle Physics

E-mail: oleksandr.viazlo@hep.lu.se

Purpose (e.g. name and website of conference/summer school) and destination of the travel:
CSCS-USI Summer School 2014, Tessin, Switzerland
www.cscs.ch/events/

Contribution (e.g. oral, poster, n/a) and tentative/confirmed:
n/a

Travel dates:
30 June 2014 – 10 July 2014

Requested amount (SEK):
16500 SEK

Date, signature: 2014-02-21 (PhD student)

Confirmation by supervisor: I have read the application and approve of the travel. I also confirm that the PhD student belongs to the Faculty of Science.

Supervisor: Oxana Smirnova

Date, signature: 2014-02-21 (supervisor)

Short description of the PhD project, aimed at a general science audience

My PhD project contains three different aspects of my research towards physics in proton-proton collisions in the ATLAS experiment at the LHC. The Large Hadron Collider (LHC) is the particle collider, which collide two opposing particle beams of either protons at up to 7 TeV, or lead nuclei at an energy of 574 TeV per nucleus. ATLAS is a multi-purpose particle detector which is intended to investigate many different types of physics that might become detectable in the energetic collisions of the LHC.

First part of my research is analysis of experimental data of proton-proton collisions and search for an evidence of new physics which is not described with so called Standart Model. Main idea of analysis is to preselect events (collisions) where two or more isolated leptons with the same charge were detected. Standart Model don't predict a lot of processes which will produce such final state, but there are a lot different theoretical models which do. Almost all these theories predict new particles which were not observed yet. That's why investigating of such events will provide clean search for new physics. But cross section of such processes are very small and one need to analyze as much data as possible - millions of events recorded by ATLAS detector, which takes most ot the analysis time. That's why code parallelism, optimization and performance is crucial.

Second part of my thesis is developing of simulation program of ATLAS tracking detector. To simulate respond of the detector we need to simulate all physics processes which occur when particle penetrate sensitive volume of detector, such as ionization of gas, electron drift to anode/cathode, collecting of charge, etc. But due tight CPU and memory restriction one need to make simulation work very fast. With time detector condition changes and it requires improving and tuning current simulation programs. My project is to implement in simulation program possibility to switch between different types of gases, used to detect particle, according to current detector condition. This requires to use C++ together with Python in a large framework, with several interdependencies. Requirements are that new code should be compatible with current interfaces, so all code should be back-compatible.

Third part of my project is not finally decided yet. There are few possibilities and one of them could be related with developing of Fast Tracker. The Fast Tracker is a project which will allow to reconstruct tracks of charged particles in detector very fast, making reconstruction directly on hardware level with help of FPGAs (Field-programmable gate arrays). FPGAs could process a huge amount of information in parallel, but to work with them one need to have a clear picture what hardware parallelism is.

Details of the travel and its relevance to the PhD education

School is organized on basis of Swiss National Supercomputing Centre and is aimed at graduate students who wish to learn the basic skills required to write, develop and maintain parallel applications in scientific computing. The pur-

pose of the summer school is to teach programming skills and therefore a large proportion of the course will be dedicated to practical exercises.

Analysis of experimental data of proton-proton collisions require to run in huge amount of data and several times to calculate systematic errors, that's why it is really important to have well done parallel code which use all available computer resourses in the most efficient way. Also data-analysis is very scalable because experimental data consist from millions of similar events of proton-proton collision which can be analized separately from each other. It applies also for my analysis too. And using parralel scripts will speed up some steps of it up to 16 times, which will save time for actual study of physics.

As my analysis codes are written on C++ one can easily use OpenMP or MPI interfaces to implement possibility to run them using all available cores on machine or a node. First week of the school will be completely dedicated for these two interfaces, including lectures and practise.

Second week of the school will be dedicated for OpenACC and CUDA interfaces which mainly are used in parallel applications using graphics processing units (GPU), such as Nvidia graphical cards. These interfaces are more "hardware"-based and they are of really big interest to me regarding my participation in Fast Tracker (FTK) project. Because FTK will be build on FPGAs (Field-programmable gate arrays) - integrated circuits which allow to implement purely hardware parallel calculations and share similar concepts with OpenACC and CUDA. Also CUDA interface is widely using in particle physics for online track reconstruction in tracking detectors.

In general, concepts of parallel programming are very important for particle physicist because of a huge amounts of data to analyze. CERN are deeply concerned about efficiency of simulation and analysis codes and not long time ago CERN made a decision to rewrite a lot of codes to make more native implementation of parallelism which means that having knowledge about it will help me to make more significant contribution to the ATLAS experiment.

List of COMPUTE activities

- COMPUTE Winter meeting 2013
- COMPUTE Winter meeting 2014 (will attend)
- COMPUTE GEANT4 course (will attend)

Also I was planning to attend course about Grid technologies, but unfortunately due to the planned trip to CERN I didn't manage to do it.

Cost Estimate

- Airplane ticket: 2000 SEK
- Train ticket from/to airport: 500 SEK
- School fee (including hotel): 1000 CHF $\approx$ 7400 SEK
- Daily allowance (including meals): 11x600 = 6600 SEK
- Total: 16500 SEK

Publications

Works in Progress:

- ATLAS Collaboration, "Search for anomalous production of prompt same-sign lepton pairs and constraints on physics beyond the Standard Model with 8 TeV data"
- ZEUS Collaboration, "Measurement of Charm and Beauty Production in Deep Inelastic Scattering at HERA"

OLEKSANDR VIAZLO

Magistrasvagen 47B ⋄ Lund, Sweden 22643
+46762211741 ⋄ oleksandr.viazlo@hep.lu.se

EDUCATION

Lund University *2012-present*
PhD student & High energy physics

National Taras Shevchenko University of Kyiv *2010-2012*
Master of Science in Physics & High energy physics

National Taras Shevchenko University of Kyiv *2006-2010*
Bachelor of Science in Physics & High energy physics

EXPERIENCE

DESY, Hamburg 2008-2012
guest scientist

- short visits, summing up to about 1.5 years
- working on my bachelor and master projects.

PRESENTATIONS AND POSTERS

- "Search for anomalous production of prompt same-sign lepton pairs and constraints on physics beyond the Standard Model with 8 TeV data", poster, ATLAS Overview Week 2013
- "Performance study of the Transition Radiation Tracker with the focus on the influence of the active gas-mixture on the hit and track parameters", poster, Nordic Physics Days 2013
- "Measurement of charm and beauty production in DIS with secondary vertexing in the ZEUS experiment", presentation, TESHEP 2010.

TECHNICAL STRENGTHS

Operating systems	advanced user of Linux and Windows
Programming languages, advanced	C/C++, bash, Python, AWK
Programming languages, beginner	Fortran, QT4, HTML
Mathematics packages	Matlab, Maple
Codes for simulations of ionizing particle transport	MCNP, FLUKA, GEANT4
Frameworks	expert in ROOT
Parallel Computing	beginner in MPI, OpenMP, CUDA
Other	advanced in LaTex

RESEARCH EXPERIENCE AND INTERESTS

Beyond Standart Model searches

- Search for anomalous production of prompt same-sign lepton pairs and constraints on physics beyond the Standard Model with 8 TeV data, ATLAS. Main person for electron channel. Presented this analysis as a poster at ATLAS overview week 2013. Paper is in progress.

Simulation and performance of tracking detectors

- Simulation and digitization of Transition Radiation Tracker (TRT), ATLAS. My project is focused on the implementation of Monte Carlo simulation of the Argon-based gas mixture as an active gas in the TRT with the possibility to simulate some of the TRT sectors with Argon-, while the others with Xenon-based mixtures. During 2013, some sectors of the TRT were operated with Argon-based mixture and it is expected to use Argon mixture for future runs as well.
- Studied performance of TRT with Argon- and Xenon-based mixture. Investigated track hit and momentum resolution.
- The Fast Tracker project (FTK), ATLAS. Plan to take part in development of online hardware tracking based on FPGAs.

Heavy flavour physics

- Master and bachelor projects were focused on the measurements of the cross sections for charm and beauty quark jet production in the region $Q^2 > 1000$ GeV^2 with ZEUS experiment. The measured cross sections were planned to use to extract F_2^{cc} and F_2^{bb} proton structure functions. Paper is still in progress.

SCHOOLS AND CONFERENCES

- Partikeldagarna (Lund), October 2013
- ATLAS Overview Week (Marrakech, Morocco), October 2013
- CERN School of Computing (Nicosia, Cyprus), August 2013
- Nordic Physics Days (Lund), June 2013
- Terascale Monte Carlo School (DESY, Hamburg), March 2011.
- TESHEP (Romania), July 2010.

AWARDS

- 1st diploma of the "Physicist-2006" Olympiad in Physics, National Taras Shevchenko University of Kyiv, Department of Physics, 2006.