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The Norwegian University of Science and Technology (NTNU) creates knowledge for a better world and solutions that can change everyday life.

Faculty of Engineering
Department of Energy and Process Engineering

PhD Position - LHC detector cooling with R744 refrigeration units (SO IV - 206/18)

Description

A PhD position is available at the Department of Energy and Process Engineering (EPT) within the Refrigeration research group and CERN EP-DT and EN-CV in Geneva, Switzerland on the subject of "Developing and evaluating the possible use of R744 as the primary cooling system serving the next generation of the Large Hadron Collider (LHC) detectors". The appointment has a duration of 4 years.

One of the important issues for CERN is represented by the choice of the best possible primary system for the particles detector cooling systems, which must comply with stability, reliability and environmental sustainability constraints. Due to the European F-gas regulation and a global consensus (Paris COP and Kigali agreement) an adaptation of new strategies is needed to reduce the usage of fluorinated gasses. These fluids are widely used as working fluids in current refrigeration systems; however, due to their high greenhouse gas potential alternatives have to be found. Carbon dioxide (CO₂), also called R744 when used as a refrigerant, is nowadays widely applied in commercial and industrial refrigeration applications. During the past 30 years, NTNU and SINTEF have developed various R744 systems for all kind of applications and do have a wide network within the refrigeration industry.

The background for the research work is that in the last years at CERN, CO₂ evaporative cooling has been one of the favourite technologies chosen for the thermal management of tracking detectors at LHC. The ATLAS Insertable B-Layer and the CMS Pixel phase 1 upgrade have adopted it and their systems are now successfully operational. The CERN teams are now merging the lessons learnt on these two systems in order to design and build the cooling systems for the new Upstream Tracker and the Velo upgrade in LHCb. Meanwhile, the design of the ATLAS and CMS upgrades has taken shape, and both experiments heavily rely on CO₂ evaporative cooling, with cooling capacity requirements of up to 400 kW and evaporating temperature on the detector below minus 40 °C. For this application, a pumped loop is the best solution in terms of operation, temperature stability and radiation resistance requirements. The CERN teams are now working on the design of a large-scale demonstrator system, which will take into account requirements and constraints from both ATLAS and CMS. Until now the primary refrigeration system are applying conventional HFC refrigerants.

The scope of the work is to develop a primary cooling system applying natural working fluids and to support the research teams at CERN responsible for the main detector cooling systems applying oil-free R744 technology. An evaluation of cooling concepts for a primary cooling system with R744 should be done for evaporation temperatures close to the triple point of CO₂ (-54°C) and a cooling capacity of up to 0.5 MW. In addition, beside pumped circulation, an evaluation of applying R744 turbo compressor technology, as the first stage circuit would be of interest for possible future evolution of the system. These investigations should be based on system simulation with dynamic tools like Modelica, in close collaboration with the teams at CERN. A verification and validation of simulation results will be done on first pilot units. The findings will support the modification of the specifications for the next pilot and full-scale units. The work of the PhD candidate will contain pre-design, define specifications, assist build up and assembly, verification of measurement and control devices, commissioning and performing experimental campaigns.

Qualifications

Required:

- a highly motivated candidate with a Master's degree with focus in refrigeration technology
- strong background knowledge in experimental investigations of refrigeration systems and
- experience in applying computer simulation tools (e.g. Modelica) of complex multi-physical systems

Desired:

- knowledge related to R744 refrigeration technology
- a strong interest for designing and adapting refrigeration processes
- ability to perform modelling / simulation of systems including heat- and mass transfer

A prior and concrete experience with the aforementioned disciplines are considered as an advantage.

Language:

• Excellent English skills, spoken and written are required. Applicants from non-English speaking countries outside Europe must document English skills by an approved test. Approved tests are TOEFL, IELTS, and Cambridge Certificate in Advanced English (CAE) or Cambridge Certificate of Proficiency in English (CPE).

The main work is performed at NTNU, while research intervals (6-12 months) at CERN in Geneva are part of the program. The expected start up time for the position is August/September 2018.

Conditions

PhD Candidates are remunerated in code 1017, and are normally remunerated at gross NOK 449 400 before tax. There will be a 2 % deduction to the Norwegian Public Service Pension Fund from gross wage.

Engagement as a PhD Candidate is done in accordance with "Regulation concerning terms and conditions of employment for the posts of post-doctoral research fellow, research fellow, research assistant and resident", given by the Ministry of Education and Research of 19.07.2010. The goal of the positions is to obtain a PhD degree. Applicants will engage in an organized PhD training program, and appointment requires approval of the applicants plan for a PhD study within three months from the date of commencement.

The position is of 4 years duration, of which 25% teaching duties.

For further information, please contact Professor Armin Hafner, Department of Energy and Process Engineering, NTNU, Trondheim. E-mail armin.hafner@ntnu.no. Please observe that applications should not be sent to this e-mail address.

See <https://www.ntnu.edu/iv/doctoral-programme> for more information.

The engagement is to be made in accordance with the regulations in force concerning State Employees and Civil Servants. The positions adhere to the Norwegian Government's policy of balanced ethnicity, age and gender. Women are encouraged to apply.

The application

The application must contain information of educational background and work experience. Certified copies of transcripts and reference letters should be enclosed. Applications with CV, grade transcripts and other enclosures should be submitted via this webpage at www.jobbnorge.no.

Mark the application with SO IV-206/18.

Start-up date may be discussed, but tentatively September 2018.

Application deadline is 31 Juli 2018.

According to the new Freedom of Information Act, information concerning the applicant may be made public even if the applicant has requested not to be included in the list of applicants.

Jobbnorge-ID: 155384, Søknadsfrist: Søknadsfristen er gått ut