The ATLAS experiment at the LHC
The ATLAS endcap signal feedthroughs

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As described in detail in the 1996 Annual Report, ATLAS is building a multi-purpose *pp* detector which is designed to exploit the full discovery potential of the Large Hadron Collider (LHC) at CERN. The TRIUMF group is responsible for the engineering of the hadronic endcap calorimeter (HEC), and contributes to the production of high density cryogenic signal feedthroughs for both endcap cryostats. The feedthroughs are critical to the success of ATLAS. They have been built and tested at the University of Victoria by TRIUMF and Victoria staff. The endcap signal feedthroughs are currently (December 2002) being installed on one of the two endcap cryostats. The operation is expected to last until the end of February 2003. The second installation period is scheduled for early summer 2003. The ATLAS endcap signal feedthrough project was covered in details in the 2001 TRIUMF annual report. This report focuses on recent progress.

Reviews

A Canadian involvement in the endcap signal feedthroughs was already proposed in 1995. From the $12.2M Major Installation Grant awarded to ATLAS in the 1997-98 competition, a total of $4.28M is earmarked for the endcap signal feedthrough project. The most recent status report was presented at the last NSERC ATLAS Review, held at TRIUMF the 5, 6 and 7 December 2002.

Overview of the project

The ATLAS liquid argon calorimetry is composed of a barrel section and of two endcap sections. Each endcap cryostat contains an electromagnetic calorimeter, two wheels of one HEC, and a forward calorimeter. The calorimeter signal and calibration lines are routed to the outside of each endcap cryostat via 25 feedthrough assemblies arranged approximately equally spaced in azimuth. The low voltage needed to operate the endcap hadronic calorimeter preamplifiers, which are located in the cold, are also supplied via the signal feedthroughs as well as various monitoring lines.

The design is based on gold plated conductive pins insulated and sealed by glass inserts in a stainless steel carrier. The carriers are then welded into the cold and ambient (temperature) flanges. A total of 1920 signal and calibration lines per feedthrough assembly is required in the chosen design. The ambient and cold flanges are connected by a bellows to isolate the feedthrough vacuum from the cryostat inter-vessel vacuum. The cold flange is attached to a transition piece, known as a funnel, which is welded to the cryostat via a bi-metallic joint. The electrical signals are brought from the calorimeter to the cold flange by coaxial kapton cables; these are called pigtail cables. Cables located in the vacuum between the cold and the ambient flange, i.e. inside the bellows, carry the signals through the cryostat wall; these are called vacuum cables. For each endcap, four feedthrough assemblies also carry the low voltage for the HEC preamplifiers. Fig. 1 shows an overview drawing of one endcap signal feedthrough.

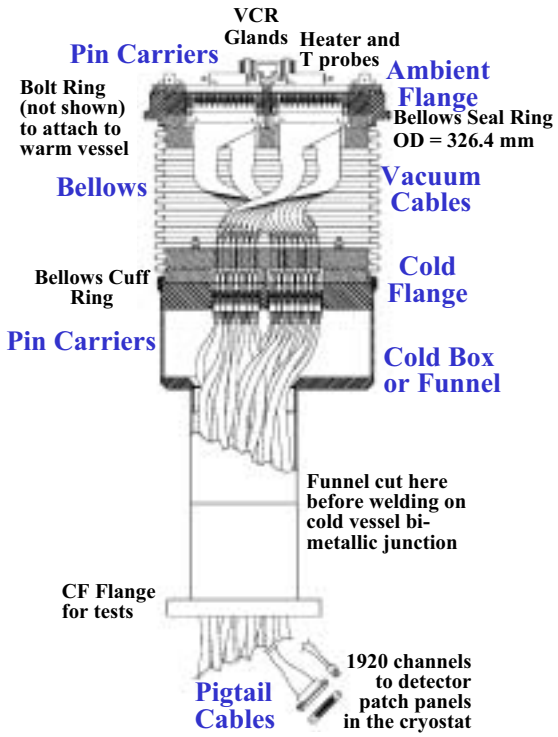

Fig. 1. Overview drawing of one endcap signal feedthrough, identifying its most important components.

Procurement of components

Pigtail cables

The development of the pigtail cables was part of a larger effort to develop signal and calibration cables for the whole of the LAr readout chain. They were purchased through Orsay, along with the other ATLAS LAr cables, from Axon. A Memorandum of Understanding for the procurement of the endcap pigtail cables was signed by Orsay and ATLAS-Canada. A detailed procurement schedule was developed, and reception of pigtails in Victoria was completed in the fall of 2002.

Pin carriers

Extensive and detailed tests comparing the ceramic and glass pin carrier technologies were made in 1997

and 1998. Both technologies were found suitable for our project. The green light was given at the feedthrough Production Readiness Review (held in CERN on 29 January 1999) to purchase glass technology pin carriers made of low inclusion 304L stainless steel. The order was placed in June 1999. Reception was completed early in 2002.

Assembly and installation

A total of 50 feedthrough assemblies plus 5 spares have been produced (see Fig. 2) following a detailed assembly procedure, quality plan and quality assurance plan. These include the description of the testing of components from their arrival in Victoria through the completion of feedthrough units. Complete material traceability is ensured through the use of detailed traveller sheets. The funnel and cold flange of each feedthrough assembly are part of the cryostat pressure vessel. An officially licensed company has done the welding and extensive testing to conform to accepted welding code.

Fig. 2. Vacuum cables being installed on a feedthrough by Paul Birney (TRIUMF) at the University of Victoria.

The shipment of feedthrough assemblies to CERN is done by air freight. All but five assemblies are now in CERN. Upon arrival at CERN, each feedthrough assembly is subjected to an ambient temperature leak test and a basic electrical test. We are responsible for these tests. The required testing equipment was commissionned at CERN in October 2001, when the first feedthrough assemblies arrived at CERN.

The installation of the feedthrough assemblies on the cryostat is a delicate and complex operation. Although the feedthrough installation is not a Canadian responsibility, our group is actively assisting during the operation. In particular, given the softness of the pins, members of our team will manually connect the so-called warm cables that join the outside of the ambient flange to the electronics crate baseplane. Each feedthrough assembly, once welded on the cryostat, must also be electrically tested.

The installation of the feedthrough assemblies on the first endcap cryostat (see Fig. 3) started on 2 December 2002 and is expected to last until the end of February 2003. As of 20 December 2002, six feedthrough assemblies have been successfully installed (see Fig. 4). Installation on the second cryostat is scheduled for early summer 2002. It is expected that Canada's involvement in the feedthrough project will end during 2003 with the connection of the warm cables to the ambient flange.

Fig. 3. The first endcap cryostat of the ATLAS liquid argon calorimeter after arrival at CERN, still in its transport craddle (April 2002).

Fig. 4. First six feedthrough units installed on the first endcap cryostat (December 2002) and a close-up on one of the welds. Photos by Aboud Falou, Orsay.