The ATLAS experiment at the LHC
The ATLAS endcap signal feedthroughs

(M. Lefebvre, University of Victoria)

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 have been installed on the two endcap cryostats between December 2002 and September 2003. The ATLAS endcap signal feedthrough project was covered in detail in the 2001 TRIUMF annual report. This final endcap signal feedthrough project report focuses on the 2003 activities.

Reviews

A Canadian involvement in the endcap signal feedthroughs was already proposed in 1995. From the $12.2M NSERC Major Installation Grant awarded to ATLAS in the 1997-98 competition, over $4M was allocated to the endcap signal feedthrough project. The most recent status report was presented at the last NSERC ATLAS Review, held at TRIUMF on 5 November 2003.

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.

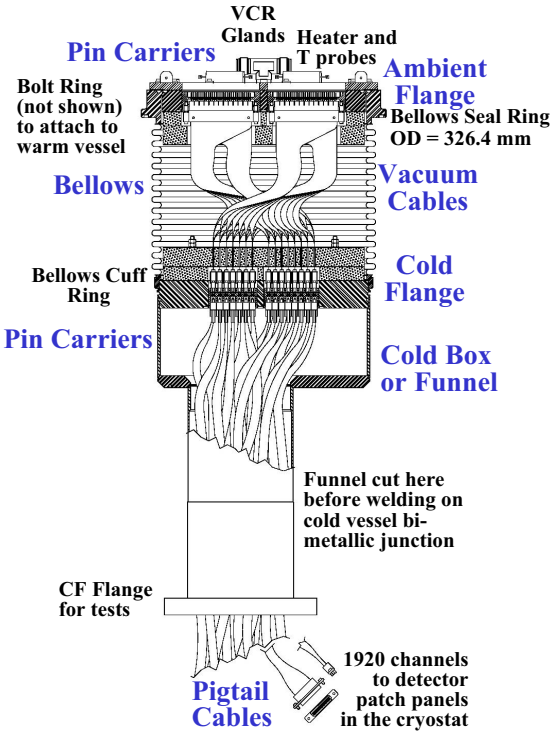

Fig. 1. Overview drawing of one endcap signal feedthrough, identifying its most important components.

Assembly and installation

A total of 50 feedthrough assemblies plus 5 spares have been produced 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 traveler 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.

The shipment of feedthrough assemblies to CERN was done by air freight. The last shipment was completed in January 2003. Upon arrival at CERN, each feedthrough assembly was subjected to an ambient temperature leak test and a basic electrical test. We

are responsible for these tests, the last of which were performed in June 2003.

The installation of the feedthrough assemblies on the cryostat was a delicate and complex operation. Although the feedthrough installation is not a Canadian responsibility, our group actively assisted during the operation. The installation of the feedthrough assemblies on the first endcap cryostat started on 2 December 2002 and ended on 4 January 2003 (see Fig. 2). Installation on the second cryostat (see Fig. 3) started on 23 July 2003 and ended on 26 September 2003 (see Fig. 4).

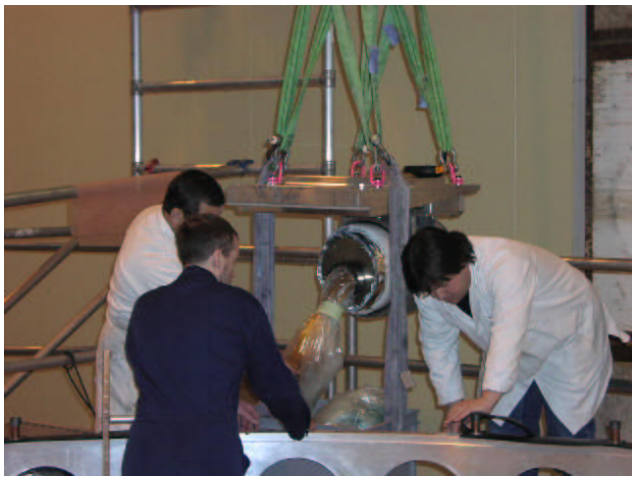

Fig. 2. Paul Poffenberger (front, Victoria) during feedthrough installation on the first ATLAS endcap cryostat.

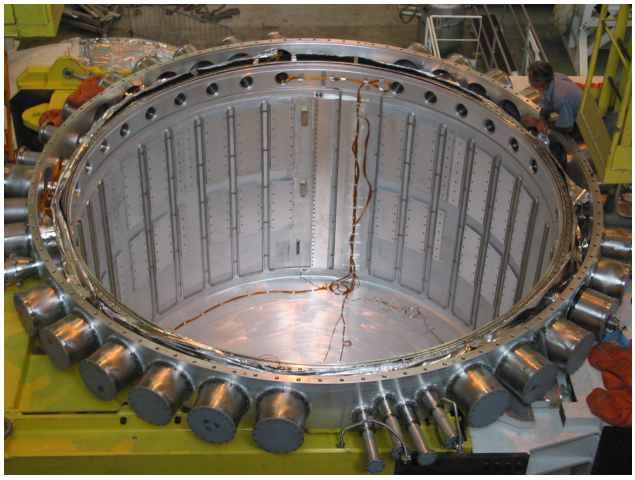

Fig. 3. Second ATLAS endcap cryostat with its cover removed, before feedthrough installation, CERN 26 June 2003.

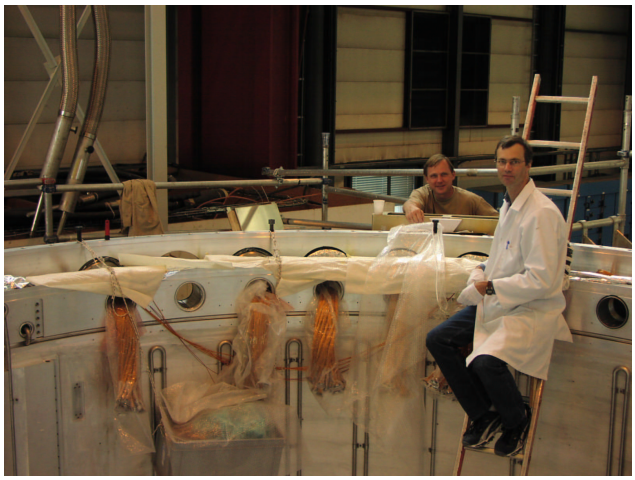

Fig. 4. Paul Birney (TRIUMF) and Ken Sexton (BNL) during feedthrough installation on the second ATLAS endcap cryostat.

Members of our team manually connected the so-called warm cables that join the outside of the ambient flange to the electronics crate baseplane; each baseplane and corresponding pedestal are associated to two feedthroughs (see Fig. 5). Given the softness of the pins, this was a particularly delicate operation, Each feedthrough assembly, once welded on the cryostat, was also electrically tested (see Fig. 6). Results of these tests will form part of the ATLAS detector database.

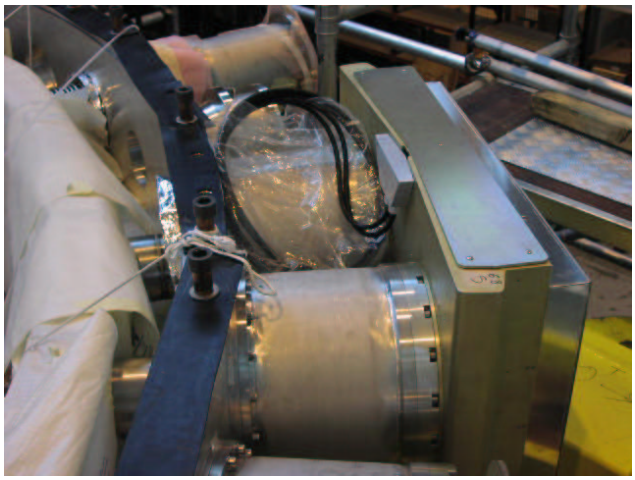

Fig. 5. View of the first mounted pedestal on the first cryostat.

Fig. 6. Fiona Holness (Victoria) performing electrical tests on feedthroughs recently welded on an ATLAS endcap cryostat.

A paper describing the ATLAS LAr signal feedthroughs is being written in collaboration with our colleagues from Brookhaven National Laboratory (who produced the barrel signal feedthroughs), and will be submitted to Review of Scientific Instruments in 2004. Other tasks in 2004 will include finalizing the inventory, the storage of spare parts, the interfacing of electrical tests results with the ATLAS database, the decommissioning of the feedthrough production equipment, and the maintenance of readiness for repairs until the endcap cryostats are in operation in the ATLAS cavern.