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JRA1 – Status of Mechanics, Cooling and Infrastructure

Ingrid-Maria Gregor, Carsten Muhl*

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Abstract

During the EUDET Annual Meeting in Paris October 2007 the status of the cooling, mechanics and infrastructure was presented. In this document the given presentation is summarised.

*Deutsches Elektronen Synchrotron DESY, 22607 Hamburg, Germany

1 Introduction

Within EUDET JRA1 a test beam telescope will be developed. It will provide a high precision of better than 3 μm, even at the lower energies available at the DESY test beam facility. The mechanical setup should allow for a wide range of different configurations from a very compact one useful for pixel sensors to a two-arm layout with sufficient space in between the arms to accommodate TPC prototypes. The lateral dimensions of the active area should be large enough to cover high precision pixel devices without mechanical movement of the device under test. Obviously, for larger devices mechanical actuators will have to be used. A minimum size of 20 mm in one lateral dimension is adequate. The second dimension could possibly be smaller.
This memo describes the status of the mechanics, cooling, and infrastructure for the JRA1 telescope as of October 2007.

2 Telescope Mechanical Design

It is foreseen that the beam telescope will be operated in widely varying R&D applications with very different devices under test (DUTs). Four telescope parameters are particularly relevant in this context: the number of measurement planes, the active area, longitudinal size and layout of the telescope, the mechanical support for the DUT and the environmental conditions such as temperature.

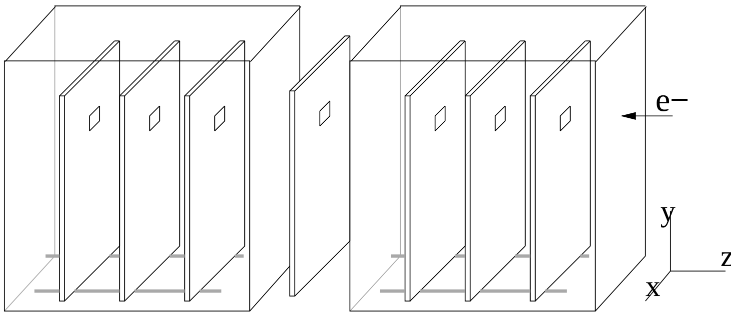

Figure 1: Mechanical concept with three separate areas for the two reference arms and the DUT.

Based on detailed analytical calculations [1] it was decided to provide six telescope planes, also for redundancy and flexibility. The telescope will be subdivided into two arms of each 3 sensors to allow more flexibility without limiting the size of the DUT which will be located between the two arms.
In Figure 1 the mechanical concept for the telescope is illustrated. Three "boxes" will be the main elements. Box 1 on the left side in the illustration is in a fixed position, an "optical" bench within the box guides the three reference planes of the arm in front of

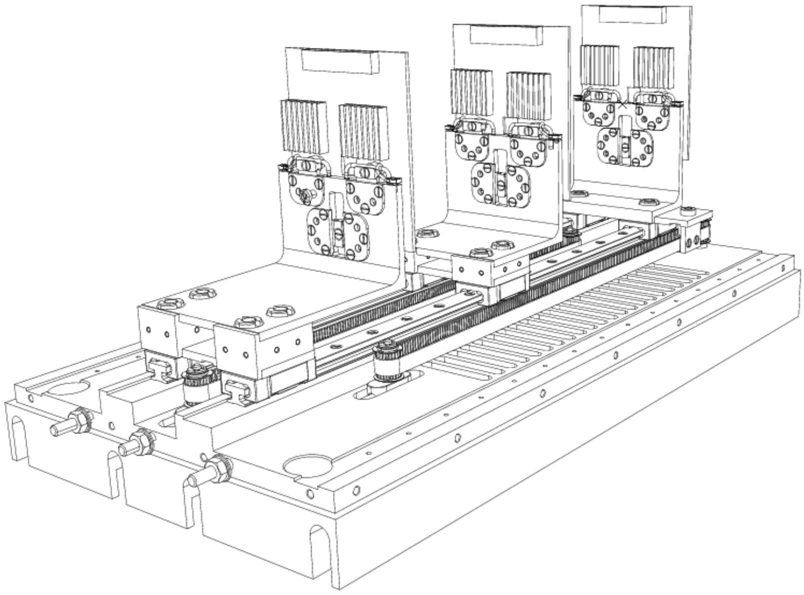

Figure 2: Technical drawing of one arm of the telescope mechanics.

the DUT. The box is temperature controlled. Box 2 is movable in z-direction to ease the installation of the DUT as well as to give the possibility of larger DUT devices. The third “box” is the space between the boxes 1 and 2. A cover over this gap ensures thermal enclosure, but this is up to the telescope user. In this illustration the beam is impinging from the right side. For large DUTs mechanical actuation is foreseen in order to move the device through the active area of the telescope.

In Figure 2 the inner mechanical concept of one telescope arm is illustrated. Three sensor jigs (L-piece) are positioned on a track system. For each of the three positions of one telescope arm a different L-piece was designed to allow a minimal distance of x mm between sensor planes. The track system which guides the L-pieces allows a maximum distance of 200 mm between the outer planes. The distance between the planes is adjustable using a tool from above.

The lower supporting frame is connected to a cooling device (see section 3). The sensors are kept in position on the L-pieces by a clamping mechanism. This design was chosen as high mechanical accuracy was expected. Figure 3 shows a photograph of the inner track system holding one of the L-pieces. A drawing of the complete setup as it was prepared for the CERN test beam is shown in Figure 4. Box 1 and 2 were positioned on a support table built out of a modular system of construction profiles[1]. This allows an easy modification for future different mechanical needs. Each L-piece track system is enclosed by an aluminium lid keeping the sensors in a light tight volume with constant temperature. Special openings for cable feed throughs to the AUX board are foreseen

[1]Rose and Krieger

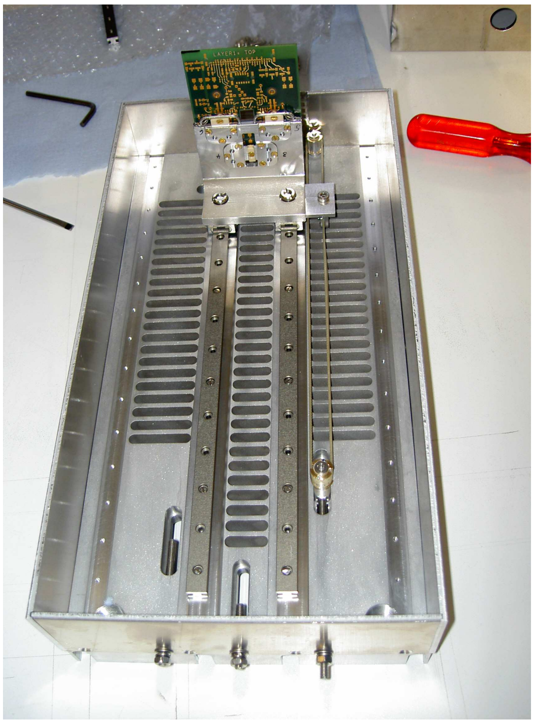

Figure 3: A picture of the actual implementation.

as well as openings for the beam passage covered by a 30um thin aluminium foil. On top of the lids mechanical support for the auxiliary (AUX) boards are located. The gap between box 1 and 2 (box 3) houses a precisely machined platform with fittings for a XY table. All support legs of the table are adjustable in height. A photograph of the setup installed at CERN H8 test beam is shown in Figure 5.

2.1 Planned Improvements

During the test beam at CERN this mechanics was used for the first time and some lessons were learn ed, summarised below:

- The installation of the sensor chips onto the L-pieces is more complicated and more dangerous for the chips than anticipated.
- The mechanical holding system for the sensor boards is not as stable as planned. During the transport to CERN the sensor boards were moved up to 1 mm.
- The thermal contact of the sensor boards to the cooled parts of the mechanics is very low due to plastic distance holders. A ΔT of 20°C was measured between the cooling system and a thermal sensor on the sensor board.
- Adjustment and alignment of the telescope to the beam axis was difficult due to the weight of the table.

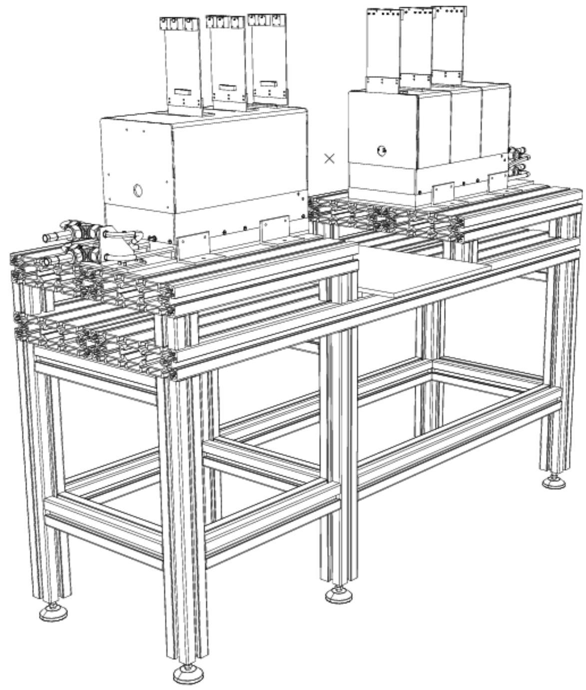

Figure 4: The complete mechanical setup for the CERN test beam.

Most of this points were already observed before the transport to CERN but due to the time schedule there was no time to improve this.
Apart from the L-piece, most of the mechanical setup was working according to the expectations, but of course a number of improvements have to be done. The main change is a new design of the L-piece. It will be simplified, in future the sensor board will be directly screwed onto the L-piece to improve the thermal contact. Furthermore the encloser which are also the mechanical support for the AUX boards are redesigned to give more flexibility. The overall telescope table will be equipped with actuators to ease the alignment to the beam. For easier alignment and more flixibility to the beam axis larger scaler tables will be used.

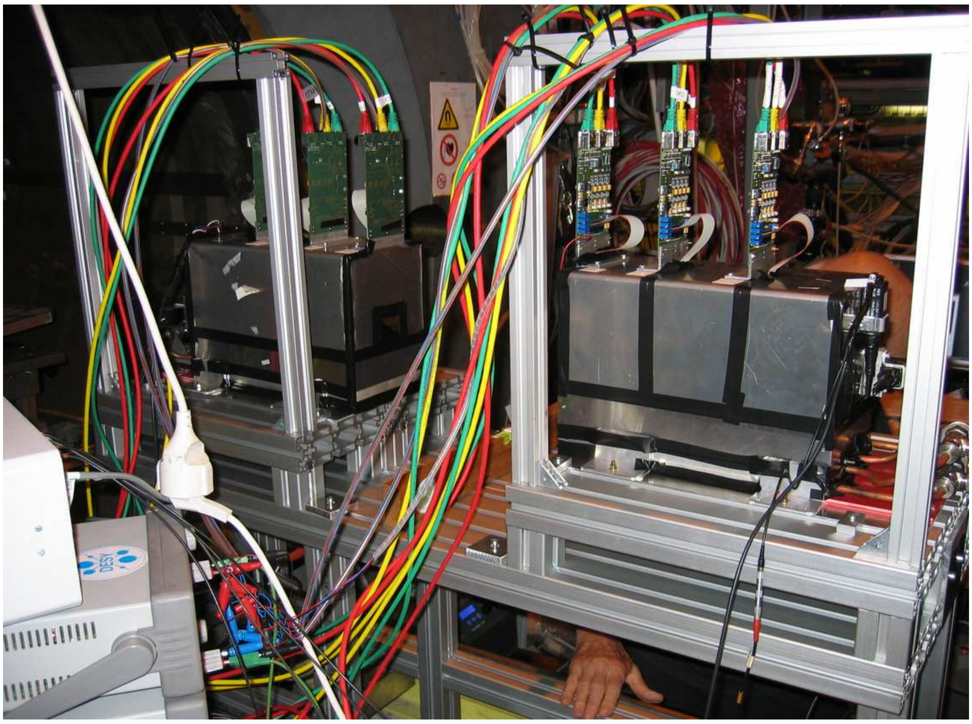

Figure 5: Photograph of the mechanical setup installed at CERN H8 test beam.

Figure 6: Photograph of the cooling device Huber ministat 230-4.

3 Cooling

Laboratory tests showed that the noise of the MimoTel chips can be improved by keeping the temperature of the sensor board below 20°C. Active cooling is therefore necessary. As cooling device a Huber ministat 240-3 was selected. This system is a cool-heat bath and circulation thermostat with air cooled refrigerator. As coolant R507 is used, a mixture of pentafluorethan and trifluorethan. The cooling power of 0.5 kW at 0°C it sufficient to cool 6 sensor planes and the air volume within the sensor boxes. Figure 6 shows a photograph of the device.
In case the DUT needs cooling, this should be provided by the DUT user.
The cooling machine is connected via tubes to specially foreseen pipes at the telescope mechanics.

4 Infrastructure

Apart from the mechanics and the cooling a lot of other hardware is needed to run the telescope. For the CERN test beam campaign the telescope was send to a laboratory outside of DESY for the first time. A hardware list of all necessary details were prepared to keep track of system. It includes all cables, low voltage power supplies, mechanical tools, crates and NIM modules. All necessary hardware was available and will be kept as a package from now on.

5 Conclusion and Outlook

In the previous sections the status of the mechanics, cooling and infrastructure for the JRA1 Telescope was summarised. At the time of the EUDET annual meeting the demonstrator was well tested at different test beams, including the mechanics, the cooling and all necessary infrastructure. In a next step the mechanics will be improved to ensure the cooling of the sensor chip and to ease the handling. The L-piece holding the sensor board will be redesigned.

Acknowledgement

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References

[1] A.F. Zarnecki, P. Niezurawski, "EUDET Telescope Geometry and Resolution Studies", EUDET-Report-2007-01