Integration of the NA62 Gigatracker

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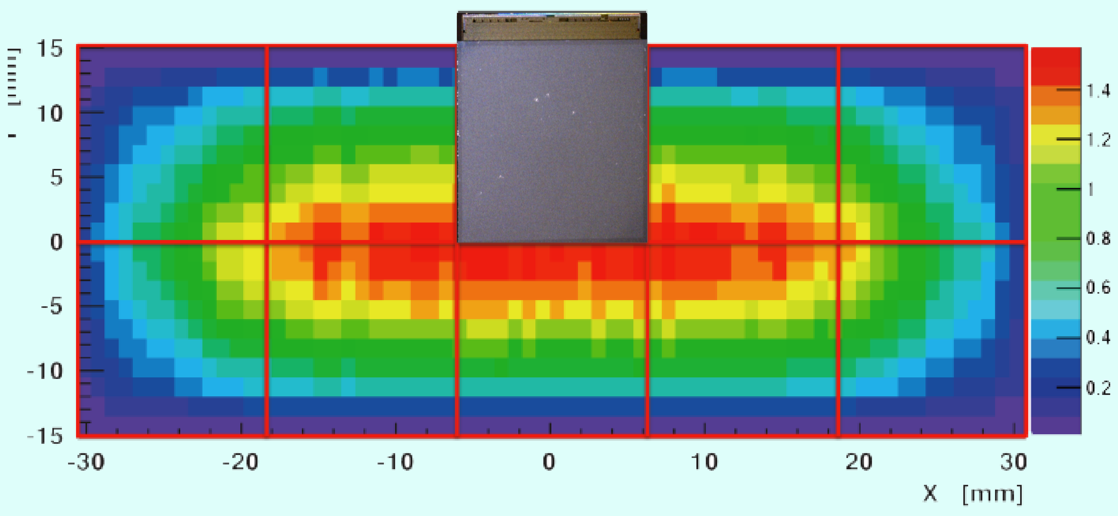
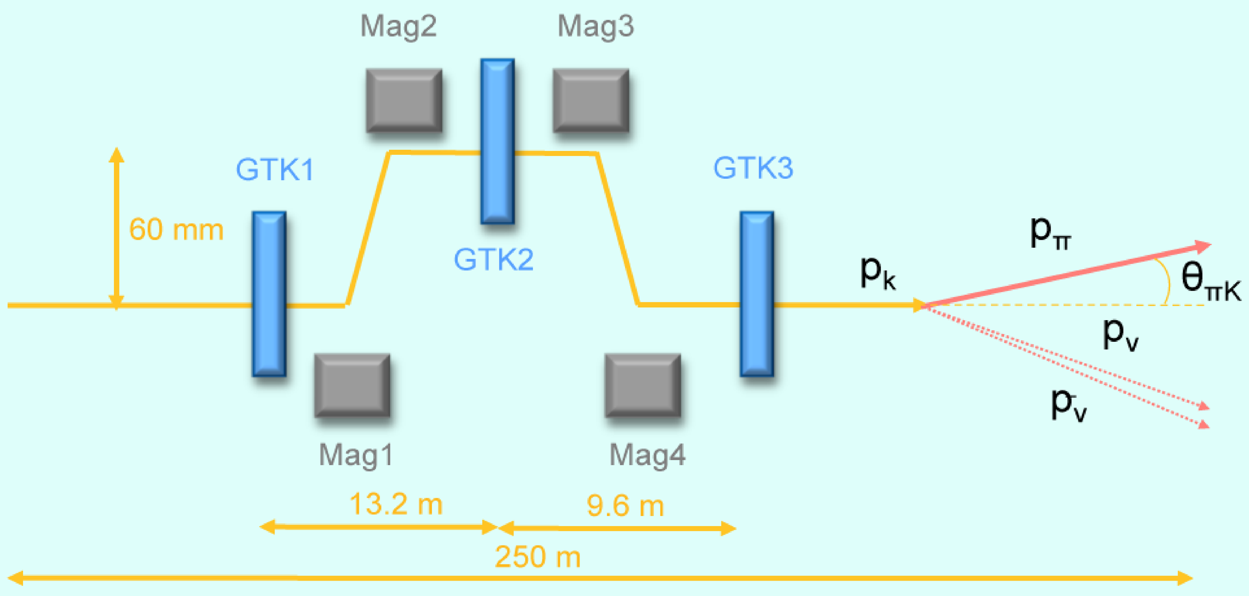
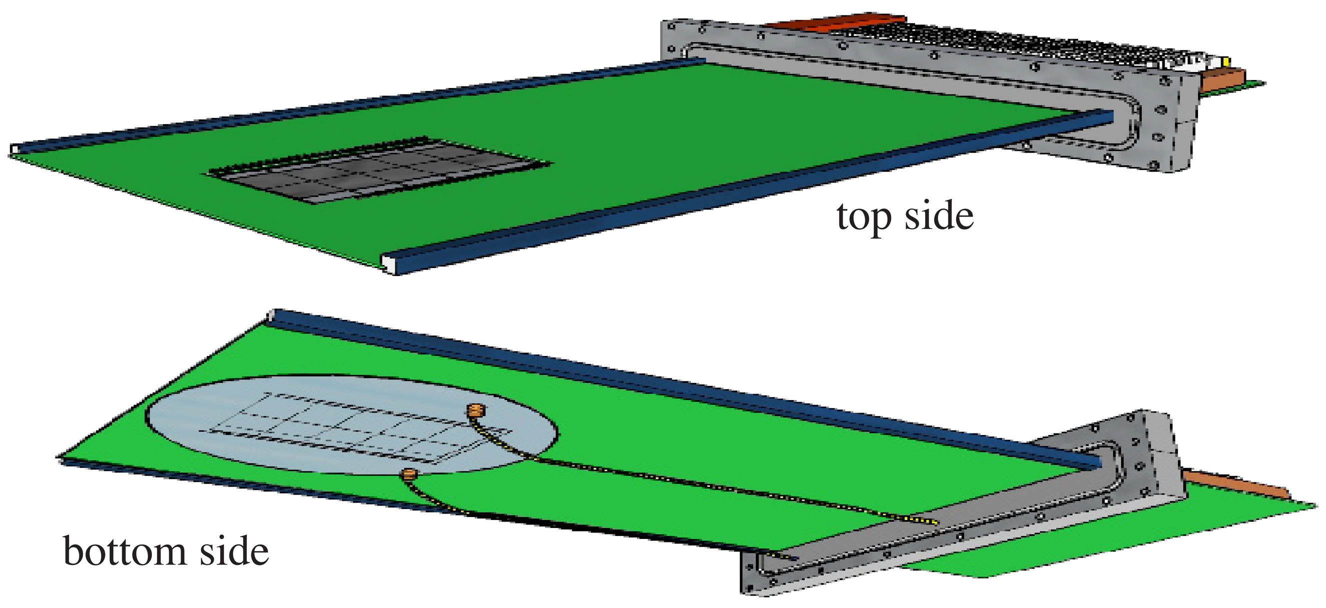


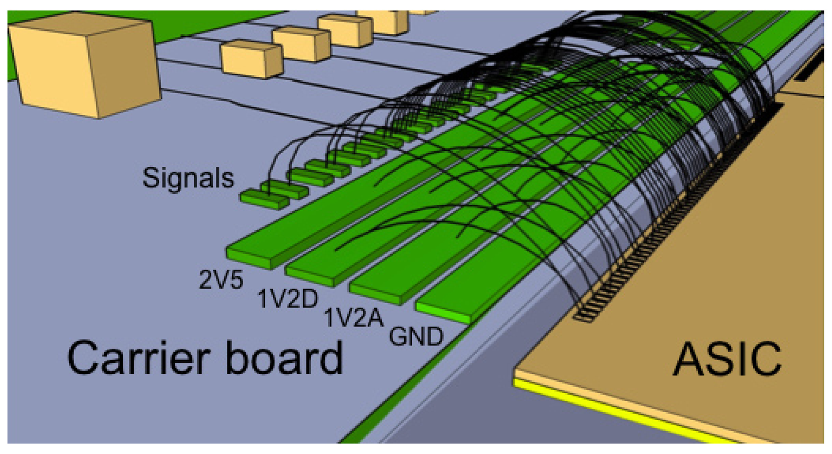
The Gigatracker (GTK) is a hybrid pixel detector composed of three stations in the rare kaon decay experiment, NA62, at CERN SPS. It provides precise measurements of momentum, time and angle of the incoming 75 GeV/c kaon in a beam line with four achromat magnets. After the GTK the kaon decays into one pion, one neutrino and one anti-neutrino and the GTK hits are time correlated with measurements from a RICH detector after the decay.



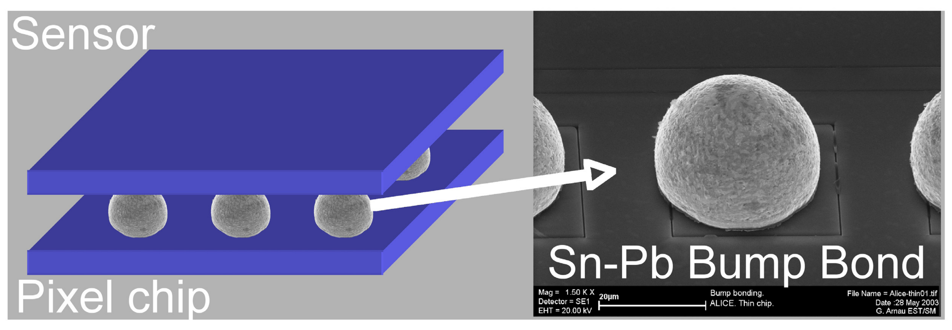
The beam particle rate is 800 MHz. Each of the three stations has a sensor size of 60 x 27 mm^2 and contains 18000 pixels of the size 300 x 300 μm^2. The active area is bump bonded to a matrix of 2 x 5 pixel ASICs, which time tag the arrival of the particles with a binning of 100 ps. The detector operates in vacuum at -20 to 5 °C and the material budget per station is below 0.5% X_0. Due to the high radiation environment of 2 x 10^{14} 1 MeV neutron equivalent per cm^2 and year it is planned to exchange the detector modules regularly. The low material budget, cooling requirements and the request of an easy module access has driven the electromechanical integration of the Gigatracker.



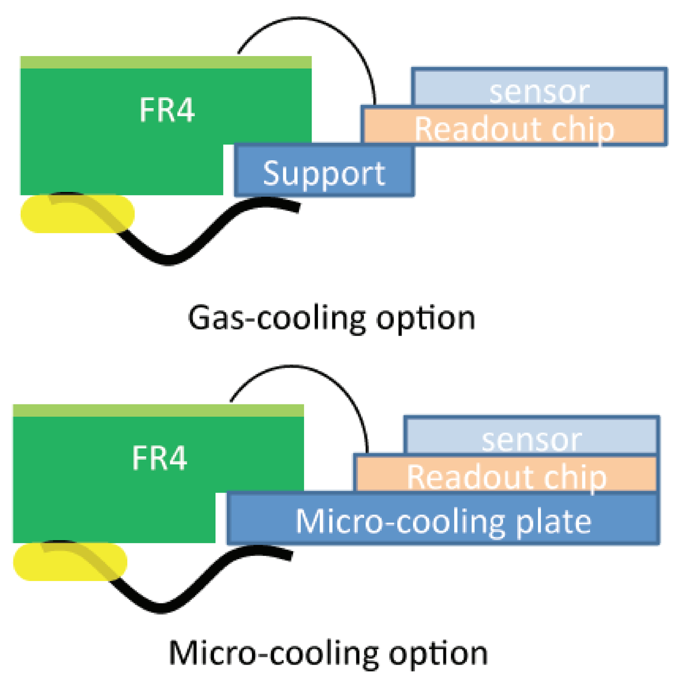
The assembly carrier holds the sensor-pixel ASIC assembly and references it precisely in place, provides electrical connections to the detector electronics for power, control and the high speed Gigabit electrical transmission lines and provides the mechanical interface between the detector assembly and the cooling. The design is compatible with both cooling options.



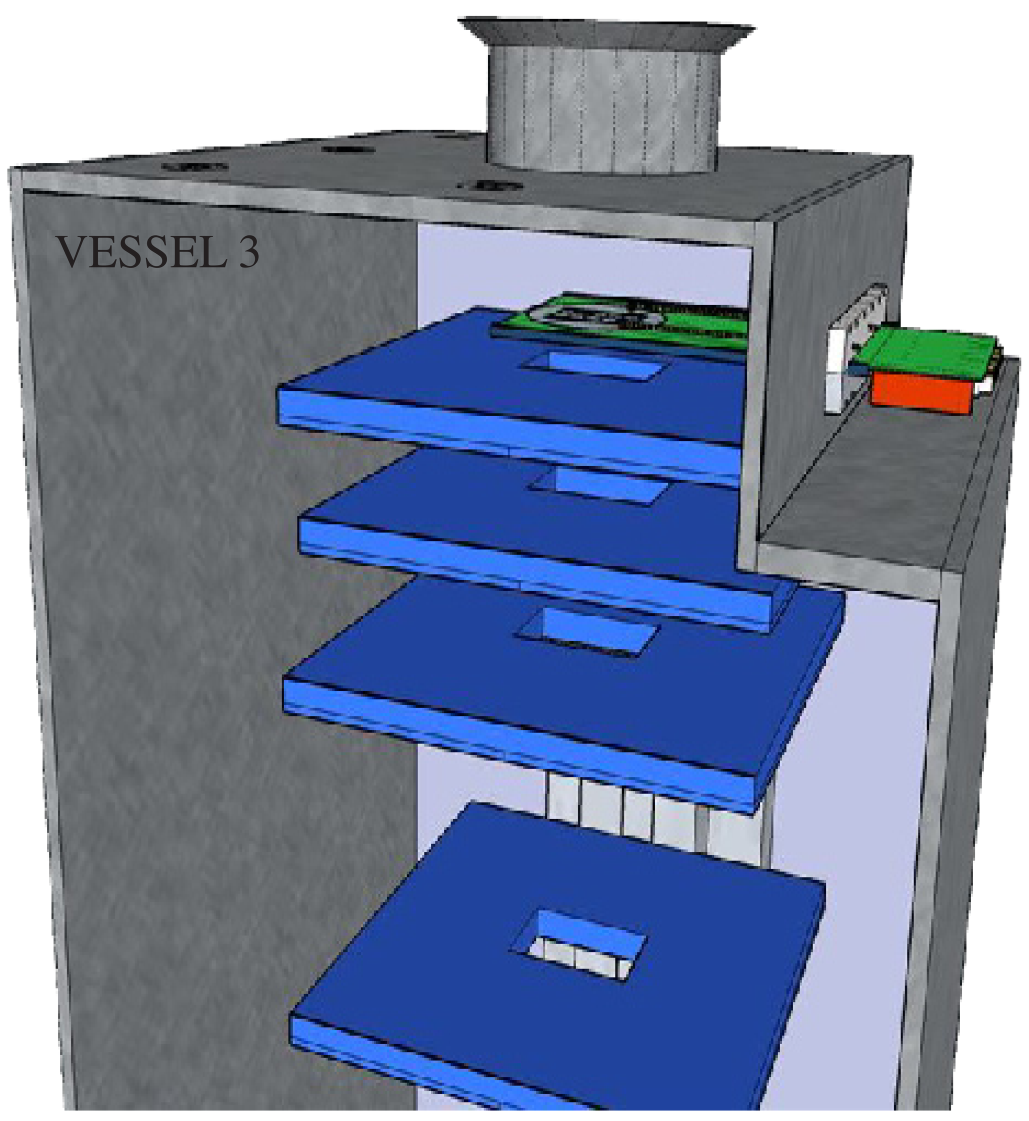
Wire bonds provide the electrical connections between the ASICs, the sensor and the GTK assembly carrier. In order to avoid the need of a precise pitch adapter to the printed circuit board, a staggered wire bonding scheme is proposed where the pitch in the PCB is larger than the ASIC pad pitch of 73 μm.

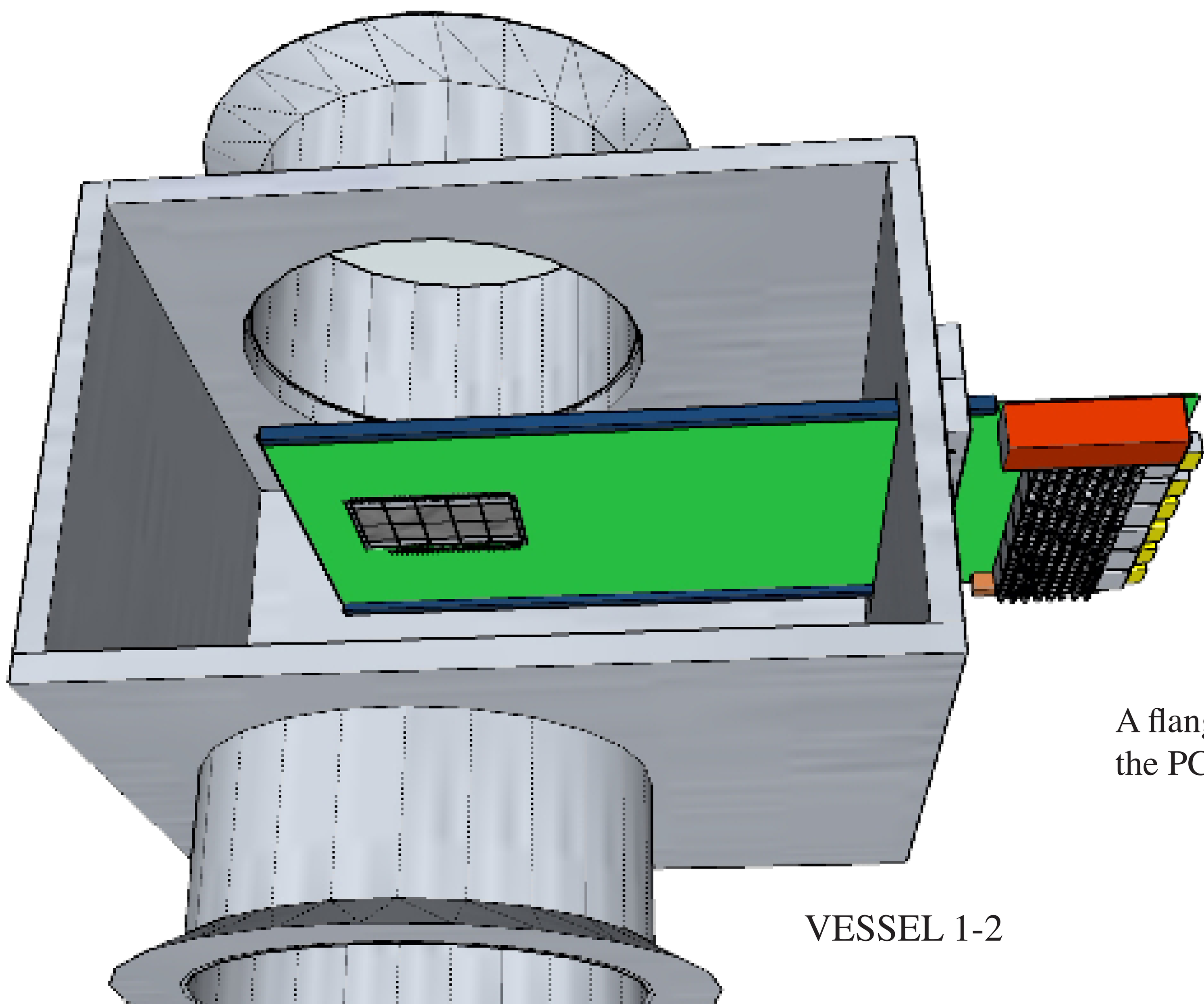


The sensor of 200 μm thickness is bump bonded to the read-out ASICs, thinned to 100 μm. Sn-Pb or Sn-Ag bump Bonds will be used.

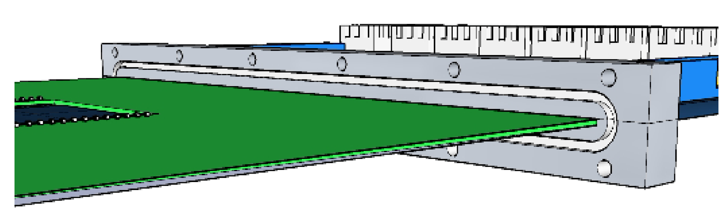


The assembly carrier is constructed as a mixture of a FR4 printed circuit board combined with a multi layer Kapton based sequential built up (SBU) printed circuit board. The SBU holds micro vias allowing to cope with high signal density.



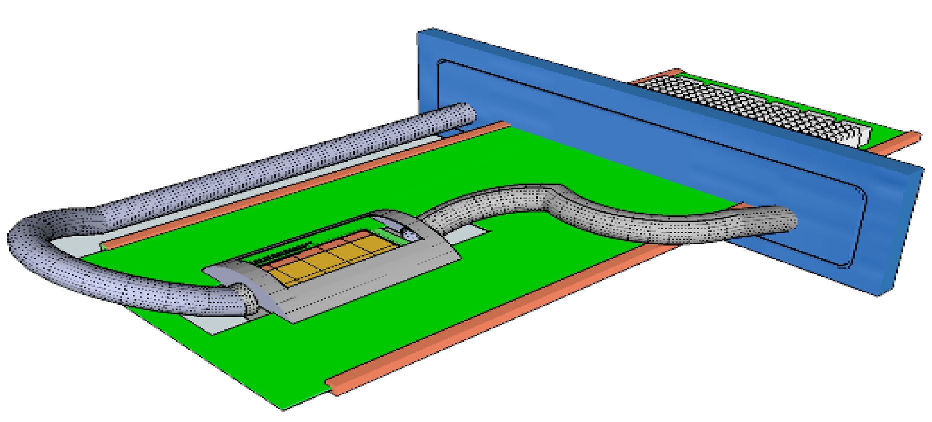


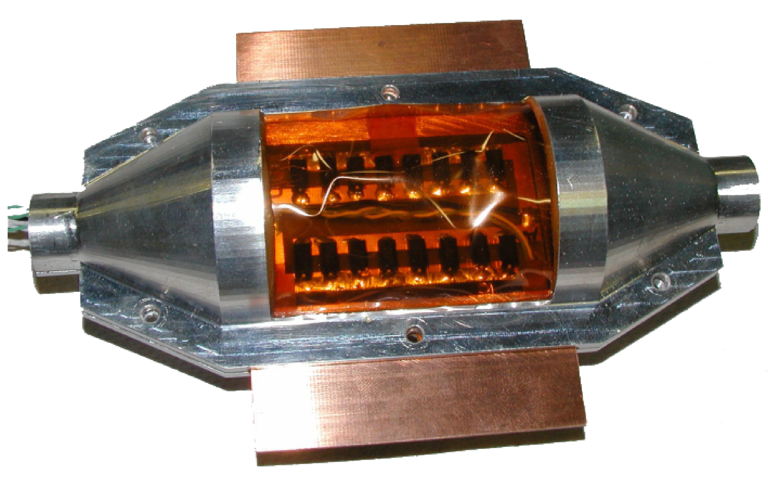
A flange equipped with an O-ring is tightly glued around the PCB acting as vacuum feed-through.



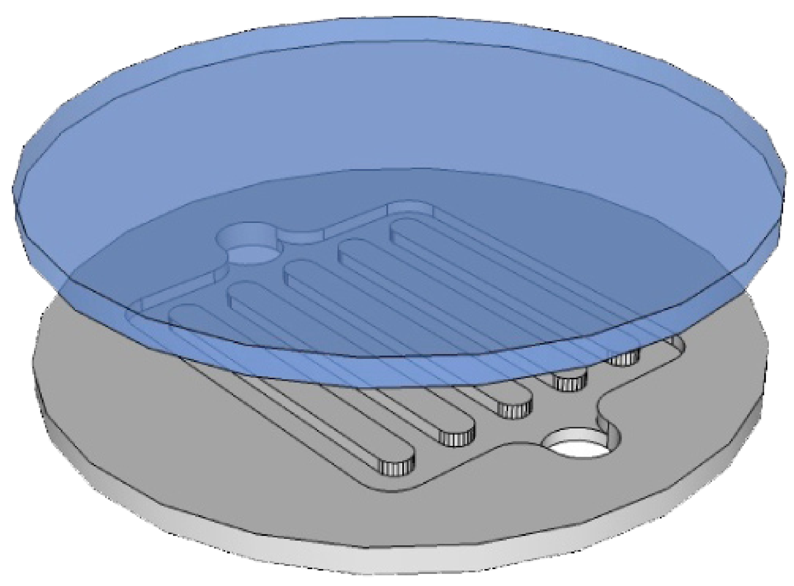
Each of the three GTK stations will be installed inside a dedicated vacuum vessel at three different positions along the NA62 experiment beam line. The vessels for GTK1 and GTK2 are identical and are 292 mm x 239 mm x 190 mm in size, whereas GTK3 is 550 mm x 560 mm x 2000 mm. It contains 6 CHANTI detectors as well. The electromechanical integration foresees a system which allows the insertion and removal of the station into a pre-aligned detector structure with minimum intervention effort in the experimental setup.

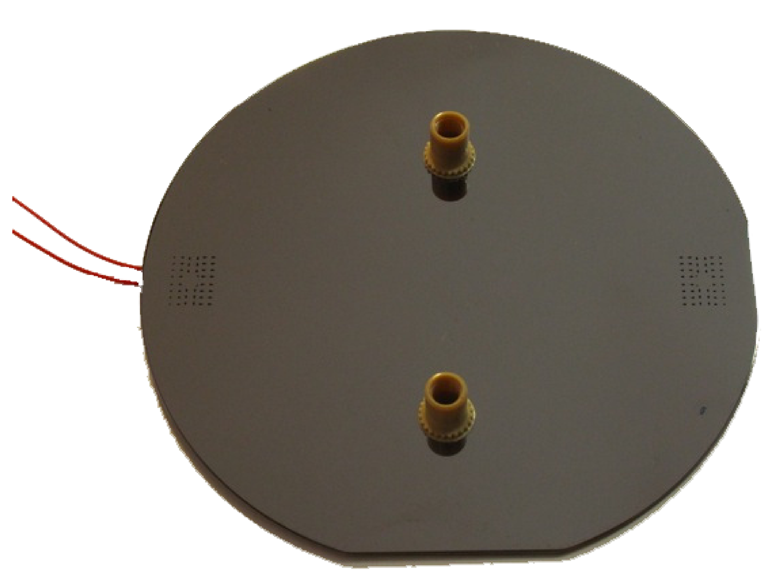
In order to decrease radiation induced sensor performance degradation and also to avoid overheating and thermal run-away an efficient cooling system must be implemented. Two options are considered.





One option, the gas cooling, consists of a vessel with Kapton windows on both sides of the detector placed inside the beam vacuum where a gaseous nitrogen flow ensures the cooling. The nitrogen will enter the vessel at a temperature of 100 K. The cold flow will keep the operation temperature of the module less than 5°C. The total thickness of the Kapton foils is 100 μm.





The other option, the micro channel cooling, is using a 150 μm thick silicon cooling plate containing 100 x 50 μm^2 micro channels with C_6F_{14} as cooling fluid. The cooling plate is glued to the sensor assembly. The development aims for an operating temperature of -20°C to -30°C.