5.1 Gap production

The gas gaps for 144 forward upscope RPC chambers will be produced by KODEL at Korea University. A total of 432 gaps are needed for the low η restoration. However, based on previous experience, about 10% additional production should be planned to replace gaps which passed the quality assurance test at KODEL but failed after the transportation to CERN. And if an additional 30% of contingency is allowed, then the total number of gaps is 600.
The 600 gaps will be produced with the same technology as developed for the production of the initial 432 forward RPC chambers at KODEL.

The general production procedures can be divided into several sequential steps.

Initially HPLs will be inspected for defects in color, scratch on the surface and any mechanical damages on the edges and corners. The surfaces of all selected HPLs are cleaned with IPA. After the HPLs are cleaned, the surface is graphite coated. The next step is to insulate the graphite surface with PET film. PET film is glued to the graphite surface by the machine shown in Figure. 5.1a. The gaps are then assembled and placed under a pressing machine (Figure 5.1b) for 24 hours for glue hardening.

All assembled gas gap are treated with linseed oil mixed with heptane. The rate of linseed oil administration into the gas gap placed in its vertical position is 100 cm/hour. After the completion of the linseed oil administration, a small compressor is used to immediately remove the remaining oil in the gas gap. Then, dry air of 30°C is circulated over the oiled surfaces of the gaps. The flow rate of air is from 60 to 100 liters/hour. And the period of the air circulation is from 48 to 72 hours.

A check of the mechanical and electrical quality of the gas gap is finally performed. The criteria for accepting the gas gap are very strict. For the mechanical test, no pop-up spacer should be found when the gas gap is over-pressured with 20 hPa for 10 minutes. In addition, the rate of leakage of the gas gap should be less than 0.2 hPa for 10 minutes. For the electrical test of the gas gaps, high voltage is applied to the gas gap and the amount of current drawn is recorded. First a voltage of 8.5 kV is applied for 12 hours to eliminate the faulty gas gaps which draw high Ohmic currents. Then a voltage of 9.4 kV is applied for 96 hours to select the qualified gas gaps with reasonably low currents. The current limit for accepting small-size, medium-size, and large-size gaps were set to 2.0μA, 3.0μA, and 5.0μA respectively.

For the gas gaps which pass the tests, transportation is arranged. Wooden boxes are specially designed for safe transportations. The gaps inside the wooden box are stored vertically and are clamped by using partially pre-stressed bars.

The transportations are normally done via air-carrier for the safety reason. All gas inlet and outlet pipes of the gas gap should be open for sudden change of the atmospheric pressure during the transportation.

Fig. 5.1: a) electrode insulation machine;
b) gap assembly machine.

5.2 Gap production schedule and cost

Preparation for the gas gap production is over and ready to produce the 600 gaps in 12 months. In each two months period of production, about 100 gas gaps will be completed and shipped to chamber assembly sites. One scenario is to start the production in the following order: RE4/2 Positive, RE4/2 Negative, RE4/3 Positive, RE4/3 Negative.

Production Schedule	
Number of gaps	Months
600	12

Cost Estimation	
Number of gaps	Cost
600	400K CHF