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Assembly of a large slat chamber prototype for the ALICE Muon Spectrometer

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Abstract:

We present a report of the assembly of a 2400 mm long slat chamber prototype. This prototype is assembled by following the final design for the stations 3, 4 and 5 of the ALICE Dimuon tracking system.

1 Introduction

The system of five trajectography stations for the Alice Dimuon Arm Spectrometer is made with wire chambers, more exactly Cathode Strip Chambers (CSC). Stations 1 and 2 are located upstream of a dipole magnet, station 3 is located inside the magnet, stations 4 and 5 are located downstream.

Stations 3, 4, 5, made by two chembers each, designed and developed by a collaboration of 5 laboratories [1], feature a modular design in order to achieve large diameter detectors (ø630-5220 mm), using rectangular modules (slats) featuring a maximum size of 2450 x 580 mm^2. The second main feature of slat chambers is the use of a large amount of lightweight materials in order to achieve a low X/X_0 ratio with a mean value of 2%.
132 slats are required to make the 6 chambers of the station 3, 4, 5 system.

Slat wire chambers are made by 2 self-supporting sandwich panels on which PCBs with their cathodic pads and the associated Front End Electronics are glued.
Anodic wires are glued (not welded) on spacers which also provide gap between anodic and cathodic planes. Sealing is achieved by a removable silicone seal without any screws and O-ring seal in order to limit the amount of matter and to avoid machining of sealing planes.

After the integration and test at CERN of the first "final design" 2400 mm long slat in 2001, expected schedule is to start mass production by the end of 2002, and finish production by the end of 2004.

2 Prototype characteristics

A 2400 mm SLAT prototype, in-beam tested at the end of October 2001, was integrated at Subatech (Nantes) between May and June 2001, by SUBATECH - CEA - INFN groups. One of the main components is the 12 printed circuit boards (PCB) system, 6 bending and 6 nonbending, that makes cathode planes. The main features of these PCBs are:

Raw material: standard FR4

FR4 thickness: 0.4 mm

[1]SUBATECH Nantes, CEA Saclay, IN2P3 Orsay, INFN Cagliari, PNPI Gatchina

Cu thickness (base): 0.005 mm

Cu thickness (final): approximately 0.020 mm

Circuit Nominal Size: 400 mm x 580 mm

Active area: 400 mm x 400 mm

Bending Pad Size: 25 mm x 5 mm

Nonbending pad size: 7.143 mm x 25mm

Vertical Interpad: 0.250 mm

Horizontal Interpad: 0.500 mm

Minimum strip width: 0.180 mm

Minimum strip distance: 0.180 mm

Border Cutting: by ERMES Company, required to keep a border of 0.250 mm (+ 0.0 mm, -0.100 mm)

Drilling-boring: done at INFN Cagliari with a milling machine.

Measurements: done at INFN Cagliari.

Producer: ERMES Technology, Via Ivrea 18-10080 San Benigno Canavese (Torino). Tel +39 11 9887472.

Price: 300 Euro per circuit + 300 Euro per code (tooling)

Delivery time: 4 weeks.

In order to provide mechanical stability, PCBs are glued on 2450 mm long sandwich panels made by a carbon fibre/epoxy skin and Nomex honeycomb core. Between panels and circuits there is an electric insulator layer made by a 0.250 mm thick P.I. Nomex layer. Spacers are glued on circuits providing the gap between cathodes and the pitch for wires which are glued on. Field wires are made by tungsten, with a diameter of 0.020 mm, while edge wires have a diameter of 0.050 mm; wires have a mechanical tension of 40 g.

3 PCB measurements

3.1 Circuits coding

Each PCB is coded with a serial number given after the production. The first 3 letters stand for the producer, in this case ERM for Ermes, the second 2 digits indicate the year, 01 in this case, the following letter indicates bending or nonbending (B or N) and the last 2 digits are a progressive number. We have in the end for example ERM01N01.

3.2 Cathode planes measurements

Measurements have been done at INFN Cagliari, with a positioning system whose accuracy is 0.007 mm on 1000 mm length. The main aims is to check the overall circuits dimension, the position of reference marks and the border dimensions, namely the distance between the last pad rows and the cut border along the size where the PCB are glued one next to the other.

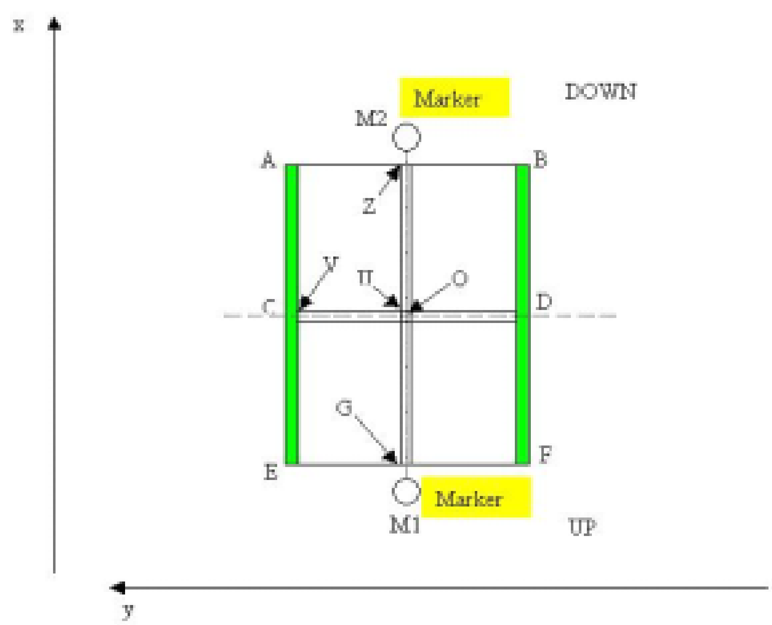

Figure 1: *PCBs measurements scheme.*

Step 1: Position Marks

Measurement of the nominal position of the reference marks M1 and M2. Coordinates are referred to the origin O. The nominal position of mark M1 is: XM1 = - 215.000 mm, YM1 = 0.000 mm, the position of mark M2 is: XM2 = 215.000 mm, YM2 = 0.000 mm.
The results of these measurements are reported in Tab. 1 at columns 4, 5, 6, 7 respectively.

Step 2: Overall dimensions

We measure for each circuit the following lengths: EG, GF; DU, UC; AZ, ZB. Points G,U,Z are located at the border of the central pads. We report in Tab. 1 the results of these measurements together with the overall dimensions EF, DC and AB.

Step 3: Drilling

Drilling is performed without taking into account the position of etched markers. We drill at a nominal reference position of Y = 0 and X= + 215.000 mm and X = - 215.00 mm. These positions are measured by an optical centering device with a magnification factor equal to 50. It is mounted on the axis of the milling machine.

Circuit CODE	Interpad X	Interpad Y	XM1	YM1	XM2	YM2	EG	GF	EF	DU	UC	DC	AZ	ZB	AB
Nominal	0,25	0,5	-215	0	215	0	199,75	200,25	400	200,25	199,75	400	199,75	200,25	400
ERM01N01	0,275	0,519	-215,007	-0,011	215,007	0,005	199,711	200,162	399,873	200,162	199,745	399,907	199,742	200,174	399,916
ERM01N02	0,275	0,511	-215,004	-0,026	215,028	0,024	199,696	200,222	399,918	200,192	199,709	399,901	199,372	200,189	399,921
ERM01N03	0,272	0,522	-215,023	-0,055	215,057	-0,007	199,704	200,173	399,877	200,182	199,719	399,901	199,736	200,206	399,942
ERM01N04	0,264	0,507	-214,992	-0,043	215,037	-0,007	199,723	200,180	399,903	200,187	199,701	399,888	199,717	200,199	399,916
ERM01N05	0,277	0,522	-214,993	-0,050	215,042	-0,002	199,732	200,173	399,905	200,196	199,720	399,916	199,720	200,195	399,915
ERM01N06	0,275	0,522	-215,006	-0,033	215,043	-0,004	199,730	200,187	399,917	200,117	199,708	399,895	199,731	200,182	399,913
ERM01N07	0,277	0,518	-215,006	-0,023	215,046	-0,005	199,709	200,209	399,918	200,194	199,724	399,918	199,755	200,193	399,948
ERM01B01	0,273	0,498	-214,978	0,053	215,060	-0,004	199,679	200,210	399,889	200,218	199,669	399,887	199,664	200,251	399,915
ERM01B02	0,272	0,505	-214,962	0,038	215,096	-0,016	199,724	200,214	399,938	200,217	199,689	399,907	199,680	200,258	399,938
ERM01B03	0,264	0,504	-214,993	-0,033	215,053	0	199,729	200,233	399,962	200,255	199,728	399,983	199,702	200,260	399,962
ERM01B04	0,274	0,500	-214,965	0,035	215,080	-0,006	199,739	200,120	399,859	200,157	199,721	399,878	199,707	200,191	399,898
ERM01B05	0,273	0,497	-214,942	0,012	215,054	-0,003	199,699	200,174	399,873	200,171	199,711	399,882	199,716	200,209	399,925
ERM01B06	0,273	0,504	-214,999	-0,051	215,073	-0,001	199,765	200,138	399,903	200,185	199,722	399,907	199,744	200,216	399,960
ERM01B07	0,276	0,507	-214,999	-0,031	215,076	0,011	199,727	200,151	399,878	200,171	199,748	399,919	199,745	200,206	399,951

Table 1: *Cathode planes measurements. The nominal values are displayed in the second row.*

The PCBs gluing sequence in bending and nonbending planes is (with respect to the numbering):

- Bending Plane: PCB 1 - 2 - 3 - 4 - 6 - 7
- Nonbending Plane: PCB 1 - 2 - 7 - 5 - 4 - 6

It has been checked that ground vias are missed in every bending PCB (down side): the problem, coming from a processing defect, will be solved by connecting with a strip the last pin of the near group of resistors to the missing vias (fig. 2). This operation is to be done at the same time of soldering the 50 Ω resistor.

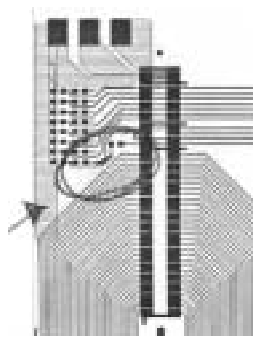

Figure 2: *Schema of unconnected vias problem.*

4 Assembly

4.1 Insulator gluing

Gluing procedures of panels, insulator and circuits are now almost standard. They are the first group of operations that have to be done in assembly phase.
First of all, the insulator sheet (Nomex) is glued on sandwich panels (carbon and Nomex honeycomb sandwich). The chosen adhesive is a two-part epoxy with high shear and good resistance environmental stability to dynamic loading, the 2 components Araldite 2011. Data about mechanical resistance as function of mixture composition (resin + hardener), show that a 100/60 mixture comes out to be a good compromise between mechanical resistance and polymerization time (fig. 3).

In order to achieve a 0.040 mm glue film (0.020 mm per surface) over a total surface of 2450 x 425 mm^2, 44.6 g of glue are required. Indeed it is more convenient to prepare

Araldite 2011, mélange 1.67/1 en poids (100/60), masse volumique 1.066 g/cm3

E = 415 kg/mm^2,
résistance cisaillement à 20°C = 1.90 kg/mm^2,

Résine	1.7	2.5	3.3	4.2	5.0	5.8	6.7	7.5	8.3
Durcisseur	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Total	2.7	4.0	5.3	6.7	8.0	9.3	10.7	12.0	13.3

Résine	10.0	11.7	13.4	15.0	16.7	25.1	33.4	41.8	50.1
Durcisseur	6.0	7.0	8.0	9.0	10.0	15.0	20.0	25.0	30.0
Total	16.0	18.7	21.4	24.0	26.7	40.1	53.4	66.8	80.1

Figure 3: *Araldite mixture data.*

a glue quantity equal to a tabulated value next to those desired, in our case 53.4 g.

The glue is spread with a roller both on Nomex foil and panel (23 g on each surface). This procedure is made by putting on the roller a weighed glue quantity in order to know the surface that is to be covered by that quantity. After glue spreading the Nomex foil (whose dimensions are slightly larger than the sandwich) is laid on the panel and fixed at angles by adhesive tape. The panel is then put under vacuum (pressure: - 0.9 bar) for 24 hours. When panels are glued, the exceeding Nomex is trimmed by a cutter.

4.2 PCBs gluing

The second operation is the PCB circuits gluing on sandwich panels. PCBs are positioned by ø 3 locating pins inserted into accurately located bores on the assembly tooling. The assembly tooling, designed by Subatech, is mainly a granite table with ø 3 H7 bores located within a ± 0.010 mm tolerance. A set of PVC masks is used to protect connectors and guarantee that the circuit surface is at the same level of panel (essential requirement in under vacuum gluing): in those masks there are some holes where connectors are housed.

Figure 4: *PCBs gluing procedure.*

Gluing procedures are absolutely equal to those used in the Nomex case. However, it is here necessary to put stick-on label strips between PCBs in order to avoid glue dregs and pouring in interstices. These strips are removed before panel positioning. After the glue is spread on panel and circuits, the panel is laid on PCB and positioned by putting some spacers between pins and panel. The polymerization phase is completed under vacuum; a second sandwich panel is put on those glued in order to make sure that pressure is uniformly distributed over the whole surface. Because of having only one assembly table, bending and non bending planes cannot be glued at the same time.

After gluing, circuits are cleaned by using propanol 2 (isopropyl alcohol, C_3H_8O).
It is useful to notice that glue spreading and panels positioning operations make PCB moving: this is undesired because circuits are inserted into pins and this motion may cause holes widening, so an altered positioning of all PCBs. It is advisable for the future to fix circuits more strongly, by using for example scotch strips, to reduce undesired motions. An other improving option could be to work on circuits (cleaning, glue spreading and so on) before positioning them on pins, in order to completely eliminate the holes widening.

Figure 5: *Polemerization completed under vacuum.*

The check made on every glued plane shows a good gluing quality, good planarity, without any glue smudge or variation in circuit position over tolerances.

4.3 Spacers gluing

Spacers aim is to set both 2.5 mm pitch for tungsten wires and 2.5 mm gap between anode and cathode.
Spacers are made by a modified polyphenylene ether resin (PPO), the NORYL, produced by GE Plastics. It is an extremely versatile material, with excellent dimensional stability, low mould shrinkage and a very good hydrolytic stability. This last property is very useful when HV is put in the chamber for the first time, it allows to reach quickly the nominal voltage with small leakage currents. This material was widely used in LEP detectors.
The particular type of NORYL resin foreseen for our spacers was the *SE0, unreinforced, flame retardant, UL94 V-0.* Actually the *731 (HG), EN 130, unreinforced, Standard* has been used because it was available and has similar properties.

Bending plane spacers are provided with V-shaped grooves for wire positioning; one type is linear, 40 cm long (fig 6), and an other angular (fig. 7) for the four corners.

Spacer positioning along x direction was made by simple contact between adjacent pieces, as shown in fig. 8.

To put a constraint in the other direction (y, along the smaller dimension) Plexiglas supports have been designed (not shown on the pictures). These supports, one for each PCB, 50 mm wide and 500 mm long, are inserted into pins (the only constant reference frame). They are provided with a groove in order to lock spacers in y direction. It has been necessary to glue a 0.420 mm shim on one side of each support in order to guarantee the correct 0.125 mm distance between the last pad border and the spacer.

The next procedure is spacer gluing on bending plane: it has been calculated that the glue needed to have a 0.040 mm glue thick layer over all their surface is 5.3 g (3.3 g + 2.0 g). This amount has to be equally shared between spacers and PCBs on which they are glued. Spacers must be chemically treated before gluing in order to prepare their surface and increase the glue set. The Araldite producer suggests to use a sulpha-chromic bath to prepare a surface made of polyethylene or polypropylene (as shown in fig. 9):

Alternatively there is a list of adhesives suggested by GE that can be used and for which the compatibility with the NORYL is guaranteed (see www.geplastics.com).

Long adhesive tape strips are arranged on cathode planes to delimitate a gluing surface a few millimeters smaller than spacers. Interstices between PCB are then sealed up with cyanoacrylate in order to avoid gas leakages (as was noticed on a previous prototype). The glue is spread with a small roller on spacers and circuits. As in the previous gluing phase the polymerization is completed under vacuum. Before that, it is very important to level every sharp corner because pressure forces may cause displacement or deformation of gluing parts. In the center of every spacer, the most probable point of deformation, a scotch strip is put to reduce its mobility. When the system is under pressure a maximum differential pressure of -0.2 bar is reached.

After the plane is removed from vacuum a visual check shows a good gluing quality, with good contact between spacers and a uniform glue layer. However it has been checked that on PCB 7 (down side) the spacer has moved, spacing out from its neighbour, and the glue layer is here not uniform. This shifting is considered within

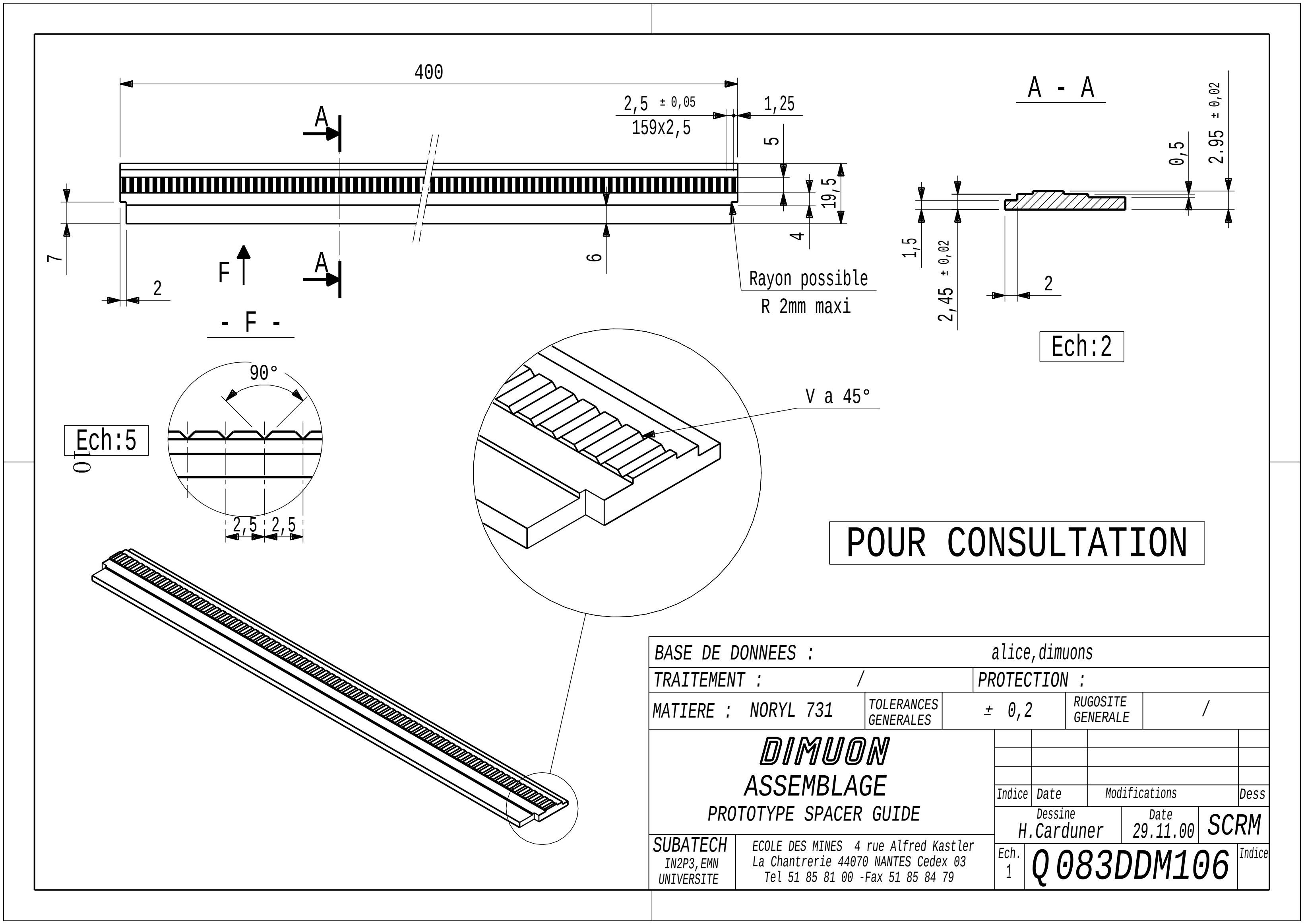

Figure 6: *Technical design of bending plane linear spacer.*

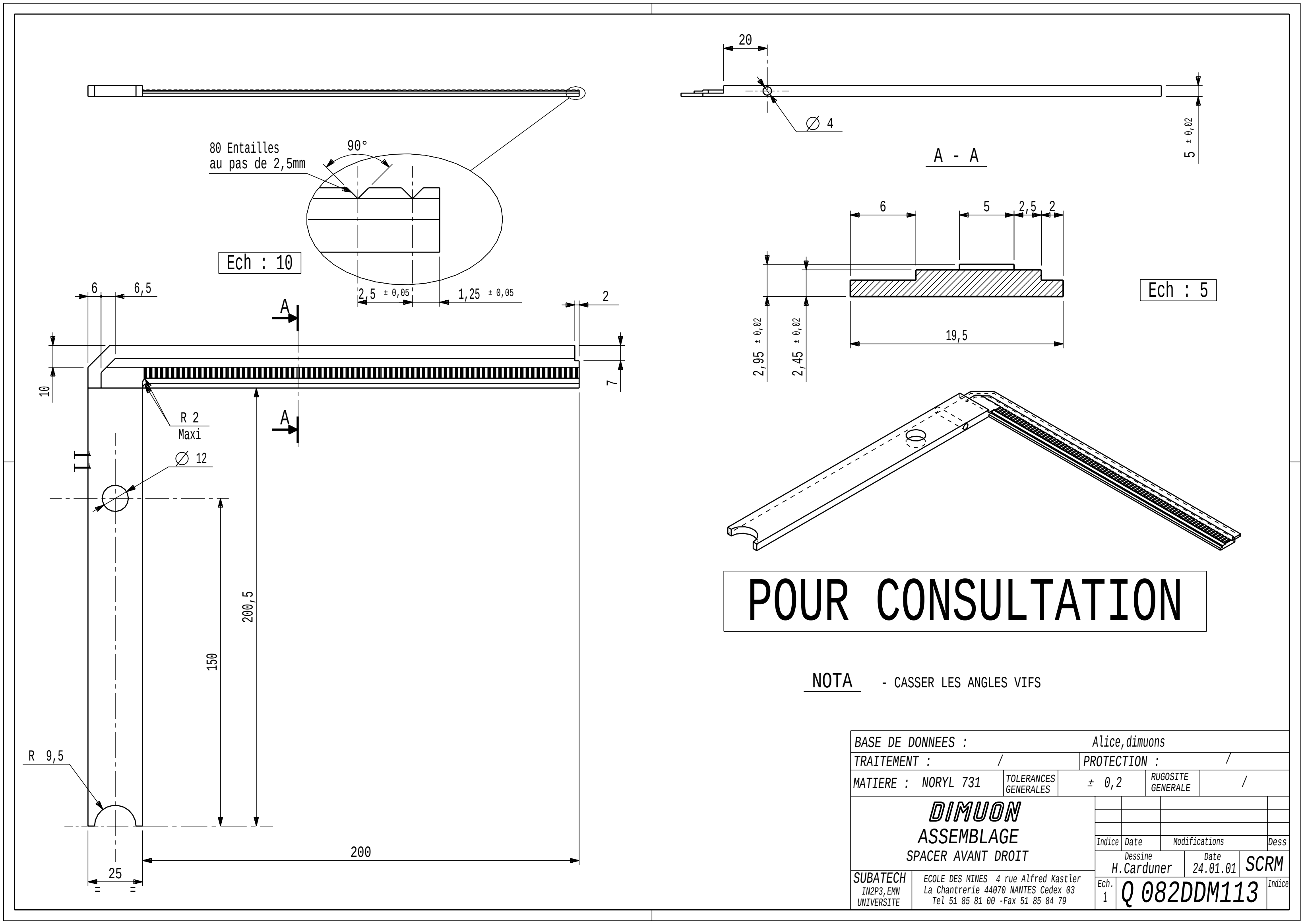

Figure 7: Technical design of bending plane angular spacer.

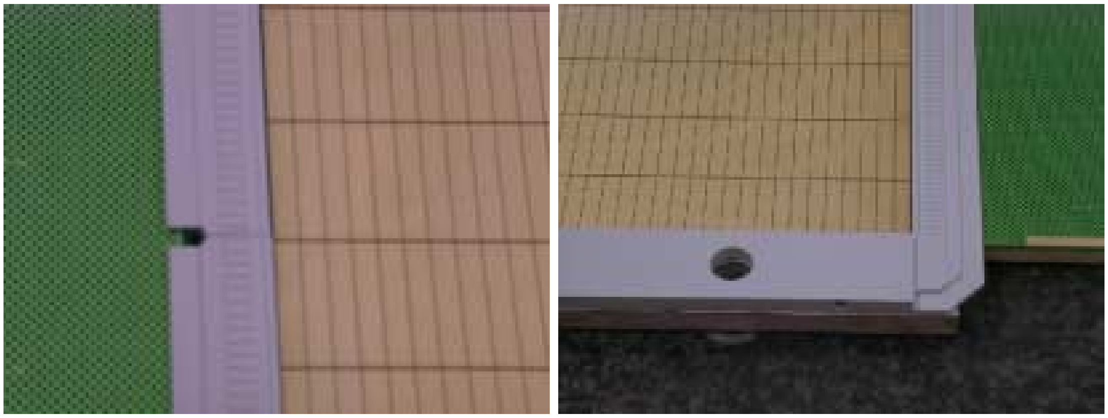

Figure 8: *Spacers glued on PCB: linear (left) and angular (right) types.*

Polyéthylène Polypropylène	(a)	Nécart	Soigneux	Bain sulfo-chromique Acide sulfur. 3,5 kg (1,85 l) Eau 0,15 kg Bichromate de potassium 0,25 kg (0,28 l)	20 °C	15 mn	Rincer soigneusement à l'eau et sécher.
	(b)	Nécart	Soigneux	Traitement électrique par effet corona	—	—	La durée du traitement électrique est en général limitée sur le Polyéthylène à une durée de 3 jours.
	(c)			Passer la surface à la flamme d'un bec Bunsen ou dans la partie bleue d'une flamme d'acétylène			Eviter la surchauffe.

Figure 9: *Sulpha-chromic bath method.*

tolerances and not to be repaired.

Before wire gluing, the problem of nonbending spacers gluing comes out. These spacers, without V grooves, are all straight (without angular parts as in the bending plane), 400 mm long (fig. 10).

Since they can be trimmed, we have a great positioning freedom. There are essentially two possibilities:

- to line up the first spacer with the panel border: in this way the interspaces between PCB are totally covered by spacers and a gas leakage in that zone is easily localized;
- to line up one spacer along each PCB. This would require four spacer pieces at the corners.

It is also checked the problem of possible motion of spacers during the gluing procedure. Their mobility is in fact decreased by a Rohacell layer glued between cathode planes, but on the other side they are completely free to move. It is then advisable for the future to provide nonbending spacers with holes for positioning on pins.

4.4 Wires gluing

The next operation is wire gluing on spacers. Field wires are made by 0.020 mm gold plated tungsten (for this prototype, and non gold plated tungsten later) and are wounded by a wiring machine at CEA, Saclay, with a nominal tension of 40 g. This machine stretches wires with a 2.5 mm pitch on two rectangular frames of equal size, bolted one in front of the other on an aluminium structure in order to keep them parallel. Each frame is constituted by two sides (parallel to wires) made of aluminium and the other two (on which wires are tightened) made of carbon fibre and about 1300 mm long. The two frames are then needed to achieve the number of wires necessary for a 2400 mm long slat.
In order to work on wires (positioning, gluing, cutting) without moving them or decreasing their tension, they must be previously glued on frame. Firstly it is necessary to remove a scotch strip a few centimeters wide just to have enough space to spread the glue. This is a very difficult procedure because of wires fragility and it has to be done by removing the scotch in diagonal with respect to wires. The used glue is once again the standard Araldite 2011 epoxy (the procedure needs 25.3 g of glue: 15.8 g + 9.5 g), deposited by a syringe and then spread out by a spatula. During this operation it is important to spread out the glue in order to have the maximum portion

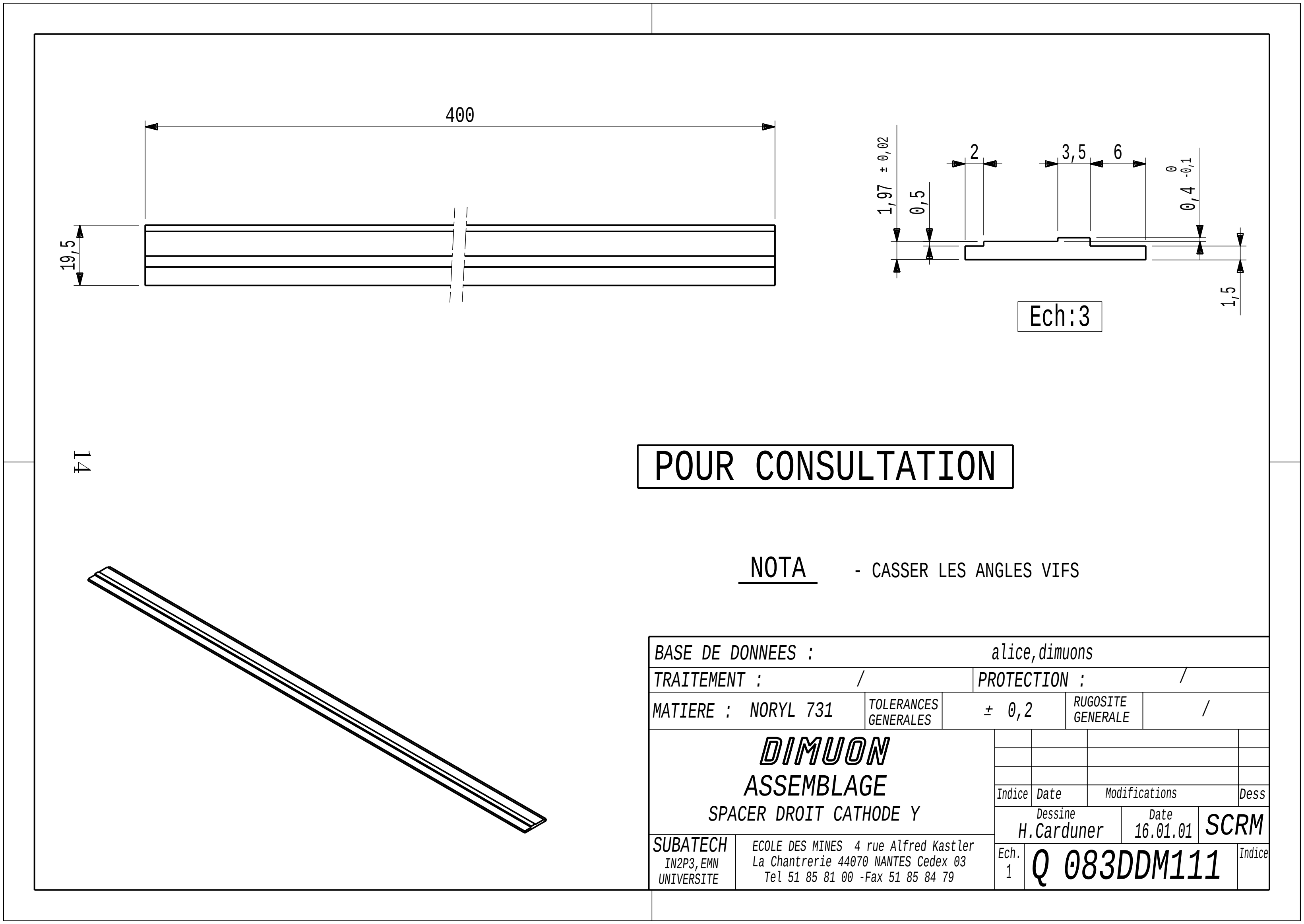

Figure 10: *Technical design of nonbending plane spacer.*

of wires covered by it. The procedure is repeated on both frames and it requires 24 hours to be completed.
Before to glue wires, their mechanical tension is checked. A qualitative measurement can be done by using a very simple device constituted by a bar, put across the frame, on which there is an indicator. With a 1 g weight, provided with a hook to anchor it to the wire, it is possible to estimate if the tension is more or less than 25 g, by looking at the position of the hook (it must be above the lowest line of the indicator, as shown on fig. 11).

Figure 11: *Wire tension check device.*

After the tension check, wires are cut from the frame. They are fixed to the frame by using scotch before cutting.
Frame positioning on assembly table is achieved by using two graduated screws fixed on two sides of the cathode to control x and y position (fig. 12).

The cathode plane is fixed on the assembly marble table by two pins put in opposite direction. The procedure of centering the frame with respect to the cathode plane is quite long and difficult. This is due to the error in the wires alignment for this wounded frame: when the first are aligned with the corresponding grooves on spacers, the alignment is guaranteed only for the first meter of the frame. There is in fact a sensible increase of wire pitch along the entire frame. Moreover wires aren't stretched perpendicularly with respect to the frame, so the frame positioning becomes very difficult. At the end the grease is taken off wires in the gluing zone by brushing them with a sable brush soaked in alcohol. The positioned frame is then kept at about 1 mm from spacers in order to put the glue on spacer grooves before positioning wires.

Figure 12: *Frame positioning (left) and screw particular (right).*

This is because it is more correct to let the wires gluing between two layers of glue: in fact the glue is put on grooves and then wires are positioned inside them. The glue used is always the Araldite: four portions of 4 g each (2.5 g + 1.5 g) are prepared to have four people working at the same time. It is also advisable to dilute each glue portion with 0.5 g of alcohol in order to increase its fluidity. The glue is then put into spacer grooves by a syringe with a neck. The glue in excess is removed by using a spatula. It is important to notice that the presence of four people working at the same time is needed because of glue polymerization time (1 h). Working in this way the time spent is less than 45 min. Moreover all these procedures must be repeated for the other frame to complete the whole slat.

Because of some uncertainty in wire positioning on frame it is necessary to adjust some wire by hand. This is also because wires don't fit into grooves naturally if the glue layer is too thick and they have to be checked one by one. Afterwards the groove for copper strip is cleaned from glue and wires are kept gluing for 24 hours. Then the copper strip is glued in order to guarantee the electrical continuity between anode wires. The copper strip used is a 3M tape, 6.5 mm wide, with conductive glue (in fact there is a similar type but with not conductive glue, that is absolutely useless for the aim). It is necessary to prepare some strips 400 mm long in such a way that each PCB has a conductive "track" isolated from the next one. The exceeding tape is then trimmed with a cutter that, at the same time, cuts the wires outside the chamber.
There is an alternative option, on development at Subatech, to achieve electrical continuity with a conductive varnish.

Figure 13: *Wire cleaning (left) and glue putting on spacers (right) operations.*

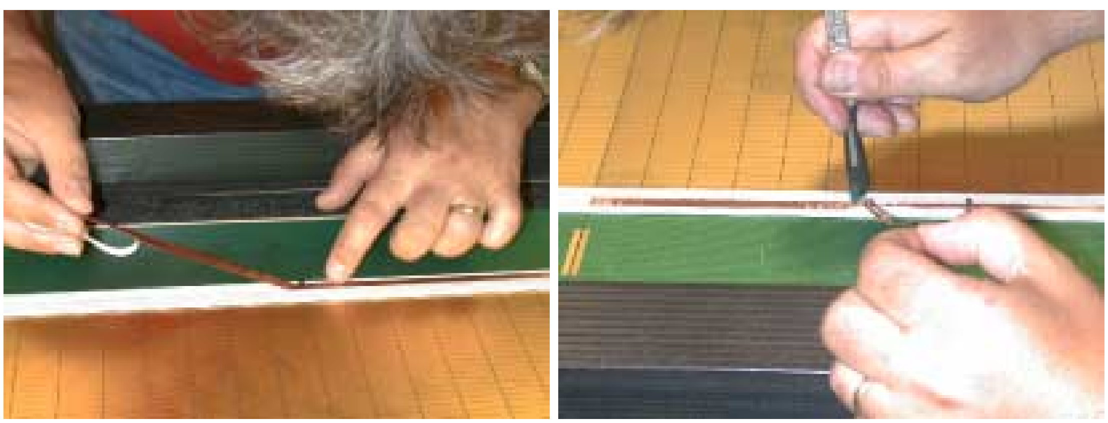

Figure 14: *On the left, copper strip putting; on the right, copper strip cutting.*

Edge wires are then tightened and glued. They are two in the PCB 7 side and one in the PCB 1 side. These wires have a diameter of 50 μm and are tightened by using a lead weight with a hole and with a plastic pin to fix the wire: nominal tension is 70 g but a lower tension is expected because the wire is tightened hanging up the weight that releases its force on bench borders.
At the end a test has been done in order to check the electrical continuity between wires (by a tester). An HV test has been done in order to detect wires with too low stretching load, that are easily attracted by cathode plane. It is checked that with a tension of 500 V there is a current of about 2 nA, in practice negligible (thanks to Noryl spacers).

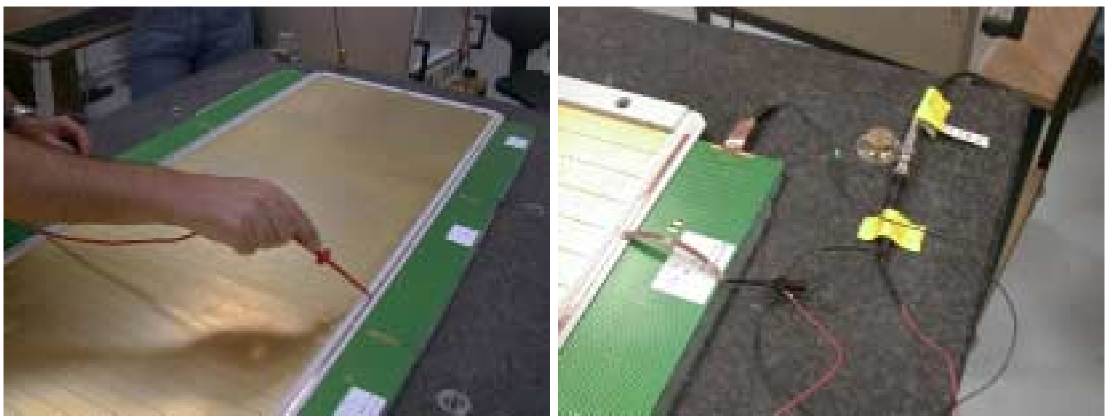

Figure 15: *Continuity and HV test (respectively on the left and on the right).*

HV microcables (from FILECA) soldering is the last operation. The cable is firstly soldered on a copper strip glued on the spacer, then it is soldered on a pit on the PCB together with the HV capacitor (1 nF, 2 kV). HV cables (one for each PCB) are then grouped and soldered on a plaque that provide a singular or global supply. There are also other six spare cables on the other side, soldered at the ground pit.

4.5 Rohacell gluing

A Rohacell spacer is glued in the interspace between PCBs outside the detector active area. The Rohacell spacer is milled to obtain some grooves where HV cables and pits with capacitors are positioned. Moreover another groove should make easier

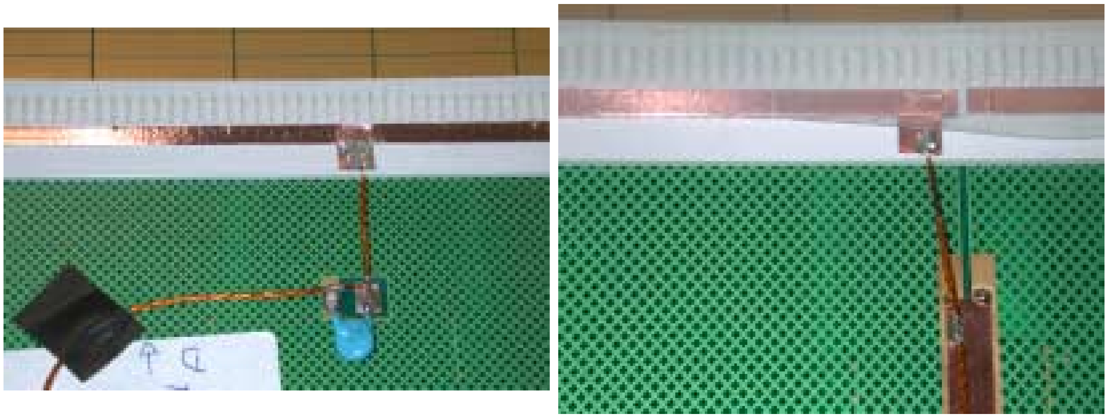

Figure 16: *Particular of HV capacitor (left) and HV cable soldered on strip (right).*

the extraction of a nylon fishing-line tightened between spacers and the silicon. The fishing-line is put there in order to allow the slat reopening for maintenance when used as a zip device. The Rohacell layer is glued on the bending plane PCB by using the RTV 160 silicon, produced by GE Silicones, and it is finally put under vacuum.

Figure 17: *View of completed bending plane (left) and particular of Roachell spacer (right).*

4.6 Nonbending spacers gluing and closing

The next procedure is spacers gluing on the nonbending plane. These spacers, as described in §4.3, are laid down on those of the bending plane and aligned one for each PCB. Empty spaces at the corners are filled by small pieces produced on purpose, as shown in fig. 18 (right).

Figure 18: *View of bending plane with non bending spacers positioned (left) and particular of corner (right).*

The Araldite glue is then spread on them (quantities are the same of bending gluing) by using a little roller. Next, the EMAX Sil 93 silicon is spread in the closing groove between bending and nonbending spacers: the procedure is done by lifting the spacer, spreading on the silicon by a gun and then leaning again the spacer. It must to be done very quickly because the Sil 93 makes a skin after a 10-20 min time. Before laying the nonbending plane, the RTV 162 silicon is spread on Rohacell in a such a way that it is then glued on circuits of the other plane. The silicon type choice is due to its lower sealing power: it can be removed, making the slat easier to be opened. At the end the nonbending plane is laid on spacers and positioned by pins where it is inserted; the slat is then put under vacuum.

Although a 12 hour time is not sufficient for a complete polymerization, the slat has been taken from vacuum and pins have been removed. This procedure is in general unadvisable because pins are completely dipped on silicon and their extraction need some rough treatment that may produce displacement or traumas.

Figure 19: *Particular of silicon spreading (left) and under vacuum closing operation (right).*

4.7 Gas leakage test

After sealing the slat is subjected to a gas leakage test. The Ar/CO2 gas is fluxed into the slat and the output tube is connected to a bubbler in order to verify the presence of an output flux. This first test gives a negative result. By using a leak detector it is checked that each connector vias is a leak source. All these vias are then sealed with cyanoacrylate: the test is now repeated and the result concerning gas leakage is positive.

Taking into account results of this test, the way of sealing slats used for this prototype will no more be used, because the cyanoacrylate glue strongly disturbs electrical continuity in connectors and because the connector vias are not the normal boundary limits.
For next slats, sealing will be done in 2 steps, the first one before putting the Rohacell spacers. This is done in order to allow check and repair of leakage at the real boundary limit of the gas and in order to repair leakage exactly where there are located. Final step will be the assembly of Rohacell spacers which aim to give stiffness to PCBs and not to give a better sealing.

5 Conclusions

The first large size SLAT prototype (made according to the final design) for the ST345 chambers of the ALICE Dimuon tracking system has been assembled in May

- June, 2001 in Subatech, Nantes. After the assembly it has been sent to IN2P3 Orsay for a set up of the MANU345 front end electronic and to CERN for in-beam tests.

The prototype assembly has been very useful to show positive and less positive aspects of procedures. In the following list we present the positive ones:

- The PCB's design for the maximum pads density, according to the new electronics, has been confirmed. It is the main step in the future developement of other density PCBs. In this assembly it has also been possible to test the production of two different companies and the result is good.

- The PCB positioning and all the gluing procedures (carbon panels, insulator, PCBs) are almost standard and are now finally approved.

- The wire gluing operation, tested in a big prototype for the first time, has given a very good result. It is still under study the possibility to use a conductive varnish instead of the Araldite glue with the copper strip.

There are also some problems in assembly procedure:

- Spacers gluing operations showed a difficult positioning of spacers on the cathode plane. For bending plane spacers the positioning operation is quite good. Althought for the non bending one it is necessary to modify the design of spacer in order to achieve a better positioning and a different gluing procedure (see §4.6).

- Sealing operations have given a less positive result and it has been necessary to adjust the procedure as discussed in §4.7.

The prototype has been in-beam tested once again on October 2001 at the PS (CERN). This test showed a very low noise level (around 1200 e^-) and a spatial resolution of 0.08 mm in the bending plane and of 0.6 mm in the nonbending. Moreover the detector has an efficiency greater than 96% for a voltage within 1650 V and 1750 V [1].

References

[1] "ALICE Internal Note on test beam results." To be submitted