MEMORANDUM OF UNDERSTANDING

BETWEEN

INSTITUTE OF HIGH ENERGY PHYSICS AT BEIJING

AND

THE CMS MUON SUBDETECTOR COLLABORATION

FOR

DRIFT-TUBE ELECTRONICS ASSEMBLY

Friday, 16 July, 1999

1 Introduction

This Memorandum of Understanding (MoU) defines the partnership between IHEP, Beijing, and the CMS Muon Subdetector Collaboration, hereinafter referred to as CMS-MSC, in the assembly and test of the High Voltage Boards, the High Voltage Coupling boards and relative Interconnection cables of all DT chambers. The detector is described in the CMS Technical Proposal, December 15, 1994, the Technical Design Reports, and subsequent technical documents elaborating that design.

This MOU is an agreement under the MOU between European Organisation for Nuclear Research (CERN) and the Chinese Academy of Sciences (CAS) and other funding agencies concerning the CMS Collaboration, which in turn is under the umbrella agreement titled:"Co-operation Agreement Concerning the Further Development of Scientific and Technical Co-operation in the Research Projects of CERN" signed by CERN and the Chinese Government of the People's Republic of China, represented by its State Science and Technology Commission (now the Ministry of Sciences and Technology of China), in 1992.

This MoU is designed to explicitly describe the mutual long-term responsibilities and contributions between IHEP and the CMS-MSC and covers the time period from 1999 through 2004, in accordance with the overall construction schedule of the CMS detector, cf. Annex 7 of the CERN-China MoU. It does not constitute a legal, contractual obligation on the part of any of the parties to this MoU. It reflects an arrangement that is satisfactory to the parties, which also agree that this arrangement is not contradictory to or exceeding the respective obligations defined in the CERN-China MoU

2 Mutual Responsibilities between IHEP and CMS-MSC.

2.1 HVB's, HVC's and relative Interconnections

IHEP shall be responsible for the timely delivery of the specified quantity of tested and working Boards, and Interconnections.

The design, prototypes development, and final specifications of the High Voltage Boards, the High Voltage Coupling boards and the relative Interconnections of the Barrel Drift Tubes, as well as the definition of HV testing procedures and parameters, described in Appendix A, shall be responsibility of the CMS-MSC. IHEP shall be responsible for the High Voltage entrance-test of HVB printed circuit boards, the assembly of the boards and cables, and the final HV test of the finished boards

2.2 Setting up of the assembly and test facilities at IHEP

The CMS-MSC shall provide to IHEP all the necessary Assembly and HV-Test Jigs, described in Appendix B, equipped with the necessary software, where required . IHEP agrees to take part in the development of test Jigs and procedures and to provide facilities of adequate size and quality for setting up a site for assembly and test of the HVB's, HVC's and relative Interconnections. Maintenance and operational expenses associated with running the facilities through the entire period of production and testing shall be the IHEP responsibility. Manpower needed to set up the IHEP assembly and test site shall be provided by IHEP

The CMS-MSC and IHEP share responsibilities in transferring the technical knowledge involved in assembly and tests and in the optimisation of the relative procedures for the mass production. Negotiated contributions from INFN and IHEP sides shall cover a visit of IHEP technical personnel to LNL-Padova assembly site for training in assembly and test procedures and take part in the production of a pre-series of about 500 boards of each type, plus the relative Interconnections. One, or more, subsequent visits to IHEP of personnel CMS-MSC will be arranged in the phase of setting up of the assembly and test facilities and in the running-in phase of production at IHEP and shall be covered by CMS-MSC.

Ordinary maintenance of assembly and test equipment shall be the IHEP responsibility, The CMS-MSC shall provide training of IHEP personnel in maintenance of the assembly and test Jigs as well as reasonable help in repairs. Broken key elements shall be repaired under responsibility of IHEP, with the assistance of CMS-MSC expertise.The CMS-MSC shall cover the shipping and insurace costs of the Jigs from Europe to entry port in China, delivery and insurance costs to IHEP as well as local Custom fees and taxes, if applicable, shall be covered by IHEP.

At the end of the production the assembly Jigs shall be returned to CMS-MSC that shall cover the shipping and insurance costs of the Jigs from exit port from China to final destination. IHEP shall be responsible for delivery and insurance to exit port and cover the relative expense.

2.3 Assembly and testing at IHEP

The CMS-MSC shall provide, free of charge, the raw materials and components necessary for assembly listed in Appendix C. The adequate equipment and facilities shall be set up by IHEP by the time when the first shipment is expected. A schedule of shipments is to be cost optimised and will be determined later in common agreement.

The CMS -MSC shall cover shipping and insurance costs of assembly materials to entry port in China; delivery and insurance to IHEP as well as local Custom fees and taxes, if applicable, shall be covered by IHEP.

During the construction period the total of HVB's, HVC's and interconnections shall be fully assembled and the boards tested at IHEP. The CMS-MSC shall provide assembly materials in amounts allowing for production in accordance to the agreed upon schedule.

The IHEP shall provide a team of adequate size and experience. The team shall carry out the whole assembly and the HV tests on the boards.

The IHEP shall be responsible for the shipping and insurance of all the finished materials to exit port from China according to a schedule to be negotiated with the CMS-MSC. Shipping conditions should comply with the requirements to guarantee safe delivery of the materials.

The CMS-MSC shall cover the shipping and insurance costs of assembled materials from the exit port from China to the final destination, plus Custom fees and taxes outside China, if applicable. IHEP shall pay for the delivery and insurance to exit port.

2.4 Schedule

A tentative schedule, covering items 2.1 through 2.3 of this MoU is provided in Appendix D. It is based on the current overall CMS detector Schedule , as well as the availability of funding and resources within The CMS Muon Subdetector and the IHEP. The actual schedule may depend in particular on the consequent availability of materials.

The contents of Appendices A to D are susceptible of complements and/or amendments on the basis of mutual agreement between the two parties.

In particular, the specifications in Appendix A may need adjustments as a result of the experience made in the pre-production carried on in LNL-Padova and IHEP-Beijing.

2.5 Summary on the IHEP contribution costs

IHEP shall pay for all its personnel as required for the assembly and testing phase and in the setting up of the adequate facilities, as well as to cover the local Custom fees and taxes, when applicable, and the shipping and insurance cost form IHEP-Beijing to the China port and viceversa.

The value of the China contribution in the CMS Muon D-T electronics is estimated to be 550 kCHF (see CMS-MoU, Annexes 6, 8A,.9.5B, 10.7) .

3 Management

3.1 CMS Muon Subdetector Management

For the purpose of this MoU the CMS Muon Subdetector Management has chosen to take residence at CERN. The CMS Muon Subdetector Managers have appointed appropriate Subdetector Co-ordinators responsible to them for subsystems. IHEP collaborates with the CMS Muon Subdetector Collaboration through the involvement in the Barrel Muon.

The appointed co-ordinators in the Barrel Muon System are the muon technical co-ordinator, the muon chambers co-ordinator, the muon electronics co-ordinator, the muon resources manager. The CMS Muon Subdetector contact person, in matters concerning this MoU, for the IHEP-Beijing is Marco De Giorgi INFN-Padova.

3.2 China CMS management for the execution of this MoU

IHEP assembly and test site contact person: Zhuang Baoang

3.3 Reporting

The progress of the setting up of the assembly site at IHEP and the subsequent assembly and test activities will be reported monthly by the IHEP contact person to the CMS Muon Subdetector contact person.

4 Makers and Concurrence

The following persons concur in the terms of this Memorandum of Understanding. These terms will be updated as appropriate in Amendments of this Memorandum.

Signatures:

For CMS Muon Detector	for IHEP Beijing
______________________________ Fabrizio Gasparini CMS-Muon Project Leader	______________________________ He Sheng Chen China CMS Spokeperson
______________________________ Marco De Giorgi Project Responsible	______________________________ Zhuang Baoang IHEP Project Manager

Copy sent to:

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Michel Della Negra
CMS Spokesperson

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Diether Blechschmidt
CMS Resource Manager

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Cristiana Peroni
CMS-Muon Resources Manager

APPENDIX A :

HVB, HVC and Interconnection descriptions

- HVB is a printed circuit board 305 mm long by 36 mm wide by 3.5 mm thick. It will lodge 4 groups of hybridised resistors, 6 HV blocking capacitors, 18 pins for input/output connections of high voltages to the board, and 16 wires providing for connections to the chamber anode electrodes. The function of HVB is to provide the drift tubes of the chambers with the appropriate high voltages.
  The required quantity of tested and working HVB's is 11500 of which a small quantity of 320 special boards, about half in length, are marked " ^ " in the component list

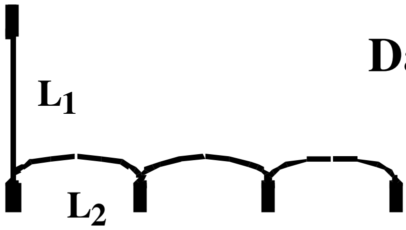
- HVC is a printed circuit board 160 mm long by 11 mm wide by 1.6 mm thick. It will lodge 16 HV coupling capacitors, 16 smd 2MΩ resistors (for reference to ground of the capacitors LV side), 2 arrays of 17 sockets s.i.l. (ϕ=0.5mm), 4 pins for guidance, 3 fork-contacts, and 16 wires providing for connections to the chamber anode electrodes. The function of HVC is to provide HV decoupling from the anode wires of the drift tubes of the chambers to the Front-End boards that will be connected to it via the 2 s.i.l. socket arrays.
  The required quantity of tested and working HVC's is 11500 of which a small quantity of 320 special boards slightly elongated are marked " º " in the component list

- Interconnections constitute a set of HV wires of different length and shape; they are meant to connect:
  ⇒ the primary high voltages from HV connectors on chamber covers to HVB's (S&C+W connections),
  ⇒ to parallel groups of HVB's to the same primary HV connections (Jumpers),
  ⇒ to connect HVB's and HVC's to anode wires of chambers (Wire connections)
  ⇒ to parallel Strip and Cathode electrodes of several drift tubes to the same point on HVB's (Daisy Chains).
  The drawing "High Voltage Interconnections" gives the dimensions, the mounting specifications and the quantities of the interconnections.

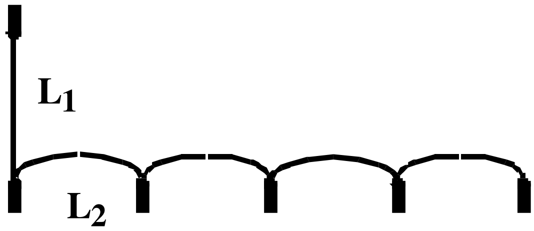
All the quantities quoted above include 5% of spares.

HIGH VOLTAGE INTERCONNECTIONS

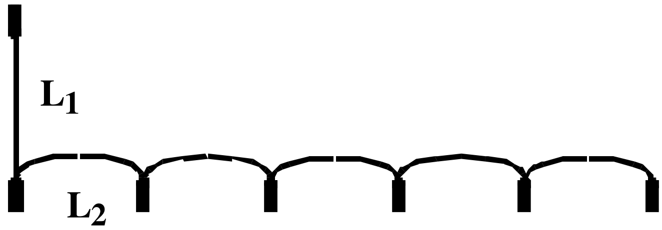
Daisy Chains — Quantity



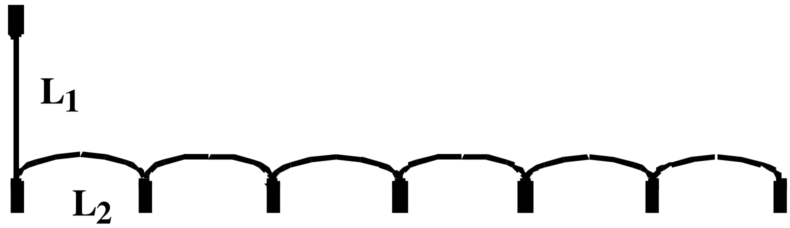
"S" 43200
"C" 43200



"S 1000
"C" 1500

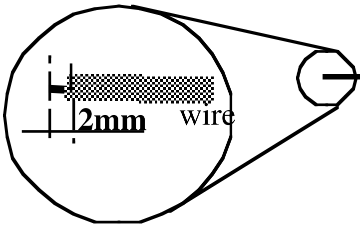


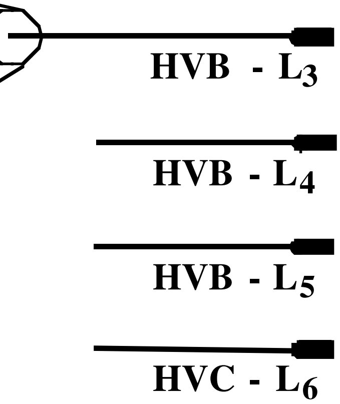
"S" 260
"C" 1000



"C" 260

Wire Conn.





"W" 177500

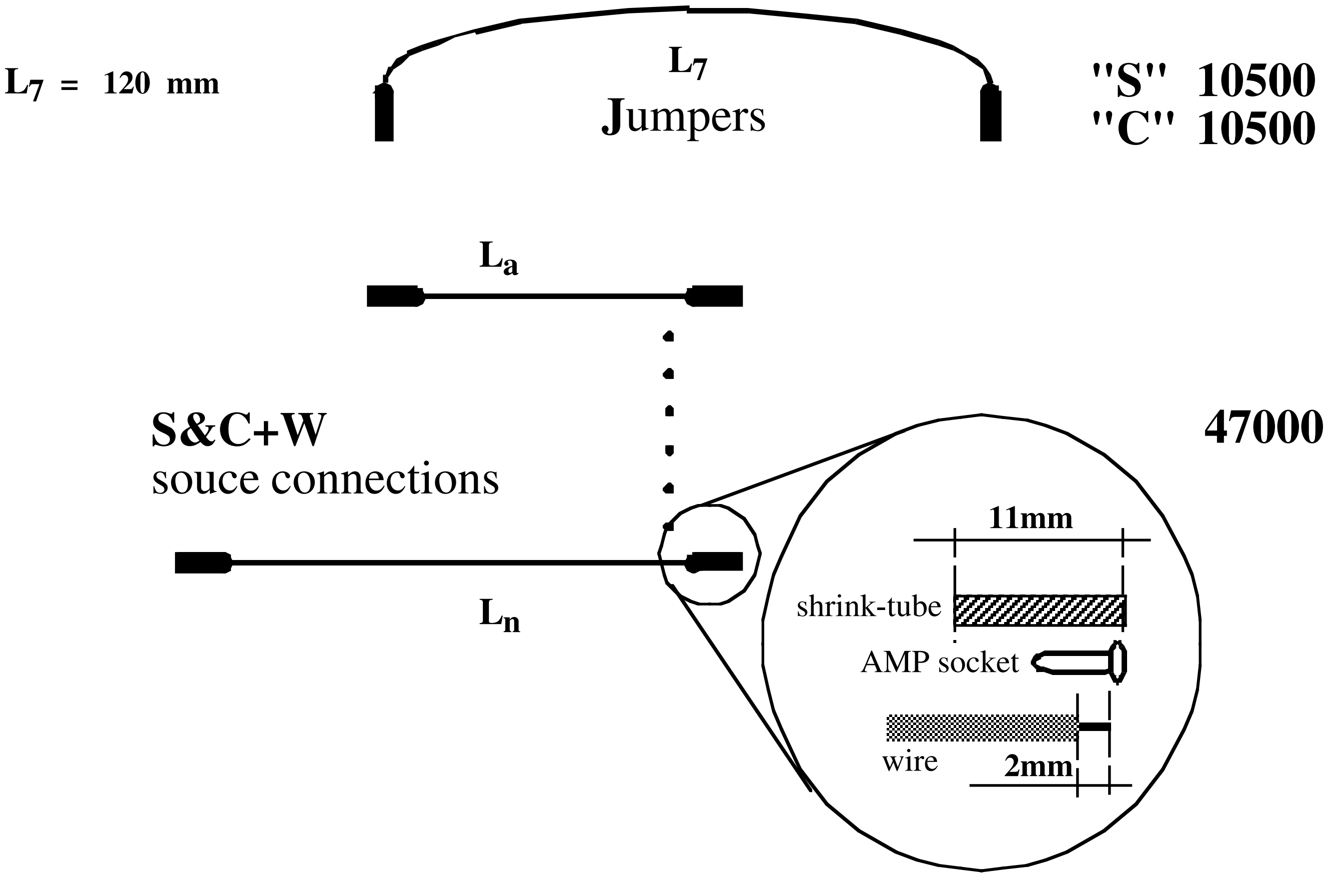
"W" 1250

"W" 1250

"W" 180000

L_1 = 95 mm
L_2 = 70 mm
L_3 = 50 mm
L_4 = 135 mm
L_5 = 70 mm
L_6 = 37 mm

HIGH VOLTAGE INTERCONNECTIONS



Shrinking tubes of three different colours are foreseen for S,C,W connections respectively:

	Red for	**"W"**
	White for	**"S"**
	Yellow for	**"C"**

HVB mounting specifications

- HV pins, HV Capacitors and GND contacts should be mounted by use of the appropriate jigs and oriented as in the pre-series.
- HV hybrid resistors soldered to PCB pads by means of appropriately short wires and positioned precisely with respect to pads using the dedicated jigs.
- Wire connections assembled as shown in the HV Interconnection drawing
- All soldering points should be carefully executed so to avoid spikes
- To clean soldering residuals, mounted boards should be washed with the appropriate solvent to be specified.
- All soldering points on one face of a set of boards (~20)should be isolated with the proper amount of 3M-DP 190 epoxy glue and then the opposite side should be treated; each set of boards should be left curing for at least 48 hours at 45º C temperature.
- Boards should be handled with gloves
- Boards shall be finally labelled by means of the appropriate instrument.

HVC mounting specifications

- Guidance pins and GND contacts should be mounted by use of the appropriate jigs
- HV Capacitors should be oriented as in the reference specimen
- Wire connections assembled as shown in the HV Interconnection drawing
- All soldering points should be carefully executed so to avoid spikes
- To clean soldering residuals, mounted boards should be washed with the appropriate solvent to be specified.
- All soldering points of capacitors on the HV face should be isolated with the proper amount of 3M-DP 190 epoxy glue, as in the reference specimen, and left 48 hours to cure at 45º C temperature. Epoxy glue should be stored as specified by the fabricant.
- Boards should be handled with gloves
- Boards shall be finally labelled by means of the appropriate instrument.

Test procedures and specifications

- The Jigs will automatically disconnect and record faulty boards, record currents and maintain the book-keeping of the whole test in accordance to the Quality Control rules of CMS Muon Subdetector.
- A quick entry HV test at +5kV, +/-2.5kV should be made on groups of 16 arriving HVBs' with the appropriate jig (~30 minutes in air), to check them for discharges or leakage
- Mounted boards should be inserted in the appropriate Test Jig in groups of 16
- The appropriate HV's (+/-2.25 kV,+4.5kV for HVB and +4.5 kV for HVC) applied and relative currents checked to be ≤ 200 nA for the lot of boards under test, into 10 minutes since the HV's were applied.
- In case no board shows undue currents or discharges, the Test Jig should be closed and the gas flow started (85%Ar - 15% CO_2); "bad" boards should be set apart for further inspection
- As soon as the O_2 content reaches a value below 500ppm all currents should be monitored to be ≤ 70 nA for at least 3 hours; in case of a discharge or of higher currents, the guilty board shall be excluded by HV and set apart for further inspection

APPENDIX B :

Mounting ant test jigs list

Provided by the CMS Muon Subdetector:

- Mounting jig for GND spring–contacts and for guidance-pins on HVC.
- Mounting jig for wire-connections
- Mounting jig for hybrid resistors
- Mounting jig for HV capacitors
- Insertion jig for HV pins on HVB
- Bending jig for HV pins on HVB
- Dispenser for 3M DP-190 epoxy insulating glue
- Jig for HVB entrance HV test
- Jig for HV test in Ar-CO2 gas mixture of mounted HVB
- Jig for HV test in Ar-CO2 gas mixture of mounted HVC
- Oxygen meter
- High Voltage power supply for test-Jigs
- Personal computer equipped with Test-Software
- Labelling jig

Provided by IHEP:

- Gas system

APPENDIX C :

HVB component list

ITEM	Type p/n	per Board	per Board^ (320)	Total
pcb	HVB-20Ch	1	1	11500
hybrid resistors	MIPOT hyb HV-6 hyb HV-8	4 2[a]	2	43700 1300
HV pins	Micomp c.c. 118.1 (or eq.)	18	9	203600
GND contacts	custom	3	2	33800
blocking capacitors	Murata DE1010 B471k6kV	6	6	68500
Wire connections	Fileca F 1510 P 007 50 mm long	16	8	*
wire-sockets	AMP 380.598-2	16	8	*
Shrinking tubes	T&B MLP-BG 93/ (0 /2 /4) (or eq.)			*

[a] only on 650 HVB's
* see *Interconnections and raw materials list*

HVC component list

ITEM	Type p/n	per Board	per Board° (320)	Total
pcb	HVC-16Ch	1	1	11500
SMD resistors	1M - 1206	16	21	180000
i.c. sockets	Precidip 350-10-120-00-106	34	44	386000
pin-guides	Multicontact IT. S1-B (or eq.)	4	4	45000
GND contacts	custom	3	3	33800
coupling capacitors	Murata DE1010 B471k6kV	16	21 max	180000
Wire connections	Fileca F 1510 P 007 37 mm long	16	21 max	*
wire sockets	AMP 380.598-2	16	21 max	*
Shrinking tubes	MLP-BG 93/ (0-2-4) (or eq.)			*

* see *Interconnections and raw materials list*

Interconnections and raw materials list

ITEM	Type p/n	Total
wire	Fileca F 1510 P 007	90 km
shrinking tubes	MLP-BG 93/ (0-2-4) (or eq.)	11.5 km
wire sockets	AMP 380.598-2	946000 pc
Tyxotropic Glue	3M DP-190	~80 l

APPENDIX D :

TentativeTime schedule

- About 150 HVB's plus the relative quantity of Interconnections to be built at LNL-Padova assembly site for training of IHEP personnel

  By end July 1999

- Transfer of Jigs and shipment of first batch of components to IHEP-Beijing for pre-production

  By end September 1999

- Setting up of Assembly and Test Site at IHEP-Beijing

  By mid November 1999

- Production of further ~ 350 HVB'sand relative Interconnections at IHEP to test the production line and to cover the year 1999 pre-production of Chambers

  By mid December 1999

- Start mass production at IHEP-Beijing at a rate of approximately 500 HVB and 500 HVC plus the relative quantity of Interconnections every month (the production of special boards shall be evenly distributed in time)

  By end January 2000

- Delivery to CMS Muon Subdetector of a first batch of 500 boards per type plus the relative quantity of Interconnections

  By mid March 2000

- End mass production at IHEP-Beijing

  Before December 2002