GEM chambers for SoLID Nilanga Liyanage

University of Virginia

SoLID Spectrometer



Main Challenge: large area

- COMPASS GEM chambers only 30 cm x 30 cm; there were total 22 chambers, total area ~ 2 m².
- Requirements for SOLID more than an order of magnitude larger.

Plane	Z (cm)	R _I (cm)	R _O (cm)	Total Area (m²)	circumfe Inner	rence (cm) outer
4	120	39.0	87.2	1.9	245	548
5	150	48.7	109.0	3.0	306	684
6	190	61.7	138.0	4.8	388	867
7	290	94.2	210.7	11.2	592	1323
8	310	100.7	225.2	12.7	633	1414
total:				33.6		

This is the bare minimum: high rates may require multiple chambers at the same location.

• Disk area larger than available GEM foil size (currently $\sim 45 \times 45 \text{ cm}^2$); need larger foil and segmentation.

• Large total area: most current GEM foil production at CERN shop: can they handle this volume ? Need new foil manufacturing

Production at CERN

GEM size

- With existing equipments 1.5m x 0.5m active area
- Mid 2011: 2m x 0.5m active area

Volumes

- With existing equipment: 10 GEMs/month.technician
 We can hire one more technician
- Mid 2011: 24GEMs/month.technician (240GEM/year)
- With some offers for large volume production we start to see the limit price of the GEMs : in the range of 600 CHF/sqr.meter

TOTEM T1 prototype chamber made with single mask GEM foils spliced together (33 cm x 66 cm)

- Base material up to 51.4 cm wide now available
- CERN plans to buy equipment capable of producing 200 cm x 50 cm GEM foil.



This combined with Splicing: 200 cm x 100 cm GEM foil may be possible in the next two years

M. Villa, et al., Nucl. Instr. and Meth. A (2010), doi:10.1016/j.nima.2010.06.312 M. Alfonsi et al. / Nuclear Instruments and Methods in Physics Research A 617 (2010) • Assume largest dimension of GEM foil ~150 cm x 50 cm

Plane	Z	R _I (cm)	R _o (cm)	Total Area (m²)	inner circumfer ence	outer circumfer ence	Chamber segments
4	120	39.0	87.2	1.9	245	548	8
5	150	48.7	109.0	3.0	306	684	16
6	190	61.7	138.0	4.8	388	867	32
7	290	94.2	210.7	11.2	592	1323	32
8	310	100.7	225.2	12.7	633	1414	32
total:				33.6			120

rough cost estimate

Item	Quantity	Unit cost	Total cost	Material only unit cost	Material only total cost
GEM foil	~100 m ²	\$3000/m ²	0.3 M	\$3000/m ²	0.3 M
readout boards	120	\$ 2500	0.3 M	\$ 2500	0.3 M
chamber support frame	120	\$ 1500	0.2 M	\$ 1500	0.2 M
Supplies and tooling			0.1 M		0.1 M
FEE and DAQ	300 k	\$ 7.0	2.1 M	\$ 4.0	1.2 M
cables, power, etc			0.5 M		0.5 M
Gas system			0.1 M		0.1 M
Labor: Technicians	12 FTE-years	\$ 80 k	1.0 M	\$ 80 k	-
Labor: Grad students	6 student- years	\$ 50 k	0.3 M	\$ 50 k	-
support structure and integration			???		???
TOTAL:			~ 5 M		~ 2.7 M
With 33%			~6 7 M		~3 6 M
contingency			-0.7 IVI		-3.0 IVI

R&D and prototyping expenses: ~ 200 k (~ 800 k year 1, ~ 140 k year 2)

Hardware infrastructure ready for GEM testing

• A 3000 chan. APV25-S1 readout system ordered , will be ready soon: speeds are what we need for the final setup, can do tests on rate effects etc.

• A brand-new Iseg-Wiener multi-channel HV system bought; designed for sensitive detectors like Silicon strip and GEM: 16 HV channels to start with, can be expanded to 160 chan.

Some Good News: R&D funds for GEMs

• \$ 45 k from Jlab/hall A: for construction of a SBS-type prototype GEM chamber.

- Construct two 40 cm x 50 cm GEM chambers
- Gain experience in large GEM chambers
- Test different readout schemes: fine readout, coarse readout, pad readout etc.
- Plan to construct this summer; ready for beam testing by November.



Some Good News: R&D funds for GEMs

• \$ 55 k from BNL EIC detector R&D fund: for construction of a large area GEM prototype to fit in a solenoidal spectrometer

- Construct a ~ 100 cm x 50 cm GEM chamber; segment of a large circle
- Similar to the size we need for SoLID
- Test different readout schemes determined from the simulation.
- Study Issues related to high capacitance, non-orthogonal readout etc.
- Plan to construct this winter

CERN RD51 collaboration is developing a readout system for GEM chambers - Scalable Readout System (SRS) physical overview SRS of RD51



Registered SRS Users

AUCE, CONJ Wuhan, ON	ALICE DCaL and PHOS Calorimeters	DTC link protocol and Adapter,	dahoukee@emel.co	Team leader	USEF ALICE				
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CERN experiments

- ATLAS CSC upgrade Micromegas
- ALICE EMCaL, SRU-based readout backend
- NA62 Straw tracker

Other HEP experiments

- NEXT Collaboration, dual Beta decay, SiPM, PM
- BUDKER, INP, Deuteron, triple-GEM

Applications with Cosmic Tomography

- FIT Florida, homeland security, GEMs
- Geoscienes Azur CRNS- Waterquality, MMegas

R&D with MPGD's (small systems)

- Weizmann Inst. Sci., THGEM tests
- Tsinghua Univ, GEM Imaging
- Bonn/Mainz Univ, Timepix readout
- Helsinki HIP, GEM detector
- LIP Coimbra, micropatten RPC, for PET
- INFN Trieste, THGEM photon detection
- MEXICO UNAM, THGEM
- SAHA Kolkotta, Micromegas
- USTC Shanghai, GEM and MicroMegas
- Zaragoza Univ, GEM and MicroMegas
- CE Saclay, Micromegas
- some more non-confirmed

STAR FGT - outer radius ~ 0.45 m 2D Readout



50 µm Kapton

- copper both sides
- laser etching exposes bottom layer

Top layer

- Φ readout layer
- alternate lines end 18.8 cm
- 300-600 µm pitch
- 80-120 μm line width
 - need to tune for charge sharing

Bottom layer

- R readout layer
- 800 µm pitch
- 700 µm line width

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