GEM chambers for SoLID

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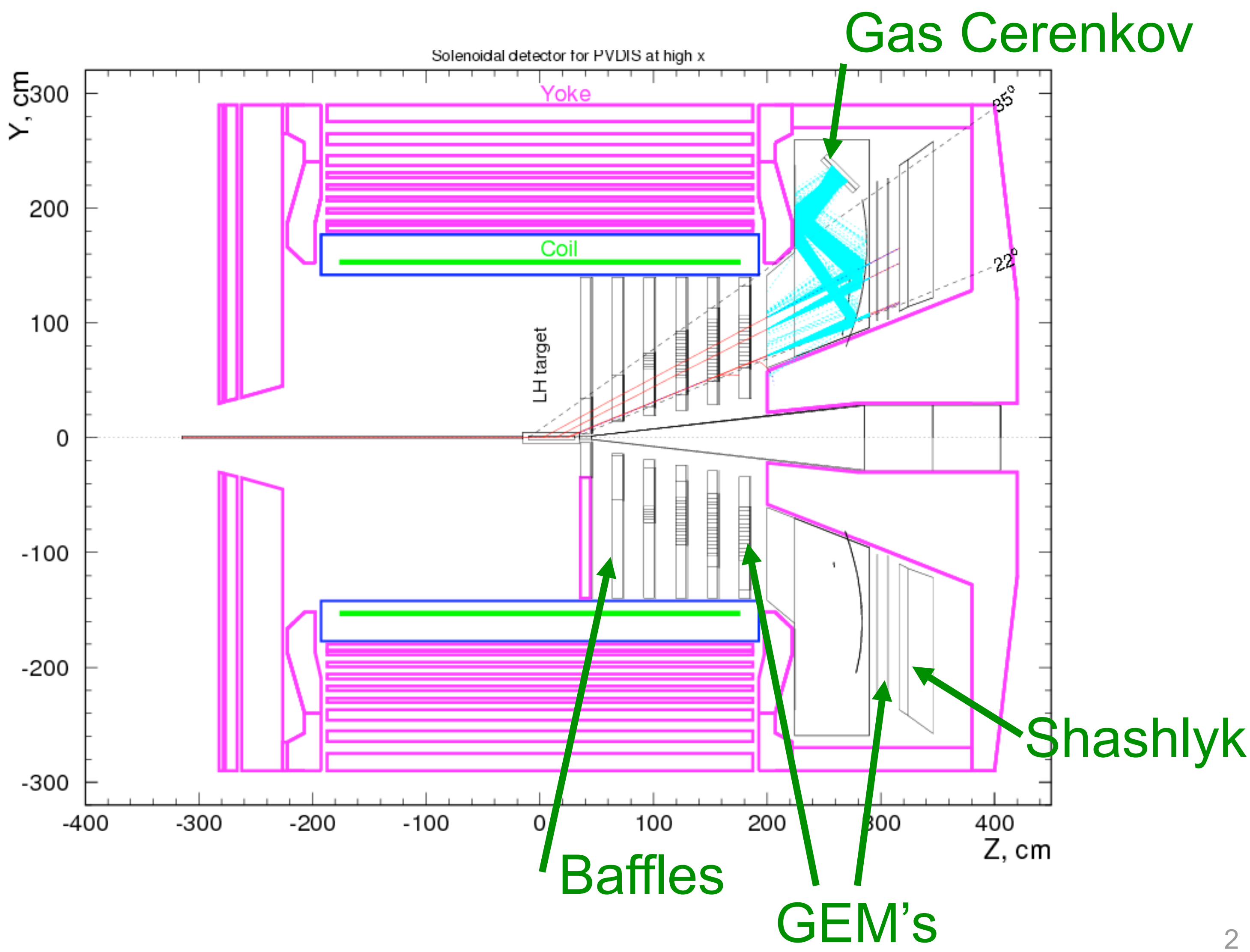
SoLID Spectrometer



Main Challenge: large area

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

Plane	Z (cm)	R_I (cm)	R_O (cm)	Total Area (m^2)	circumference (cm) Inner	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.

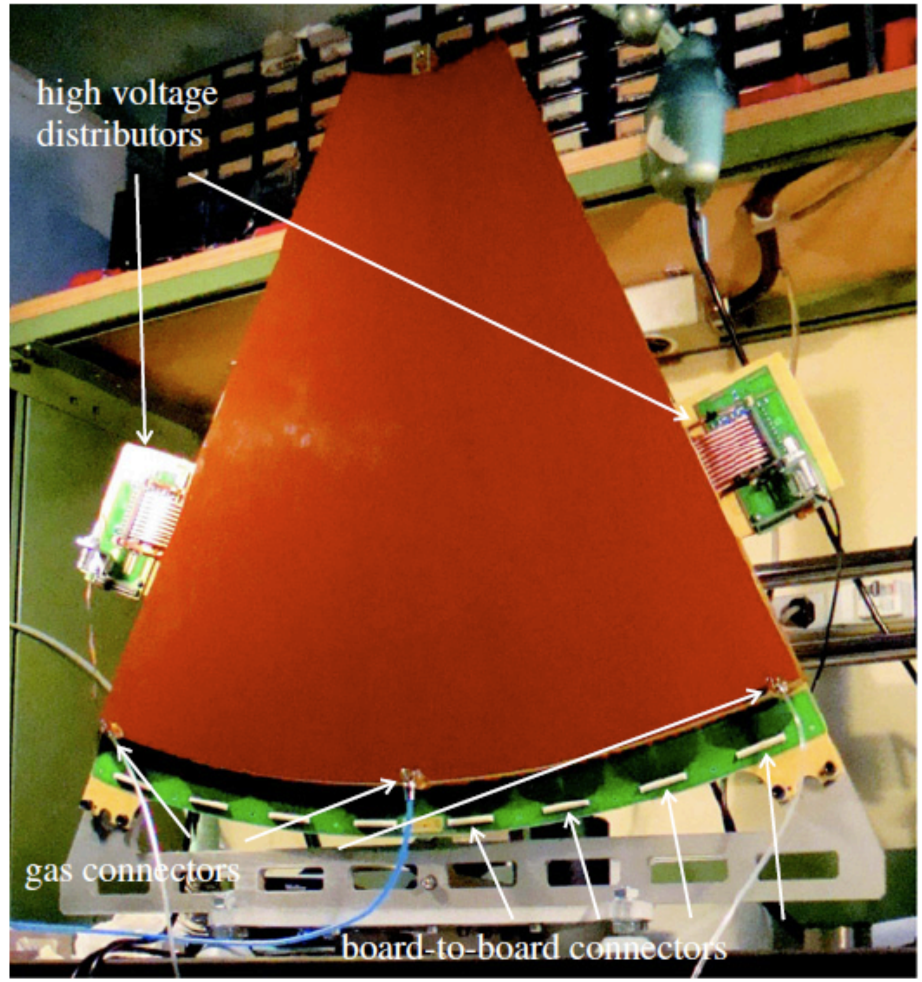
- Disk area larger than available GEM foil size (currently ~45 x 45 cm^2) ; need larger foil and segmentation.
- Large total area: most current GEM foil production at CERN shop: can they handle this volume ? Need new foil manufacturing

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 (m^2)	inner circumference	outer circumference	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% contingency			**~6.7 M**		**~3.6 M**

R&D and prototyping expenses: ~ \$ 200 k (~ \$ 60 k year 1, ~ \$ 140 k year 2)

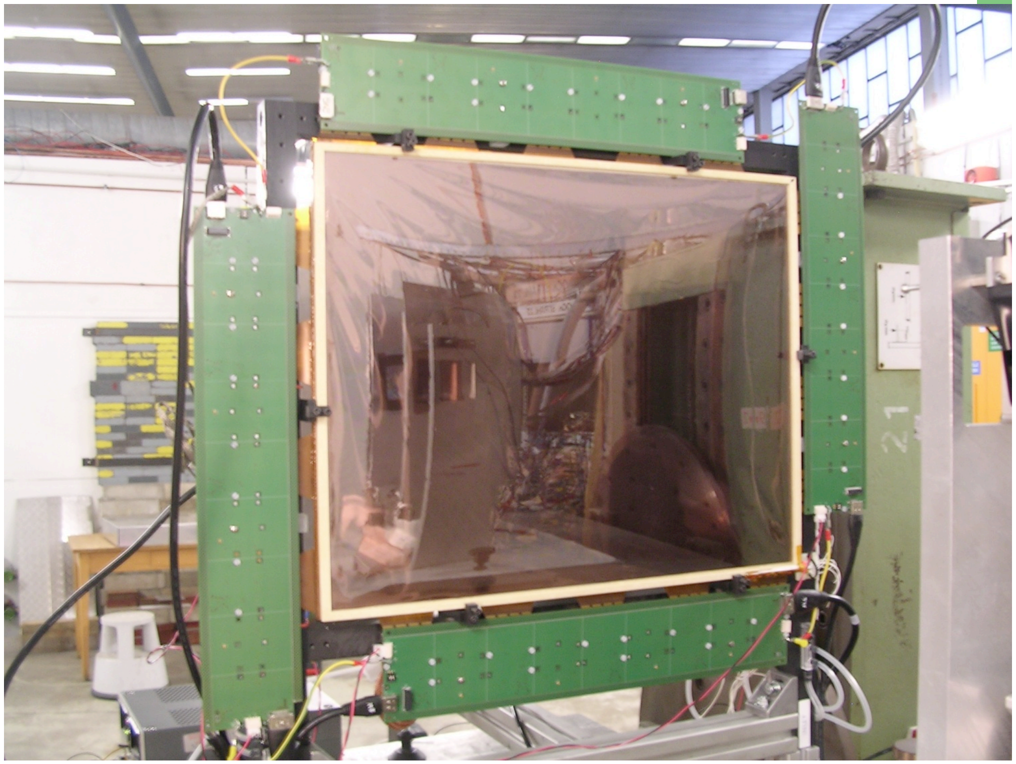
Hardware infrastructure ready for GEM testing

- 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

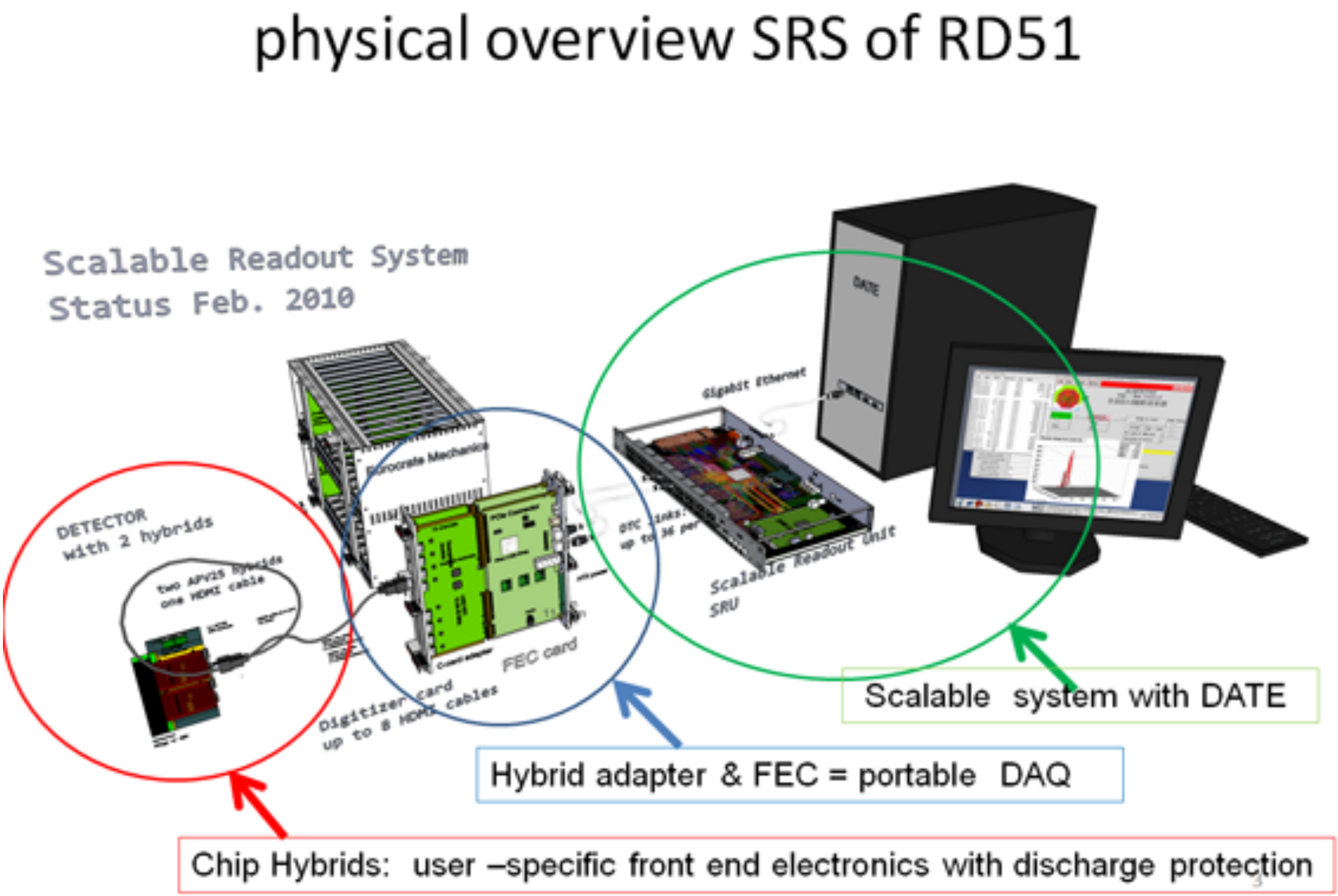
- $ 45 k from Jlab/hall A: for construction of a SBS-type prototype GEM chamber.
    - Construct two 40 cm x 50 cm GEM chambers
    - Gain experience in large GEM chambers
    - Test different readout schemes: fine readout, coarse readout, pad readout etc.
    - Plan to construct this summer; ready for 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)**



Registered SRS Users

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

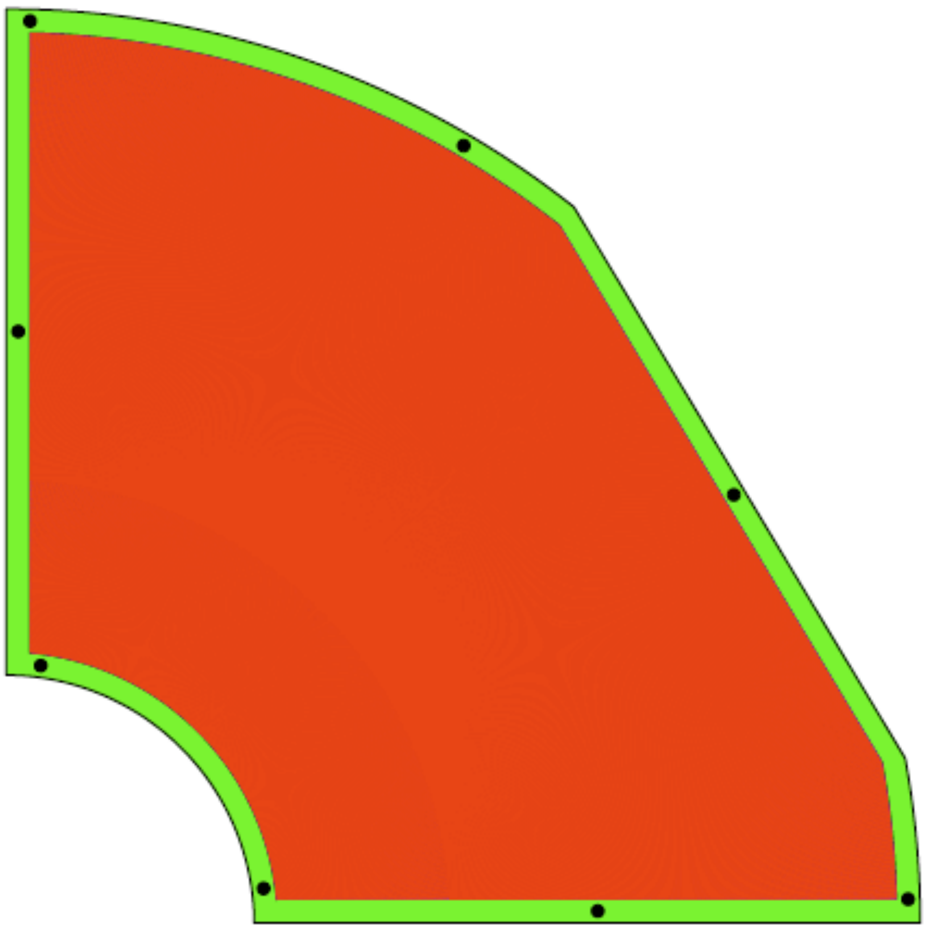
- FIT Florida, homeland security, GEMs
- Geoscienes Azur CRNS- Waterquality, MMegas

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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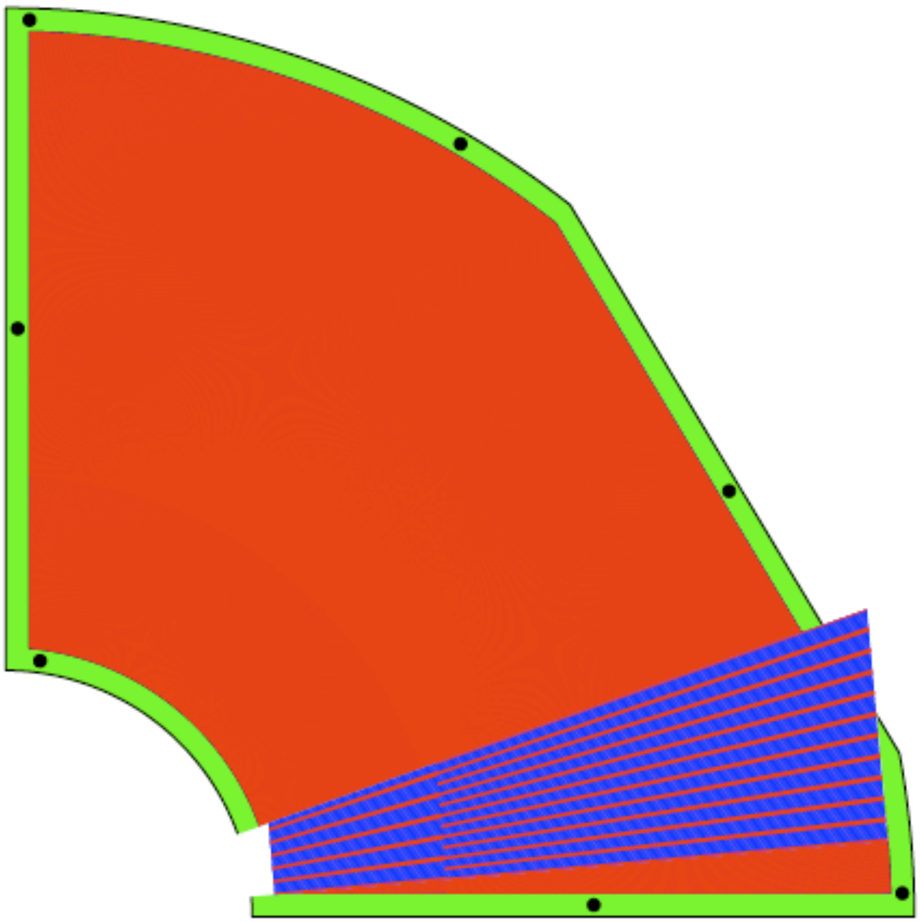

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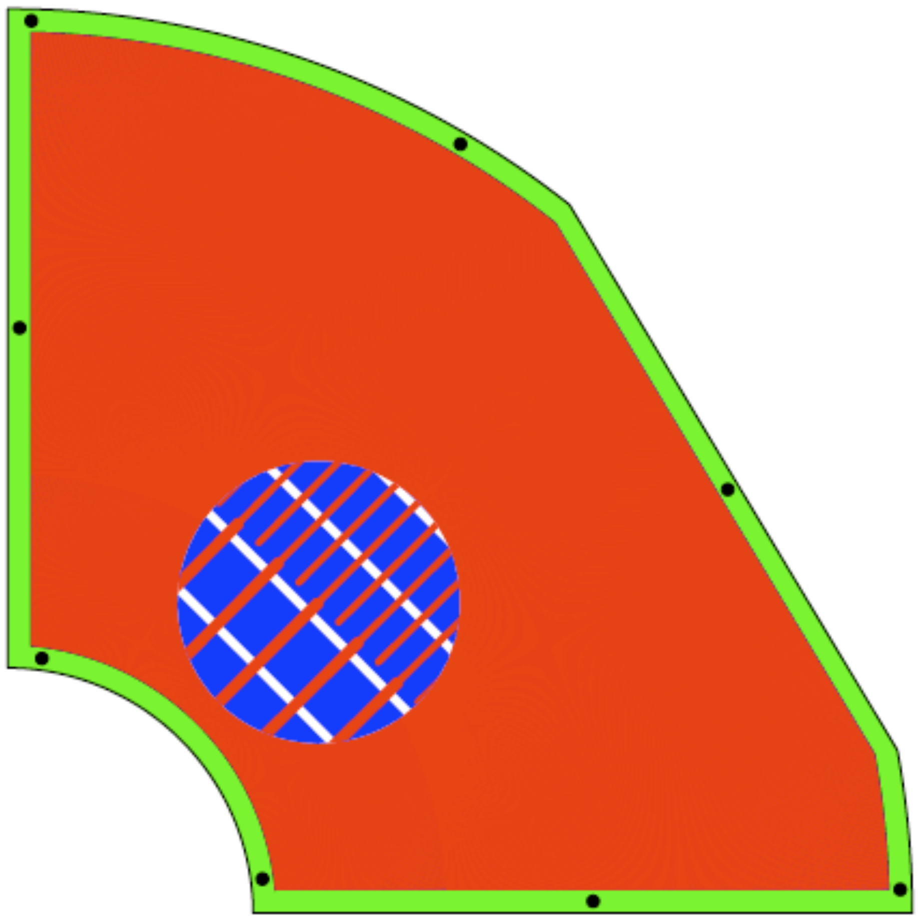

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