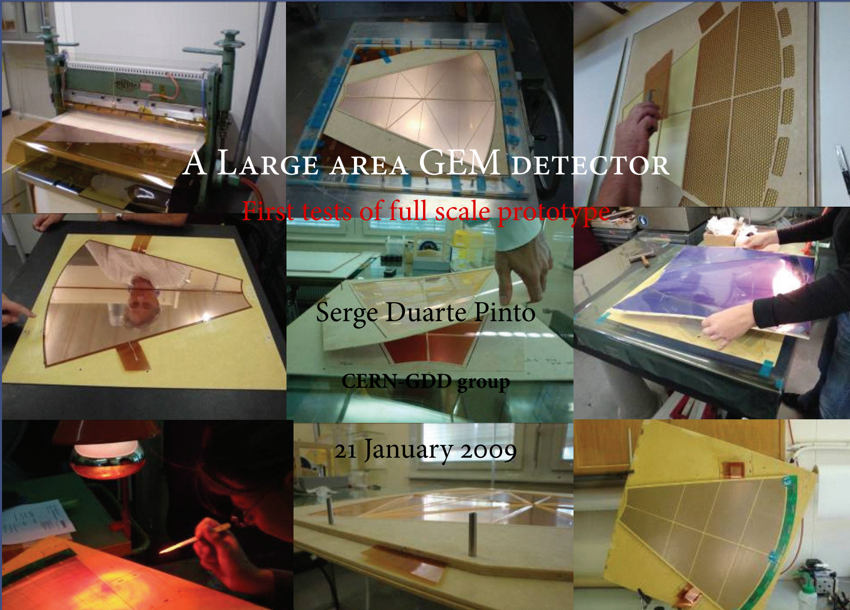
## What we (can) do to advance with large area detectors

- This meeting, *and next one end of April?*
- GEM detector design & assembly training session, 16–20 February 2009
  - One day lectures by various experienced people
  - Two days hands-on LHCb GEM detector assembly training
  - Two days hands-on GDD-group GEM detector assembly
- One of the lectures will be a crash course readout board design by Rui. This will be equally relevant for non-GEM communities, and will therefore be EVO-cast
- A few groups are having a regular "large area GEM meeting" every few weeks. Something similar is going on for thickGEMs. How about micromegas...?



# A Large area GEM detector

## First tests of full scale prototype

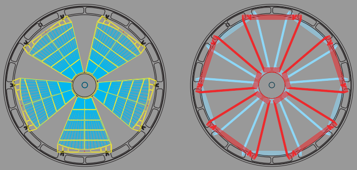
Serge Duarte Pinto

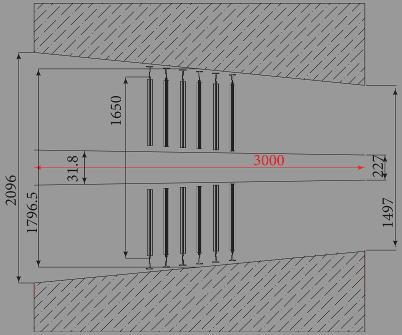
**CERN-GDD group**

21 January 2009

## Ideas for upgrade of TOTEM T1

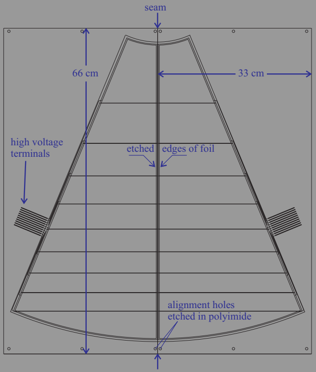
- Large triple GEM chambers (~ 2000 $cm^2$)
- Discs of 2 × 5 chambers, back to back
- Overlap allows adjustable disc radius





## Technical hurdles for fabrication of large GEMs

- Double mask technique introduces alignment errors at such dimensions
- Base material is only 457 mm wide



## Technical hurdles for fabrication of large GEMs

- Double mask technique introduces alignment errors at such dimensions ⟶ *use single mask technique*
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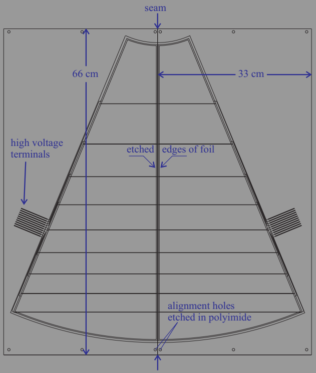
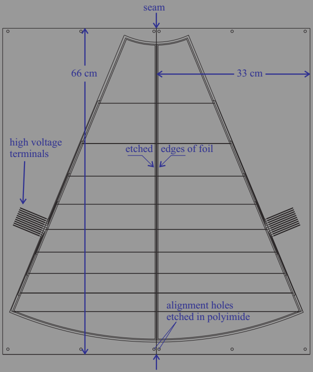


## Technical hurdles for fabrication of large GEMS

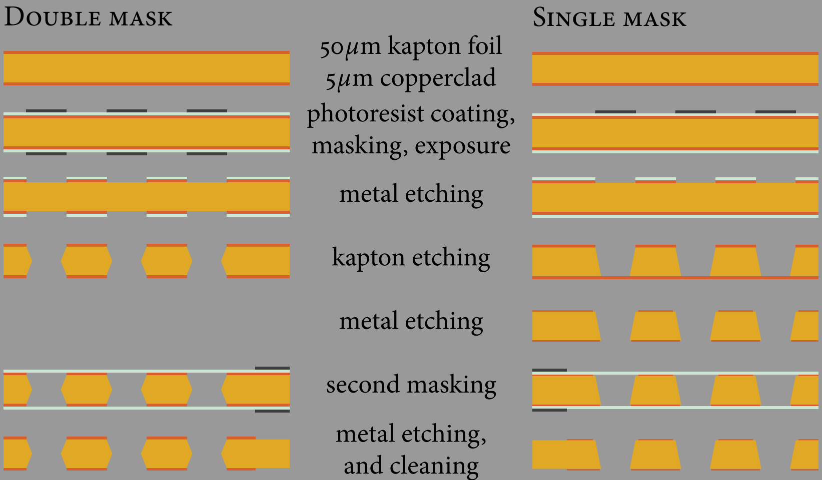
- Double mask technique introduces alignment errors at such dimensions ⟶ *use single mask technique*
- Base material is only 457 mm wide ⟶ *splice foils together*



# GEM manufacturing

*Double mask vs. single mask technique*



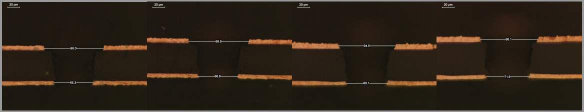


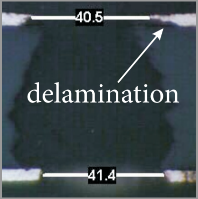
# Single mask technique

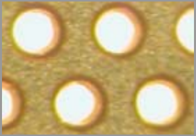
*Similar performance at lower cost*

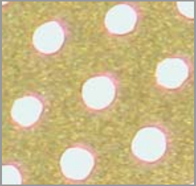
First results were not encouraging ⟶

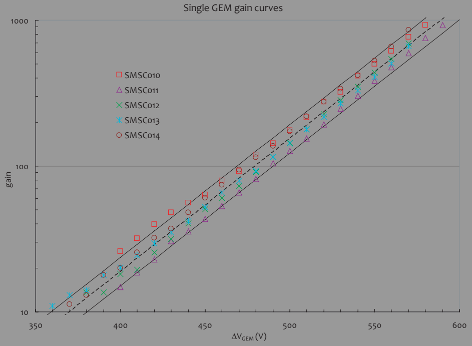
Smt now performs similar to standard gem.



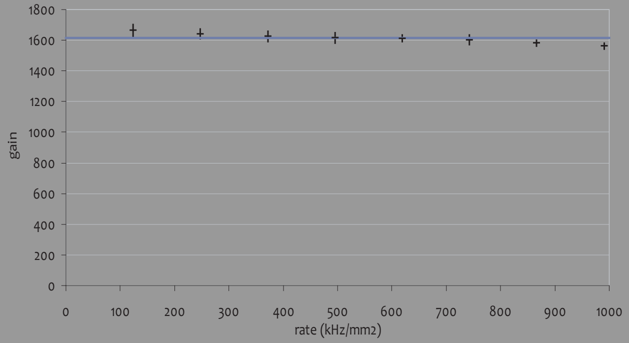






## Rate capability with copper X-ray

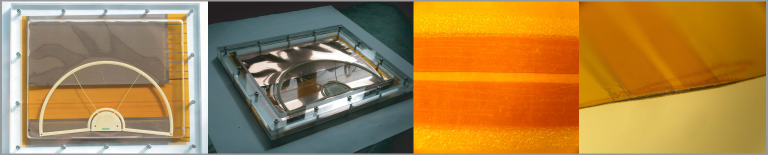


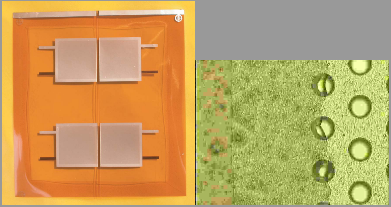

- Multiply by 320 for rate of primaries
- Charging up is stronger but very fast (seconds)
- Needs to be studied, and can still be improved by optimizing hole profile on new foils

# Splicing GEMs

*Glue foils with pyralux coverlay*

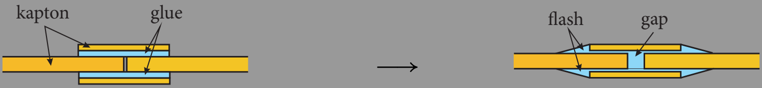






## Coverlay to glue gems

Seam is flat, regular, mechanically and dielectrically strong, and only 2 mm wide.

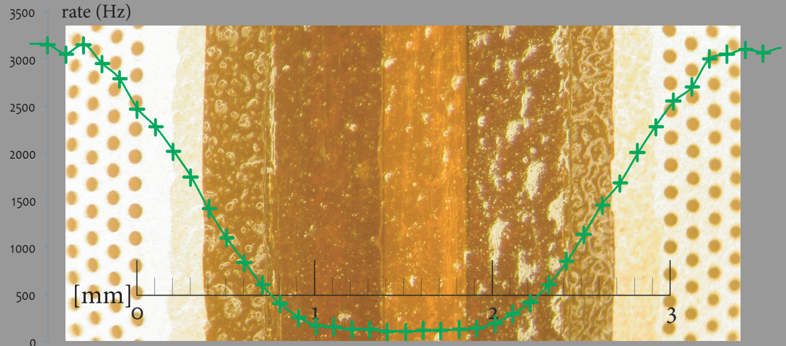



# Splicing GEMs

*Test performance near the seam*

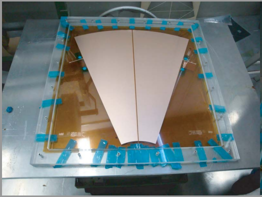
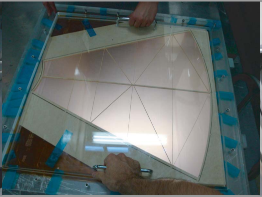


- X-ray with ∅0.5 mm collimator
- Rate scan over the seam
- Behaves normally until at the seam
- Performance rest of GEM surface unaffected

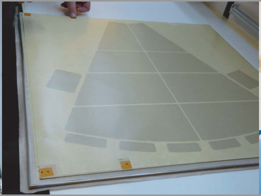


# Manufacturing
*From the design to a prototype*

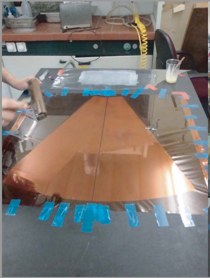
## Stretching and framing the spliced single mask GEM foils

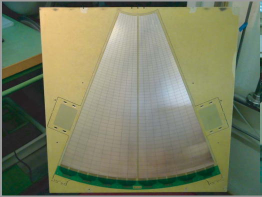
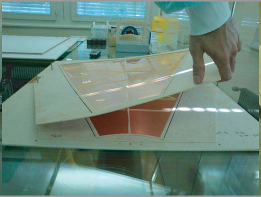
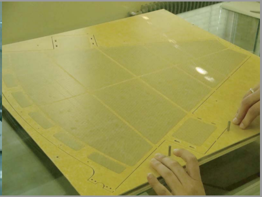

## Making the honeycomb base plane and top cover


## Gluing the cathode to the honeycomb frame



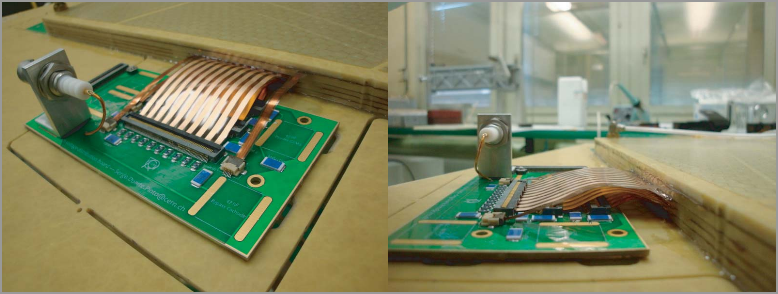
## Final assembly of all frames

# Manufacturing

*High voltage distribution*

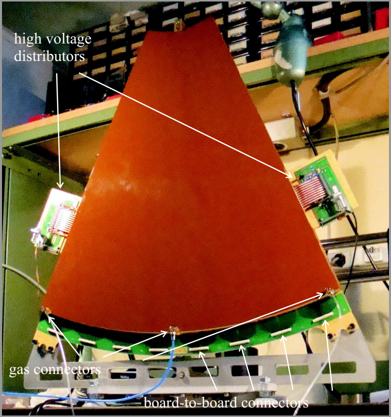
## Compact high voltage divider board



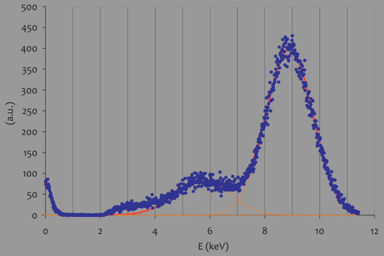
- Based on only SMD components
- Using ZIF sockets to connect to GEM terminals
- Traces that lead to GEM sectors are embedded in frame
- Easy to make, and to replace or debug

# THE PROTOTYPE

*The final detector and its performance*



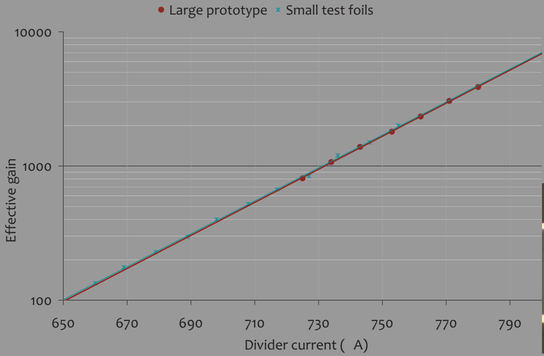

- Gas tightness & high voltage stability Ok
- Too late for testbeam by lack of electronics
- $\frac{\sigma_E}{E} = 9.5\%$ measured with Cu X-ray (8.9 keV)

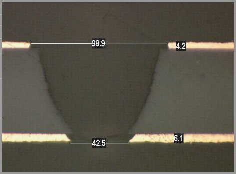


# The prototype

*The final detector and its performance*

## Gain consistent with 10 × 10 cm test foils




- Lower gain at equal voltage than standard (double mask) GEM, as expected from wide hole diameter
- Development of optimal hole profile still continues

# Perspectives

*For large area GEMs*



## Conclusions

- Single mask technique proved viable and cheap alternative
- Splicing method goes beyond limits of base material
- These techniques open the way for large area GEMS

## Perspectives

- Connect to fast electronics (VFAT or GP5/7) to study efficiency
- Discharge studies
- Test gain homogeneity
- Charging-up studies of single-, double- and tripleGEM
- Pursue optimization of SMT (steeper holes, smaller rim)

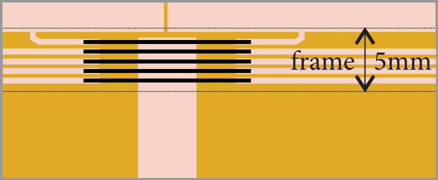
already many foils waiting to be tested …

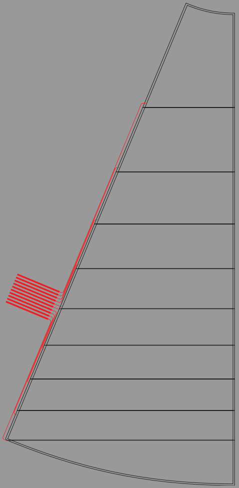
# Embedded resistors

*Screen-printed PTF resistors to be glued in the frame*

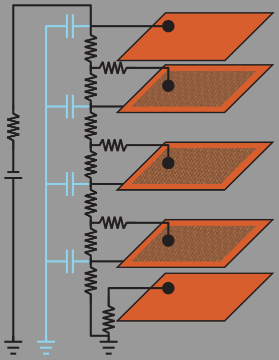
A Large area GEM detector
Serge Duarte Pinto
Activities
Totem
T1 upgrade
Challenges
Single mask technique
Manufacturing
Performance
GEM splicing
Coverlay
Test
Manufacturing
Framing & honeycomb
Cathode & assembly
High voltage
Prototype
The detector
Gain

- A half T1 GEM foil requires 10 sectors
- Makes 60 sectors per chamber, complicates HV circuitry
- Embedding resistors in frame would solve the issue
- Tolerance requirements for resistors extremely low, but still waiting for suitable high-resistivity paste



## Use bottom electrodes as shield by applying decoupling capacitors



- Simulations indicate negligible effect on discharges
- HV distribution boards of prototype have features to implement these capacitors
- must be tested with fast electronics to verify suppression of noise