RD51 WG6
Production Industrialisation

Philadelphia
May 24 2014
MPGD projects in progress at CERN Workshop in 2017

- Production
  - SBS tracker
  - ALICE TPC upgrade
  - CMS muon
  - BESIII
  - SOLID
  - CLAS 12
  - CBM
  - BM@N
  - Bonus 12
  - European Spallation Source
  - sPhoenix TPC Stonybrook
  - CMS GE2/1
  - C rad industry
  - Beamocular industry
  - Mcube muon detectors

- R&D
  - ATLAS resistive Micromegas embedded resistors for high granularity high rate detectors
  - CMS FTM multiple resistive well detectors for sub ns time resolution
  - R-well detectors for CMS & LHC-B
  - Embedded front end electronics in read-out boards
  - Embedded resistors for high rate Micromegas ILC calorimeter
  - Micromegas Picosec

<table>
<thead>
<tr>
<th>Project</th>
<th>Detectors/Dimensions</th>
<th>Count</th>
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</thead>
<tbody>
<tr>
<td>Production</td>
<td>GEM 600mm x 500mm</td>
<td>150 GEM</td>
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<tr>
<td>Production</td>
<td>GEM 600mm x 400mm</td>
<td>700 GEM</td>
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<tr>
<td>Production</td>
<td>GEM 1.2m x 450mm</td>
<td>450 GEM</td>
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<tr>
<td>Production</td>
<td>GEM 600mm x 400mm</td>
<td>30 GEM + read-out</td>
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<tr>
<td>Production</td>
<td>GEM 1.1m x 400mm</td>
<td>8 GEM + 2 read-out</td>
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<tr>
<td>Production</td>
<td>Micromegas 500mm x 500mm</td>
<td>30 Micromegas</td>
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<tr>
<td>Production</td>
<td>GEM detectors 1.8m x 0.6m</td>
<td>12 full detectors</td>
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<tr>
<td>Production</td>
<td>GEM</td>
<td>100 GEMs</td>
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<tr>
<td>Production</td>
<td>GEM</td>
<td>9 GEMs</td>
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<td>Production</td>
<td>GEM</td>
<td>50 m2</td>
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<td>GEM</td>
<td>10 GEMs</td>
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<tr>
<td>Production</td>
<td>Micromegas</td>
<td>12 x 50cm x 50cm</td>
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</tbody>
</table>
GEM Mass productions at CERN

**CMS production:**
more than 230/450 GEM already produced
Production rate 20 GEM/month

**ALICE production:**
more than 300/700 GEM already produced
Production rate 40 GEM/month

GEM UV tight “fridge” containing one batch of 14 GEM (1.8m x 0.6m max)
largest GEM detector
BM@N Dubna project 1.8m x 0.6m
Produced and assembled at CERN MPT
largest u-Rwell detector
GE1/1 active area
Single mask introduces cost reduction
10cm x 10cm GEM example

10cm x 10cm GEM low volume
- 300 CHF/piece

10cm x 10cm GEM high volume
- 80 CHF/piece
Embedded electronics in detector

- High rate detector with resistive protection
- 8 layers PCB
- FE Chip
- Glob-top protection
- Cooling pipe
CERN PMT Possibilities

• Tooling’s ok for GEMs up to 1.8m x 0.6m
• Presently 6 technicians are producing GEM.
• Soon the team will grow to 7 persons.
• Max capacity around 70 GEM per month (1.8m x 0.6m).
• There is still some free slots this year
• The GEM-Team is also producing special Flex read-outs and u-Rwell.
• We have received requests for 2m GEMs!
Industry situation
Mecaronics (Korea): Feb 2017 RD51 talk conclusion

  - Large bipolar lithography (~$0.5M) purchase
  - 3 months minimum to be built & delivered
  - 2017.06: production line completed & commissioning
  - 2017.07: test production (GE11 large type)
    - 10 GE11 GEMs: to be shipped to CERN for QC
  - 2017.08: final decision for Korean foil.
  - 100 GE11 GEM (Larger one)
- 2017 early
  - another 100 GE11 (Smaller one?)
Micropack (India) road-map
RD51 talk (feb 2017)

• Road map
  – Thin GEM 100mm x 100mm
    • Awaiting enquiries from all related agencies & users/CERN for production lots
  – Thin GEM 300MM x 300mm
    • Trials for process stabilisation and testing should be initiated in March 2017. Submission of samples to CERN April/May 2017
  – Thick GEM
    • Awaiting enquiries for further requirements from users.
Techtra (Poland) :
RD51 talk conclusion (Feb. 2017)

• Small GEMs & detectors:
  – 1. Production of small GEMs with over 90% yield
  – 2. Production of small GEM detectors.
• Big GEMs:
  – 1. Good openings uniformity on first copper layer
  – 2. Good openings uniformity on Kapton layer
  – 3. Good leakage currents: below 1nA@600V@70cm2
  – 4. Electroetching process needs to be adjusted
  – 5. Kapton etching needs to be optimized.
  – 6. GEM handling & packaging needs to be improved
  – 7. Poor production yield, about 30%
  – 8. Long production time
Extra information concerning TECHTRA company

- **GEM 10 cm x 10cm** → regular delivery to CERN since 2 years
- In 2016 CERN have subcontracted GEMs to TECHTRA for a total amount slightly above 200 000 CHF
- **GEM 30cm x 30cm double mask** → Ok since 1 year
- **GEM 500mm x 600mm single mask** → OK since a few months but an improvement of yield is necessary.
- **GEM 1.5m x 500mm** already ordered
- Participation to CMS GE1/1 being organized
Industry Status summary

- Techtra - Poland
  - 10cm x 10cm up to 30 x 30 routinely produced
  - 60cm x 50cm GEM ready (30% yield, single mask technique)
  - 120 cm x 50cm in progress (ready fall 2017)
- Mecaronics - Korea
  - No problem up to 30cm x 30cm GEMs
  - Currently doing R&D on 50cm x 50cm (double mask technique)
  - Presently setting up the facility for larger GEMs
  - 120cm x 50cm GEMs expected for end 2017
- Micropack - India
  - 10cm x 10cm GEMs have been produced and tested positively
  - 30cm x 30cm recently produced, soon under test (double mask)
- Eltos - Italy
  - THGEM up to 60cm x 60cm
  - Resistive read-out boards for Micromegas up to 2m x 50cm
- Elvia - France
  - THGEM up to 60cm x 60cm
  - Resistive read-out boards for Micromegas up to 2m x 50cm
  - BULK Micromegas up to 50cm x 50cm
B107 status

Construction of the new workshop's building

Start: beginning 2012    expected completion date: beginning 2018
**Move organisation**

starting date beginning 2018

- Installation of new machines beginning 2018, no modification of the activity in 102:
  - (3 months)
  - Etcher, Developer, Stripper, Jet pumice, Plating line
  - Desmearing line, Brown oxide line, Large dryer
  - NI/AU line, AU plating Bath, CU plating bath, Hoods etc
- Move plating activity (no stop)
- Transfer GEM missing equipments (1 week)
  - 1 Laminator/Alcohol stripper/Electro-etching line/large exposure lamp
- Move Photolithographic equipment one by one (3 days stop per machine)
  - Laminators, LDI
  - UV lamps, ovens
- Transfer the CNC machines and test machines one by one (3 days stop per machine)
  - Driller, Router
  - AOI, Electrical tester
- Transfer Pressing equipments (3 days per equipment)
  - Large press
  - Std press
- Transfer photoplotter + developer (3 days stop)
- Transfer clean room equipment (1 week stop for clean room activities)
- Repair and transfer remaining equipment from 102

**Move effective mid 2018**
Conclusion

• Heavy GEM production at CERN but still some free slots
• Industry will probably deliver the first large GEM this year (1.2m x 0.5m)
• The new building will be nearly ended at the end of this year.