RT6: Production (WG6)

Objective: Development of cost-effective technologies and industrialization (technology transfer)

Task 1: Development and maintenance of a common "Production Facility"

To reduce costs, it is in the interest of the collaboration to share the resources that are used to produce MPGDs. By de-facto CERN's TS-DEM-PMT workshop has played this role by providing detectors to experiments and institutes, many of which are members of the collaboration. It is at CERN where the technology to produce GEMs was created and many innovative ideas to fabricate MPGDs and read-out boards have been generated and put in practice. The PMT workshop has experienced personnel available whose full time job is to produce circuits and detectors and provide them to the collaboration members at cost. PMT is capable of producing detectors in prototype quantities and in series for small experiments (TOTEM GEM, T2K Micromegas). This mix of creating production processes, prototyping of various MPGDs and producing small series, combined with the experience of transferring production technology to industry (e.g. GEM, ATLAS TRT) suggests that CERN's workshop should be the common production facility for the collaboration.

With the current equipment in PMT it is possible to produce large detectors in small quantities but possibly not with the level of quality needed for repeatable productions of large MPGDs. Some equipment is limiting the maximum possible size of the MPGDs (e.g. laminator, exposure equipment, ovens, chemical bathes) and certain production steps can therefore not be made in the most optimal way. Current resources of CERN do not allow the level of investment needed to improve this situation without any external help.

To develop and maintain the common production facility at the required level, the following tasks have to be executed:

1.1 Make an inventory of production needs (MPGD type, size, volume) for the duration of the collaboration

1.2 Make an inventory of the available equipment and the limits that they impose on the capabilities (type, size, volume, quality)

1.3 Make a list of equipment and other resources needed to get the production facility up to the required level

1.4 Obtain resources

1.5 Operate the facility (maintain, produce, document procedures, risk analysis …)

Define required resources (FTE, skills), start/end date, deliverables

Task 2: Issues of fabrication reproducibility

Remove this task: not on level to be a task in itself: is part of Task 3.

Task 3: MPGD production industrialization (quality control, cost-effective production, large-volume production)

Quality *assurance* is needed once a development of a detector type is out of the prototyping phase. Quality *control* in the sense of all tests and controls needed during production to guarantee that the technical parameters of the circuits are within the specification, is an important factor of quality assurance. For the final products currently measurements such as leakage current, sparking voltage and certain visual controls are used.

To have production better under control and to be able to compare different methods of fabrication or production sites certain objective standards are needed. E.g. a standard method and tools to measure hole sizes of GEMs, with well-defined acceptability criteria may even help to improve the cost. The creation of these standards may be part of RT2, Task 1 (Development of common test standards).

A strict quality assurance system with highly detailed manufacturing procedures and quality control should be put in place for any large-volume production. It is expected that the quality control used in the common production facility can be adapted for large scale productions. Final quality assurance procedures can only be made for specific projects.

The aim of the common production facility is to develop production processes and to produce MPGDs in small to medium quantities. To be able to produce larger quantities (several hundreds per year of a single large type) the equipment and the organisation of operating the facility may need to be different. Depending on many parameters this may require investments by the common production facility or it may need the involvement of industry. Only when the different parameters of a specific project are known (e.g. type, size, volume, delivery times, available budget) it can be decided which path to take.

Tasks:

3.1 Define quality control standards for the different type of detectors

3.2 For specific large volume productions: write quality assurance procedures

3.3 For specific large volume productions: decide production method

Define required resources (FTE, skills), start/end date, deliverables

Task 4: Collaboration with Industrial Partners

There are several reasons why industrial involvement may be needed:

- The demand for MPGDs is larger than the common production facility can provide
- Allow price reductions due to large scale or industrial manufacturing methods
- Assure the availability for commercial applications

As the technology to produce most types of MPGDs is highly specific and difficult (THGEM is an exception), a transfer of technology is needed. This transfer is not easy: the technology to produce MPGDs is completely different than the products these companies normally make. If there is not a firm order for productions the companies may not be very interested or the transfer may take long; companies may be reluctant to set up technology transfer contracts as they may have difficulties seeing the market for this type of product or fear licensing issues.

CERN has experience in transferring production technology to industry and has set up several contracts with commercial companies to produce GEMs for example. The results for MPGDs are unfortunately not yet very successful as despite the transfer has taken place several years ago, even for GEMs of the small 10x10 cm size the quality is not yet up to the required level. A company producing GEMs seems to be reluctant to collaborate with CERN to solve the few remaining quality issues while another company stopped producing GEMs from one day to another.

There is therefore a high risk that the production of large MPGDs in industry may not immediately give the required results.

CERN's Technology Transfer unit is active in this field and has helped TS-DEM to collaborate with several companies. It is expected that the experience that is built up with the transfer of GEM technology will be invaluable for other MPGD projects. Qualification of companies before transferring technology, contractual obligations, IP licensing and other issues are a few of the subjects that may improve the chances of a successful transfer.

Industry involvement can also be useful for cost effectively making certain specific production steps (e.g. the stretching of mesh for Micromegas, exposure step for GEMs).

Tasks:

4.1 Define IP and TT policy (see VI Collaboration with industrial partners)

4.2 Understand issues of interests of industry

4.3 Understand in which cases transfer to industry is required or useful

4.4 Transfer MPGD fabrication technology to qualified companies (which detector type, define requirements, contracts …)

4.5 Understand which production steps may be subcontracted and associated IP transfer issues

Define required resources (FTE, skills), start/end date, deliverables