Production Status in Japan

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Osaka Univ.

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MICE CM17@CERN
Contents

▪ Waveguide QA result
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▪ Status and Plan
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Results of QA
- the first production for Station5-
Production of Waveguide

- A flow chart of assembling fibers

1. G-tech create test pieces for fibers.
2. Transmittance test at Osaka univ., and exclusion bad fibers.
3. G-tech creates Waveguide with tested fibers.
4. Transmittance test Waveguide at Osaka univ.
Check list for Quality test

- By eyes
- Photo with Flash
- Transmittance test

Injection → Reflection Crack!! Lower transmission
Setup of transmittance measurement

LED : Wave length=525nm (3HF : Wave length=520nm)

LED photo data (RAW format) of a connector

Intensity mapping data of a connector

CCD readings of a fiber
**Uniformity of Transmittance test**

Number of fibers

<table>
<thead>
<tr>
<th>binView</th>
<th>binView</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entries</td>
<td>128</td>
</tr>
<tr>
<td>Mean</td>
<td>1.327e+04</td>
</tr>
<tr>
<td>RMS</td>
<td>278.7</td>
</tr>
</tbody>
</table>

Mean 13300  Light intensity

12400  13900

Intensity map of a connector

<table>
<thead>
<tr>
<th>binlist</th>
<th>binlist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entries</td>
<td>128</td>
</tr>
<tr>
<td>Mean x</td>
<td>8.469</td>
</tr>
<tr>
<td>Mean y</td>
<td>4.5</td>
</tr>
<tr>
<td>RMS x</td>
<td>4.596</td>
</tr>
<tr>
<td>RMS y</td>
<td>2.287</td>
</tr>
</tbody>
</table>

It can be considered as uniform, within about 10% error.
Transmittance test of test assembly -results-
Result of transmittance test : Test piece 1

Test piece 1

- Detail
  - Crack: 6
  - Surface Violation: 2
  - Glue: 2
  - Unknown: 3
  - These 13 fibers were rejected.
Result of transmittance test: Test piece 2

Test piece 2

<table>
<thead>
<tr>
<th>binView</th>
<th>Number of fibers</th>
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<tbody>
<tr>
<td>Entries</td>
<td>225</td>
</tr>
<tr>
<td>Mean</td>
<td>1.067e+04</td>
</tr>
<tr>
<td>RMS</td>
<td>295.3</td>
</tr>
</tbody>
</table>

Light intensity

Mean: 10670
Red: 8820
1 fiber were identified as bad and rejected.
Result of transmittance test: Test piece 3

Test piece 3 (3 line unused)

No fibers are connected here

Mean: 9368
Red: 8707
1 fiber had reflection and rejected.
Result of transmittance test: Test piece 4

Test piece 4

Mean: 9350
Red: 8200〜8300

3 fibers were identified as bad and rejected.
Waveguide test results
Result of transmittance test: External Waveguide No.1

Mean: 13300
Green: 13170

- 1 fiber had reflection, and good transmittance.
Result of transmittance test:
Internal Waveguide No.1(1,2,5,6)

Mean: 12990
Green: 12000
• 1 fiber had damage on the surface and slightly lower transmittance.
Result of transmittance test:
Internal Waveguide No.1(1,3,4,6)

- All fibers were identified as good.
Summary

Status & Plan

- 1st External guide and Internal guide was already assembled.
- There is no fibers which has intensity 10% less than Mean.
- Now we are assembling next Waveguides and will produce for station 5 test.
- Mapping check has been recorded in Video file. →
Connector parts of waveguide for station 5

- Bulkhead/Lead connector (1A / 2A)
  - 1.10 mm drilling with countersunk hole on the back end (by G-Tech)
- 22-way connector (3A)
  - 1.08 mm holes by 1.067 mm drill (AC precision)
- D0 connector
  - 1.067 mm drilling (Fermilab)
- Flexible conduit
  - Adaptaflex PAFS21 and PAFS28
- Heat shrink tube
Mechanical strength of the external waveguide

- D0 connector boot and flexible conduit can be detached by pulling by hand
- Found that heat shrink tube at the connection does not have enough strength
- Epoxy glue at the connections, and then covered by heat shrink tube
- Also, we will find better heat shrink tube
  - Glue paint on inner wall of the tube
External waveguide for Station5

Flexible conduit PAFS21 (φ21.2 x 400mm)
Flexible conduit PAFS28 (φ28.5 x 2200mm)
Heat shrink tube (100mm)

Epoxy glue
D0 boot
D0 connector

Cut here at ridge
Internal Waveguide for Station 5

1A

1-128

3B 3A

1 1-20
2 21-42
3 43-64
4 65-86
5 87-108
6 109-128

1400mm
Internal Connector (1A, 3A)

1A Surface

3A Surface
External Connector (D0, 2A)

D0 Surface

2A Surface
Assemblies

- **Test assembly**
  - External + Internal = Constant (430cm)
  - 440cm-long 225 channels
  - Select better fiber canes
- **External waveguide**
  - 310cm – 200cm (Not yet decided)
  - For 10 stations
- **Internal waveguide**
  - 120cm – 230cm (Not yet decided)
  - For 15 stations
- **Station Spacing:** 20cm-25cm-30cm-35cm? (to be decided in a month)
Total = 430 cm

- **External + Internal**
  - (350 cm + 20 cm)/2 x 640 ch/station x 5 stations = 5.92 km
  - Easy to QC, same length of the combination Int. + Ext.
- **Internal + Internal**
  - (430 cm + 20 cm) x 640 ch/station x 10 stations = 28.80 km
  - Easy to QC, same length of the combination Int. + Ext.
- **Total**
  - 34.72 km
Production status & plan

- Fiber preparation for 5 sets of waveguides has been done
  - Finished testing 830 fiber canes of 450cm
- QA on the first production has been done → later presented by Takatomi YANO
- The fabrication process will be improved by:
  - Fixation by epoxy glue at the conduit connections
  - Better heat shrink tube with glue painted inside
  - Air removal from optical cement by vacuum extractor
  - More careful gluing on the connector surface

- Remaining sets of waveguides for station 5 will be delivered on Feb. 28th.
- Will be tested at Osaka Univ. and be shipped to Fermilab by March 2nd.

- Need larger holes in the next production
  - 5 fibers out of 128 cannot be fit into D0 connector
- G-Tech will start cutting all the fiber into 440cm-long canes soon after production for station 5
  - 128 x 5 x 10 stations = 6400 canes
- Need decision on station spacing to proceed waveguide fabrication

- One week manufacture for one station
- 3 months for full production
  - Hopefully, by the beginning of May
Flash light reflection
- External waveguide #1 -

• No fiber has reflection at D0 connector
• One fiber has reflection at lead connector end
  – Incomplete optical cement / Air bobble (?)
  – Damage of larger diameter fiber (?)
  – Need more careful treatment and feedback
Flash light reflection
- Internal waveguide #1 -

- All the fiber have no reflection light
- Slight damage on cladding layer of the 5th 22-way connector
- The problem seems to be just on the surface
- Could be recovered by final polishing at Fermilab
Channel Assignment

- Inject light from a clear fiber to connector surface
- Scan injection point by hand
- Take movie
- Perfect assignment on all the connectors!
LED transmission test
- External waveguide #1 -

• All the fiber have good transmission within 10%
LED transmission test
- Internal waveguide #1 -

- All the fiber have good transmission within 10%
Summary

• The first production of external/internal waveguide have minor problems found in visual inspection of connector surface and in photo of flash light reflection
  – Could be removed at final polishing in Fermilab
• All the channels show good transmission.
• QA of waveguides for Station5 will be finished by March 2\textsuperscript{nd} and ship them to fermilab for cosmic-ray test.