# In-House Manufacturing of ALMA Receiver Parts

Mechanical Engineering Shop, Advanced Technology Center
(NAOJ)

At the Mechanical Engineering Shop (ME Shop) in Advanced Technology Center, we have been working on in-house manufacturing (mass production processing) of four critical parts for the ALMA receiver cartridges. We are pleased to announce that we have successfully completed the target production volume (73 units) in March 2013. Including prototyping, it took four years period to complete manufacturing. The aims of in-house manufacturing were twofold: in budgetary terms, we wished to achieve cost savings, and in technological terms, to establish high-precision processing in 'mass production'. We have mostly been successful to achieve both of these. The products' details and our approach to making these are outlined below.

The following two points required particular attention in mass production. (1) Until this project, the ME Shop had been principally involved in manufacturing one-off processing pieces such as in prototyping manufacturing, and the current project was the first attempt at mass production over a relatively long period. (2) Responding to machining request for upcoming common use programs other than ALMA. After detailed discussion with the ALMA receiver development team, dedicated machinery for mass production was selected, 50 % of machinist manpower was allocated, and the ME Shop took charge of machining the following four parts for mass production.

(a) Band 4 Cold Optics Support Structure
(b) Band 4 Warm Optics Frame
(c) Band 4 Warm Optics Elliptical Mirror
(d) Band 8 Cold Optics

All these products were fully machined from aluminum blocks. Each produce has strict tolerance on its key geometries. The following plans were taken to meet these demanding requirements.

- Dedicated processing staffs.
- Use of dedicated processing machinery and thorough environmental control, such as air temperature.
- Use of materials with quality certificates attached.
- Final machining process after feedback to the machinery setting from the precision measurement using a three-dimensional profiler etc.

Including the prototyping manufacturing, Mr. Tetsuo Nishino was in charge of all processing of (a) and (b), and Mr. Takeo Fukuda was in charge of (c) and (d). The 73 final products all passed inspection for ALMA specification.

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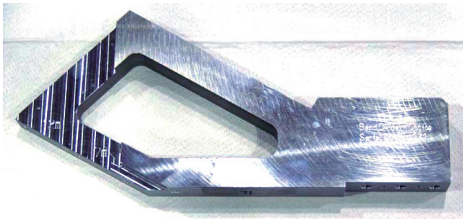
|---|---|
| Product Name | (a) Band 4 Cold Optics Support Structure |
| Materials | A6061 (aluminum alloy) |
| Materials Block Size | 100 × 113 × 130 (mm) |
| Product Dimensions | 90 × 109 × 121 (mm) |
| Processing Machinery Used | Wire electrical discharge machine, milling machine |
| Accuracy Required | Height ± 0.05 (mm) Parallelism between upper and lower surface 0.015 (mm)<br>Positional tolerance between base location holes and upper surface pins Φ 0.05 |
| Average Processing Period | 2.5 months for 1 lot (10 units) |



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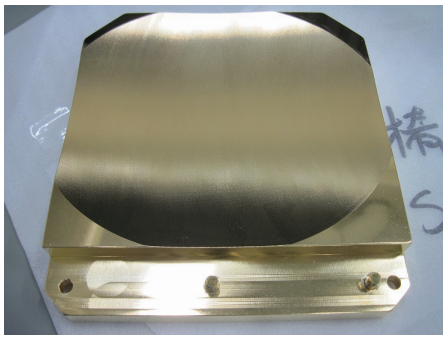
|---|---|
| Product Name | (b) Band 4 Warm Optics Frame |
| Materials | A5083 (aluminum alloy) |
| Materials Block Size | 25 × 260 × 390 (mm) (1 pair) |
| Product Dimensions | 25 × 135 × 320 (mm) |
| Processing Machinery Used | Wire electrical discharge machine, milling machine |
| Accuracy Required | Angular accuracy in each of the three surfaces for mirror attachment is ± 0.01 degrees |
| Average Processing Period | 2.5 months for 1 lot (12 units) |



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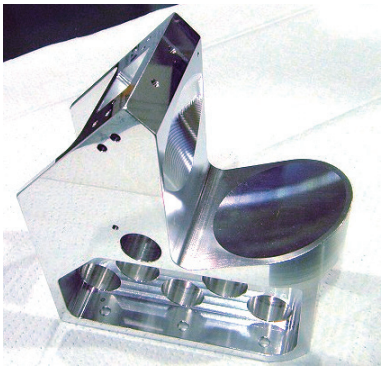
| Product Name | (c) Band 4 Warm Optics Elliptical Mirror |
| Materials | A5083 (aluminum alloy) + gold plating after processing |
| Materials Block Size | 21.5 × 151 × 163 (mm) (6-surface milled) |
| Product Dimensions | 21.5 × 151 × 163 (mm) |
| Processing Machinery Used | Milling machine, machining center |
| Accuracy Required | Surface contour 0.02 (mm) |
| Average Processing Period | 1 month for 1 lot (10 units) |



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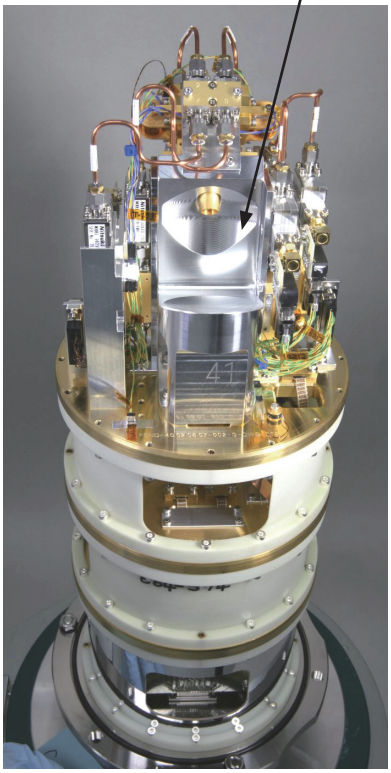
|---|---|
| Product Name | (d) Band 8 Cold Optics |
| Materials | A6061 (aluminum alloy) |
| Materials Block Size | 55 × 115 × 130 (mm) |
| Product Dimensions | 52 × 112 × 122.654 (mm) |
| Processing Machinery Used | Milling machine, machining center |
| Accuracy Required | Gradient of horn attachment surface 0.02 (mm)<br>Reference point of horn attachment location ± 0.015 (mm) |
| Average Processing Period | 2 months for 1 lot (5 units) |

Band 4 Cartridge


Band 4 Warm Optics Arrangement Diagram




Band 8 Cartridge