

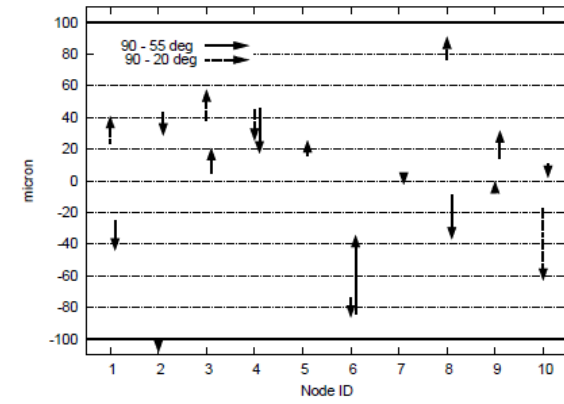
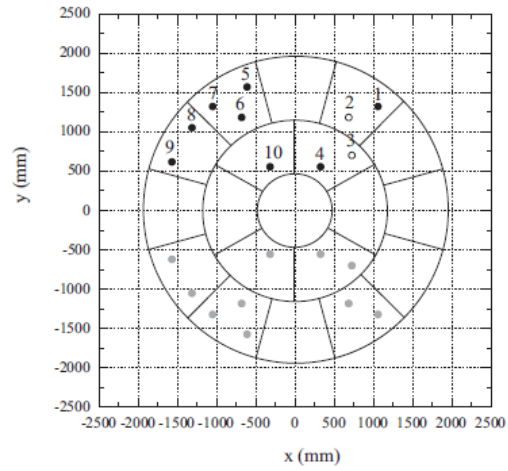
望遠鏡構造進捗状況

2010/9/17

栗田光樹夫

@京大

6月5日まで



SPIE

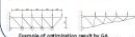
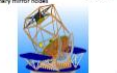


Light-weight telescope structure optimized by genetic algorithm

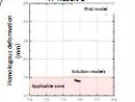
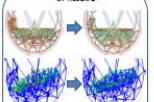

Mikio Kurita^a, Hiroshi Ohmori^b, Masashi Kunda^c, Hiroaki Kawamura^d, Noriaki Noda^e, Takayuki Seki^f, Yuji Nishimura^g, Michitoshi Yoshida^{h,i}, Shuji Sato^a, and Tetsuya Nagata^h

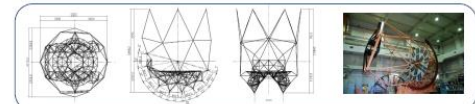
- Society of Photo-Optical Instrumentation Engineers
光学装置学会で報告

Light-weight telescope structure optimized by genetic algorithm

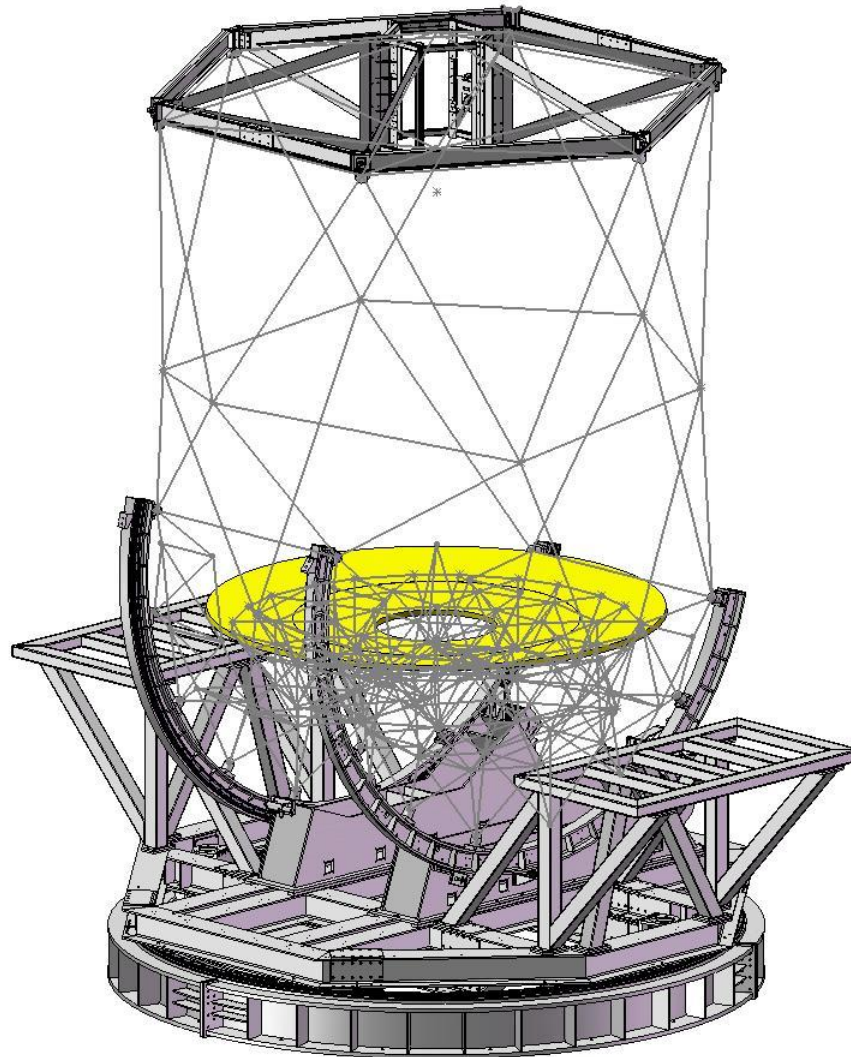
Mikio Kurita (Nagoya University)
We optimized the optics supporting structure (OSS) of a 3.8 m segmented mirror telescope by a newly developed program incorporating a genetic algorithm. The telescope employs 18 petal shaped segmented mirrors. The whole mirror is supported by 54 actuators (3 actuators per each). The program generates new OSSs which realize both light-weight structure and homogenous deformation among 54 nodes for the mirror supporting. The resultant OSS is only 8 tons including the optical elements and actuators (4 tons) with an eigen frequency of 9.5 Hz. The deviations of the 54 nodes from their original configuration of the designed OSS are less than 100 micron in the range of elevation angle of 20 - 90 degrees. We measured the deformation of the actual OSS and the result showed that the OSS achieve the designed performance.

2. Homologous Deformation and Genetic Algorithm Homologous deformation is a kind of deformation that the difference of its shape before and after deformation is zero or minimal. The idea has been utilized to use a shape of large radio antenna under the gravitational deformation. A genetic algorithm (GA) is a tool to optimize models under multi-objectives. The algorithm evaluates and selects better models by formulating the objectives and evaluating fitness of the models. In the process, the algorithm generates many new models by mutation and crossover between the pre-generated models (parent models) like a living organism. 	1. Telescope and Design Goal Diameter of Primary mirror: 68.78 m (7/3.3) Primary mirror: 2,700 kg Secondary mirror: 650 kg Tertiary mirror: 500 kg Total weight of optics: 3,850 kg Homologous Deformation Axial component of primary mirror nodes: < 0.1 mm Secondary mirror toward the primary mirror nodes: < 2 mm Tertiary mirror toward the primary mirror nodes: < 0.05 mm 	Conditions Geometrical Conditions: nodes for the optics Boundary Conditions: Elevation Supporting Optical Path: No Interference Members for OSS: Japanese Industrial Standard GA Parameters Searching population: 60 Archive population: 20 Crossover rate: 0.80 Mutation rate: 0.01 Numerical Model:  Boundary Conditions: 
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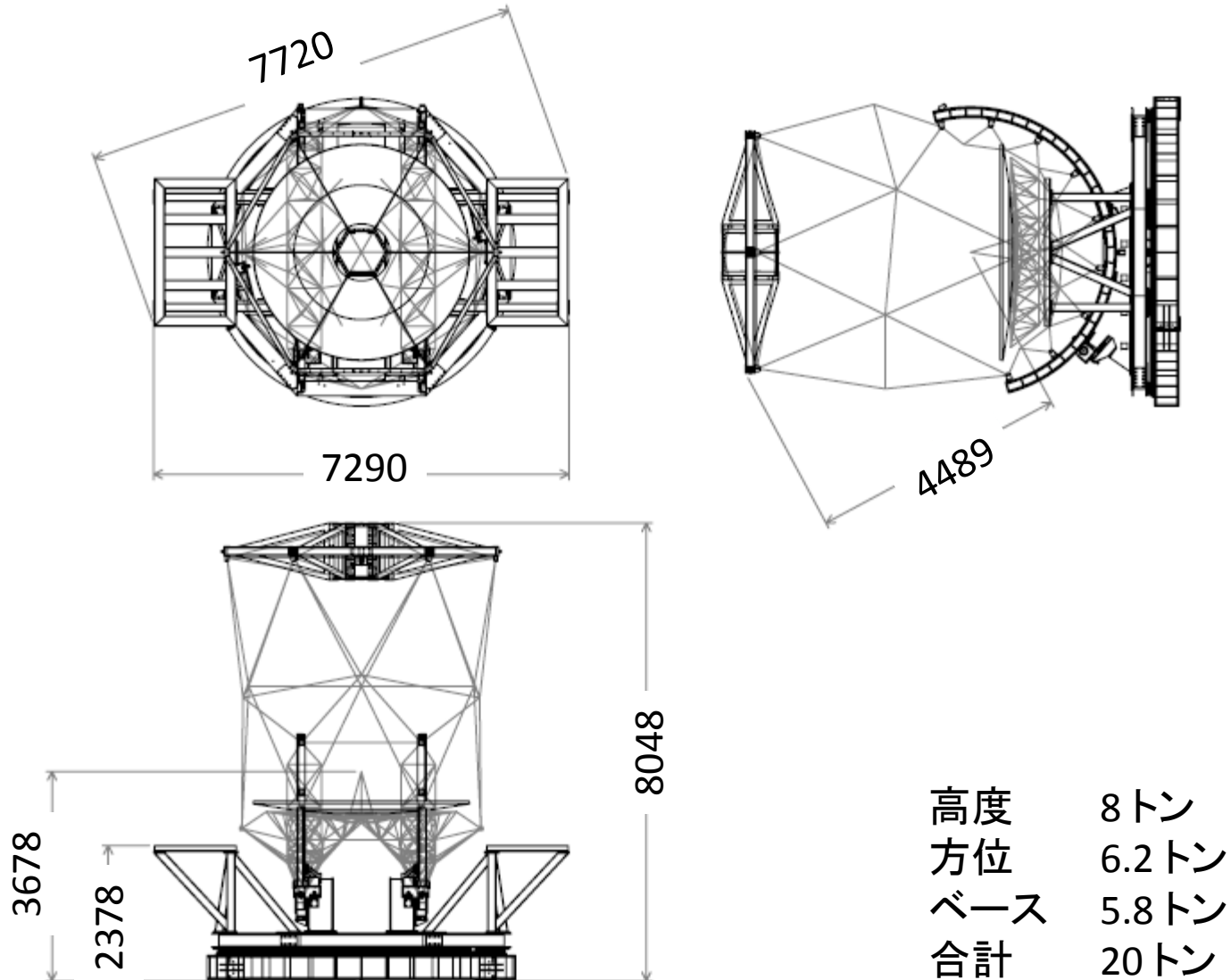
4. Result 1  Evolution of solution models in the objective space of deformation and weight. Models of smaller weight of these algorithms are better solutions. The largest homologous deformation among the primary, secondary tertiary mirrors is plotted (the deformation for the primary and tertiary mirrors are multiplied by 20 and 40, respectively to deal with those values equally). The graph shows that the final model before evolution evolved to the acceptable models. Weight Data Final model: 7.8 tons Acceptable model: 8.0 tons Initial model: 10.0 tons	5. Result 2  Final model: 7.8 tons Initial model: 10.0 tons Homologous Deformation Axial component of primary mirror nodes: 0.1 mm Secondary mirror toward the primary mirror nodes: 0.4 mm Tertiary mirror toward the primary mirror nodes: 0.046 mm	6. Experiments  We measured the homologous deformation of the 10 nodes for primary mirror supporting with Laser Tracker (LTS) at elevation angles of 0, 35 and 70 degrees. The measurement values are consistent with the design values with a standard deviation of 20 μm.
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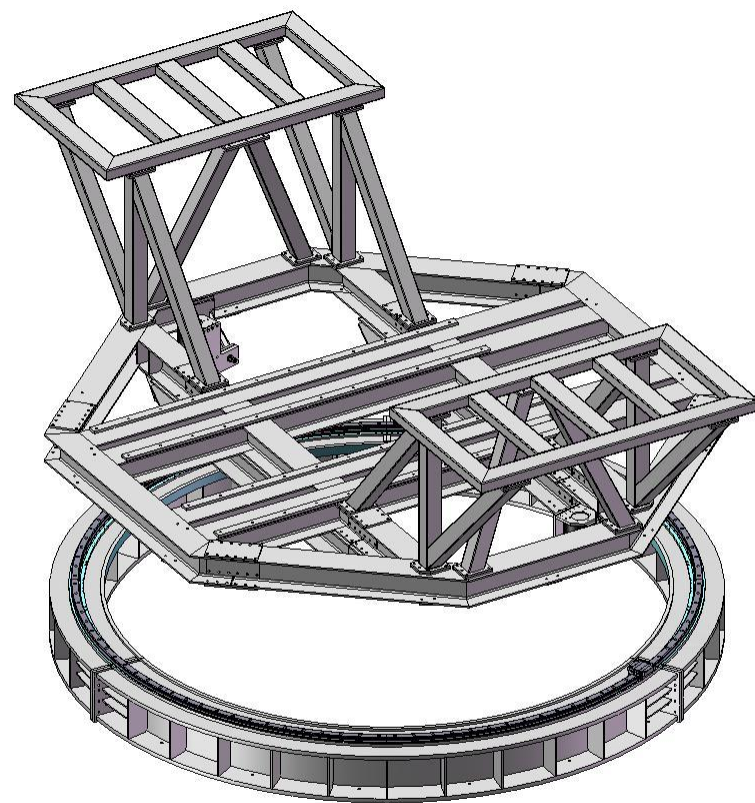
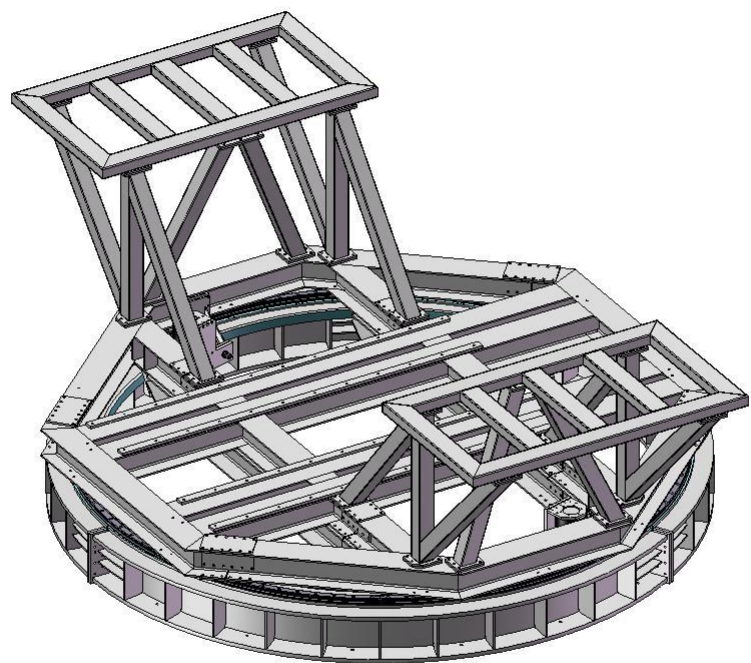
方位軸の設計



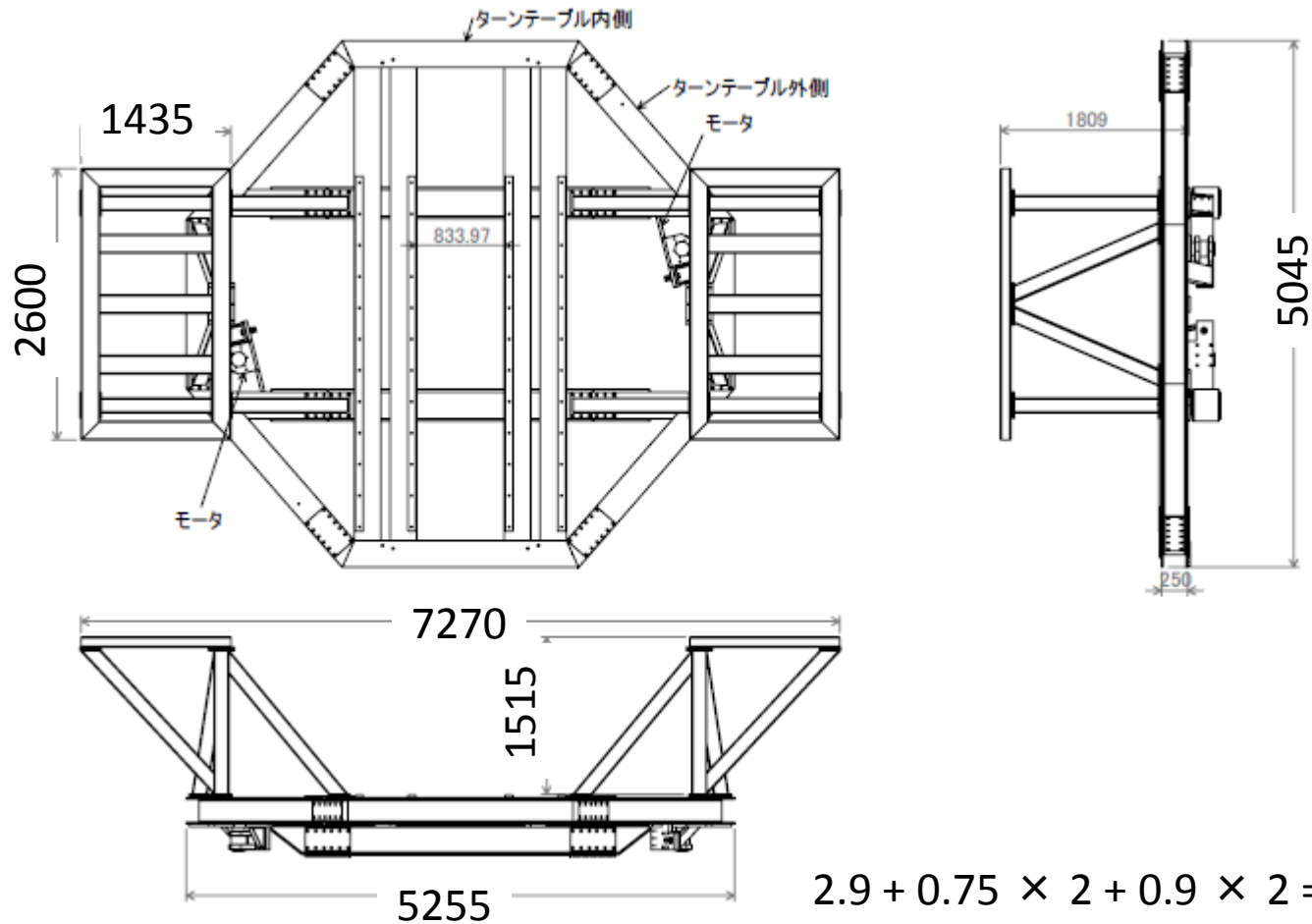
方位軸の設計



方位構造の設計

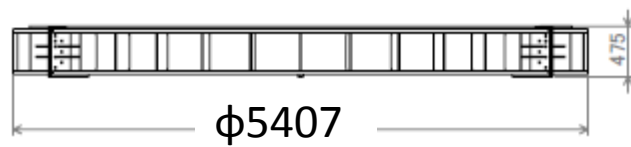
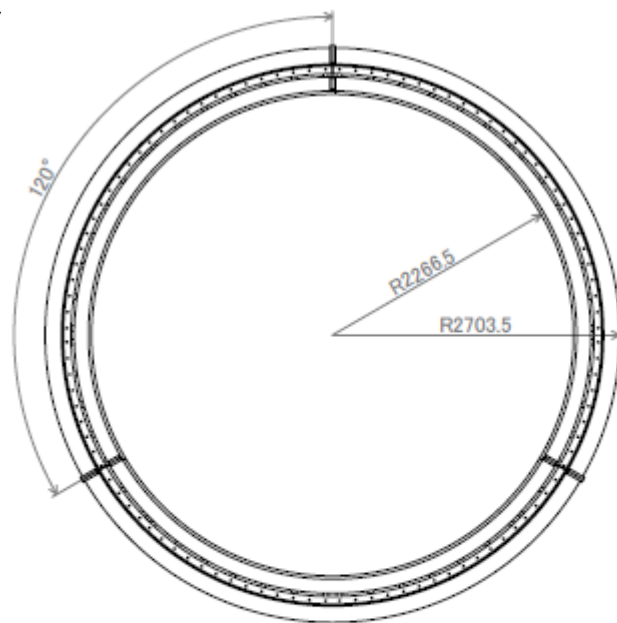


方位回転部



ベース

2.7×3 = 8トン



475

ナスミス台

