Survey and Alignment at Construction of SCSS Prototype Accelerator

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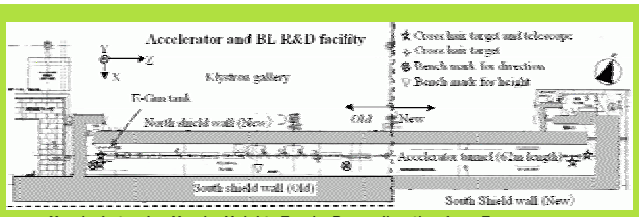
Introduction

SCSS (SPring-8 Compact SASE Source) prototype accelerator was constructed at SPring-8 site. The erection of its beam line tunnel was launched in February 2005. In October 2005, the installation of accelerator components was completed in two months. The total length of this accelerator is 60 m and its positioning tolerance required for each accelerator component is 0.3 mm. Considering such conditions, ordinary alignment procedure by using naked eye with alignment telescopes was adopted. We report survey and alignment at the construction of this accelerator.

April, 2004	250MeV prototype accelerator design started.
Feb., 2005	Construction of accelerator building was started.
August/M	Accelerator tunnel was completed.
	Grinding of floor was started.
August/E	Accelerator building was completed.
	Install and alignment of accelerator was started.
Oct. /E	Ageing of accelerator tube was started.
Nov. /B	Beam commissioning was started.
Nov. /E	Natural SR from undulator was observed.
April, 2006	Undulator #2 was installed.
	Downstream section component was re-alignment.
May	Beam commissioning was re-started.
June /E	SASE light with 49nm wavelength was observed.



X axis:Lateral Y axis: Height Z axis:Beam direction from E-gun

Surveying Instruments
Total station : Nikon GF-1, NF000-9 Tilting level:Leica N3 Automatic Level:Topcon AT-M3 Automatic nadir plumet:Leica WILD NL

1. Basic Policy of alignment

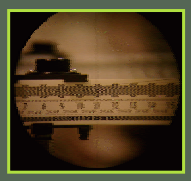
We adopted an ordinary method using naked eyes with alignment telescopes, which were aligned on two base lines. One is +700mm height offset, and the another is +700mm lateral offset. And alignment scales were also used.

Most of components were mounted on stone tables or cordierite support stands. All components were designed to avoid above sight lines.
BPMs in undulator section were re-aligned by different method using in-line He-Ne laser and airly disk.

Total length of accelerator : 60 m
Height of electron beam : 800 mm
Tolerance of alignment : ±0.3mm

Alignment telescope (Taylor Hobson Ltd.)

Alignment scale (BRUNSON Co.)



2. Bench mark for alignment

Alignment base lines (from electron beam line)
+700mm height offset (Y=1500, X≒0)
+700mm lateral offset (Y≒0, X=700)

Cross hair targets described above lines were placed at both ends and mid point of accelerator. Alignment telescopes were placed at both ends and aligned with these targets.

Z position (beam direction) was marked on the floor using a total station and automatic nadir plumets.

3. Alignment for stone table

Stone table (OELZE GmbH) # = 13
L:1.5m~2.5m W:700mm
D:350 or 450 mm
Weight:2.2t (L=2.5m)
Flatness: JIS1 grade
with align T-rail

With 4 air-pad legs
Height, Tilt:
with leveling block
Position:
floated by pressured air

Y-direction (Height) alignment
Using Y+700mm telescope with an alignment scale and precise water level
X-direction (Lateral) alignment
Using X+700mm telescope with two alignment scales
Z-direction (Beam direction) alignment
Using plumbs at up- and downstream side.

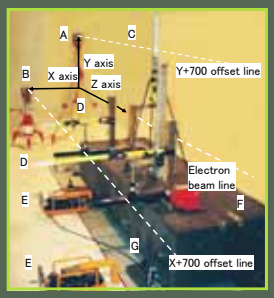


Photo of R&D for alignment method
A: Auto-level for height Y+700mm
B: Auto-level for direction X+700mm
C: Alignment scale for height
D: Alignment scale for direction
E: Jack for adjustment position
F: Stone table with align T-rail
G: Air-pad with leveling block

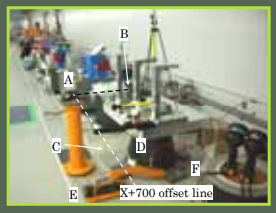
4. Alignment for cordierite support stand

Cordierite (ceramic) support stand # = 14

It has very good characteristics for vibration and thermal expansion.
Its position was adjusted by floating with pressured air. Its height was adjusted by an spacer plate.

Y-, Z-direction alignment
same method as stone table

X-direction alignment
Position was aligned with an alignment scale.
Angle was aligned by auto collimation method with a mirror, a penta reflector and X+700mm telescope.



A: Penta reflector
B: Mirror for auto collimation
C: Plumb
D: Cordierite support stand
E: Jack for alignment position
F: Lead block

5. Alignment for other components

E-Gun tank, undulators, dump magnet, etc. These components were also aligned with each reference surfaces and alignment scales.

0. Grinding of concrete floor

We grinded the concrete floor to make a very flat floor (roughness < 20 μm) using a grinding machine. The special machine equipped with a rotating diamond wheel, mounted on XYZ translator controlled by PLC.

For using air-pad system
For the tight connection between the girder and the concrete floor

Initial P-V value of concrete floor level : 8.8mm

Grinding area # = 43 size: 300×600~1000×750

Floor lever after grinding
Special area # = 8 (1000×750)
→ ±0.1mm
Normal area # = 24
→ 0~0.8mm
Area having place under base level # = 11
→ Level for grinding all place inside each area

Grinding machine "YUKA-TO-KENSAKU"

Finishing level precision ± 0.1 mm
Surface roughness < 20 μm
Surface tilt < 0.15 mm/m
Grinding speed
3 hours / 800×800 area

Final alignment precision
Components placed within 20m from telescope: ±0.1mm
Other components: ±0.2mm