ESRF

Facing the Challenges Building the Capacity

FIG SYDNEY 2010

Overview of Accelerator Alignment

D. Martin

- Introduction,
- Particle Accelerators,
- Fiducilisation,
- Accelerator Alignment,
- Experiments Alignment,
- Summary.

The European Light Source

Slide: 1

ESRF

Facing the Challenges Building the Capacity

FIG SYDNEY 2010

International Workshop on Accelerator Alignment

This presentation borrows from the considerable work of colleagues in the field of accelerator alignment. Workshops are held every two years. The proceedings from these workshops are hosted on the SLAC National Accelerator Laboratory website found at:

http://www-conf.slac.stanford.edu/iwaa/default.htm

The next workshop IWAA 2010 will be held
at DESY in Hamburg, Germany
(September 13 - 17, 2010)

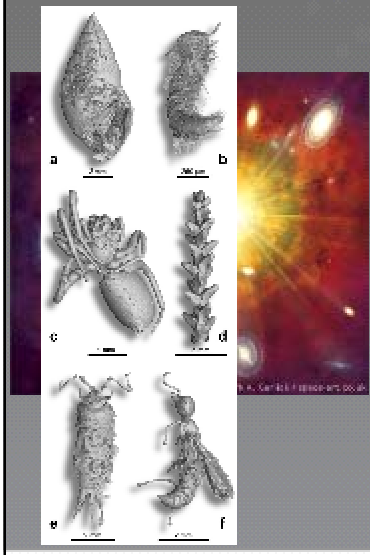
The European Light Source

Slide: 2

ESRF

Facing the Challenges Building the Capacity

Introduction



- A particle accelerator uses electric fields to accelerate charged subatomic particles to nearly the speed of light while maintaining them in well-defined trajectories.
- Beams of high-energy particles are useful for both fundamental and applied research.
- Colliders investigate the structure, interactions, and properties of matter in conditions similar to those imagined to have occurred in the first moments of the Big Bang.
- Application fields for light generated by synchrotron radiation light sources include chemistry, earth science, condensed matter physics, biology, life sciences and technology.

The European Light Source

Slide: 3

ESRF

Facing the Challenges Building the Capacity

Introduction – particle accelerators

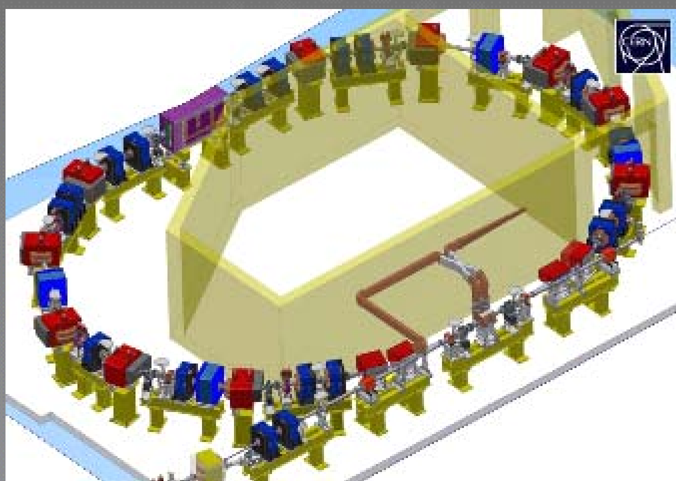


Image from: Quesnel, J.P., et al. *Status Report on the Survey and Alignment Activities at CERN*. in *Tenth International Workshop on Accelerator Alignment*. 2008. KEK, Tsukuba Japan.

The European Light Source

Slide: 4

Facing the Challenges Building the Capacity

Introduction – particle acceleration

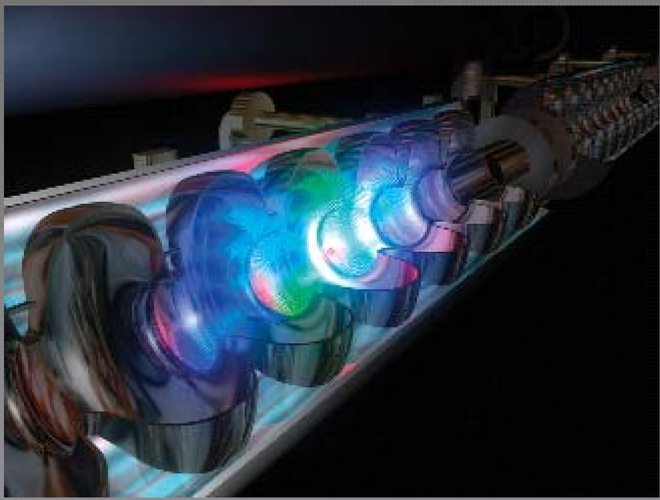


Image from the CERN document server.

The European Light Source Slide: 5

Facing the Challenges Building the Capacity

Fiducilisation

Image from the CERN document server.

The European Light Source Slide: 6

Facing the Challenges Building the Capacity

FIG SYDNEY 2010

Fiducilisation

DESY PETRA III quadrupole magnets

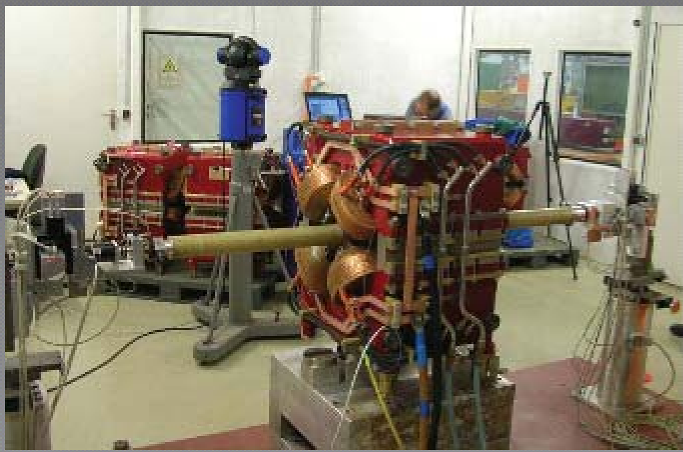


Image from: Prenting, J. *Status Report on the Survey and Alignment efforts at DESY*. in *Tenth International Workshop on Accelerator Alignment*. 2008. KEK, Tsukuba Japan.

The European Light Source Slide: 7

Facing the Challenges Building the Capacity

FIG SYDNEY 2010

Accelerator Alignment

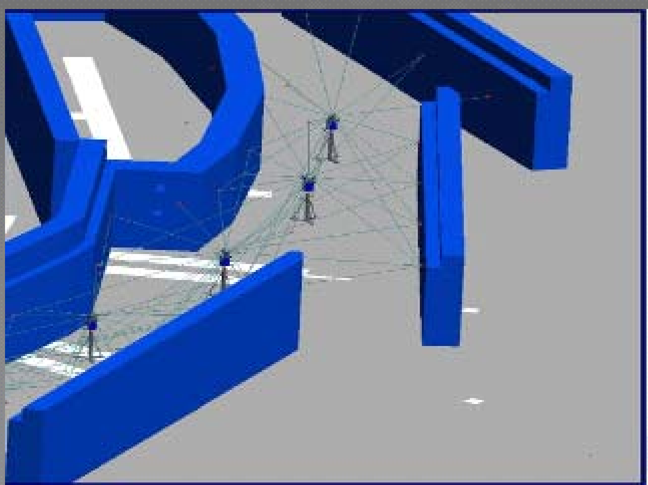


Image from: Rey, F. *Status Report on Survey and Alignment for the ALBA Synchrotron*. in *Tenth International Workshop on Accelerator Alignment*. 2008. KEK, Tsukuba Japan.

The European Light Source Slide: 8

ESRF

Facing the Challenges Building the Capacity

Accelerator Alignment

The European Light Source

Slide: 9

ESRF

Facing the Challenges Building the Capacity

Accelerator Alignment – R and Z

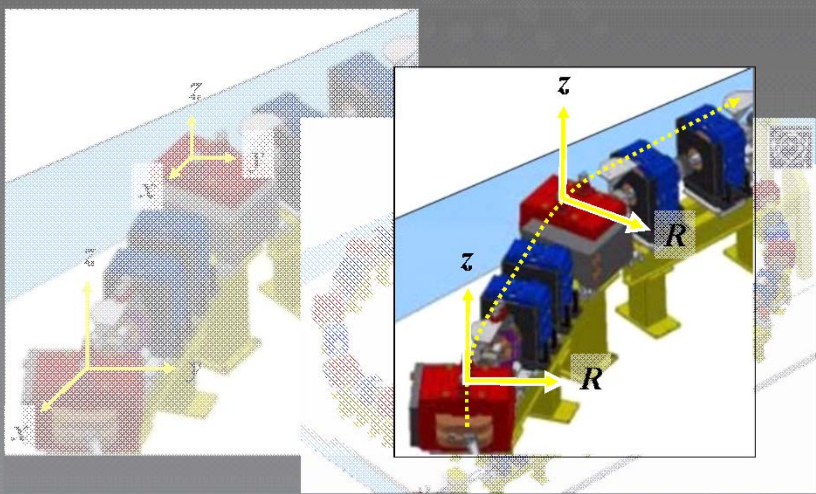
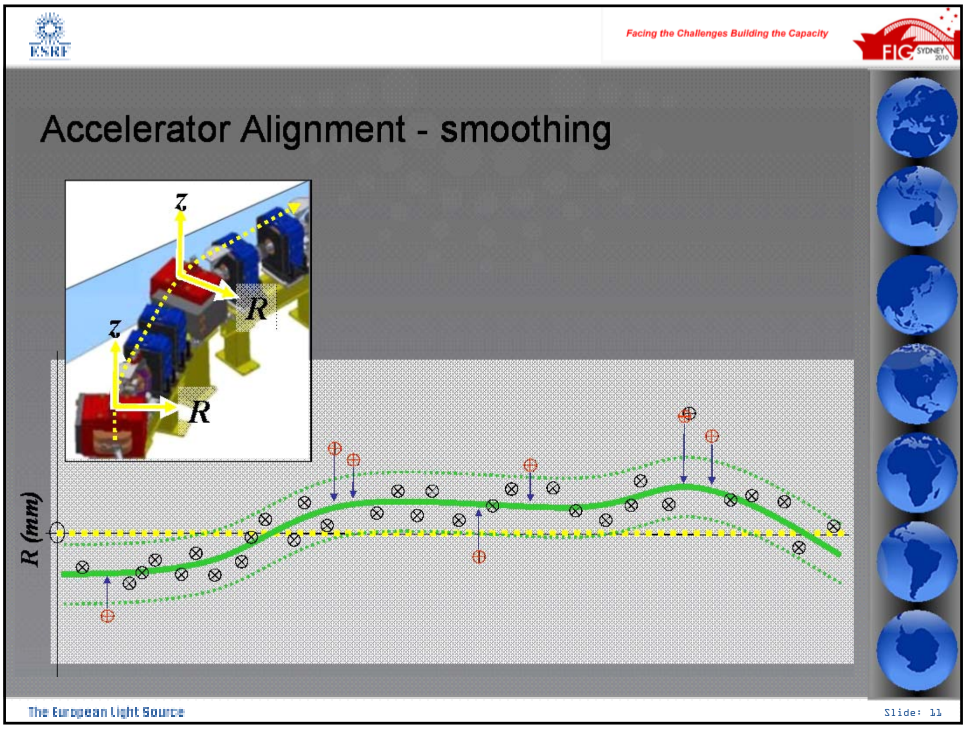
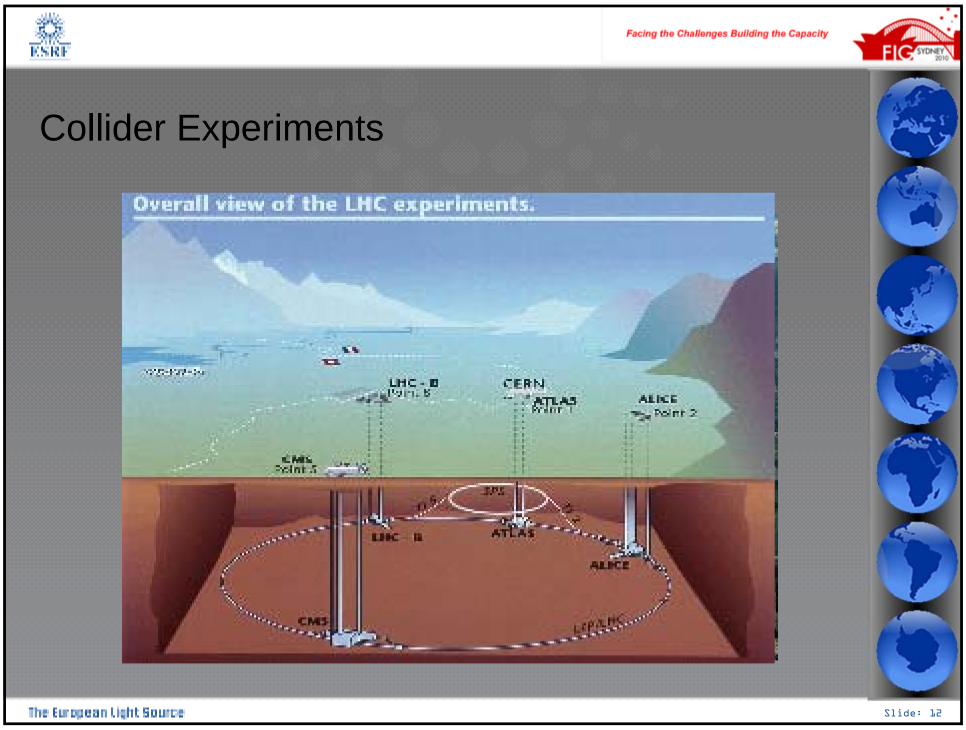


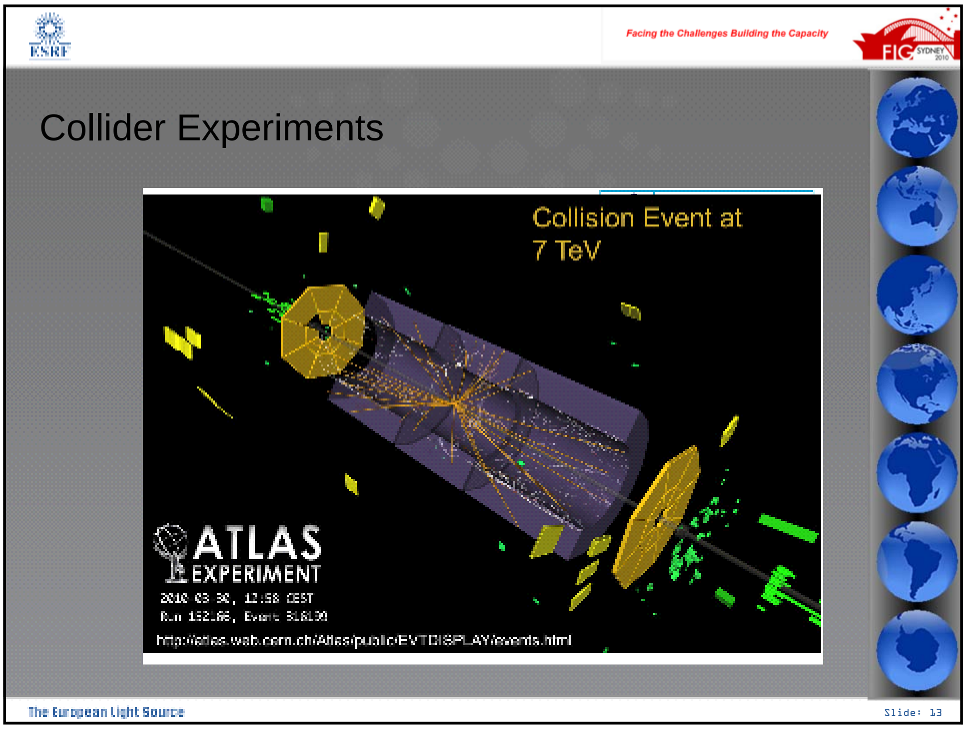
Image from: Quesnel, J.P., et al. *Status Report on the Survey and Alignment Activities at CERN*. in *Tenth International Workshop on Accelerator Alignment*. 2008. KEK, Tsukuba Japan.

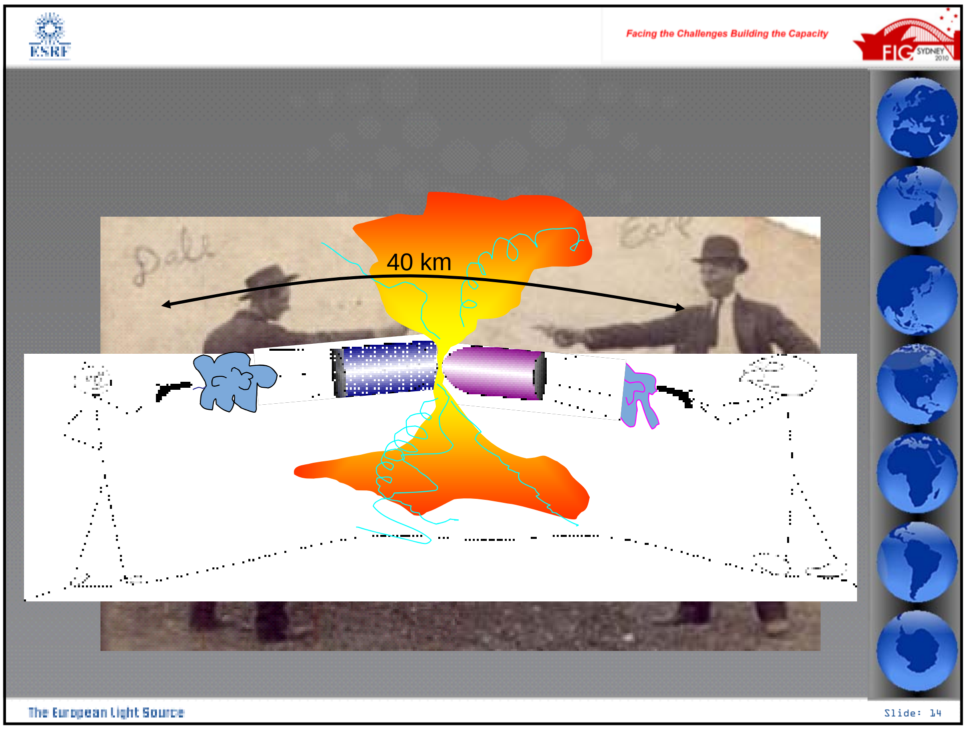
The European Light Source

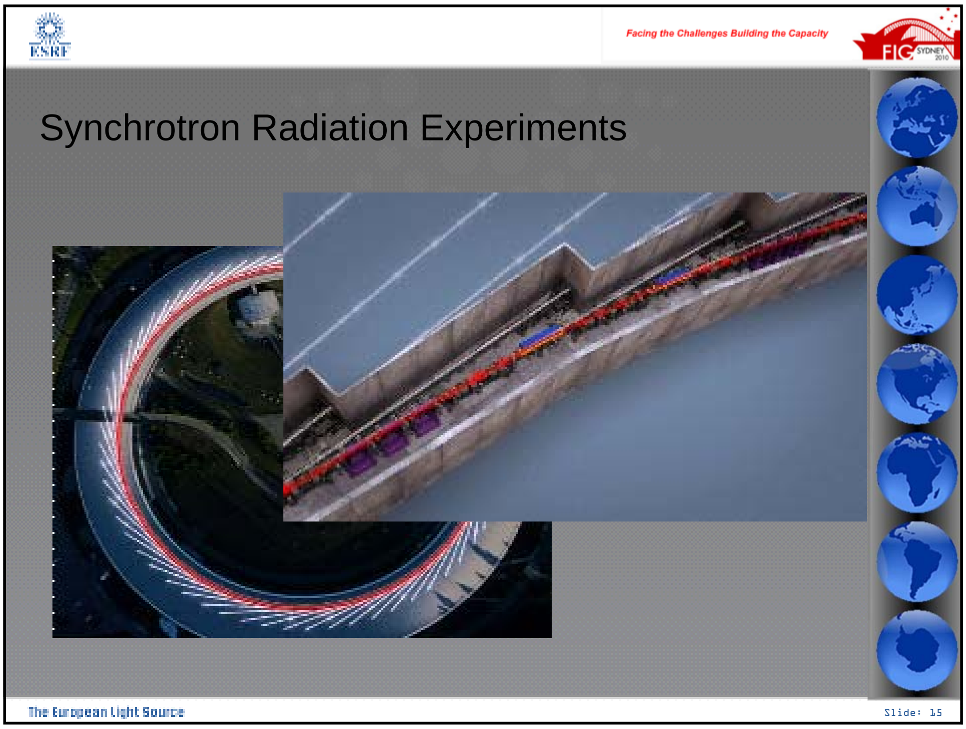
Slide: 10

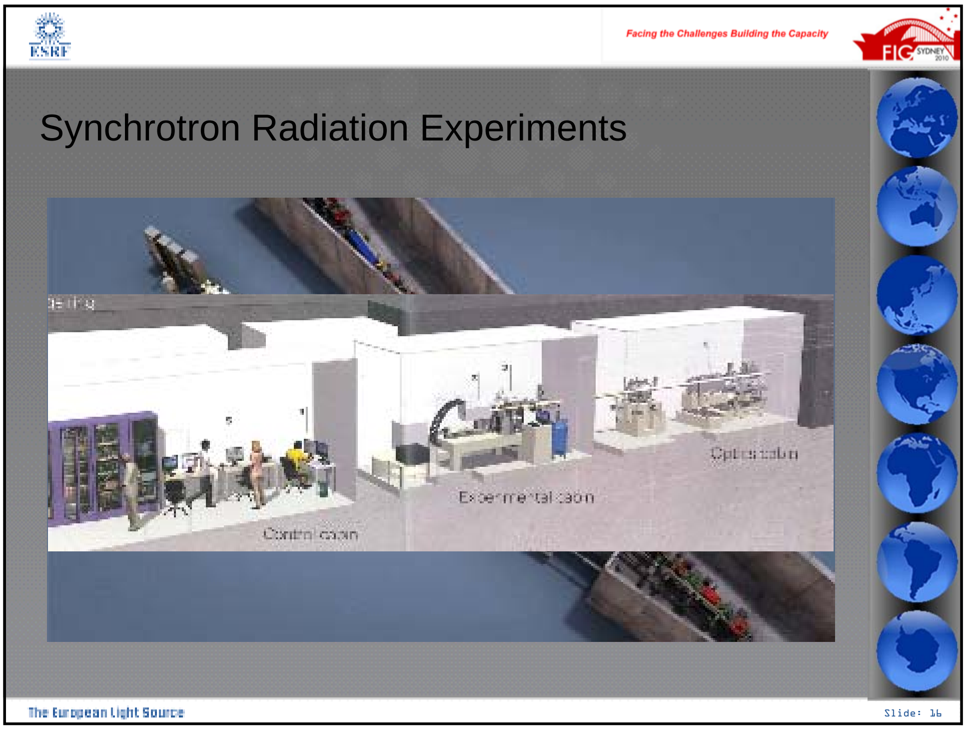

ESRF
Facing the Challenges Building the Capacity
FIG SYDNEY 2010
Accelerator Alignment - smoothing
z
R
z
R
R (mm)
The European Light Source
Slide: 11

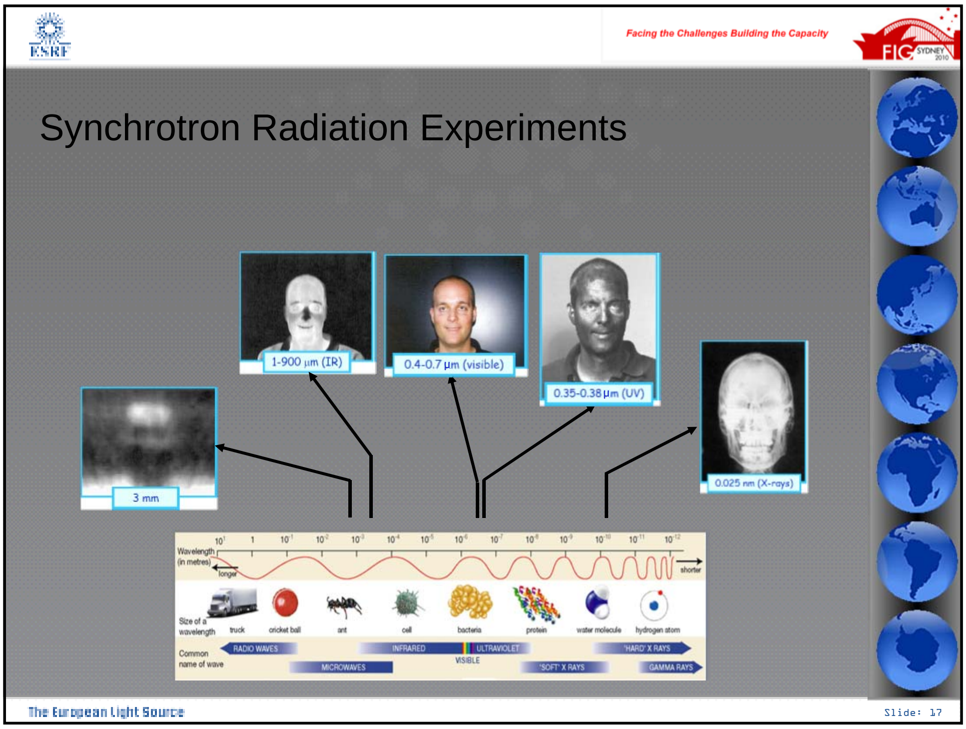

ESRF
Facing the Challenges Building the Capacity
FIG SYDNEY 2010
Collider Experiments
Overall view of the LHC experiments.
LHC - B
CERN
ATLAS
ALICE
CMS
LHC - B
ATLAS
ALICE
CMS
The European Light Source
Slide: 12


ESRF
Facing the Challenges Building the Capacity
FIG SYDNEY 2010
Collider Experiments
Collision Event at
7 TeV
ATLAS
EXPERIMENT
http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html
The European Light Source
Slide: 13

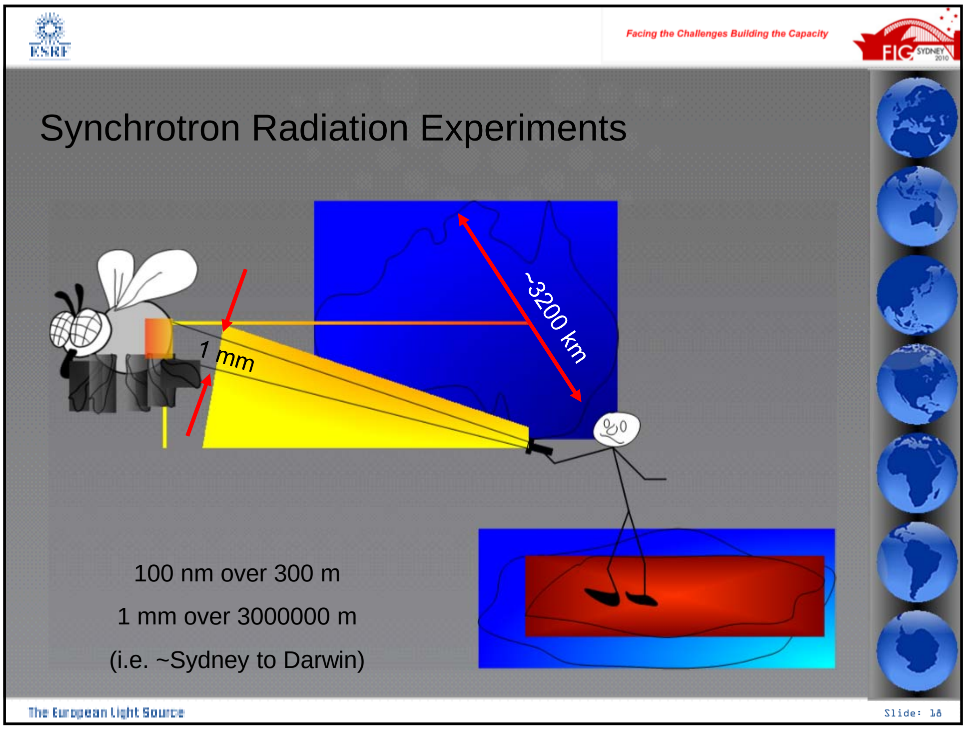

ESRF
Facing the Challenges Building the Capacity
FIG SYDNEY 2010
40 km
The European Light Source
Slide: 14


ESRF
Facing the Challenges Building the Capacity
FIG SYDNEY 2010
Synchrotron Radiation Experiments
The European Light Source
Slide: 15

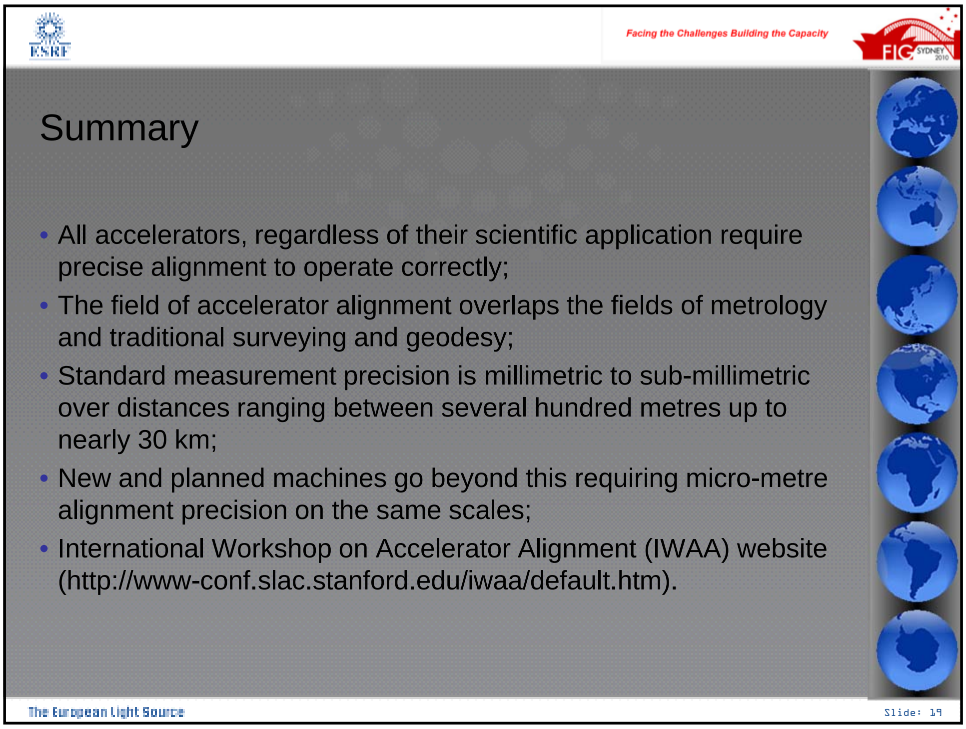

ESRF
Facing the Challenges Building the Capacity
FIG SYDNEY 2010
Synchrotron Radiation Experiments
The European Light Source
Slide: 16



Facing the Challenges Building the Capacity
Synchrotron Radiation Experiments
1-900 µm (IR)
0.4-0.7 µm (visible)
0.35-0.38 µm (UV)
3 mm
0.025 nm (X-rays)
The European Light Source
Slide: 17



Facing the Challenges Building the Capacity
Synchrotron Radiation Experiments
~3200 km
1 mm
100 nm over 300 m
1 mm over 3000000 m
(i.e. ~Sydney to Darwin)
The European Light Source
Slide: 18


ESRF
Facing the Challenges Building the Capacity
FIG SYDNEY 2010
Summary
• All accelerators, regardless of their scientific application require precise alignment to operate correctly;
• The field of accelerator alignment overlaps the fields of metrology and traditional surveying and geodesy;
• Standard measurement precision is millimetric to sub-millimetric over distances ranging between several hundred metres up to nearly 30 km;
• New and planned machines go beyond this requiring micro-metre alignment precision on the same scales;
• International Workshop on Accelerator Alignment (IWAA) website (http://www-conf.slac.stanford.edu/iwaa/default.htm).
The European Light Source
Slide: 19