Appendices

APPENDIX 1: BEAMLINE COSTINGS

It is proposed that the Australian Synchrotron should commence with a core suite of between nine and thirteen world class beamlines. Details of the proposal are given in chapter 4.

The following cost estimates for the design, construction and commissioning of each of the thirteen beamlines were prepared by the beamline proponents with support from the National Scientific Advisory Committee, the International Scientific Advisory Committee, the International Machine Advisory Committee and a number of individual Australian and overseas experts.

Work is continuing on the specifications for each beamline, and as details are finalised these cost estimates will be refined. In the meantime, every effort has been made to ensure that the beamline costing estimates are based on the most reliable and reasonable figures currently available in 2003.

Cost Estimate Assumptions

Some items have already been included in the budget for the synchrotron machine and as such are not included in beamline costings. These include:

- the 'front end' equipment (i.e. vacuum equipment, interlocks, controls and electronic equipment on the inner side of the shielding wall)
- a distributed liquid nitrogen system
- the labour costs of the beamlines manager and corporate technical staff. (However, an allowance has been included for labour for design, construction and commissioning of each beamline.)
- costs for survey and alignments, vacuum and control interfacing with the machine and radiation monitoring.

Currency Conversions

Prices quoted are in current Australian dollars. Conversion rates used are:

$A1 = $US0.65

$A1 = $CAN0.90

$A1 = GBP 0.385

$A1 = Euro 0.58

$A1 = Yen 75

Contingency

No contingency has been made for currency fluctuation or uncertainties of the cost of components. Synchrotron technology is evolving rapidly and it is possible that by 2006 some devices may be of lower cost; however, this is impossible to predict at present.

Summary of beamline cost estimates

BL	Title	Category 1	Category 2	Category 3
		$(A)	$(A)	$(A)
1	High-throughput Protein Crystallography*	5,823,000	1,655,000	
2	Protein Microcrystal & Small Molecule Diffraction	7,983,000		
3	Powder Diffraction**	5,300,000		
4	Small & Wide Angle Scattering	4,785,000		
5	X-ray Absorption Spectroscopy	5,110,000		
6	Soft X-ray	4,939,000		
7	Vacuum Ultraviolet		4,990,000	
8	Infrared Spectroscopy	2,600,000		
9	Microspectroscopy	5,339,000		
10	Imaging & Medical Therapy	7,610,000	5,120,000	
11	Microdiffraction and Fluorescence Probe			3,442,000
12	Circular Dichroism		3,100,000	
13	Lithography			4,240,000
Total		**49,489,000**	**14,865,000**	**7,682,000**

Notes: * bending magnet – then an in-vacuum undulator
** bending magnet – moving to wiggler

Beamlines 1 & 2 – Protein Crystallography & Small Molecule Diffraction

Item	Beamline 1 $(A)	Beamline 2 $(A)	
	Category A	Category A	Category B
In vacuum undulator		1,365,000	1,365,000
Liquid nitrogen cooling		200,000	200,000
Water cooled CVDD filter	23,000	23,000	
Quadrant XBPM	40,000	40,000	
4 blade XPBM	40,000	40,000	
Primary slits	114,000	114,000	
Filter unit (carbon & metal filters)	68,000	68,000	
Optical system	640,000	1,000,000	
Bremsstrahlung stop	23,000	23,000	
Secondary slits	28,000	28,000	
3 pixel XBPM	27,000	27,000	
Beamshutter (monochromatic)	23,000	23,000	
3 HLS sensors	7,000	7,000	
Exposure box	23,000	23,000	
Equipment protection system	34,000	34,000	
Micro-crystal diffractometer	752,000	752,000	
Pixel detector	1,360,000	1,360,000	
Controls & data acquisition	387,000	387,000	
Motor drivers (88)	54,000	54,000	
Graphics workstations	34,000	34,000	
Software	60,000	60,000	
Signal & power cables	28,000	28,000	
Vacuum (ion getter & turbo pumps)	122,000	122,000	
Hutches	280,000	480,000	
LAC	22,000	22,000	
Lab equipment	34,000	34,000	
Miscellaneous equipment	200,000	200,000	
Flat panel detector	800,000	200,000	
Robotics system	200,000	200,000	
4-circle diffractometer		450,000	
Cryogenic/heating specimen chamber		185,000	
Labour (@ $90,000 per FTE year)	400,000	400,000	90,000
Totals	**5,823,000**	**7,983,000**	**1,655,000**

Beamline 3 – Powder Diffraction

	$(A)
Wiggler	1,000,000
Cooling system	150,000
Collimating mirror	228,000
Double-crystal monochromator	700,000
Focussing mirror	227,000
Monochromator exit aperture	50,000
Optics & experimental hutches	242,000
Debye-Scherrer diffractometer	300,000
Conventional diffractometer	200,000
Detectors	600,000
Cryostat	80,000
Furnace	60,000
Optical table	20,000
Beamline components	379,000
Electrical infrastructure and controls	364,000
Vacuum equipment	250,000
Labour (5 FTE years @ $90,000)	450,000
Total	**5,300,000**

Beamline 4 – Small & Wide Angle Scattering

	$(A)
In-vacuum undulator 2.2cm period	1,365,000
Liquid nitrogen cooling	200,000
White beam slits (to handle 91 watts/mm2)	125,000
Monochromator (with water cooled diamond crystals)	577,000
Toroidal (doubly focussing) mirror	526,000
Miscellaneous beamline transport and vacuum components	154,000
Optics enclosure	140,000
Experimental enclosure (including utilities and safety system)	278,000
Collimating optics (motorised slits for mono beam)	46,000
SAXS camera (flight tube and associated mechanisms)	154,000
SAXS detector (CCD based on current technology)	385,000
WAXS detector (CCD)	385,000
Labour (5 FTE years @ $90,000)	450,000
Total	**4,785,000**

Beamline 5 – X-ray Absorption Spectroscopy

	$(A)
Wiggler	1,000,000
Cooling system	150,000
Collimating mirror	228,000
Double-crystal monochromator	700,000
Focussing mirror	227,000
Monochromator exit aperture	50,000
Optics & Experimental hutches	242,000
Cryostat	100,000
Furnace	50,000
Optical table	20,000
Fluorescence detector	800,000
Additional detectors	100,000
Beamline components	379,000
Electrical infrastructure and controls	364,000
Vacuum equipment	250,000
Labour (5 FTE years @ $90,000)	450,000
Total	**5,110,000**

Beamline 6 – Soft X-ray Spectroscopy

	$(A)
Variable polarisation undulator	1,500,000
Liquid nitrogen cooling system	80,000
Collimating mirror	228,000
Double-crystal monochromator	700,000
Focussing mirror	227,000
Switching mirror	250,000
Exit apertures (two)	100,000
Optics and two experimental hutches	400,000
Optical tables (two)	40,000
Beamline components	350,000
Electrical infrastructure and controls	364,000
Vacuum equipment	250,000
Labour (5 FTE years @ $90,000)	450,000
Total	**4,939,000**

Note: The two experimental end stations are not included as they are being built at present for other programs and will be transferred to the Australian Synchrotron at the appropriate time.

Beamline 7 – Vacuum Ultraviolet

	$(A)
Variable polarisation undulator	1,500,000
Liquid nitrogen cooling system	80,000
Toroidal focussing mirror	228,000
Plane grating monochromator	650,000
Cylindrical mirror	200,000
Toroidal horizontal refocussing mirror	228,000
Exit apertures	50,000
Optics & experimental hutches	220,000
Optical table	20,000
UHV specimen chamber and detectors	400,000
Beamline components	350,000
Electrical infrastructure and controls	364,000
Vacuum equipment	250,000
Labour (5 FTE years @ $90,000)	450,000
Total	**4,990,000**

Beamline 8 – Infrared Spectroscopy

	$(A)
Ultra high vacuum section	
Vacuum equipment & beam tubing	150,000
Motorised mirrors (3)	90,000
Diamond window	50,000
Medium vacuum section	
Beam switchyard	100,000
Stainless steel beam tubes (3)	75,000
Movable mirrors	90,000
Vacuum equipment	150,000
Experimental enclosures (2)	220,000
Optical tables (3)	90,000
High resolution FTIR	600,000
IR microscope	500,000
Data handling & interpretation	60,000
Ancillary & safety equipment	150,000
Labour (3 FTE years @ $90,000)	275,000
Total	**2,600,000**

Beamline 9 – Microspectroscopy

	$(A)
Undulator 22 mm in vacuum	1,365,000
Liquid nitrogen cooling	200,000
Parabolic collimating mirror	228,000
Double-crystal monochromator	760,000
Toroidal focussing mirror	227,000
Monochromator exit aperture	53,000
Optics & experimental enclosures	200,000
KB micro-focus mirrors	60,000
Zone plates	60,000
Optical table	20,000
Fluorescence detector (2)	350,000
Scanning	50,000
Proportional counters	20,000
CCD detector	303,000
Beamline components	379,000
Electrical infrastructure and controls	364,000
Vacuum equipment	250,000
Labour (5 FTE years @ $90,000)	450,000
Total	**5,339,000**

Beamline 10 – Imaging & Medical Therapy

	Stage 1 $(A)	Stage 2 $(A)
Source & delivery of beam		
Wiggler (superconducting, variable field 2 – 6 T)	2,500,000	
Cooling system	250,000	
Beamline components (shutters,etc) & shielding	500,000	
Electrical infrastructure and controls	400,000	
Double-crystal (Laue case) monochromator	760,000	
Vacuum components	250,000	
Beam monitoring components	100,000	
Optical enclosure	200,000	
End stations		
Monochromator exit aperture	60,000	
Experimental Hutch #1, including services	200,000	
Optical bench	20,000	
KB mirrors (including 1 multilayer mirror)	200,000	
Tomography stage	200,000	
Imaging plate detector	250,000	
2-dimensional electronic imaging detector	500,000	
Scanning and positioning stages	100,000	
Controls & control system	200,000	
Safety shutters	100,000	100,000
Long beamline		400,000
Separate building, control room and experimental hutch #2		2,500,000
Vacuum components		100,000
Second hutch controls		100,000
Optical bench		20,000
Secondary large aperture monochromator system		1,000,000
Sample positioning system		400,000
Related infrastructure		
Computers and software for control and data processing	100,000	50,000
Labour (construction and commissioning)		
Salary (8 FTE years @$90,000)	720,000	
Salary (5 FTE years @$90,000)		450,000
Totals	**7,610,000**	**5,120,000**

Beamline 11 Microdiffraction and Fluorescence Probe

	$(A)
Water cooled mask and collimator	26,500
White beam slits	44,100
Pre-focussing mirror	441,000
Double multilayer monochromator	485,000
Multilayers	70,500
Monochromatic beam slits	26,500
Fluorescent screen	28,200
Frame grabber	1,800
Photon shutter	35,300
Pipe	44,000
Optics hutch	167,000
Interlock	56,000
Quadrant beam position monitor	21,000
KB mirrors	212,000
Be window	10,500
Slits	35,000
EDX detector	67,000
CCD	264,500
Computers	89,000
Stage and indexer	111,000
Hardware/software	111,000
Table	44,100
Position monitor	80,000
End station assembly	100,000
Optical microscope	90,000
Experimental hutch	121,000
Electrical & safety system	300,000
Labour (4 man FTE @ 90,000)	360,000
Total	**3,442,000**

Beamline 12 – Circular Dichroism

	$(A)
Water cooled entrance slits	50,000
Double-crystal monochromator	550,000
Focussing mirror	220,000
Monochromator exit aperture	50,000
Optics & Experimental hutches	220,000
Photoelectric modulator	100,000
Linear, array & IR detectors	400,000
Laser temperature & pressure jump device	75,000
Stopped flow apparatus	50,000
Optical table	20,000
Beamline components	300,000
Electrical infrastructure and controls	365,000
Vacuum equipment	250,000
Labour (5 FTE years @ $90,000)	450,000
Total	**3,100,000**

Beamline 13 – Lithography

	$(A)
Water cooled entrance slits	50,000
Double-crystal monochromator	550,000
Monochromator exit aperture	50,000
Optics hutch	120,000
Lithography scanner – mechanical system	640,000
Lithography scanner – software & control	140,000
Experimental hutch – Class 100 clean room	400,000
Beamline components	300,000
Electrical infrastructure and controls	365,000
Vacuum equipment	250,000
Labour (5 FTE years @ $90,000)	450,000
Separate class 100 clean room for developing samples	675,000
Ancillary equipment	250,000
Total	**4,240,000**