

AD-A200 743

DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

2a. SECURITY CLASSIFICATION AUTHORITY		1b. RESTRICTIVE MARKINGS	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE		3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)		5. MONITORING ORGANIZATION REPORT NUMBER(S) AFOSR-TR- 88-1120	
6a. NAME OF PERFORMING ORGANIZATION Stanford University	6b. OFFICE SYMBOL (if applicable)	7a. NAME OF MONITORING ORGANIZATION AFOSR/NP	
6c. ADDRESS (City, State, and ZIP Code) 660 Arguello Way, Encina Hall Stanford, CA 94305-6060		7b. ADDRESS (City, State, and ZIP Code) Building 410, Bolling AFB DC 20332-6448	
8a. NAME OF FUNDING/SPONSORING ORGANIZATION AFOSR	8b. OFFICE SYMBOL (if applicable) NP	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER AFOSR-86-0236	
8c. ADDRESS (City, State, and ZIP Code) Building 410, Bolling AFB DC 20332-6448		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO. 61102F	TASK NO. A6
		PROJECT NO. 2917	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) (U) THE APPLICATION OF CHANNELING RADIATION TO THE STUDY OF MATERIALS AND TO THE DEVELOPMENT OF X-RAY AND GAMMA-RAY SOURCES			
12. PERSONAL AUTHOR(S) Richard H. Pantell			
13a. TYPE OF REPORT FINAL	13b. TIME COVERED FROM 8/1/86 TO 11/30/87	14. DATE OF REPORT (Year, Month, Day) November 1988	15. PAGE COUNT 11
16. SUPPLEMENTARY NOTATION			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	Beamline, X-ray Source, Straight Beam Pipe	
	20.09		
19. ABSTRACT (Continue on reverse if necessary and identify by block number)			
<p>The equipment purchased under this grant was made possible by the DOD-URIP Program. The equipment has been used to construct a beamline for developing an x-ray source based upon channeling radiation. The beamline has been added to the Stanford, Mark III linear accelerator, which provides a high current, low emittance electron beam at approximately 40 MeV energy.</p>			
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20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL Robert J. BARKER		22b. TELEPHONE (Include Area Code) (202) 767-5011	22c. OFFICE SYMBOL AFOSR/NP

Final Report
for
Grant Number AFOSR-86-0236

November 1988

This Equipment Grant has been used to construct a beamline for developing an x-ray source based upon channeling radiation. The beamline has been added to the Stanford, Mark III linear accelerator, which provides a high current, low emittance electron beam at approximately 40 MeV energy.

Figures 1 and 2 illustrate the main features of the construction. Between the two figures, i.e. to the left of Figure 1 and to the right of Figure 2, there is about two meters of straight beam pipe which is not shown. In Figure 1, the electrons enter from the right from the 40 MeV, rf linac, and pass through an 18° bend into a dog leg containing focusing and steering magnets. The magnets were designed using the TRANSPORT code developed at SLAC. Two retractable phosphor screens, monitored by TV cameras, are located in this line to determine the size and position of the beam as a function of the magnet settings.

The electrons then pass through another bending magnet to enter the channeling beamline, the continuation of which is shown in Figure 2. This line contains the goniometer in which the channeling crystal is mounted, the dump magnet for removing the electron beam from the path of the emitted radiation, several vacuum pumps, and viewing ports and screens with accompanying TV cameras. Downstream from the beam dump is the radiation detector assembly consisting of a Bragg crystal and photomultiplier tube. With this beamline facility, we have recently measured x-ray channeling radiation from crystal planes of silicon.

Table I is a list of the items purchased on this grant, including the cost, date ordered, and the vendor. Of the initial \$233,804 awarded (with \$23,380 from Stanford University), \$15,000 remains unspent, and a no-cost extension until 9/30/87 has been requested to utilize this sum. The \$15,000 will be expended on: controls for the goniometer and detector assembly; the purchase of a photodiode detector; and additional electronics, such as a signal amplifier.

Table II is a list of items requested in the original proposal. Items which were not on the original list, but were required for completion of the beamline include:

- a second turbopump and fore pump to evacuate the larger-than-expected beam dump volume
- several vacuum gauges
- equipment for beamline alignment
- a 17 kW chiller for water cooling
- magnet power supplies
- intercom
- instrument racks and cabinets

In the original proposal it was anticipated that the linac would provide 300 MeV electrons to the channeling beamline, but linac development has been slower than anticipated. Thus, we have concentrated on the development of an x-ray, rather than a γ -ray source, using the existing 40 MeV linac and eliminating the equipment required for 300 MeV electrons. Items listed in Table II which were not purchased include:

- 300 MeV bending magnet
- 300 MeV Faraday cup

In addition, three of the five quadrupole magnets in the original request were available from previous experiments and were not purchased.



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Figure 1

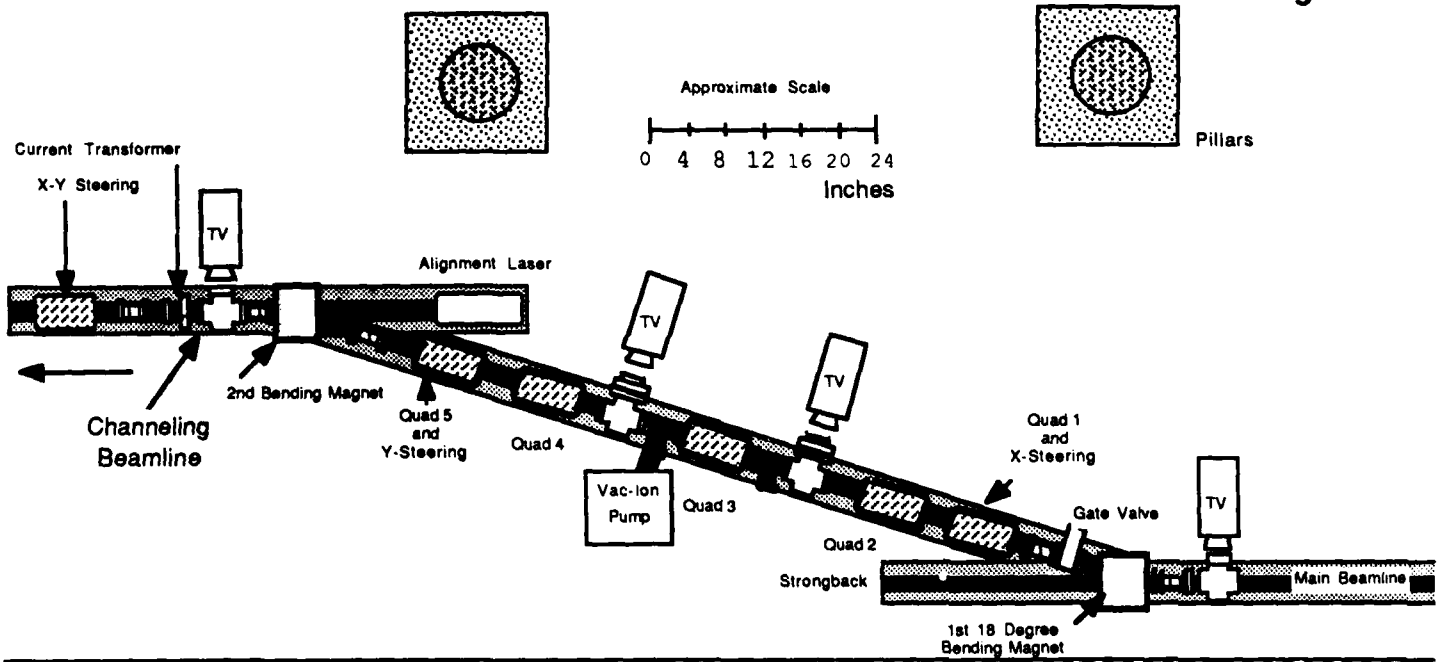


Figure 2

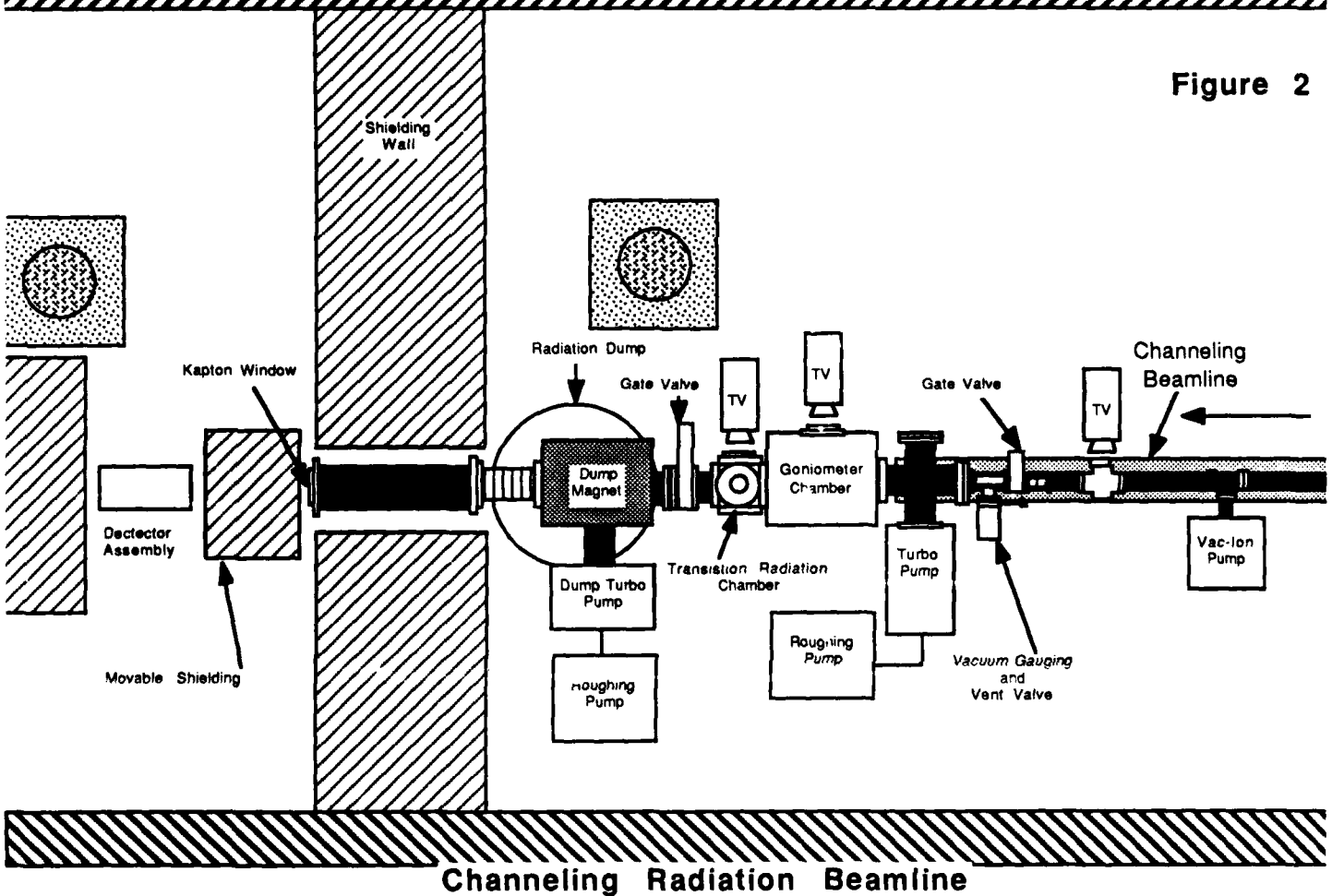


Table I: Items Purchased

<u>Description</u>	<u>Cost</u>	<u>Date Ordered</u>	<u>Vendor</u>
Theodolite	\$6,990	7-16-87	Langham-Mathis Inst.
HeNe Laser Head	299	6-10-87	Melles Groit
Nuts, Bolts and Screws	61	9-22-87	Danforth Screw and Bolt Co.,
Nuts, Bolts and Screws	150	9-22-86	Danforth Screw and Bolt Co.,
Aluminum Plate	92	11-19-86	Campbell Tool & Metal Supply
Stanchions	922	11-13-86	J&L Digital Precision Inc.
Alignment Jigs	500		Ion Support Consultants
Wire	1,000	11-19-86	Bay Associates
Temp. Monitors	655	11-19-86	Omega Engineering Co.,
Cable	560	12-4-86	Bay Associates
Cabinet	204	12-12-86	Premier Metal Products
Current Transformer	352	7-27-87	Stangenes Industries
Wire	280	1-8-87	Bay Associates
Relays	380	1-23-87	Newark Electronics
Wire and Cable	1,065	7-9-87	Bay Associates
Gaussmeter	2,156		GMW Associates
Water System	802		Haley Engineering
Helipots	194	11-19-86	Abacus Electronics
Misc. Electrical Mat.	1,841		Electrical Materials
Wire	260	1-28-87	Electrical Materials
Misc. Electrical Mat.	108	5-7-87	Electrical Materials
Wire	688	11-19-86	Electrical Materials
Ckt. Breakers	854	12-5-86	Electrical Materials
Distribution Panel	790	12-11-86	Electrical Materials
Misc. Electrical	385	12-18-86	Electrical Materials
Misc. Electrical	150	1-9-87	Electrical Materials
Misc. Electrical	382	1-5-87	Electrical Materials

Misc. Electrical	420	1-23-87	Electrical Materials
Quadrupole Magnets	1,600	12-12-87	SPRL
Magnet Steel	268	8-26-87	Robin Materials
Bending Magnet & Power Supply	21,465	7-31-87	Alpha Scientific
Steel	110	1-20-87	Alan Steel Supply
Power Supplies	9,007	10-23-86	NS Associates
Power Supplies	580	10-30-86	Hewlett Packard
Steel	207	12-4-86	Coulter Steel
Quadrupole Magnet Mounts	1,035	1-9-87	Johnston Prototype Mach.
Magnet Stand and Chamber	810	1-30-87	Boulderdash Co.,
Connectors	36	3-20-87	Kepeco
Magnet Cable	1,024		Madco
Chiller	11,243	3-4-87	M&W Systems
Lead Sheet	175	7-23-87	Specialty Steel Service
Steel	350	7-9-87	Ryerson Steel Corp.
Steel	2,220	10-14-87	PDM Steel
Paraffin	110	2-20-87	Paragon Wax Refining Co.,
Fore Pump	3,727	1-10-87	Leybold-Heraeus
Vacuum Hardware	510	7-13-87	Huntington Labs
Flanges, Quartz Window, etc.	2,768	8-26-86	MDC Corp.
Gate Valves	2,015	8-27-86	Thermionics Vacuum Prod.
Fore Pump & Accessories	2,370		Welch Scientific
Ionization Tube	455	6-26-87	Granville-Phillips
Vacuum Flanges and etc.	450	7-2-87	Huntington Mech. Labs.
Mod. of Chamber	125	5-7-87	Boulderdash Co.,
Flanges, Crosses, Tee, etc.	980	8-26-87	MDC Corp.
Steel	85	8-26-86	Ryerson Steel Corp.
Gate Valve	2,024	8-27-86	Thermionics Vacuum Prod.
Gaskets	75	8-26-87	MDC Corp.
Ion Pumps	5,467	10-16-86	Perkin-Elmer
Ion Gage Controllers	3,812	11-7-86	Granville-Phillips
Flanges, Crosses, etc.	8,420	11-13-86	MDC Corp.
Fore Pump and Access	3,483	11-14-86	Leybold-Heraeus Inc.
Beam Pipe	2,115	11-14-86	Huntington Labs

Magnet Chambers	600	11-14-86	Boulderdash Co.,
Vacuum Welding	725	11-25-86	Boulderdash Co.,
Copper	244	12-1-86	Castle Metal
Gate Valves	3,420	12-4-86	Thermionics Vacuum prod.
Machine Copper	995	12-15-86	Associated Machine
Gaskets	212	12-11-86	MDC Corp.
Flanges, etc.	2,988	1-16-87	MDC Corp.
Vacuum Welding	240	12-30-86	Boulderdash Co.,
Gaskets	136	1-3-87	MDC Corp.
Gasket Clips, Flexible Couplings	279	9-24-86	Varian Associates Inc.
Gaskets	75	8-26-86	MDC Corp.
Ion Pump Connector	430	1-3-87	Dunaway Stockroom
Bellows	450	1-5-87	Huntington Labs
Adapter	105	1-5-87	MDC Corp.
Welding	210	1-8-87	Boulderdash Co.,
Flanges, Crosses, etc.	2,654	1-8-87	MDC Corp.
Flanges, Misc.	930	1-9-87	Huntington Labs
Flanges	225	1-20-87	Huntington Labs
Welding	55	2-3-87	Boulderdash Co.,
6-Way Cross	1,270	4-23-87	MDC Corp.
Turbopump	12,028	12-4-86	Balzers
Video Switch & Camera	704	5-14-87	Video Media
Video Monitor	750	10-23-86	Video Media
Camera Lens	1,650	4-10-87	Melles Griot
Turbopump	3,115	6-28-87	Balzers
Connectors	750	1-15-87	Cypress Electronics
Cabinets	3,160	10-30-86	Premier Metal
Cabinet	420	7-9-87	Premier Metal Products
Interconnect Panels	720	7-19-87	Ion Support Consultants
Intercom	950	6-17-87	Spartan Engineering Inc.
Patch Panels	720	7-1-87	Ion Support Consultants
Photomultiplier	1,230		Bicron Corp.
Components	112		Zack Electronics
Integrator	2,991		Lecroy Research Systems

Stepping-Motor Control	5,920	1-15-87	Advanced Control Systems
Camac Module	335	3-11-87	Jorway Corp.
Ckt. Chips	45	6-3-87	Analog Devices
Ckt. Chips	45	6-3-87	Analog Devices
AT Computer	2,800	5-24-87	Stanford Bookstore
Picoammeters	2,335	11-13-86	Keithley Inst.
Current Amplifier	2,490	7-23-87	Keithley Inst.
Pulser	4,000	7-22-87	Stanford Research Systems
Instrument	3,500		EG&G Ortec
Lead Sheet	1,400	6-23-87	Specialty Steel Service
Chain Hoist & Trolley	181	6-26-87	Grainger's
Casters	120	2-13-87	Hammerslag Equipment Co.
Shielding Card	765	3-12-87	Boulderdash Co.

Table II: Items Requested

<u>Item</u>	<u>Source</u>	<u>Individual Contact</u>	<u>Cost</u>
20 Spools 4" Beampipe w/metal flanges	To be fabricated at Stanford University	Estimated by Gerry Diehart, LLNL (415) 422-9926	\$6,000
2 Ion Pumps w/Boost- a-Vac 270 liters/sec	Perkin Elmer	John Levin (408) 967-2600	14,890
2 Power supplies for ion pumps	Perkin Elmer	John Levin (408) 967-2600	3,990
1 Mechanical pump	Leybold-Heraeus	Debbie Simpson (408) 294-5055	1,350
1 Turbo-molecular pump 345 liters/sec	Leybold-Heraeus	Debbie Simpson (408) 294-5055	8,200
Miscellaneous windows and valves	To be fabricated at Stanford U.	Fred Zweers (415) 497-3015	5,000
Concrete shielding	To be fabricated at Stanford U.	Estimated by Helmut Wiedemann (415) 497-4650	10,000
1 60° bending magnet 5" gap	To be fabricated at Stanford U.	Estimated by Art Harvey, LLNL (415) 497-0231	30,000
X-Y stages, pop-ins, collimators	To be fabricated at Stanford U.	Estimated by Fred Zweers (415) 497-3015	10,000

4 TV cameras	TV Associates	Jeff Carr (415) 967-6040	1,200
4 BW TV monitors 9" Panasonic TR 930	TV Associates	Jeff Carr (415) 967-6040	640
1 Color TV monitor 12" Sony PVM 1271Q	TV Associates	Jeff Carr (415) 967-6040	718
1 Video Quantizer 606G 8-channel	Colorado Video	Bob Cornilsen (303)444-3972	3,500
6 Stepper motors M063- FC06E	N.A. D'Arcy Co.,	(415) 638-7773	1,236
Ge detector GLP-16195/10-CFG-SH	EG&G Ortec	Ginger Osborn (615) 482-4411	8,125
Ge detector GMX-30220-CFG-SH	EG&G Ortec	Ginger Osborn (615) 482-4411	32,450
NaI Scintillator 3"x 3" 905-4	EG&G Ortec	Ginger Osborn (615) 482-4411	1,285
1 photomultiplier base 276	EG&G Ortec	Ginger Osborn (615) 482-4411	305
1 photomultiplier tube	NEI	Gregory Kapp (201) 227-8215	250
2 50 MeV 30° bending magnets 2 cm gap	To be fabricated at Stanford U.	Estimated by Werner Wadensweiler Stanford, (415) 497-0231	5,000

4 300 MeV 45° bending magnets, 2 cm gap	To be fabricated at Stanford U.	Estimated by Werner Wadensweiler Stanford, (415) 497-0231	50,000
1 Quadrupole magnet	To be fabricated at Stanford U.	Estimated by Werner Wadensweiler Stanford, (415) 497-0231	5,000
3 Small scintillators (1 mm ²)	NEI	Gregory Kapp (202) 227-8215	100
3 Medium scintillators (100 cm ²)	NEI	Gregory Kapp (202) 227-8215	100
1 Large scintillator (500 cm ²)	NEI	Gregory Kapp (202) 227-8215	100
7 Photomultiplier tubes	NEI	Gregory Kapp (202) 227-8215	1,750
1 Faraday cup for 300 MeV	To be fabricated at Stanford U.	Estimated by Dieter Walz, SSRL (415) 854-2786	15,000
Keithley digital picoammeter 485	L.T. Snitzer	Ralph Townsend (415) 594-9179	695
8 HV power supplies for photomultiplier 556	EG&G Ortec	Ginger Osborn (615) 482-4411	6,560
Spectroscopy Amplifier 673	EG&G Ortec	Ginger Osborn (615) 482-4411	1,645

Dual counter 778	EG&G Ortec	Ginger Osborn (615) 482-4411	975
Gated-Biased Amplifier 444	EG&G Ortec	Ginger Osborn (615) 482-4411	1,320
Log/lin rate meter 449/2	EG&G Ortec	Ginger Osborn (615) 482-4411	895
2 Linear Gate & Stretcher	EG&G Ortec	Ginger Osborn (615) 482-4411	1,250
Universal Coincidence 418A	EG&G Ortec	Ginger Osborn (615) 482-4411	475
Buffered Interface 879	EG&G Ortec	Ginger Osborn (615) 482-4411	1,175
Alarm Control 461	EG&G Ortec	Ginger Osborn (615) 482-4411	750
1 Preamp power supply 114	EG&G Ortec	Ginger Osborn (615) 482-4411	535
2 HV power supplies for Ge detectors	EG&G Ortec	Ginger Osborn (615) 482-4411	1,340

Total:	\$233,804
University Cost Sharing:	23,380
Amount Requested:	\$210,424