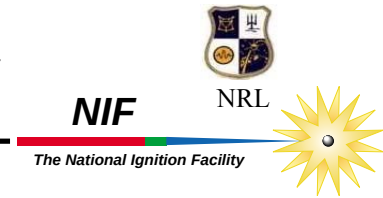
Agenda for the HENEX 65% Design Review



1. Opening (Tina Back, tinaback@llnl.gov)
2. Design Overview (John Seely, john.seely@nrl.navy.mil)
3. Mechanical Design (Layne Marlin, lmarlin@ssd5.nrl.navy.mil)
4. Optical Design (Larry Hudson, larry.hudson@nist.gov)
5. Electronic Design (Rob Atkin,ratkin@tigerinnovations.com)
6. Interface/Sensor (Glenn Holland, gholland@ssd5.nrl.navy.mil)
7. Project Schedule (Perry Bell, e061547@popeye.llnl.gov)

Questions/comments: Please refer to presentation number 6.

Rad-icon CMOS Sensor

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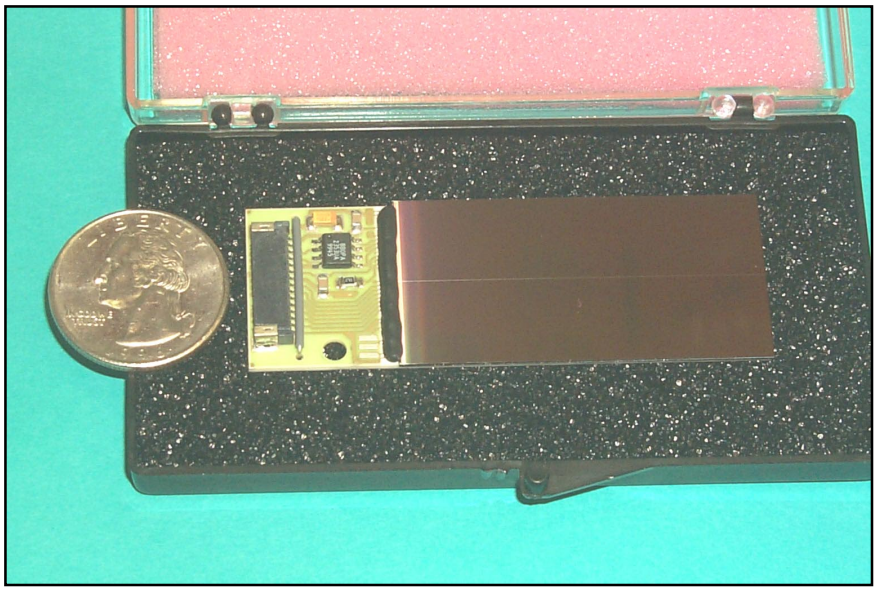
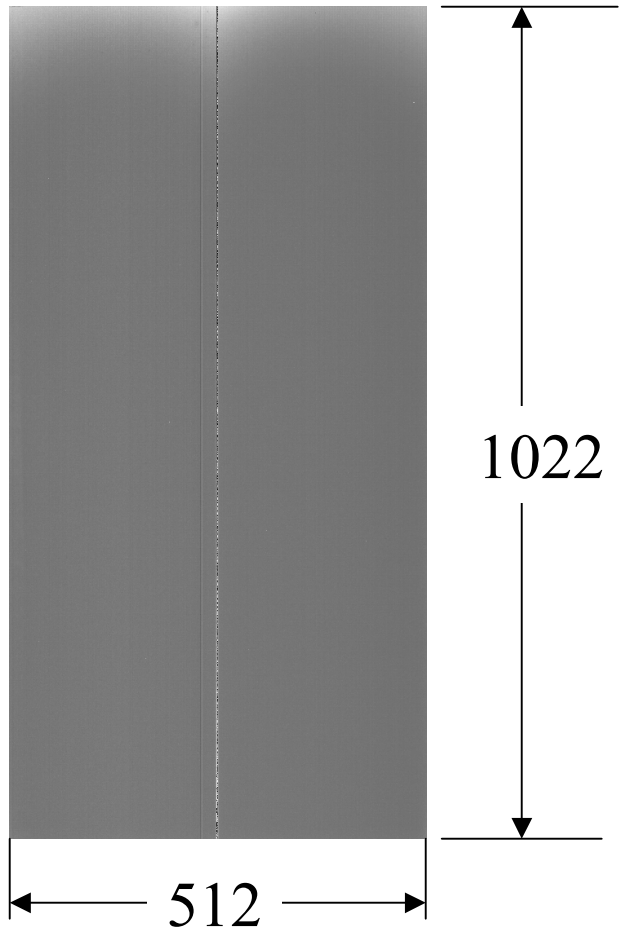


RadEye 1 sensor cost $2K ea.
www.radicon.com

20 sec dark image



512 x 1022 array imager.
48 micron pixels.
24.6 x 49 mm active area.
95% fill factor, active pixels.
Rad-hard to 100K rads.
Low power, vacuum compatible.
12 bit depth pixels.

Scintillator Coatings for Sensors

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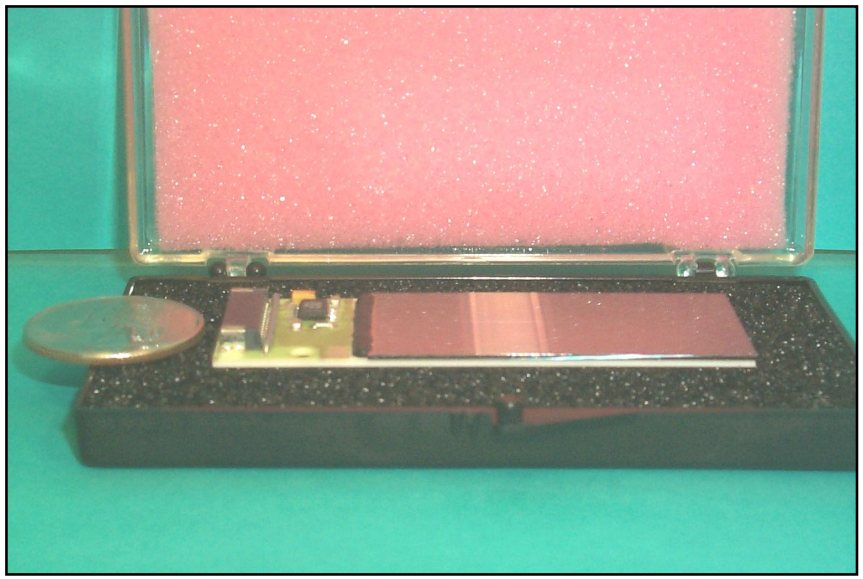

RadEye 1 sensors will be coated with scintillator (Gd_2O_2S;Tb) to improve the x-ray detection.

- **The scintillator will be applied directly on the top surface of the sensor.**
- **The coatings will be optimized for each energy channel.**
- **Applied Scintillation Technologies (AST) will supply the coatings.**

Shad-o-Box 512 tested at NIST

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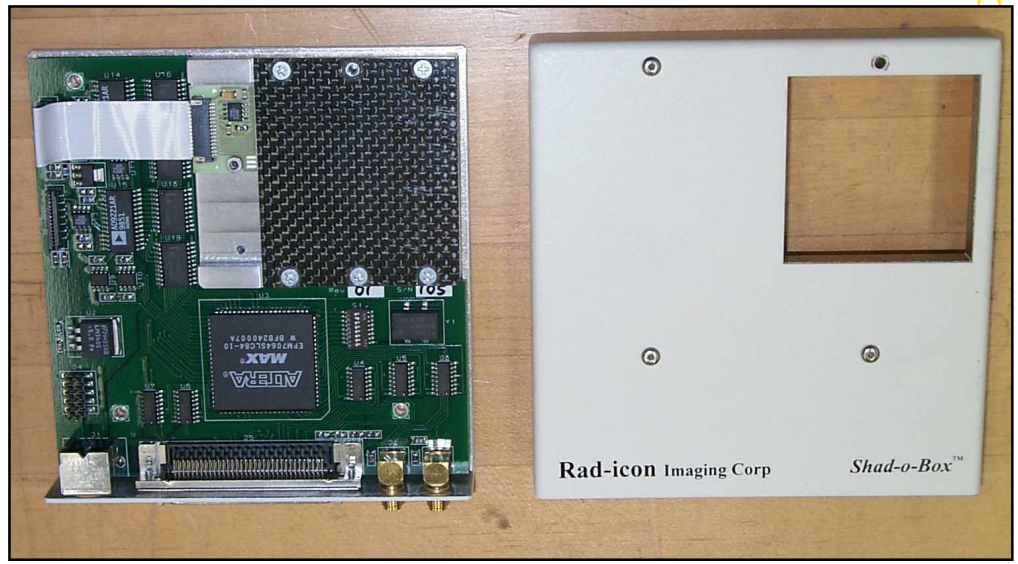

Rad-icon commercial product.

Shad-o-Box 512 (One sensor).

~$7K for the system.

10 line pairs / per millimeter resolution.

Prototype Remote Sensor Head

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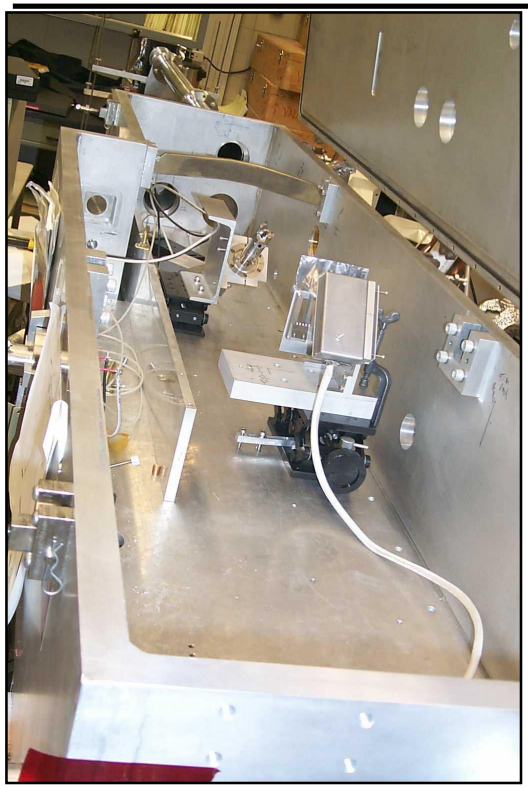

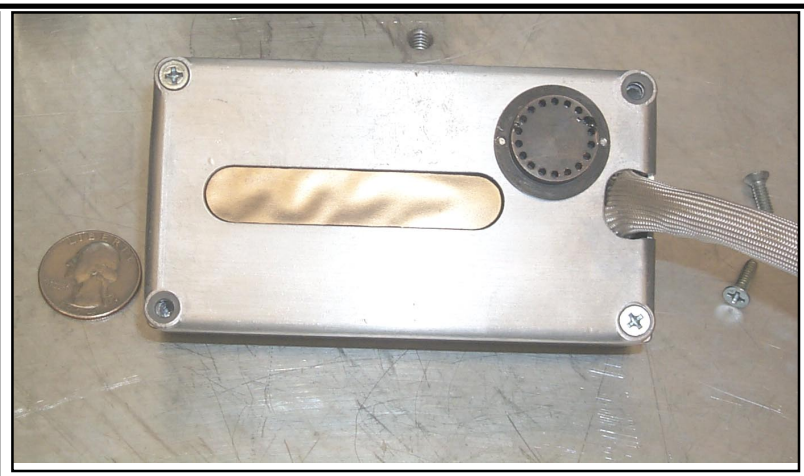

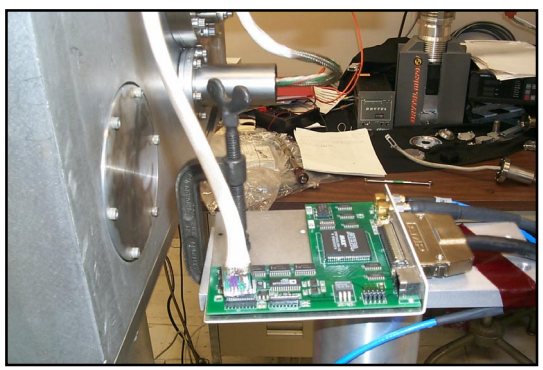

Prototype developed for RadEye 1

CMOS sensor testing in vacuum at NRL:

- **Sensor can drive a long cable (65”).**
- **.001” thick Beryllium filter.**
- **Manson source with Aluminum anode in coffin vacuum system.**
- **RAP bent crystal.**

EMP / EMI Protection

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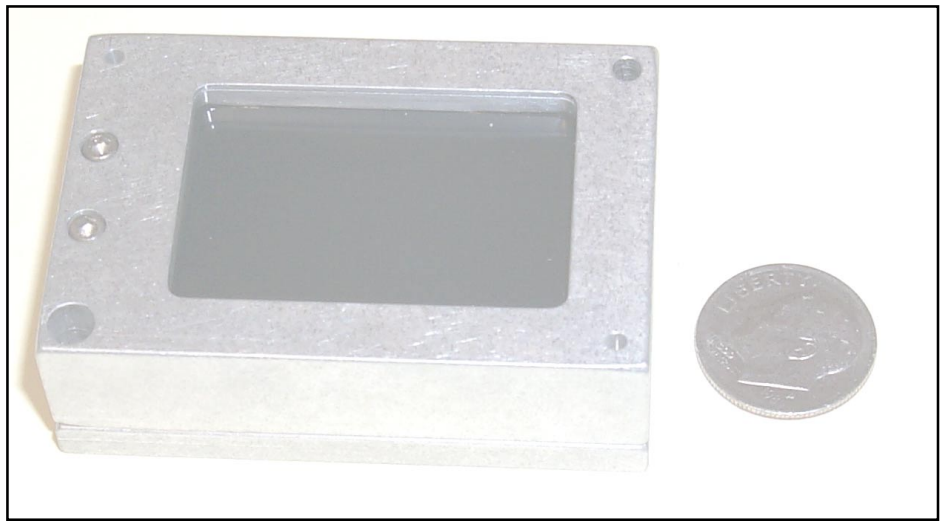

EMP/EMI shielded remote sensor head will be developed For the RadEye 1 sensor. (HXS CCD enclosure shown)

- **EMP/EMI protection achieved with conductive metal filter material (beryllium) completing the Faraday cage enclosure with the cable shield tied to the diagnostic interface.**
- **Sensor module could be exchanged with film module (fabricated at additional project cost).**

System Requirements

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1) Water cooling of diagnostic while inside the DIM under vacuum.
2) Two fiber optic cables 62.5 /125 micron multi-mode with ST connections to be used under vacuum inside the DIM.
3) Two fiber optic cables 62.5 /125 micron multi-mode with ST connections to be used between the DIM and the Diagnostic Interface Unit (DIU) installed in the screen room near target chamber. (Two fibers are needed for each different DIM to be used.)
4) The DIU will interface with the NIF DAS through the diagnostic control Processor (DCP). The DIU & DCP will require 19” rack space, 4’ high and 3’ deep.
5) The DIU & DCP require two 20 amp 110 VAC circuit power, one filtered with an Uninterrupted Power System (UPS).
6) The DCP requires an 10/100 Base-T network connection to the NIF Front-End-Processor (FEP) which will interface with the DAS.
7) A static IP address.
8) Clean storage for spare parts near target chamber, 2’x 2’x 1’.
9) Off line storage for the diagnostic, TIM diagnostic interface 6’x1’x1’.
10) Off-line charging of the battery pack, 110VAC, 2’x2’x1’ table space.

We will comply with NIF guidelines

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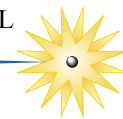
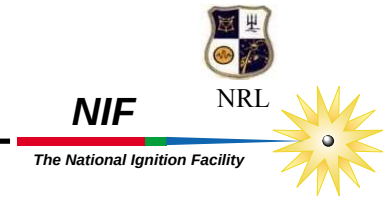


1) Guideline on Cleanliness 300/A
   $1x10^5$ 10 micron size particles to one 400 micron particle.
   NIF Vacuum_Clean. Doc.
   We will deliver a clean, double-bagged instrument for testing.
2) Guideline on diagnostic's out-gassing specification of
   less than or equal to $1x10^{-1}$ torr liter/sec.
   NIF Vacuum_Clean. Doc, NIF 0019542.doc
   Use vacuum compatible components to fabricate the
   instrument where possible.
   Vent all blind-tapped holes.
   Clean and bake out the instrument before delivery.
3) Guideline on Shielding
   NIF doc# 0008324, NIF doc# 0018673, NIF doc# 0010463.doc,
   NIF doc# oo55778.doc, NIF 0055789.doc.
   N/A due to Internal Battery Powered Diagnostic.
   The Internal Battery Pack (IBP) floats inside the Faraday Cage
   and the ground of the battery is the single point ground.
4) Guideline on the Triggering
   NIF doc# 0018678, NIF doc# 5000034-0C, NIF5002565.doc
   We will interface to the NIF 'ITS' via a 50ohm BNC connection
   to our Diagnostic Interface Unit (DIU).
5) Guideline on interface to the FEP
   NIF doc# 0018678 (Appendix "C")
   We will provide a software hand-shake that follows the
   NIF doc# 0018678 Appendix "C" rules.
6) Guideline on External Power Standard
   NIF External Power Standard 28VDC.doc
   N/A due to Internal Battery Powered Diagnostic.

Operation Procedures and Cost



The operation costs will be directly affected by the amount of debris that the diagnostic is exposed to. Filters are placed forward of the crystal assemblies to add protection. These filters will also provide spectral fiducials to aid in data reduction. The filters are easily replaced.

We anticipate the following support from an Operation Technician:

- 7 min. for pre-deployment hardware systems check, which includes inspection of filter packs and battery hook-up.
- 5 min. for pre-deployment software system check, which includes full check of interface to DAS and diagnostic.
- 5 min. for pointing of the instrument.

Approximately 17 min. total time to prepare the instrument.

Operation Maintenance Schedules

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Items	Replaceable	Inspection cycle	Re-calibration required
Filter pack assembly	yes	Before each shot	No, pure material used.
Sensor assembly	yes	Before each shot	No, if tested before at NIST If damaged then a replacement can be inserted off-line.
Crystal assembly	yes	Every 5th shot, TBD	No, if tested before at NIST If damaged then a replacement can be inserted off-line.
Battery pack	yes	Covered by DIU	No
Electronics (Sensor boards)	yes	Covered by DIU	No, each board has a known gain value.
Fiber optic cable	yes	Covered by DIU	No, just digital data lines.
Drive Electronics Boards	yes	Covered by DIU	No, TI will supply report.
Diagnostic Interface Unit (DIU)	yes	Covered by DIU self test	No
Diagnostic Control Processor (DCP)	yes	Covered by DCP self test	No, standard PC

Major Component Suppliers/Costs

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Item	Description	Part Number	Cost	Vendor, address, phone
Neutron Shielding	Ultra High Density Polyethylene	Sheet PN. UHMWNAT 2.0" 12"x12"	$40.00	Read Plastics 12331 Wilkins Avenue Rockville, MD 20852 Phone 301-881-7900
X-ray Shielding	Tantalum sheet	.010" thick 24"wide ~85" long	453.25 per LB	Strategic Aerospace Materials 150 Park Avenue Hicksville, NY 11801 Phone 516-932-3322
X-ray Shielding	Lead sheet	.016" thick 48" x 25'	475.00 Lot	Strategic Aerospace Materials 150 Park Avenue Hicksville, NY 11801 Phone 516-932-3322
Beryllium Filters	99% pure foil	PF-60	792.00 ea	Brushwellman
CMOS Area Sensors From Rad-icon	1022 x 512, 48 micron pixel size	RadEye 1	2000.00 ea	Rad-icon Imaging Corp 3193 Belick Street, Unit 1 Santa Clara, CA 95054-2404 Phone 408-486-0886
Quartz Crystal				Sawyer Crystal Systems 1601 Airport Rd.Conroe, TX 77301
KDP & Mica crystal				Crystal Associates 15 Industrial Park Waldwick, NJ 07463
Germanium Crystal				Eagle-Picher Technologies, LLC PO Box 47, Joplin, Missouri 64802-0047 USA or C & Porter Streets, Joplin, Missouri 64801 USA Phone: (417)623-8000 Fax: (417)781-1910
Quartz Crystal (111)				Virginia Semiconductor
Polishing of Quartz Crystal				Bond Optics, Inc. Etna Road, Box 422 Lebanon, NH 03766
Sinllilator / Phosphor converter	1-2 keV, 3-8keV,9-20 keV	Gadox screen	~600.00ea	Applied Scintillation Technologies 12 President Point Drive Annapolis, MD 21403 410-263-6005
K-Line filters	Pure Metal foils			Alfa
Sintered Breathers	Stainless Steel	Need for electronics box / EMP, EMI	500 min order (get Samples!)	Mott Corporation 84 Spring Lane, Famington, CT 06032 Phone 860-747-6333 Fax 860-747-8629
Cabling for sensors	15 pin connectors	Twisted pair shielded,		Custom made by NRL, interfacing with Samtec connectors jumpers (FJ-15-D-06.00-4)
Connectors for sensors	inside drive electronics on Sensor board		3.00 ea	Samtec USA P.O. Box 1147 New Albany, IN 47151-1147 Phone: 800-726-8329 Fax 812-948-5047
Connectors for sensors boards in drive electronics	Interface to Mother Board	FCI		FCI
Fiber Optic connectors	SMA /ST bulkhead connectors	These are treaded into the top plate of the drive electronics at a 45° angle		Newark
Fiber Optic cable	SMA-ST cable / Tefzel jacket			Fiber Guide
Epoxy for potting cable connectors and other things		EPO-TEK 301	25.00 for A&B kit of small size	Epoxy Technology 14 Fortune Drive Billerica, MA 01821 Phone: 978-667-3805 Fax :978-663-9782
Vacuum Electrical Feed-though	HD D-sub 44 pin connector on 2-3/4CF	Needed for Battery enclosure that will power diagnostic during shot	800.00 ea	Douglas Engineering Company 14 Beach Street Rockaway, NJ 07866 Phone 973-627-8230 Fax 973-627-5798
Rechargeable NiCad batteries		PN.P158T-ND	6.7245 ea /100	Digi-key 701 Brooks Ave. South Thief River Falls, MN 56701-0677 Phone (1-800) 344-4539 www.digikey.com
Drive & Support Electronics	EMP/EMI proof Fiber Optic Control	DCP, DIU, DE		Tiger Innovation 2404 –E South Walter Reed Drive Arlington VA 22206-1174Sales@tigerinnovations.com Website: www.tigerinnovations.com Phone:703-578-3334 POC: Rob Atkin

Early Procurements/Cost Projections

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Early procurements (included in the project budget):	**$K**		
Rad-icon sensors for sensitivity tests	10		
Scintillator test depositions optimized for each channel	5		
Electronics breadboard and sensor readout tests	100		
Crystals for bending tests (TAP and ADP)	10		
Estimated operations/replacement costs (not included in the project budget):	**$K Each**	**Number**	**$K Total**
Replacement frontend filters	1	5	5
Replacement pre-mounted crystal	10	5	50
Replacement fiber optic cables	2	2	2
Backup spare sensor assembly with scintillator & filter	20	5	100
Drive Electronics complete replacement	70	1	70
Diagnostic Interface Unit complete replacement	23	1	23
			250
Possible add-ons (not included in the project budget):			
Film assemblies (5 to mount on HENEX and 5 with pre-loaded film for the next shot)	6	10	60
Crystal characterizations (topographs,rocking curves,reflectivity)	3	5	15
Extend transmission crystal range to 60 keV	50	1	50
Implement additional CMOS sensors for x-ray & neutron dose measurements	50	2	100
Retrofit CMOS sensor electronics to have adjustable gain (software controlled)	20	1	20
Add Sleep Mode to Drive Electronics (would extend battery lifetime)	20	1	20
Upgrade battery capacity (would extend lifetime)	30	1	30
10-diode array for time-dependent flux measurements on transmission crystal channel	25	2	50
Imbedded fast digitizing electronics	200	1	200
Multi-channel fiber optic cable/feedthrough for diode channels	175	1	175
			720