

RSVP - Booster/AGS WBS & CFI

1. CFI Overview
2. Booster/AGS WBS status
3. Booster Efficiency and Collimators

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AGS RSVP
Planning Meeting

What's in the CFI ?

The costs associated with the AGS upgrade for KOPIO can be grouped in four categories:

1. 25 MHz and 100 MHz micro-bunching radio frequency cavities;
2. A5 and F3 kicker magnet upgrades;
3. Beam and accelerator physics studies; and
4. Upgrades to the extracted proton beam line and production target to handle the increased beam intensity.

Table 1. AGS upgrades for KOPIO – overall budget.

	Total Cost Can. \$million	US Contribution Can. \$million	Canadian Contribution (CFI) Can. \$million
Micro-bunching	5.310	3.662	1.648
Kickers	6.824	1.619	5.205
Beam development	1.000	0.625	0.375
Proton beam line	1.946	1.946	0
Total	15.280	7.850	7.228

WBS#	Description	Base Cost	EDIA Labour	Mfg Labour	Mfg Matls	Canadian Cont.
		Can\$	Can\$	Can\$	Can\$	Can\$
2.10.1&2	AGS RF Mods	5310	1847	1050	2413	1648
2.10.1	25 MHz ubunch cavity	2611	759	539	1313	1649
2.10.1.1	Cavity	996	108	56	832	996
2.10.1.2	Tuner	125	72	28	25	125
2.10.1.3	Tuner shop work	114	0	0	114	114
2.10.1.4	Vacuum pump	42	0	8	34	42
2.10.1.5	Power amplifier	347	108	197	42	347
2.10.1.6	Driver	61	0	27	34	
2.10.1.7	Low level	134	73	27	34	
2.10.1.8	Controls	150	73	27	50	
2.10.1.9	Damper	528	325	169	34	
2.10.1.10	Damper shop work	114	0	0	114	
2.10.1.11	Shipping					25
2.10.2	100 MHz booster cavity	2699	1088	511	1100	
2.10.2.1	Cavity	1132	325	141	666	
2.10.2.2	Tuner	134	73	27	34	
2.10.2.3	Tuner shop work	79	0	0	79	
2.10.2.4	Vacuum pump	32	0	8	24	
2.10.2.5	Power amplifier	417	182	169	66	
2.10.2.6	Driver	61	0	27	34	
2.10.2.7	Low level	170	109	27	34	
2.10.2.8	Controls	150	73	27	50	
2.10.2.9	Damper	445	326	85	34	
2.10.2.10	Damper shop work	79	0	0	79	

Table 2. Cost estimates for 25 MHz and 100 MHz cavities.

1. Kicker Magnets and Power Supplies

The **BNL contributions** to this work consist of **providing the controls and interfacing of the equipment at BNL, a new building** to house the pulse forming network, **and a new tunnel penetration. The cost for these items provided by BNL is \$1.62 million.**

Current Costs for AGS Mods WBS 2.1

System	Total Cost	NSF Contribution	CFI Contribution	
25 MHz Cavity	1682	651	1649 (1031)	
100 MHz Cavity	1637	1637	0	
A-10 Kickers	946	0	1513 (946)	
F-3 Upgrade	1763	0	2820 (1763)	
A-5 Kickers	1419	0	2270 (1419)	
Kicker Housing and Penetrations	1013	1013	0	
Beam Development Simulation	625	390	375 (234)	
Travel	197	0	315 (197)	
Total AGS Mods Cost	9282	3691	8942 (5589)	

All CFI Funding in \$CDN
All NSF Funding in \$US
Totals are in \$US (=1.6\$CDN)

WBS Number	Description	Materials			Total Mat's	Labor Hours					Total Labor Cost	Total w/o Cont	Contingency Risk Factors							Total w/ Cont		
		<\$25000	>\$25000	>\$600000		Eng'r	Physicist	Design	Tech	DTS			Shops	Tech	WF	Design	Cost	WF	Sched		Cont	Cont \$
2.2.1	Booster/AGS modifications				\$0							\$0								0%	\$0	\$0
2.2.1.1	project support				\$0	0	0	0				\$0	\$0	3	2	8	1	1	2	17%	\$0	\$0
2.2.1.1.2	installation supervision				\$0				0			\$0	\$0	3	2	8	1	1	2	17%	\$0	\$0
2.2.1.2	Booster				\$0							\$0								0%	\$0	\$0
	RF System modifications				\$0							\$0								0%	\$0	\$0
	Band II RF Feedback	\$120,000	\$240,000		\$360,000	1040	520	0	2080	160	40	\$231,183	\$591,183	3	2	8	1	2	4	20%	\$118,237	\$709,419
	Conventional				\$0							\$0								0%	\$0	\$0
	Cable Trays	\$1,500			\$1,500	80	0	0	80	0	0	\$9,141	\$10,641	3	2	8	1	2	4	20%	\$2,128	\$12,769
	Electrical modifications				\$0							\$0								0%	\$0	\$0
	Cable Repair/Replacement	\$12,000	\$0		\$12,000	120	0	0	160	0	0	\$15,716	\$27,716	3	2	8	1	2	4	20%	\$5,543	\$33,260
	Upgrade of PFN's	\$0	\$0		\$0	0	0	0	0	0	0	\$0	\$0	3	2	8	1	2	4	20%	\$0	\$0
	Magnet Coils - Mechanical	\$0	\$312,000		\$312,000	110	0	0	440	0	0	\$29,112	\$341,112	3	2	8	1	2	4	20%	\$68,222	\$409,334
	Mechanical modifications				\$0							\$0								0%	\$0	\$0
	Spare Booster F6	\$0	\$28,000		\$28,000	220	0	0	1320	0	875	\$158,768	\$186,768	3	2	8	1	2	4	20%	\$37,354	\$224,121
	Booster Injection Collimators	\$0	\$85,000		\$85,000	220	110	440	1210	0	450	\$148,172	\$233,172	3	2	8	1	2	4	20%	\$46,634	\$279,806
	Instrumentation				\$0							\$0								0%	\$0	\$0
	Project Support	0	0	0	\$0	240	120	40	440	0	0	\$49,869	\$49,869	2	4	16	2	4	16	48%	\$23,937	\$73,806
	Loss Monitors	51000	0	0	\$51,000	400	0	120	800	0	0	\$72,199	\$123,199	1	2	8	1	2	8	20%	\$24,640	\$147,839
	WCM Upgrade (D6)	5000	0	0	\$5,000	880	80	80	880	0	40	\$115,281	\$120,281	1	2	12	1	4	8	26%	\$31,273	\$151,554
	Inflector protection (C3)	5000	0	0	\$5,000	80	0	40	160	0	0	\$15,299	\$20,299	1	2	12	4	2	8	30%	\$6,090	\$26,388
	Cables	10000	0	0	\$10,000	160	0	0	320	0	0	\$26,302	\$36,302	1	2	4	1	2	8	16%	\$5,808	\$42,111
	BTA	13000	0	0	\$13,000	80	0	20	320	0	0	\$22,246	\$35,246	1	2	4	1	2	8	16%	\$5,639	\$40,885
	Controls				\$0							\$0								0%	\$0	\$0
	Instrumentation Interfaces	4000	18454	0	\$22,454	96	0	0	114	0	0	\$11,871	\$34,325	1	2	8	4	1	8	22%	\$7,552	\$41,877
	Software & Database	0	0	0	\$0	594	0	0	0	0	0	\$38,093	\$38,093	2	2	15	1	1	8	28%	\$10,666	\$48,759
	Safety				\$0							\$0								0%	\$0	\$0
	Shield Caps				\$0							\$0								0%	\$0	\$0
2.2.1.2	AGS				\$0							\$0								0%	\$0	\$0
	Conventional				\$0							\$0								0%	\$0	\$0
	Cable Trays	\$1,500			\$1,500	80	0	0	80	0	0	\$9,141	\$10,641	3	2	8	1	2	4	20%	\$2,128	\$12,769
	Electrical modifications				\$0							\$0								0%	\$0	\$0
	Cable Repair/Replacement	\$0	\$120,000		\$120,000	120	0	0	320	0	0	\$23,737	\$143,737	3	2	8	1	2	4	20%	\$28,747	\$172,485
	Active Filter	\$0	\$110,000		\$110,000	120	0	0	120	0	0	\$13,711	\$123,711	3	2	8	1	2	4	20%	\$24,742	\$148,453
	F10 Power Supply	\$0	\$250,000		\$250,000	120	0	0	120	0	0	\$13,711	\$263,711	3	2	8	1	2	4	20%	\$52,742	\$316,453
	Upgrade of PFN's	\$0	\$0		\$0	0	0	0	0	0	0	\$0	\$0	3	2	8	1	2	4	20%	\$0	\$0
	Magnet Coils - Mechanical	\$0	\$364,000		\$364,000	110	0	0	440	0	0	\$29,112	\$393,112	3	2	8	1	2	4	20%	\$78,622	\$471,734
	J10 Bump; Low ripple P.S.	\$0	\$225,000		\$225,000	120	0	0	120	0	0	\$13,711	\$238,711	3	2	8	1	2	4	20%	\$47,742	\$286,453
	Mechanical modifications				\$0							\$0								0%	\$0	\$0
	AGS RC Networks	\$16,000	\$0		\$16,000	55	0	55	220	0	0	\$17,509	\$33,509	3	2	8	1	2	4	20%	\$6,702	\$40,210
	New F5 (2)	\$0	\$30,000		\$30,000	220	0	440	1760	0	1500	\$260,511	\$290,511	3	2	8	1	2	4	20%	\$58,102	\$348,613
	New F10 (2)	\$0	\$26,000		\$26,000	220	80	440	1320	0	1600	\$254,273	\$280,273	3	2	8	1	2	4	20%	\$56,055	\$336,327
	New H20 (2)	\$0	\$40,000		\$40,000	440	110	440	1760	0	2400	\$364,767	\$404,767	3	2	8	1	2	4	20%	\$80,953	\$485,720
	Collimators				\$0							\$0								0%	\$0	\$0
	Sextupole Coils**	\$0	\$160,000		\$160,000	110	0	0	440	0	0	\$29,112	\$189,112	3	2	8	1	2	4	20%	\$37,822	\$226,934
	Instrumentation				\$0							\$0								0%	\$0	\$0
	Project Support	0	0	0	\$0	240	120	80	440	0	0	\$52,017	\$52,017	2	4	16	2	4	16	48%	\$24,968	\$76,985
	Loss Monitors	20000	0	0	\$20,000	180	0	20	640	0	0	\$44,700	\$64,700	3	6	18	3	6	24	78%	\$50,466	\$115,167
	Wall Current Monitor	10000	0	0	\$10,000	880	20	20	880	0	0	\$103,335	\$113,335	1	2	10	1	3	8	23%	\$26,067	\$139,402
	IPM Servo	2000	0	0	\$2,000	40	0	0	80	0	0	\$6,576	\$8,576	1	2	2	1	2	2	8%	\$686	\$9,262
	Motion Systems	40000	0	0	\$40,000	80	0	20	160	0	0	\$14,225	\$54,225	1	2	4	1	2	4	12%	\$6,507	\$60,732
	Video	37000	0	0	\$37,000	80	0	20	160	840	0	\$77,813	\$114,813	1	2	4	1	2	4	12%	\$13,778	\$128,591
	Ring Grounds	25000	0	0	\$25,000	40	0	0	240	0	0	\$14,596	\$39,596	1	2	4	1	2	4	12%	\$4,752	\$44,348
	Cables	5000	0	0	\$5,000	20	0	0	120	0	0	\$7,298	\$12,298	1	2	2	1	2	2	8%	\$984	\$13,282
	Controls				\$0							\$0								0%	\$0	\$0
	Instrumentation Interfaces	21350	36124	0	\$57,474	68	0	0	180	0	0	\$13,384	\$70,858	1	2	8	4	1	8	22%	\$15,589	\$86,447
	Software & Database	0	0	0	\$0	152	0	0	0	0	0	\$9,748	\$9,748	2	2	15	1	1	8	28%	\$2,729	\$12,477
	Ring Ground Interface	8100	0	0	\$8,100	15	0	0	60	0	0	\$3,970	\$12,070	1	2	4	4	1	4	14%	\$1,690	\$13,760
	Software & DB	0	0	0	\$0	50	0	0	0	0	0	\$3,207	\$3,207	2	2	8	1	1	4	17%	\$545	\$3,752
	Power Supply Interfaces	6310	5000	0	\$11,310	20	0	0	34	0	0	\$2,987	\$14,297	1	2	8	4	1	8	22%	\$3,145	\$17,442
	Software & Database	0	0	0	\$0	52	0	0	0	0	0	\$3,335	\$3,335	2	2	15	1	1	8	28%	\$934	\$4,268
	Safety				\$0							\$0								0%	\$0	\$0
	Shield Caps				\$0							\$0								0%	\$0	\$0
	Labor Hours					7952	1160	2275	18018	1000	6905									0%		
	FTE					4.5	0.7	1.3	10.3	0.6	3.9									0%		
	TOTALS - DIRECT	\$413,760	\$2,049,578	\$0	\$882,500	\$509,962	\$99,308	\$122,145	\$903,242	\$75,700	\$619,379	\$2,329,735	\$4,793,073							21%	\$1,020,921	\$5,813,994
	indirect %	24.98%	12.63%			40.73%	40.73%	40.73%	40.73%	12.35%	12.35%									23.24%	0.00%	0.00%
	TOTAL	\$517,108	\$2,308,394	\$0	\$2,825,502	\$717,673	\$139,756	\$171,895	\$1,271,140	\$85,049	\$695,872	\$3,081,385	\$5,906,887							21%	\$1,258,163	\$7,165,050

What Limits Total Proton Intensity?

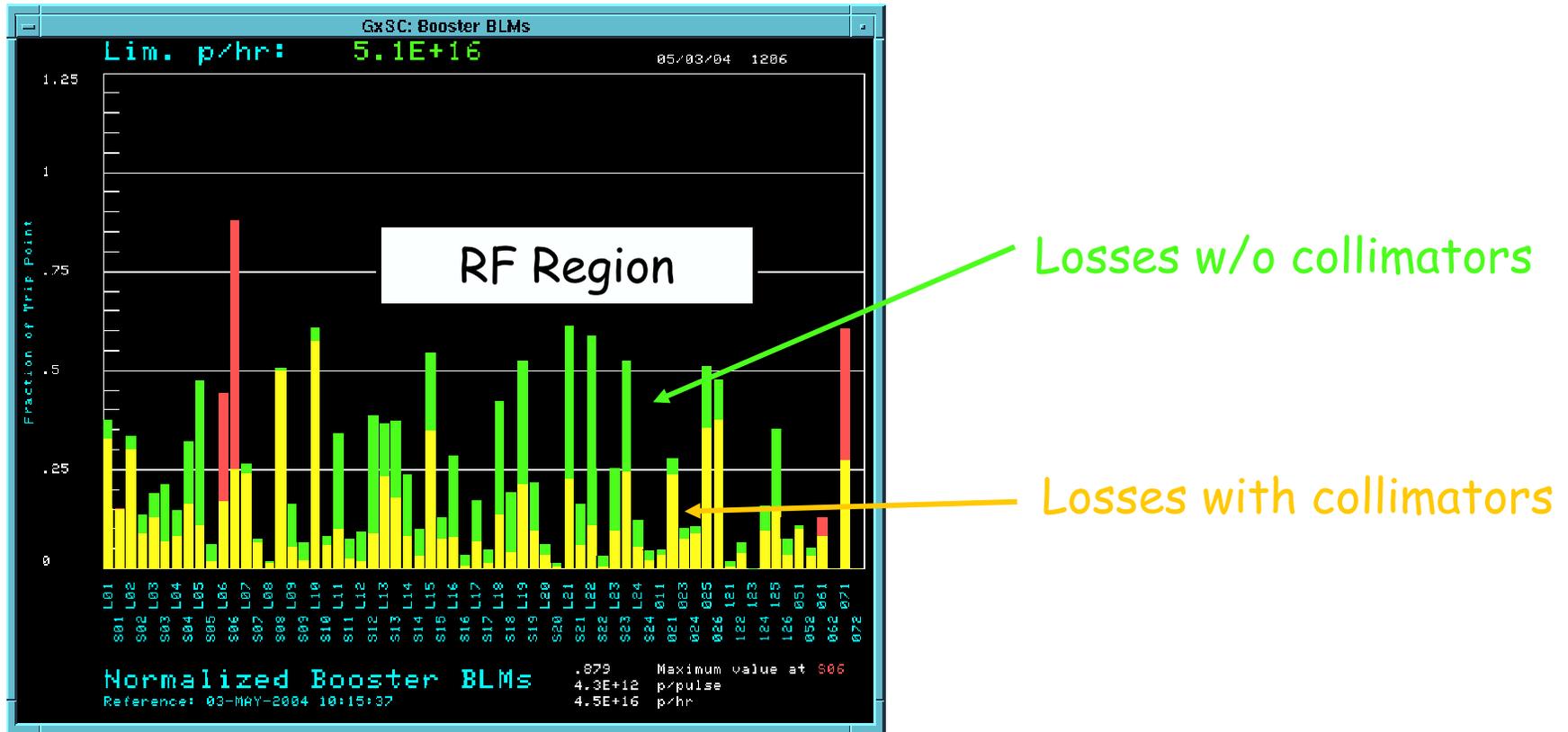
- Maximum number of Protons the Booster can stably accelerate: $5E12$
- Maximum average Booster rep. Rate: currently 7.5 Hz, may have to go to 10 Hz for NuMI+ (full) MiniBooNE
- (NUMI only) Maximum number of booster batches the Main Injector can hold: currently 6 *in principle*, possibly go to 11 with fancy loading schemes in the future
- (NUMI only) Minimum Main Injector ramp cycle time (NUMI only): 1.4s+loading time (at least $1/15s * nbatches$)
- Losses in the Booster:
 - Above ground radiation

➤ Damage and/or activation of tunnel components

Our biggest worry at the moment!!!!

Collimator Commissioning

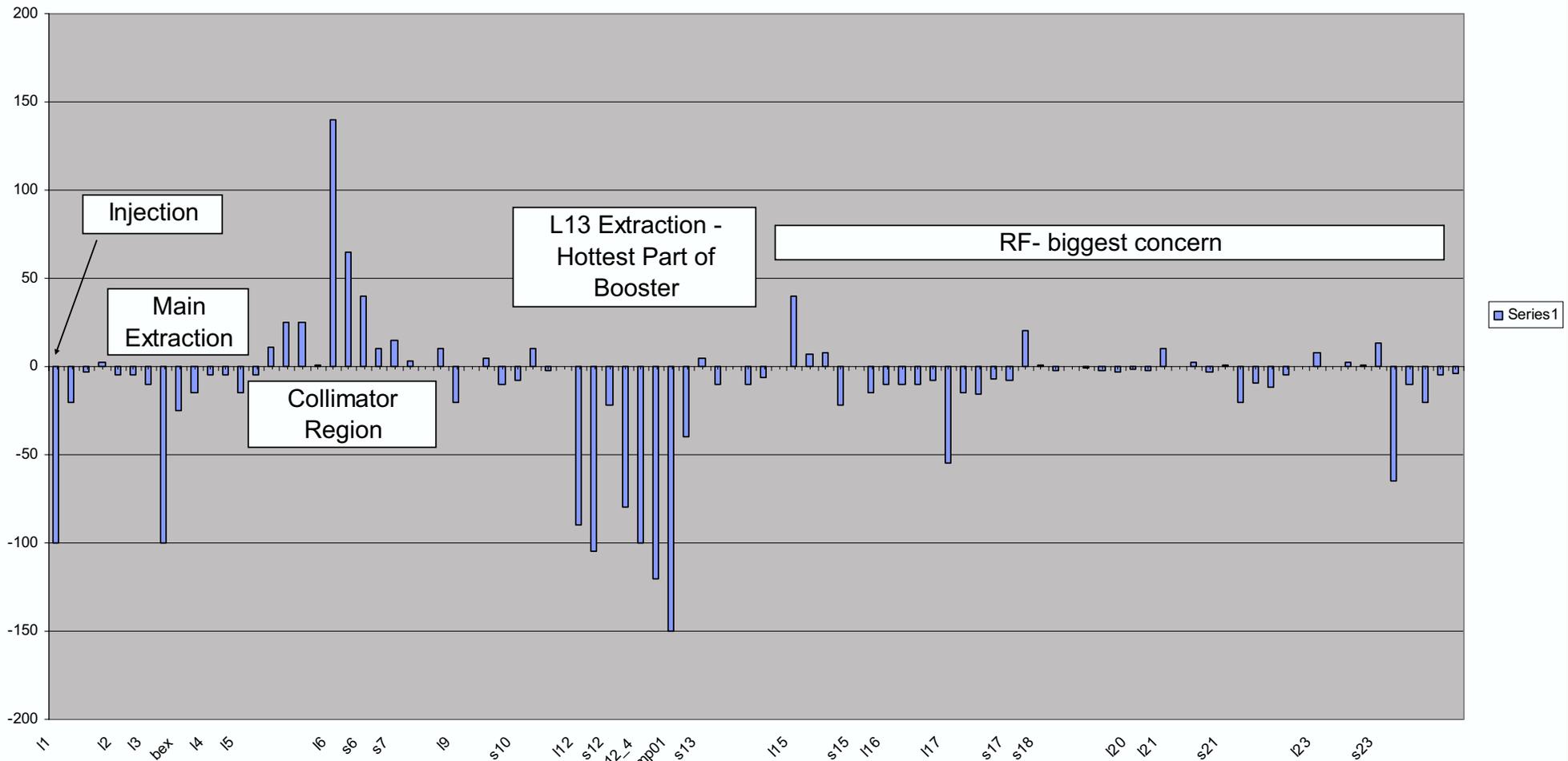
- We have begun to use the collimators in normal operation:



- Not (yet) as good as expected, but encouraging.

Effect of Collimators on Activation

- One week of continuous collimator operation...
 - Difference from previous week measurement (mr/hr @ 1ft)



KOPIO R&D -- 2004						
	\$64.13	\$85.61	\$53.69	\$50.13	\$89.70	
Work Description	Eng'r Hours	Physicist Hours	Design Hours	Tech Hours	Shops Hours	Comments
Liaison engineer	520					.25 time -- Liaison services & neutral beam concept
Liaison physicist		520				.25 time
General layout			320			1 man - 2 months
Baseline support	240	240	160	80		Support for bottoms up estimate
primary beam design	160	160	80	80		
Shielding design	80	160				primary beam dump, target area, neutral beam, exp area
Target thermal analysis	80	80	40	80	80	mechanical prototype -- testing in D-line ?
Instrumentation	80	80	40		80	EPM, intensity meas, target monitoring development
Electrical layout	80		40			Royal replacement development
Controls R&D	80	80	40			PS and Inst controls analysis and development
Safety system R&D	80		40			PASS analysis and development
Switchyard collimator R&D	80	80	40	80		extraction and primary beam lines
Total hours	1480	1400	800	320	160	
Total direct cost	\$94,912	\$119,854	\$42,952	\$16,042	\$14,352	
Burdened cost	\$133,570	\$168,671	\$60,446	\$22,575	\$16,124	
				Total	\$401,387	

