



EMC Upgrade Cost & Staff Estimates

M. Zucker

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Hardware Costing Basis

- Power supplies
- Shielded racks & EMI filters (digital)
- Shielded crates, EMI filters, cabling (VME)
- Shielded racks, EMI filters, cabling (analog)
- Shielded Euro crates & board retrofits (analog)
- Remote sensor head cabling, connector, filter adaptations



Analog power supplies

- Baseline Kepco JQE-, ATE- and MAT- series low-noise linears
- Approx. 75 ea. 100W supplies per IFO (TBD, depending on load sharing/proximity)
- Estimated \$92k/IFO incl. mounting provision & wiring
- Possible offset; trade in Sorenson switchers



Digital racks, crates, I/O cabling

- Racks with cooling (8/IFO)
 - AMCO w/ Monel gasketing, honeycomb air filter panels; \$3.5k/ea
 - added \$0.5k for powerline filtering & mounting provisions
- VME crates (13/IFO)
 - ELMA EMC-rated \$3.8k ea. incl. p/s
 - re-use existing boards, no additions/upgrades
 - est. \$4.2k/crate for EMI filters, shielded internal cabling, panels, gaskets (!)



Analog racks, crates, sensor/driver heads

- Racks (9/IFO)
 - Baselined same rack solution/cost as digital
 - Lower internal I/O count --> less cost in extras, about \$4k/rack
- Crates (15/IFO)
 - quoted like ELMA VME crates, delete power supply, add custom Eurocard backplanes (VXI-type crate similar at 10% accuracy)
 - Add board shielding kits, extender cards for backplane isolation
 - Add EMI filters, internal wiring, panels, gaskets
 - estimate \$10.5k/crate (re-use existing circuit modules)
- Remote heads (35/IFO)
 - Estimated \$435/head average for recabling, ground isolation



Hardware Cost Estimate Summary

	estimate/ifo	3 ifo's
Source mitigation		
RFI/EMI containment racks, digital electronics	\$ 32,184	
RFI/EMI shielded VME crates	\$ 104,780	
Linear power supplies	\$ 92,313	
Analog signal protection		
Shielded racks, analog electronics	\$ 36,207	
Shielded Eurocard crates and board adaptations	\$ 154,740	
Remote sensor/actuator cable shielding	\$ 15,250	
Subtotal: installed hardware	\$ 435,474	\$ 1,306,422
Site test ranges & RFI analysis equipment		\$ 100,000
Total		\$ 1,406,422



Estimated Personnel Commitment

- Retrofit (~ 2 calendar years):
 - 1 FTE experienced EE
 - probably divided between 2 individuals, at least one preferably at a LIGO observatory (development testbed, integration site, test range)
 - 1/2 FTE experienced instrumentation scientist
 - 1/2 FTE junior engineer and/or experienced technical assistants.
 - Staffing approximately doubled during installation, wiring and field testing by addition of commissioning and site staff.
- Standing commitment afterward
 - Approx. 0.25 FTE resident at *each site*
 - Test range support
 - As-built compliance & diagnostic survey
 - Gatekeepers for integration of new hardware
 - EMC responsibility integrated with design, fab, test at institutes
 - Alternative: Establish EMC "department" as parallel organization?



Concluding Remarks

- Monumental achievement:
three working interferometers!
- Took some shortcuts to get there
 - arguably the fastest route, but not without hidden costs
- Correcting, stabilizing the configuration is the first task
- For the long run: change our working culture & priorities