ILC US detector R&D

A status report on recent activities on defining a US program and how to get it funded

J.Brau, Univ. of Oregon & H.Weerts, Argonne

Contributions from many people, lead by ALCPG (American Linear Collider Physics Group) and chaired by Jim Brau and Mark Oreglia

Status up to now

Contributions to detector R&D:

I LCDRD funds universities and some (small) labs (grant at Oregon)

II Contributions from base/internal funds at national labs (FY06):

LCDRD Program

Topic	FY05 Projects	FY05 $0.817M	FY06 Projects	FY06 $1.348M
LEP	5	15.7%	6	13.1%
VXD	1	9.0%	4	13.2%
TRK	8	32.6%	8	21.6%
CAL	9	39.0%	13	44.8%
PID(mu)	2	3.8%	2	5.7%
projects	25		33	
NSF		$0.117M		$0.300M
DOE		$0.700M		$1.048M

WWS R&D Panel reviewed the scope of the global program, and noted there was effort on most topics, particle ID other than muon, and forward tracking being notable weaknesses.
In general, all areas active.

LCDRD - FY06
Lum/Energy/Pol, VXD, Tracking

Luminosity, Energy, Polarization

3.1 John Hauptman	Gas Cerenkov Cal for Lum Measm't
3.4 Eric Torrence	Extraction Line Energy Spectrometer
3.5 Mike Hildreth	BPM-Based Energy Spectrometer
3.6 Yasar Onel	Polarimetry
3.7 William Oliver	Compton polarimeter backgrounds
3.8 Gio. Bonvicini	Incoherent and coherent beamstrahlung

Vertex

4.1 Charlie Baltay	Pixel Vertex Detector
4.2 Marco Battaglia	Monolithic Pixel Detector Module
4.4 Henry Lubatti	Vertex Detector Mech. Structures
4.5 Gary Varner	Pixel-level Sampling CMOS VxDet

Tracking

5.2 Lee Sawyer	GEM-based Forward Tracking
5.7 Dan Peterson	MPGD Readout for a TPC
5.8 Keith Riles	Tracker Simulation and Alignment Sys.
5.10 Bruce Schumm	Long Shaping-Time Silicon Strip
5.13 Stephen Wagner	Reconstruction Studies for SiD Trk
5.15 Eckh. von Toerne	Calor-based Tracking-Long-lived Part.
5.17 Dan. Bortoletto	Thin silicon sensors
5.19 Dan Peterson	TPC signal digitization

LCDRD - FY06 (cont.)
Cal, Part ID (muons)

Calorimetry

6.1 Vishnu Zutshi	Scintillator-based Hadron Calorimeter
6.2 Uriel Nauenberg	Scintillator EM/Had Cal and BeamCal
6.4 Usha Mallik	Particle Flow Studies
6.5 Raymond Frey	Silicon-tungsten EM calorimeter
6.6 Andy White	Digital Hadron Calorimetry w/ GEMs
6.9 Dhi. Chakraborty	Particle-Flow Algorithms and Sim.
6.10 Graham Wilson	ECAL Concepts for Particle Flow
6.14 José Repond	Had Cal with Digital Readout (RPCs)
6.18 John Hauptman	New Concept Detector
6.19 A.J.S. Smith	Calorimeter and Muon ID
6.20 Tianchi Zhao	Scint/Cheren Rad Plates Cal w/ SiPMs
6.21 Satish Dhawan	Modular DAQ Development
6.22 Gerry Blazey	Scintillator-based Tail-catcher/Muon Tracker

Muon

7.2 Paul Karchin	Scintillator Based Muon System
7.5 Robert Wilson	Geiger-Mode APDs for Muon Sys.

FY07 Proposal

- For inclusion in proposal to NSF and DOE for 3rd year of umbrella grant
- Areas of Detector R&D included in the scope of the umbrella grants are:
  - 1. Luminosity, Energy, and Polarization measurements of the ILC beams at the interaction point
  - 2. Vertex detector development
  - 3. Tracking detectors, including solid state and gaseous devices
  - 4. Calorimeters for measurement of energy of high energy neutral and charged particles, and particle jets
  - 5. Muon detectors and particle ID detectors

http://physics.uoregon.edu/~lc/lcdrd/

FY07 proposals & evaluation

- 40 projects for FY07 from univ. and "small" labs
- $ 4.8 M – limited by realization of limited availability of funds
- 30 continuations of efforts supported in FY06
- 10 requests for new projects.

- Evaluation teams of 2-3 experts reviewed each of the specific topics
- Executive committee of eight
  - Conflict of interest was considered carefully, and dealt with to avoid inappropriate influence in the review process.
- Evaluation of each proposal for the following factors:

  RATING: overall quality of the research plan and goals, and the strength of the team to carry out the objectives (excellent, good, satisfactory, poor)

  RELEVANCE: the relevance of the project to the linear collider detectors (critical, important, useful, irrelevant)

  CONCEPTS: the importance of the work (except for the LEP - luminosity, energy, polarization proposals) to an active linear collider detector concept (critical, important, useful, irrelevant)

critical that project contributes to advancing detector technology for specific sub-detector capabilities of priority for the ILC physics program

FY07 LC Detector R&D

We are hopeful for increased funding in FY07
- discussed $3M for LCDRD

Encouragement led to development of early proposal for a few (9) high priority, urgent efforts (~$1M)
followed by annual round for another $2M

Supplemental proposal
1 – call for abstracts (received 22)
2 – selection of highest priorities/urgent needs (9)

http://physics.uoregon.edu/~lc/lcdrd/supplement-06a.html

Supplemental LCDRD Proposal

Process under the auspices of the LCSGA

1 – abstracts (received 22)
totaling about $10M over 2 years

2 – selection of highest priorities/urgent needs (9)
selection made by Oreglia/Weerts/White/Karlen,
chaired by Brau
consensus by four made it unnecessary
for chair to "vote"

Proposal submitted to DOE and NSF

agency review to decide on funding of projects

http://physics.uoregon.edu/~lc/lcdrd/supplement-06a.html

Supplemental LCDRD Proposal

SELECTION CRITERIA

1. **Is the focus of the R&D project addressing a critical need of the ILC detectors?**
   1. critical, very high priority 2. important, priority
   3. useful 4. irrelevant

2. **What does this project provide which is unique to the ILC detector R&D effort?**

3. **How urgent is the planned R&D with the support proposed? Consider a realistic level of support that might come from the supplemental program over 2 years, as well as the base support. Are there urgent steps being taken by this R&D?**
   1. extremely urgent 2. important, but only mildly urgent
   3. needed eventually 4. not needed at all

4. **Deliverables - will the R&D supported with the funding result in significant deliverables?**
   What deliverables?

5. **Rating - overall quality of the research plan and goals, and the strength of the team to carry out the objectives**
   1. excellent 2. good
   3. satisfactory 4. poor

http://physics.uoregon.edu/~lc/lcdrd/supplement-06a.html

Supplemental LCDRD Proposal

- High Performance Digital Hadron Calorimetry for the International Linear Collider
  PI - J. Repond
- Development of a Silicon-tungsten Test Module fo an Electromagnetic Calorimeter
  PI - R. Frey
- TPC Development
  PI - D. Peterson
- Pixel Vertex Detector R&D for Future High Energy Linear e+e- Colliders
  PI - C. Baltay
- Energy Spectometers for the International Linear Collider
  PI - E. Torrence/M. Hildreth
- Pixel-level Sampling CMOS Vertex Detector for the ILC
  PI - G. Varner
- Detector to Measure the Beam-strahlung Gammas
  PI - W. Morse
- Long Shaping-Time Silicon Microstrip Readout
  PI - B. Schumm
- Scintillator Based Muon System R&D
  PI - P. Karchin

2 VXD
2 TRK
3 CAL
1 Muon
1 LEP

This resulting distribution was not by design

http://physics.uoregon.edu/~lc/lcdrd/supplement-06a.html

LAB Detector R&D (FY06)

Estimates of funding prepared at DOE, but not official

	physicist FTE	engineer/ tech FTE	compute prof. FTE	admin FTE	total FTE	SWF $K	detector	travel	total M&S	Total K$
SLAC	7.15	0.38	3	0.55	11.08	2,007	427	32	460	2,467
LBNL (1)					2.79	335			145	480
FNAL (2)	4.1	7.1	0.	0.	11.2	1,635	370	50	420	2,055
Pixels	2.8	2.7	0.	0.	5.5	833	309	33	342	
HCAL	0.1	1.6	0.	0.	1.7	237	6	6	12	
Solenoid	0.3	0.4	0.	0.	0.7	100		3	3	
Test Beam	0.1	1.8	0.	0.	1.9	249	14		14	
Muon Syst	0.9	0.7	0.	0.	1.5	216	41	8	49	
ANL (3)					3.25	355	150		150	505
BNL (4)						100				
Lab Total					**28.27**	**4,332**			**1175**	**5,507**

(1) an old estimate from Jim Siegrist; not sure it is accurate
(2) PPD only; hope to increase FTE to 16. There may be <1 FTE not included from CD
(3) assumes get $100K from LDRD; took overhead factor as 1.33 for SWF to convert non-Ohd to Ohd bearing
(4) verbal estimate from Sally Dawson

Labs have separate organization
– but there is coordination and collaboration with LCDRD

Activities in last year….towards US program

Long planned visit to DOE/NSF on: April 28, 2006

Two days after EPP2010 went public

Participants:

J.Brau, M.Oreglia, M.Tigner,A.White, H.Weerts & P.Grannis,
J.Kotcher, J.Reidy + some observers

Jim presented overview, request for next year, findings of the WWS R&D panel and request for FY08 through FY09

Also presented at P5:
http://www.slac.stanford.edu/grp/ppa/reviews/20060420-P5/index.htm

Make the case for additional/supplemental funding in FY07 and beyond

Present profile, which is similar to what C.Damerall has presented to GDE RDB based on WWS R&D

Next page

US Funding Profile

POSSIBLE SCENARIO

FY06: $7M = $5.5M (labs) + $1.5M (high LCDRD)
FY07: $10M
FY08: $12M
FY09: $14M

TOTAL FY06-FY09 ~ $43M

THIS PROFILE WOULD REDUCE THE FUNDING GAP WITH THE EUROPEANS OVER A FEW YEARS – BUT NOT ELIMINATE IT!

Highest priorities:

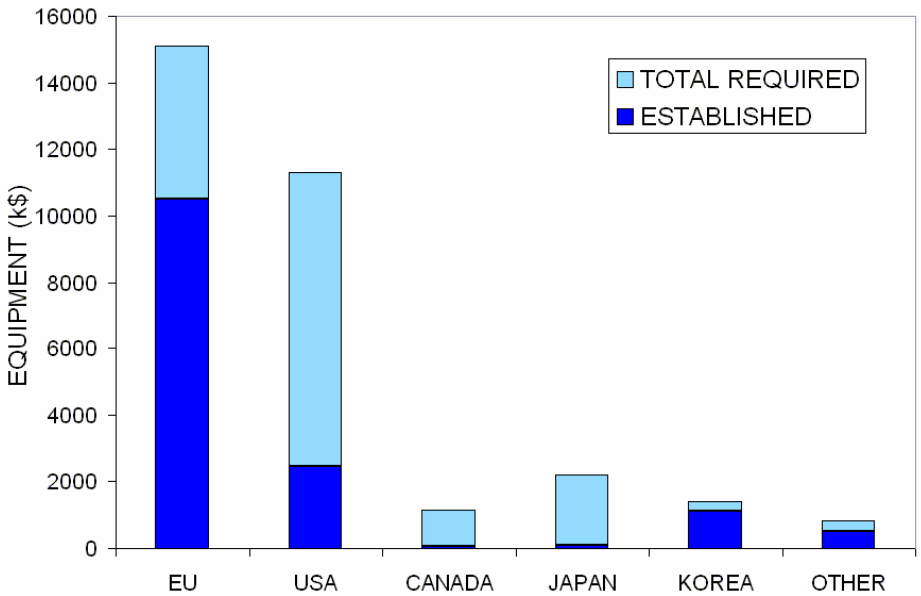
FY07 - calorimeter prototypes

FY08 - calorimeter prototype beam tests
solenoid
tracker prototypes

FY09 - intensify vertex detector effort
advance established R&D program

Global Perspective
(WWS R&D Panel)

US Detector R&D effort lags behind Europe



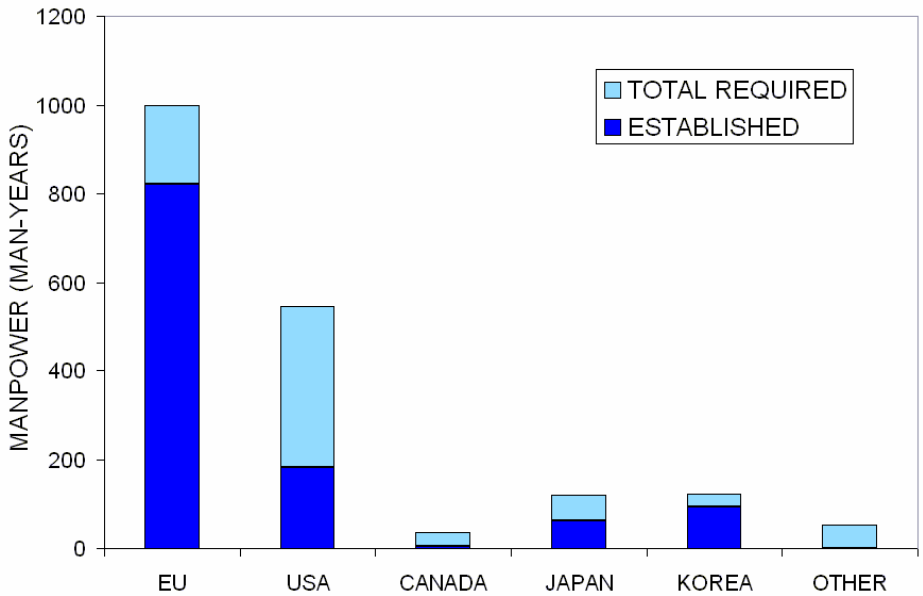


Fig 1. Urgent R&D support levels over the next 3-5 years, by funding country or region. 'Established' levels are what people think they will be able to get under current conditions, and 'total required' are what they would need to establish proof-of-principle for their project.

Feedback at April 29, 2006 meeting

Comments/Questions:

What is basis for request i.e. what is included ?

Funding limited in past, community lost interest….

What is profile needed if US is to be competitive ?

Several confusing discussions of ingredients of the US ILC detector R&D program

Can you define a program by this afternoon ?

Clear message: If community does not define program, DOE/NSF will do it

Action: Get back to P.Grannis with initial outline of program in one week, refine it afterwards

May 2006: activities

Assumptions:

Need proof of principle and
start prototype work in 2011
Assume construction start on 2012

Define an initial **US** program, that accomplishes these goals for ILC detectors. Put in M&S and manpower required independent of where manpower would come from. Include all manpower.

Had several meetings in very short time and several "subdetector" oriented groups filled information into spreadsheet.

This was a "bottoms-up" exercise, simply putting in what people in US thought they needed

Initial version looked like ➔

Example of subsystem.

MUON

Prelimary and initial attempt at US ILC detector R&D program.

Manpower "need" is in FTE per year.

		FY07 Need	FY07 Cost(K$)	FY08 Need	FY08 Cost(K$)	FY09 Need	FY09 Cost(K$)	FY10 Need	FY10 Cost(K$)	FY11 Need	FY11 Cost(K$)	Total Cost
MUON	M&S	135	$ 135	160	$ 160	170	$ 170	150	$ 150	140	$ 140	$ 755
MUON	Postdocs	2	$ 200	2.5	$ 250	2.5	$ 250	3	$ 300	2.5	$ 250	$1,250
MUON	Staff	1.9	$ 285	3.3	$ 495	3.3	$ 495	3.8	$ 570	4.3	$ 645	$2,490
MUON	EE	0.3	$ 36	0.4	$ 48	0.2	$ 24	0.6	$ 72	1.2	$ 144	$ 324
MUON	ME	0.25	$ 30	0.35	$ 42	0.35	$ 42	0.35	$ 42	0.35	$ 42	$ 198
MUON	students	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	$ -
MUON	techs	0.55	$ 55	1.1	$ 110	1.6	$ 160	1.8	$ 180	2.3	$ 230	$ 735
MUON	G. Sci/CP	0.5	$ 50	0.25	$ 25	0.25	$ 25	0.25	$ 25	0.5	$ 50	$ 175
MUON	Draft/DesM	0.25	$ 25	0.25	$ 25	0.25	$ 25	0.1	$ 10	0.1	$ 10	$ 95
MUON	Draft/DesW	0.5	$ 50	0.75	$ 75	0.75	$ 75	0.5	$ 50	0.2	$ 20	$ 270
MUON	TOTAL		$ 866		$1,230		$1,266		$1,399		$1,531	$6,292

Calculate SWF cost with overall numbers: postdoc 100K, staff 150K
Sub leaders put in "Need", costs are calculated

Bottoms up estimate….first try

US program | PRELIMINARY & INITIAL attempt | Version 0.46

TOTAL		FY07 Cost(K$)	FY08 Cost(K$)	FY09 Cost(K$)	FY10 Cost(K$)	FY11 Cost(K$)	Total Cost
LEP	TOTAL	$ 2,835	$ 2,835	$ 2,835	$ 4,673	$ 4,673	$ 17,850
VXD	TOTAL	$ 4,477	$ 4,384	$ 5,130	$ 3,974	$ 3,176	$ 21,141
SI-track	TOTAL	$ 872	$ 1,732	$ 1,977	$ 1,407	$ 1,087	$ 7,075
TPC	TOTAL	$ 1,119	$ 1,583	$ 2,064	$ 1,337	$ 1,307	$ 7,410
EMCAL	TOTAL	$ 1,445	$ 1,835	$ 2,980	$ 2,630	$ 2,810	$ 11,700
DHCAL	TOTAL	$ 3,661	$ 1,760	$ 1,849	$ 2,040	$ 1,450	$ 10,760
AHCAL	TOTAL	$ 1,370	$ 2,040	$ 1,340	$ 800	$ 710	$ 6,260
Forward	TOTAL	$ 430	$ 685	$ 890	$ 965	$ 815	$ 3,785
Solenod	TOTAL	$ 442	$ 644	$ 704	$ 824	$ 632	$ 3,246
MUON	TOTAL	$ 866	$ 1,230	$ 1,266	$ 1,399	$ 1,531	$ 6,292
Reconstruction & Analysis	TOTAL	$ 4,200	$ 4,200	$ 3,400	$ 4,650	$ 5,550	$ 22,000
Back End Elec	TOTAL	$ 205	$ 375	$ 660	$ 920	$ 1,020	$ 3,180
INFRA_EE	TOTAL	$ 182	$ 188	$ 193	$ 199	$ 205	$ 968
Test_FNAL	TOTAL	$ 1,590	$ 1,480	$ 885	$ 995	$ 1,490	$ 6,440
Test-SLAC	TOTAL	$ 500	$ 500	$ 500	$ 870	$ 870	$ 3,240
US program	**TOTAL**	**$23,694**	**$ 24,970**	**$26,173**	**$26,813**	**$26,456**	**$ 128,106**

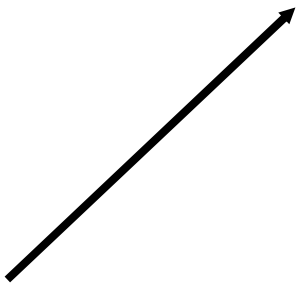
Feedback from DOE

Send result of initial attempt to P.Grannis on May 8.

Feedback:

A lot of information

Please split out the manpower coming from
SLAC & FNAL
Other labs
Universities
Put in milestones



This has to do with uncertainties about how "base program" can/will contribute to this exercise.

Next Steps…….I

Add required templates to spreadsheets to fill in information about:

Milestones
Manpower at labs, funded from "base" program

Also total amount of request seemed large.

Simple exercise of scale:

2 detectors is about ~$1.000M (high end in 07$)
Assume R&D = 20% ➔ ~$200M worldwide
US share ~1/3 ➔ ~$70M

Feeling that request is too high……..

Delays: supplemental funding requests and CR hit in October……

In Fall 06 ALCPG went back to ALCPG subgroups and asked them to do a "top down" estimate for each subsystem.

ALCPG exercise

Next Steps…….II

All input received by end of December 2006 from subsystems

Thanks to all ALCPG subgroups & leaders for going through this exercise

Milestones in a document
Manpower at labs, funded from "base" program Not yet

Took Jim and me a while to put it all together and get bugs out.
We added management reserve, request agencies (~10%)

Resulting spreadsheet and short description of program with milestones, can be found at:

http://www.hep.anl.gov/weerts/US_program_topdown_AR012.xls
http://physics.uoregon.edu/~lc/lcdrd/US_program_draft.pdf

Current "Top-down" request

H.Weerts

US program "Top Down" ILC US detector R&D program Version - AR 0.12

TOTAL		FY07 Cost(K$)	FY08 Cost(K$)	FY09 Cost(K$)	FY10 Cost(K$)	FY11 Cost(K$)	Total Cost
LEP	T	$ 1,684	$ 1,684	$ 1,684	$ 2,916	$ 2,916	$ 10,883
VXD	T	$ 2,440	$ 2,800	$ 3,440	$ 3,650	$ 3,650	$ 15,980
Si-tr_tot	T	$ 1,025	$ 1,215	$ 1,375	$ 1,330	$ 1,280	$ 6,225
TPC	T	$ 822	$ 1,819	$ 1,315	$ 2,066	$ 943	$ 6,965
ECALall	T	$ 1,175	$ 1,490	$ 1,825	$ 1,630	$ 1,485	$ 7,605
HCALall	T	$ 4,084	$ 3,631	$ 2,404	$ 2,110	$ 1,850	$ 14,079
Forward	T	$ 565	$ 793	$ 813	$ 813	$ 788	$ 3,772
Solenoid	T	*$ 452*	*$ 724*	*$ 1,004*	*$ 1,114*	*$ 702*	*$ 3,996*
MUON	T	*$ 661*	*$ 1,105*	*$ 1,141*	*$ 1,224*	*$ 1,281*	*$ 5,412*
							$ -
Algo & Reco	T	*$ 1,570*	*$ 1,630*	*$ 1,630*	*$ 1,630*	*$ 1,630*	*$ 8,090*
							$ -
							$ -
Back End Elec	T	*$ 205*	*$ 375*	*$ 660*	*$ 920*	*$ 1,020*	*$ 3,180*
INFRA_EE	T	*$ 182*	*$ 188*	*$ 193*	*$ 199*	*$ 205*	*$ 968*
Test_FNAL	T	$ 970	$ 1,270	$ 870	$ 1,255	$ 1,515	$ 5,880
Test-SLAC	T	$ 525	$ 525	$ 525	$ 625	$ 625	$ 2,825
US program		**$ 16,360**	**$ 19,248**	**$ 18,879**	**$ 21,482**	**$ 19,890**	**$ 95,860**
Mngmt reserve	#	$ 1,000	$ 1,500	$ 2,000	$ 2,500	$ 2,000	$ 9,000
US program	T	**$ 17,360**	**$ 20,748**	**$ 20,879**	**$ 23,982**	**$ 21,890**	**$ 104,860**

Bottoms up numbers for reference

Total Cost	Savings..
$ 17,850	$ 6,968
$ 21,141	$ 5,161
$ 7,075	$ 850
$ 7,410	$ 445
$ 11,700	$ 4,095
	$ -
$ 17,020	$ 2,941
	$ -
$ 3,785	$ 13
$ 3,246	$ (750)
$ 6,292	$ 880
$ -	$ -
$ 22,000	$ 13,910
$ -	$ -
$ -	$ -
$ 3,180	$ -
$ 968	$ -
$ 6,440	$ 560
$ 3,240	$ 415
$ 128,106	$ 32,247

Note - itatlics with 9 pt font indicates not yet updated with ALCPG review

Not gone anywhere yet

M&S part only…….

M&S part only		FY07 Cost(K$)	FY08 Cost(K$)	FY09 Cost(K$)	FY10 Cost(K$)	FY11 Cost(K$)	Total Cost
LEP	M	$ 313	$ 313	$ 313	$ 469	$ 469	$ 1,875
VXD	M	$ 400	$ 450	$ 500	$ 550	$ 550	$ 2,450
Si-tr_tot	M	$ 150	$ 250	$ 250	$ 250	$ 250	$ 1,150
TPC	M	$ 85	$ 384	$ 73	$ 556	$ 33	$ 1,131
ECALall	M	$ 305	$ 290	$ 395	$ 170	$ 85	$ 1,245
HCALall	M	$ 1,839	$ 1,317	$ 500	$ 600	$ 400	$ 4,656
Forward	M	$ 20	$ 75	$ 75	$ 75	$ 50	$ 295
Solenoid	M	$ 10	$ 20	$ 20	$ 10	$ 10	$ 70
MUON	M	$ 105	$ 160	$ 170	$ 150	$ 140	$ 725
							$ -
Algo & Reco	M	$ -	$ -	$ -	$ -	$ -	$ -
							$ -
							$ -
Back End Elec	M	$ -	$ 100	$ 150	$ 150	$ 100	$ 500
INFRA_EE	M	$ 50	$ 50	$ 50	$ 50	$ 50	$ 250
Test_FNAL	M	$ 150	$ 350	$ 150	$ 400	$ 400	$ 1,450
Test-SLAC	M	$ 200	$ 200	$ 200	$ 300	$ 300	$ 1,200
US program	T	$ 3,627	$ 3,959	$ 2,846	$ 3,730	$ 2,837	$ 16,997

Rather modest compared to the total.
Most effort is in manpower.

Next Steps III

ALCPG asked a group of people to review the current "top-down" request (with rather minimal information, except "needs" and milestones):

J.Alexander, J.Brau, M.Demarteau, D.Karlen, R. van Kooten, R.MacFarlane, M.Oreglia & H.Weerts

Two meetings so far, end of January & February

Collecting written feedback from this group for feedback to ALCPG subgroups

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Next major milestone: Review of "US ILC detector R&D program" on June 18, 19 by DOE and NSF @ Argonne.

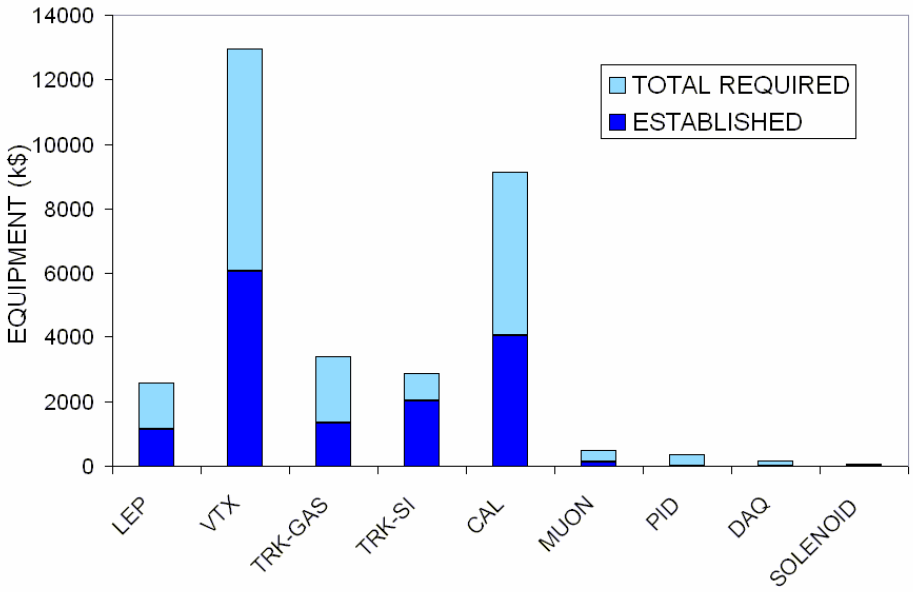
Purpose of review: the content of the program, especially in context of global R&D program (WWS R&D reviews important).

This will be critical for level of funding of ILC detector R&D program in next few years

THE END

Global Perspective
(WWS R&D Panel)

By Subsystem



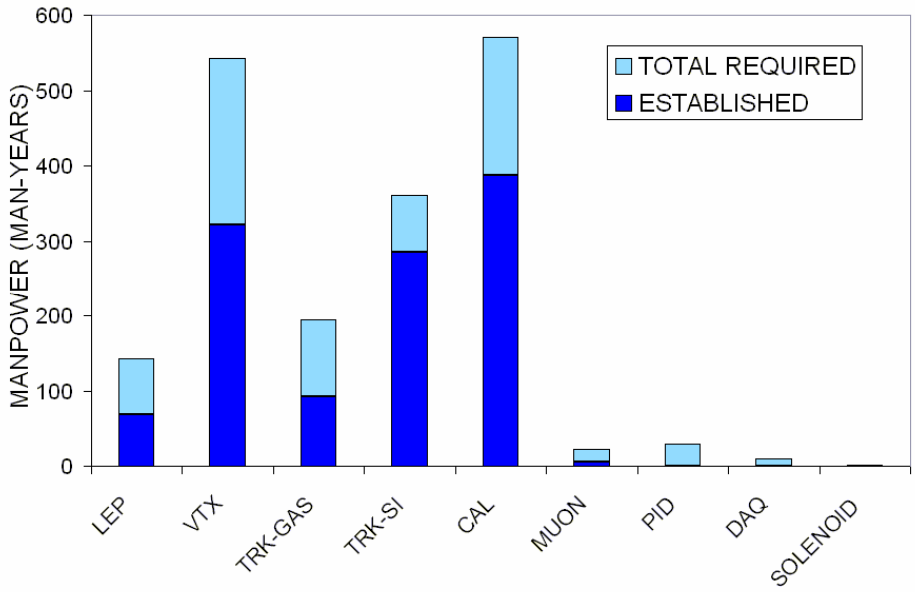


Fig 2. Urgent R&D support levels over the next 3-5 years, by subdetector type. 'Established' levels are what people think they will be able to get under current conditions, and 'total required' are what they would need to establish proof-of-principle for their project.