



CMS

Financing of LHC projects and CMS

Compact Muon Solenoid

LHC Days in Split
Split, Croatia

A. Petrilli, October 7, 2004



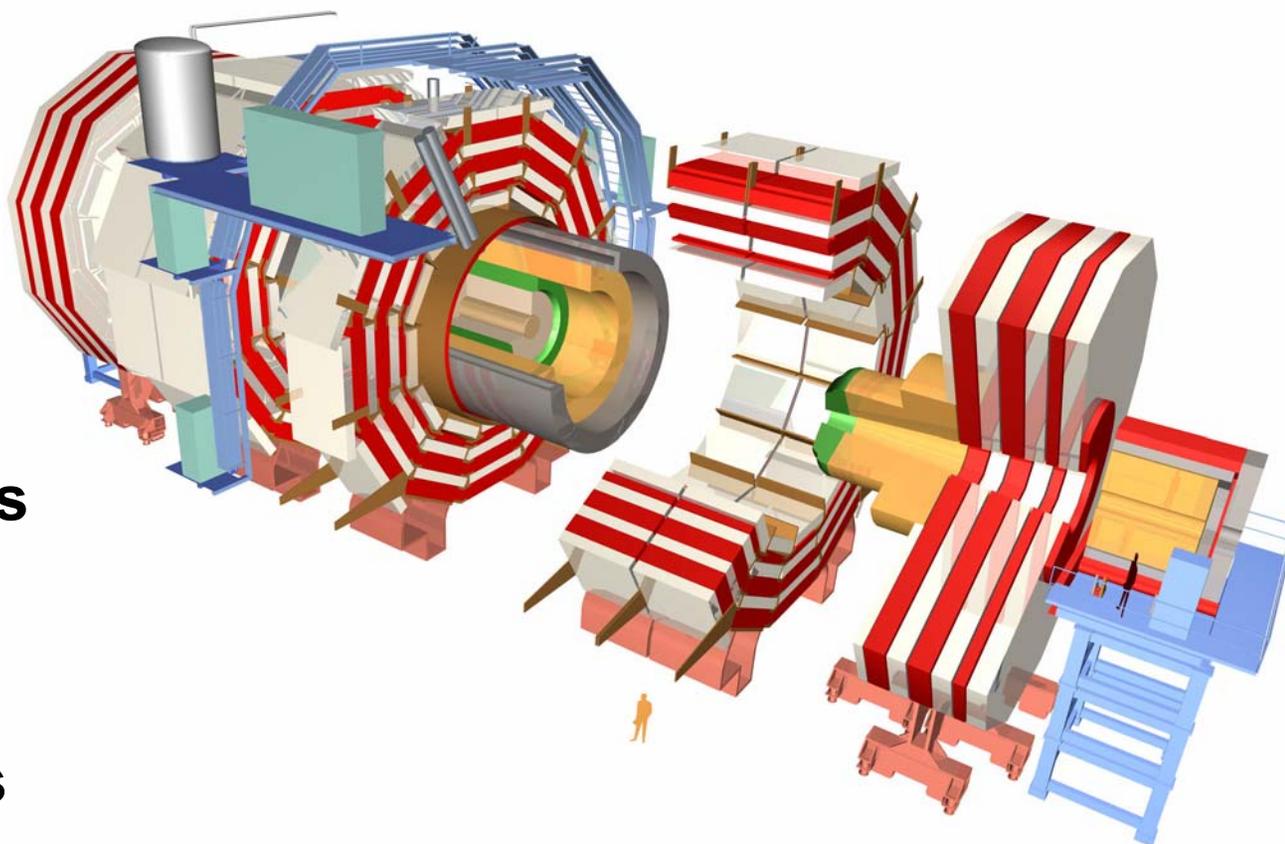
An LHC experiment

- **All my experience is with the CMS experiment**
- **Most of the following is CMS specific**
- **While details may vary, there will be many similarities with other experiments**
- **CMS is the reference for what follows**



Size and Complexity

- **12'000 tons**
- **500 MCHF**
- **Over 2000 people**
- **139 Institutes**
- **37 Funding Agencies**
- **36 Countries**





Sum of kCHF		System									
Type	Funding Agencies	1. Magnet	2. Tracker	3. ECAL	4. HCAL	5. Muon Detector	6. Trigger-DAQ	7. Offline Computing	8. Infrastructure	9. Commissioning & Integration	Grand Total
Funding	Austria	1,240	1,810			50	1,300	100			4,500
	Belgium	1,665	3,690					100			5,455
	Bulgaria					440					440
	CERN	16,868	17,700	17,900		2,300	7,470	200	23,955	12,307	98,700
	China	1,215				3,100				500	4,815
	Croatia	129		200							329
	Cyprus	235		471							706
	Estonia	106									106
	Finland	1,770	2,980				1,020	100			5,870
	France-CEA	3,447		3,000			840				7,287
	France-IN2P3	6,300	7,450	7,750				200			21,700
	Germany	5,440	8,120			5,406		200		543	19,709
	Greece	1,480		1,360			2,060	100			5,000
	Hungary	368			500	100	90				1,058
	India	1,000		1,000	2,500						4,500
	Iran				510				700		1,210
	Italy	16,800	23,300	4,900		18,327	100	500			63,927
	Korea	815				500	500				1,815
	Pakistan	625				1,820					2,445
	Poland	940					2,060				3,000
	Portugal	730		1,315			255				2,300
	RDMS-DMS			100	5,715	1,000					6,815
	RDMS-Russia			3,140	5,701	3,810			1,450	150	14,251
	Serbia									400	400
	Spain	2,140				5,022		100			7,262
	Switzerland-ETHZ	25,000		47,900			2,000	600			75,500
	Switzerland-PSI	2,610	3,600	1,720			500	70			8,500
	Switzerland-Universities		2,500								2,500
	Taipei	866		1,874							2,740
	Turkey	368			690						1,058
	United Kingdom	2,857	2,700	3,411			850	200			10,018
	United States-DOE	26,960	1,480	10,715	26,257	24,214	9,750		1,100		100,476
	United States-NSF	3,600	990	2,015	7,338	2,159	765	1,130			17,997
	Funding Total	125,574	76,321	108,771	49,211	68,248	29,560	3,600	27,205	13,900	502,390
	Cost Estimate	-125,809	-77,359	-111,984	-49,212	-69,134	-37,619	-3,600	-27,955	-14,650	-517,322

Contributions vary
from as little as
106 kCHF to as
much as 100
MCHF

And all
contributions are
important



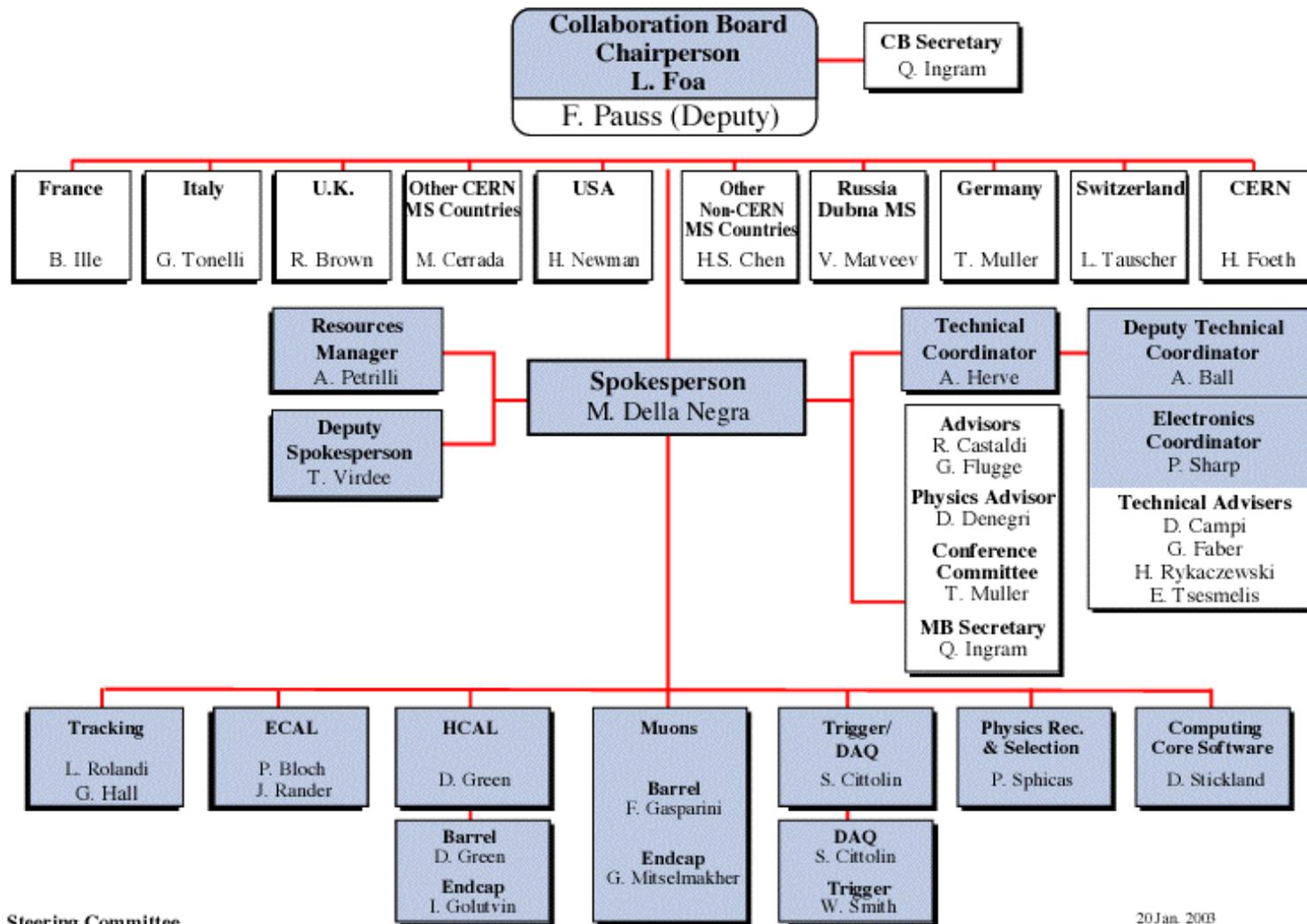
Funding

- **The funding shown is only for *deliverables***
 - **Cost of Institutes' personnel is not included**
 - **Cost of R&D, prototyping is generally not included**
- **How can you fund and manage such a huge project?**
 - **Centrally collecting funds and handling the whole project is not possible nor always optimal**
- **CMS case: divide responsibilities and delegate**



CMS Organization

CMS Management Board and Steering Committee



 Steering Committee

20 Jan. 2003



CMS Organization (2)

- **The CMS Collaboration is organized as a federation of subsystems**
 - **Each has its own financial and institutions boards**
 - **Matters internal to the subsystems are directly dealt there**
- **The result is a more manageable structure which can follow more closely the needs and goals of everybody**



Optimizing Funds Management

- **The ratio of Common Funds to the total funding of CMS is around 12%**
 - **Common Funds are managed centrally and globally funded by the Collaboration**
- **The remaining funding, 88%, is managed in a decentralized fashion inside the various CMS subsystems**
 - **Biggest subsystems: Magnet 125 MCHF, ECAL 110 MCHF**



How to Contribute

- **Two main ways:**
 - **Cash**
 - **Transfer of funds and responsibility, e.g. Magnet Common Fund**
 - **In-kind**
 - **Responsibility for a particular item at an agreed value, e.g. support feet for the Magnet**
- **And payments to specific contracts**



Formalities

- **Memorandum of Understanding for CMS Construction**
 - Institutes and/or Funding Agencies sign a commitment to fund the experiment
 - Annexes are included presenting the repartition of the funding and the cost estimates for the detector
 - Not legally binding, but **honor bound**
- **Resources Review Board**
 - **Oversight committee for the CMS Construction, all MoU signatories are represented**
 - Meets twice a year (next one end of October, 19th meeting), approves budgets and expenditures



Matching Funds and Costs

- The MoU specified in 1998 an **estimated total cost of 460 MCHF and matching funding**
- Review of the cost estimates in 2001, Cost to Completion
 - Cost increases for a total of **55 MCHF**
 - A few problems in the funding
- New cost estimate of **515 MCHF**
- Additional funding promised, total of 500 MCHF
 - Deficit covered with staging of less urgent and critical parts



After Construction

- **Construction of the LHC experiments is scheduled to finish in 2007**
- **Experiments will have to function for many years**
- **There is a need to **Operate** the detector and to **Maintain** it**
- **Estimates have been made in 2001 and are constantly updated for the Maintenance & Operation costs**
- **Memorandum of Understanding for M&O has been presented to the Resources Review Board in Spring 2002 and signatures have been collected**



Maintenance & Operations

- **M&O is divided in two categories, **A** and **B****
 - **A** covers the common needs of the CMS experiment as a whole
 - **B** covers the needs of each CMS subsystem
 - Each subsystem has its own category B M&O
- **M&O-A** is shared amongst Institutes by number of participating scientists
- Each subsystem chooses independently the cost sharing for its own **M&O-B**



Maintenance & Operations (2)

- **M&O-A** contributions are handled like a Common Fund, centrally invoiced, collected, managed and reported in detail to the Resources Review Board.
- **M&O-B** is handled directly by the Institutes to maintain and operate the equipment under their responsibility.
 - Only a small share of the M&O-B might need to be centrally handled under the supervision of the subsystem concerned



Some Facts for Croatia in CMS

- **Participates in**
 - **Magnet: Common Fund, cash contribution**
 - **ECAL: Crystals and APDs, payments to contracts**
- **Total contribution 329 kCHF (280 MoU, 49 Cost to Completion)**
- **0.2% of ECAL funding**
- **0.3% of Magnet Common Fund**
- **0.4% of CMS PhDs**
- **2.1% of CMS ECAL PhDs**



Some Facts for Croatia in CMS (2)

- **Industry participation: Koncar**
 - **Copper busbar**





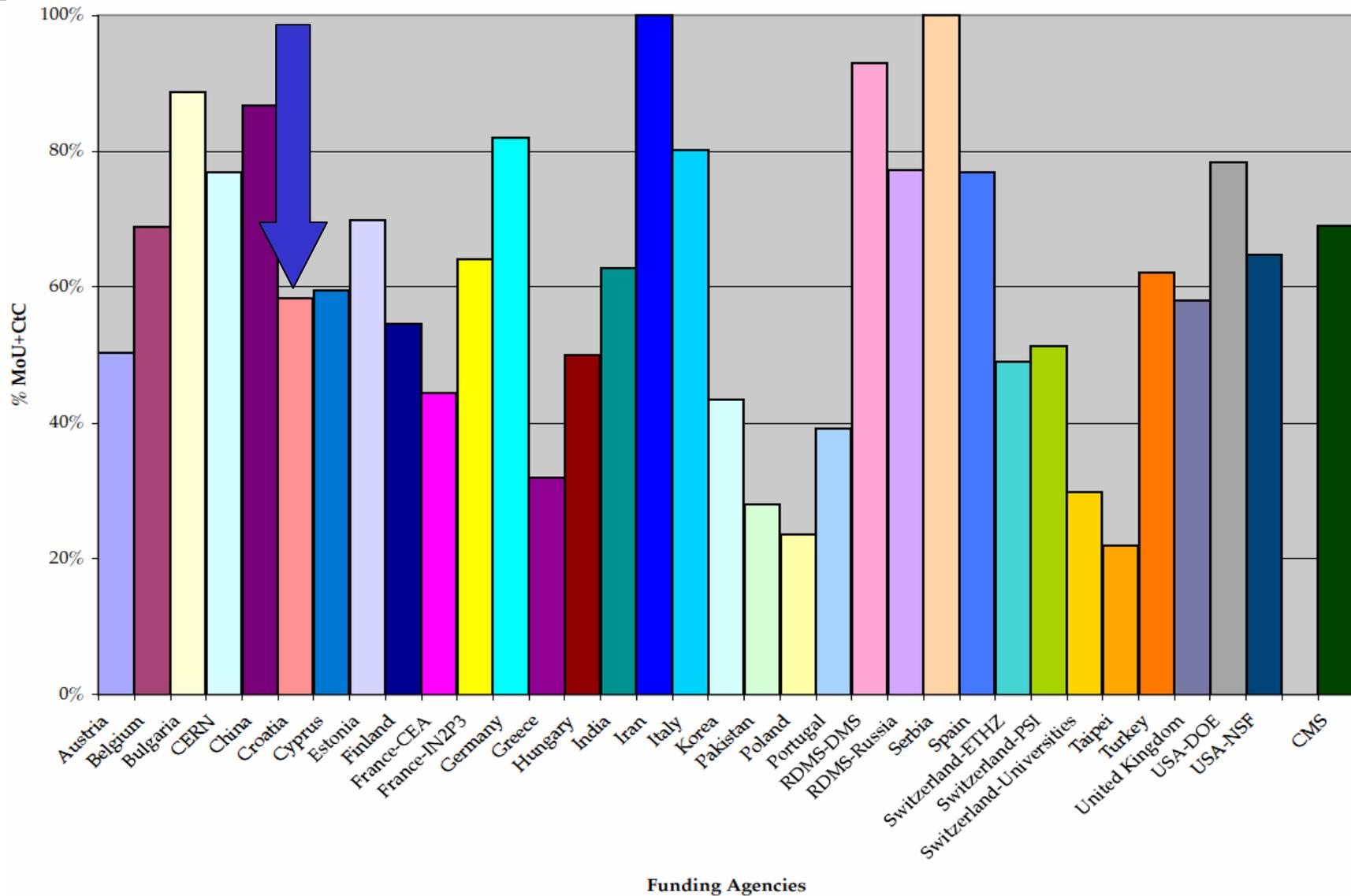
Draft Budget 2005 for Construction by FA

	COMMON PROJECTS					SUB-DETECTORS					Infrastructure	Commissioning & Integration	TOTALS	
	Common Fund	Payments to Contracts	In-kind Contributions	Subtotals for Magnet	Offline Computing	Totals Common Projects	Tracker	Electromagnetic Calorimeter	Hadron Calorimeter	Muon Detector				Trigger and Data Acquisition
Funding Agencies	MAGNET				OFFFL	Σ						Σ	Σ	
Austria	111			111	5	116	150				788	938		1,054
Belgium	207			207	15	222	168					168		390
Bulgaria														
CERN							3,028	1,220		100	1,637	5,985	7,875	13,860
China													404	404
Croatia	9			9		9		25				25		34
Cyprus								60				60		60
Estonia														
Finland					15	15	192				330	522		537
France - CEA								427				427		427
France - IN2P3					40	40	1,800	1,148				2,948		2,988
Germany							509			740		1,249	129	1,378
Greece	180			180	20	200		260				260		460
Hungary	50			50		50								50
India	145			145		145		250				250		395
Iran														
Ireland														
Italy					60	60	3,805	1,819		343	71	6,038		6,098
Korea										250		250		250
New Zealand														



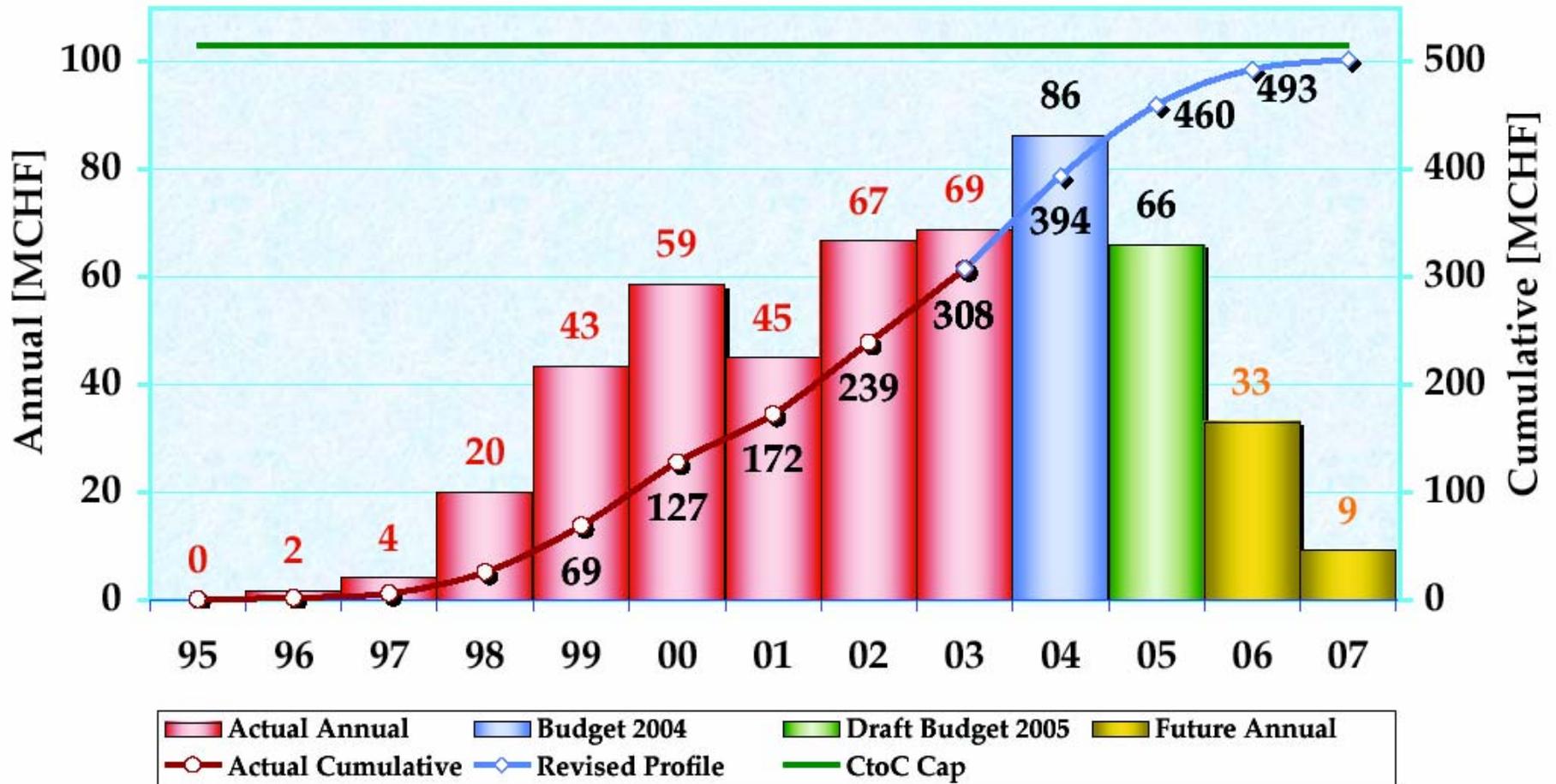


Commitment by Funding Agency 2003





Payments 2003





Scientists Participation in CMS



Funding Agency	PhD #	PhD %
Austria	12	1.2%
Belgium	26	2.7%
Brazil	4	0.4%
Bulgaria	4	0.4%
CERN	60	6.2%
China	14	1.5%
Croatia	4	0.4%
Cyprus	2	0.2%
Estonia	2	0.2%
Finland	13	1.3%
France-CEA	14	1.5%
France-IN2P3	38	3.9%
Germany	43	4.5%
Greece	20	2.1%
Hungary	6	0.6%
India	21	2.2%
Iran	2	0.2%
Ireland	1	0.1%
Italy	151	15.7%
Korea	5	0.5%
Mexico	1	0.1%
New Zealand	3	0.3%
Pakistan	3	0.3%
Poland	8	0.8%
Portugal	4	0.4%
RDMS-DMS	48	5.0%
RDMS-Russia	59	6.1%
Serbia	3	0.3%
Spain	26	2.7%
Switzerland-ETHZ	15	1.6%
Switzerland-PSI	9	0.9%
Switzerland-UNIV	6	0.6%
Taipei	10	1.0%
Turkey	13	1.3%
United Kingdom	37	3.8%
USA-DOE	222	23.1%
USA-NSF	54	5.6%
Grand Total	963	100.0%

LHC Days in Split



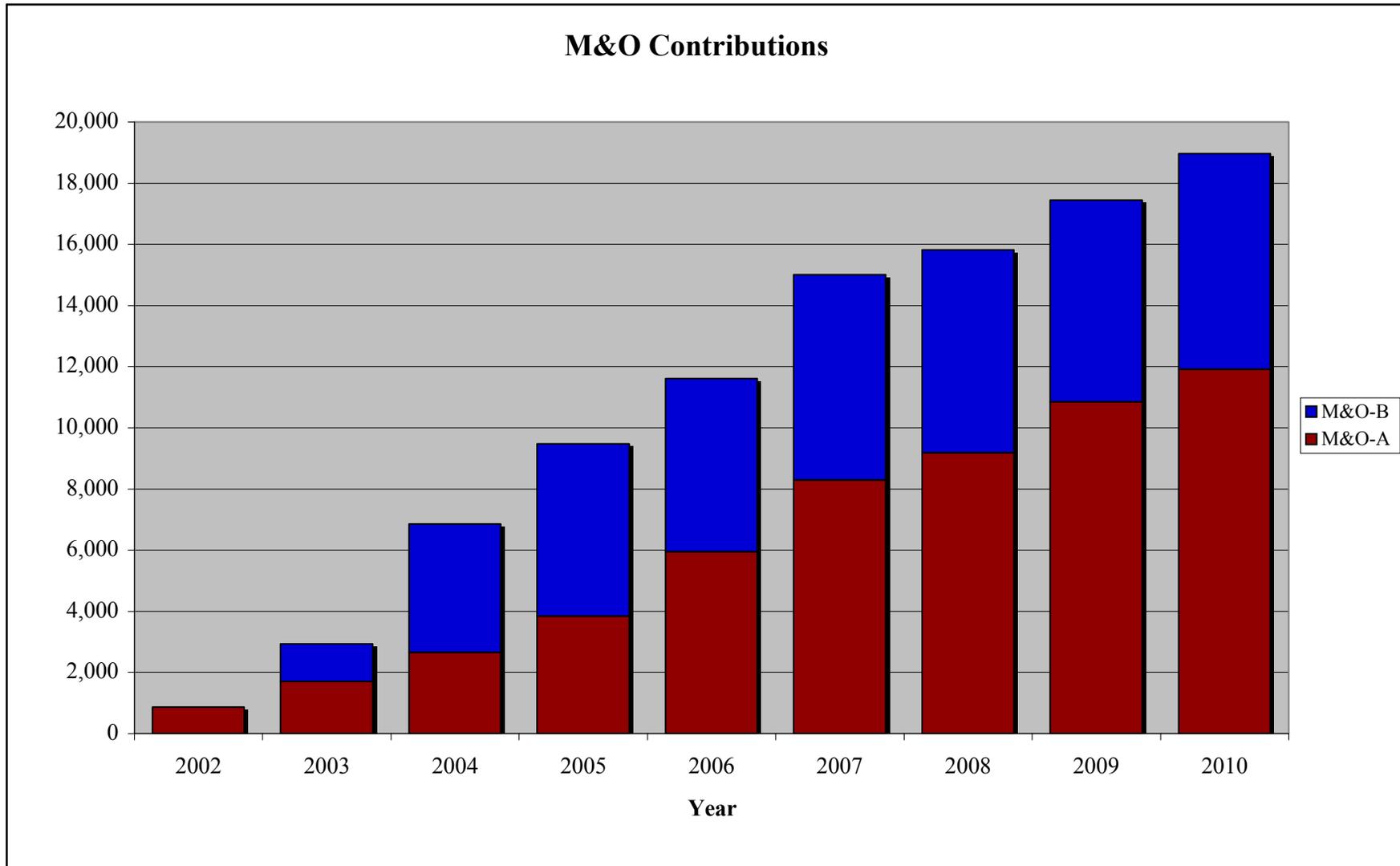
Draft Budget for M&O 2005



Funding Agency	Category A	Category B	Total Category A+B	Total Invoiced
Austria	44.7	89.3	133.9	44.7
Belgium	96.8	205.2	302.0	96.8
Bulgaria	14.9		14.9	14.9
CERN	227.1	493.6	720.7	227.1
China	55.8	20.7	76.4	55.8
Croatia	15.9	21.1	37.0	15.9
Cyprus	8.0	10.6	18.5	8.0
Estonia	8.0		8.0	8.0
Finland	48.4	88.0	136.4	48.4
France-CEA	52.1	73.9	126.0	52.1
France-IN2P3	141.5	256.5	398.0	141.5
Germany	160.1	410.3	570.4	160.1
Greece	74.5	96.2	170.6	74.5
Hungary	22.3		22.3	22.3
India	83.1	25.6	108.6	83.1
Iran	8.0		8.0	8.0
Ireland	4.0	5.3	9.3	4.0
Italy	558.4	1,250.4	1,808.8	558.4



M&O Costs 2002-2010





Conclusions

- **Financing an LHC experiment is not the same as financing a highway construction**
- **Freedom should be left to each participant to optimize the return of their investment**
 - **Scientific interest, technical interest, developing new disciplines**
 - **Help industries in participating countries to bid and compete in a highly demanding field**