



*Workshop on Grid Computing  
Islamabad, 20 October 2003*



*Role of International  
Collaborations  
in Developing  
Countries*



# *“Developed Countries”*

A *“Developed Country”* (not necessarily a rich one) has gone, sometime in its past history, through the cycle:

- *improvements to its population’s level of education*
- *progress in (and application of) science & technology*
- *deployment of its own (and other’s) natural resources*
- *wealth generation through manufacture or services*
- *improvement to infrastructure (of education, industry, energy supply, services, communications...)*

*leading to competitiveness and productivity, better social conditions and higher standard of living*



# *“Developing Countries”*

A *“Developing Country”* (not necessarily a poor country) is in the process of deploying:

- its human resources (educated people)
- its natural resources (prospecting, exploiting and transforming into higher-value items), and
- its infrastructure (of education, health, industry, transport & communications, water & energy supply, environmental, etc) in order to make its economy more efficient and competitive



# *Human Resources: Talented and Educated People*



*Talented people are born anywhere in the world they are not a privilege of developed countries!*

*Talented people without education, however, will remain talented but uneducated people!*

*Talented, but uneducated people:*

- *will not contribute much to their country's development*
- *some of them will even use their talents in a detrimental way*



## *Educated, not just Talented People*

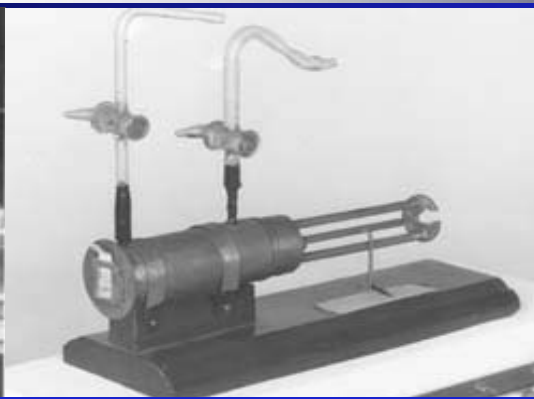
*Maxwell, Thomson, Rutherford, Curie, Fermi, Dirac, Einstein (physics), Watson, Crick (biology), Mendeleev, Pauling (chemistry), Fleming, Pasteur (medicine)....have dramatically changed our world through their research followed by its technological applications*

*All these scientists were not just talented, they were found to be talented as they were educated! Therefore, without education their talents would have been lost for the progress of mankind!*





# Talented and Educated People from "Nowhere" : Impact on Science



J.J. Thomson discovered the electron with a simple apparatus



Abdus Salam unified the theory of EM and Weak Interaction came from a small Pakistani village - and went to study/work in the UK



A. Einstein was born in a small German town, worked in Switzerland and the USA....he has even been a Hopi Indian....

E. Rutherford discovered the nucleus, (in his "den") in Christchurch/NZ



# Natural Resources & Infrastructure



*Educated people are a necessary, but not a sufficient condition for the development of their country:*

*It is only with educated people that a country can develop its natural resources and infrastructure, hence its industry*

*A country's wealth thus depends on its educated people producing items or a providing service - commerce or just selling natural resources does not produce wealth*



# *Best Capital Investment Country = Talented and Educated People*



*Japan is a striking example: it was a poor island nation with few natural resources and bad infrastructure (as well as closed ports until the late 19<sup>th</sup> century) - but Japan always had a strong tradition for good education.*

*When Japan "opened up" in about 1880, it began to complement the education of its most talented people by sending them to study in "developed countries".*

*Some 30 years after its "opening to the World" Japan's navy destroyed the Russian fleet at Tsushima. One generation later later, and (like Germany) following its total destruction, Japan (with less inhabitants than Pakistan) succeeded to rebuild its country to become the second most powerful economy on the globe*





# *Need of a Modern Infrastructure*

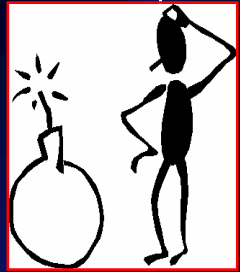
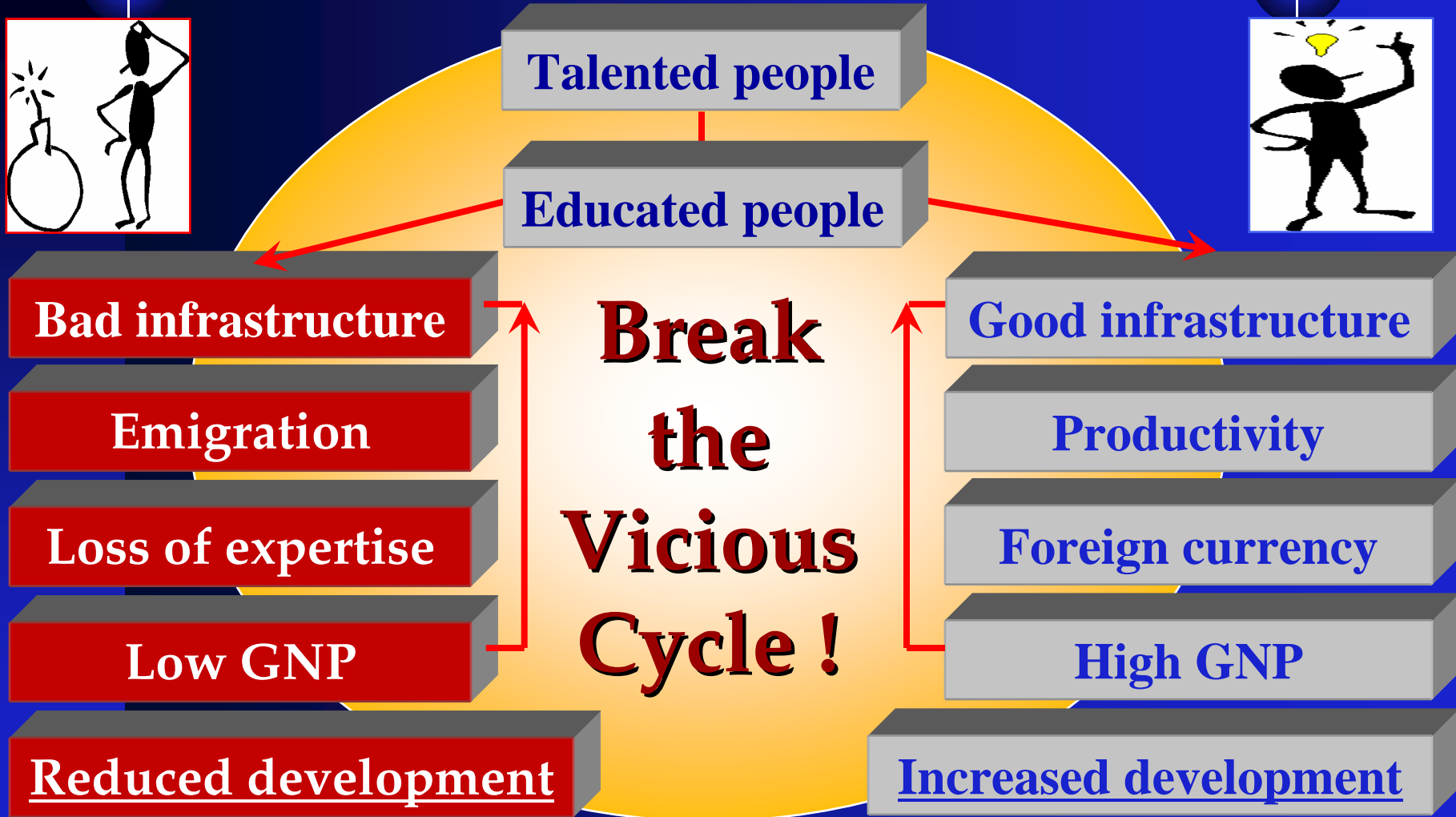


*Next to the need for educated people, a country needs **modern and competitive infrastructure and proper tools** as the working environment*

*An **obsolete or decrepit infrastructure** in universities, institutes or hospitals, **inadequate equipment, poor communication networks**, and to a certain degree also **low salaries** etc. will cause the best scientists to migrate to better equipped countries whilst the other scientists "stay at home"*

*--> A very negative "Darwinistic process" <--*

# The Vicious Cycle





# The “Negative” Development Aid



A “Developing Country” with a *poor infrastructure* (in particular in the area of science, research and education) is often providing, “free of charge”, its most talented people (who’s education it paid from its scarce resources) to *Developed Countries*

Therefore, investments in education are *wasted if no investments are also made in the science, research and education infrastructure (+ salaries)*



# *Science cannot progress in Isolation*



*However, science has become rather complex, and only very few scientists can make any progress in isolation: “to limit the community of scientists to a small group leads to common spiritual poverty” (A. Einstein)*

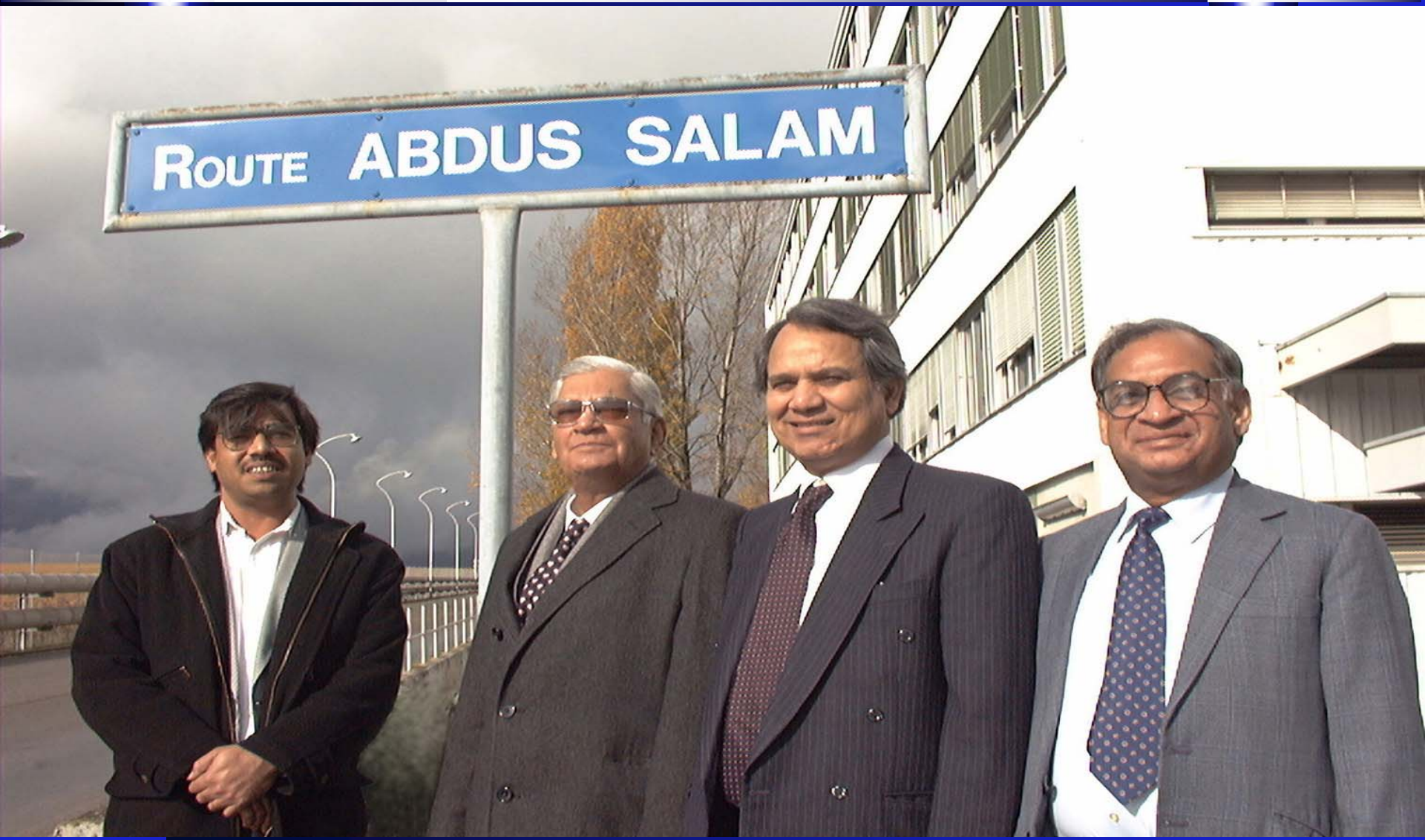
*Most scientists in isolation will soon cease to be scientists - as such they will no longer be able to educate younger talents, and their “knowledge” will eventually have become obsolete.*

*This was recognized by Abdus Salam, Ishfaq Ahmad, and others when they promoted institutions like the ICTP, Nathiagali or the NCP....*





# *Promoters of Science "at home"*





# *Help scientists from “Developing Countries to work “at home”*



*Governments should therefore make their best effort to provide opportunities to its scientists to work in their home country, and make it also attractive for them work there. Governments should also provide good communications with the rest of the world*

*In developing countries **this action is required by governments**, as **industry** in developing countries is usually **not so much interested** to make large investments in science unless the outcome promises substantial financial returns*



# *International Basic Science Collaborations*



*At the same time, scientists must be also able to collaborate with their colleagues from other countries - as otherwise they would soon be “out of touch”, i.e. they would become much less useful (or quite useless) for the development of their own country*

*... and there are plenty of opportunities for international basic science collaborations which are a good training ground - or an opportunity to make a major contribution to mankind*

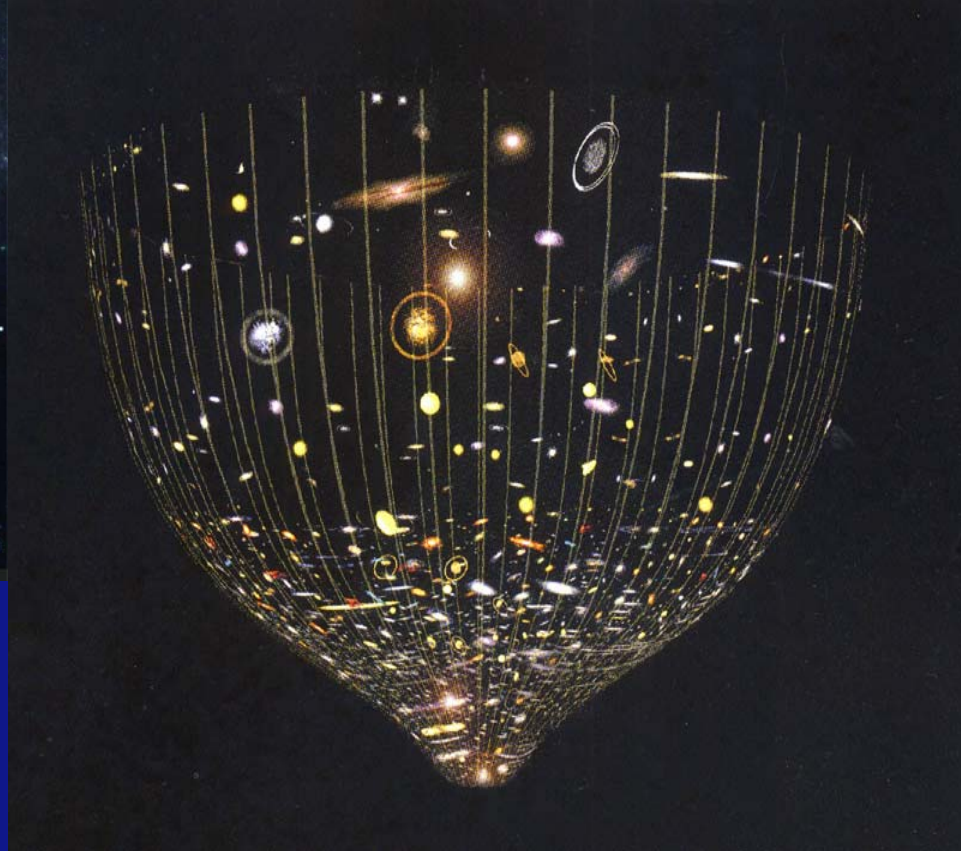




# *Astrophysics and Elementary Particle Physics need big Instruments*



## *Elementary Particle Physics*

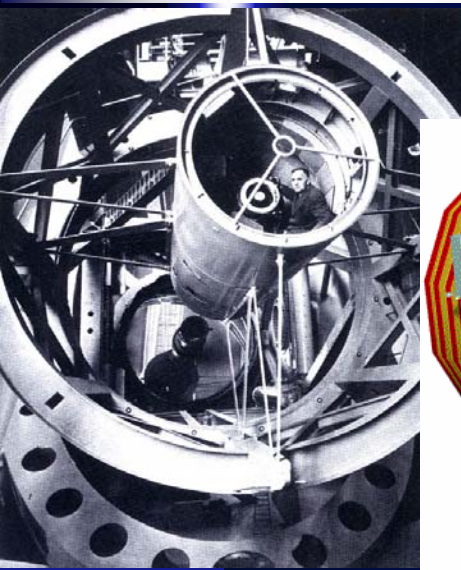


## *Astrophysics*

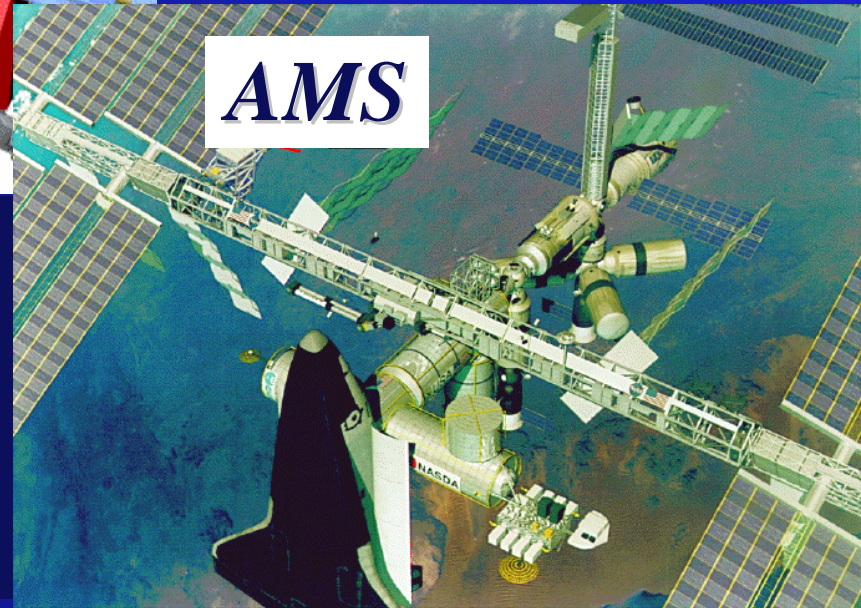




# *The big Instruments for Astrophysics and Elementary Particle Physics are expensive*



**CMS**



*Instruments like the Hubble telescope, the CMS-, or the AMS- detectors cost many \$ 100 million, therefore they can only be built by large international science co-operations*



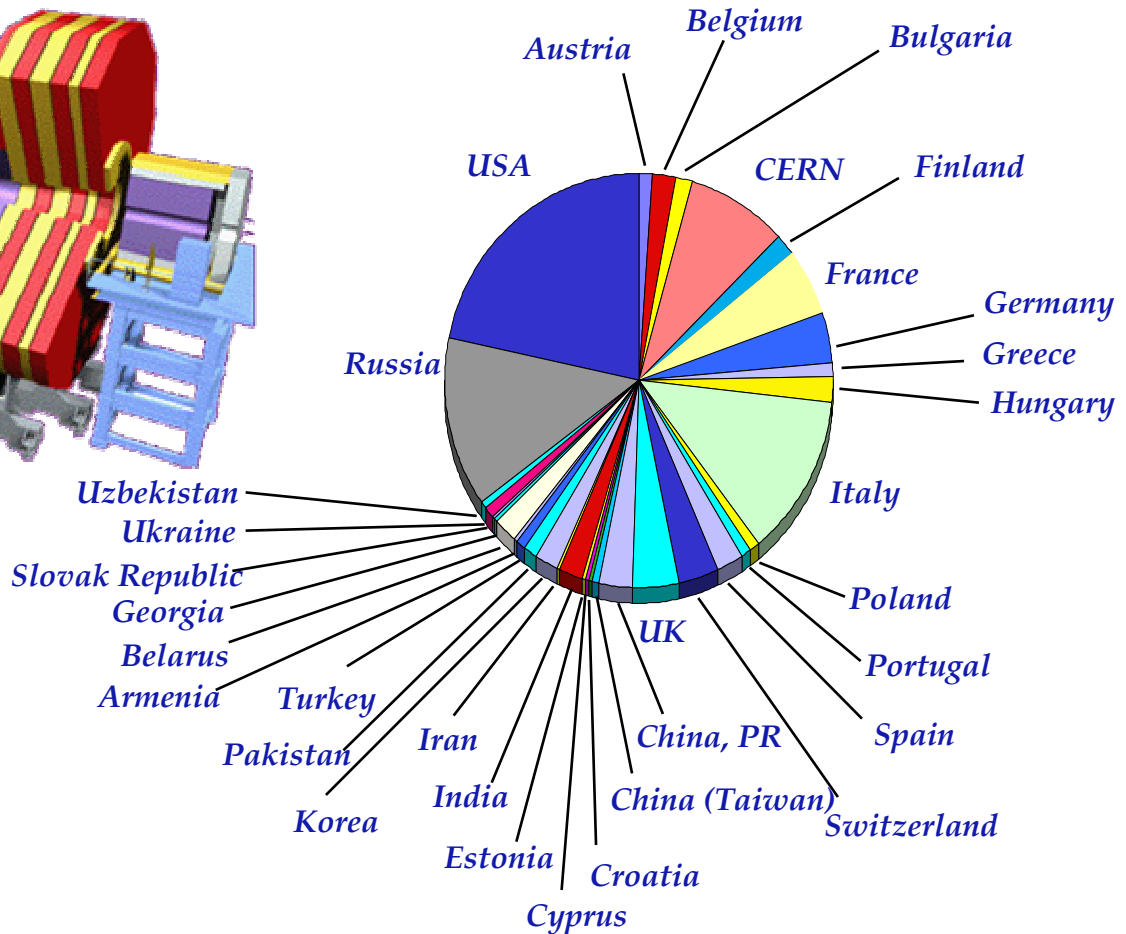
# CMS : 1'800 scientists from 32 Countries Data stored for Analysis : > 1 PB/year ...



Raw event data rate:  
 $10^9$  events at 40 MHz  
equiv. to ~ 1 PB/s

Offline storage rate:  
100 MB/s

Rate of ~ 50'000 cell  
phones



1840 physicists from 147 institutions from 32 Countries





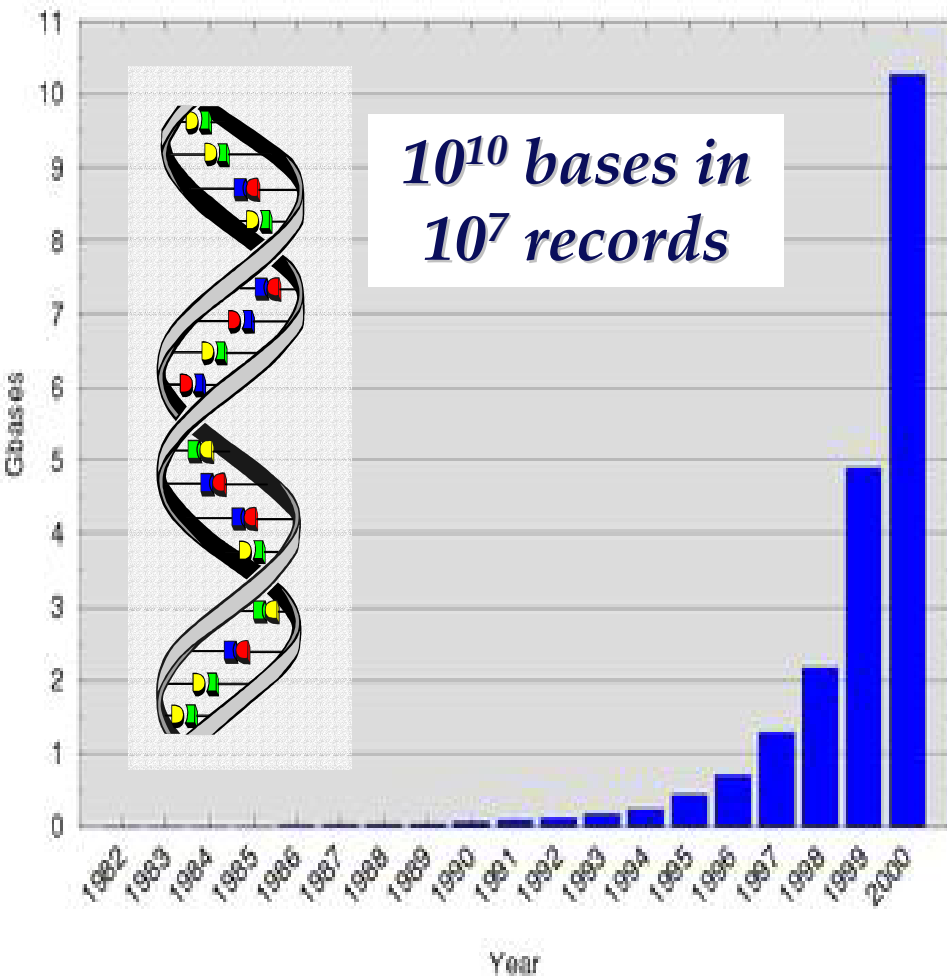
# *Science cannot progress in Isolation*



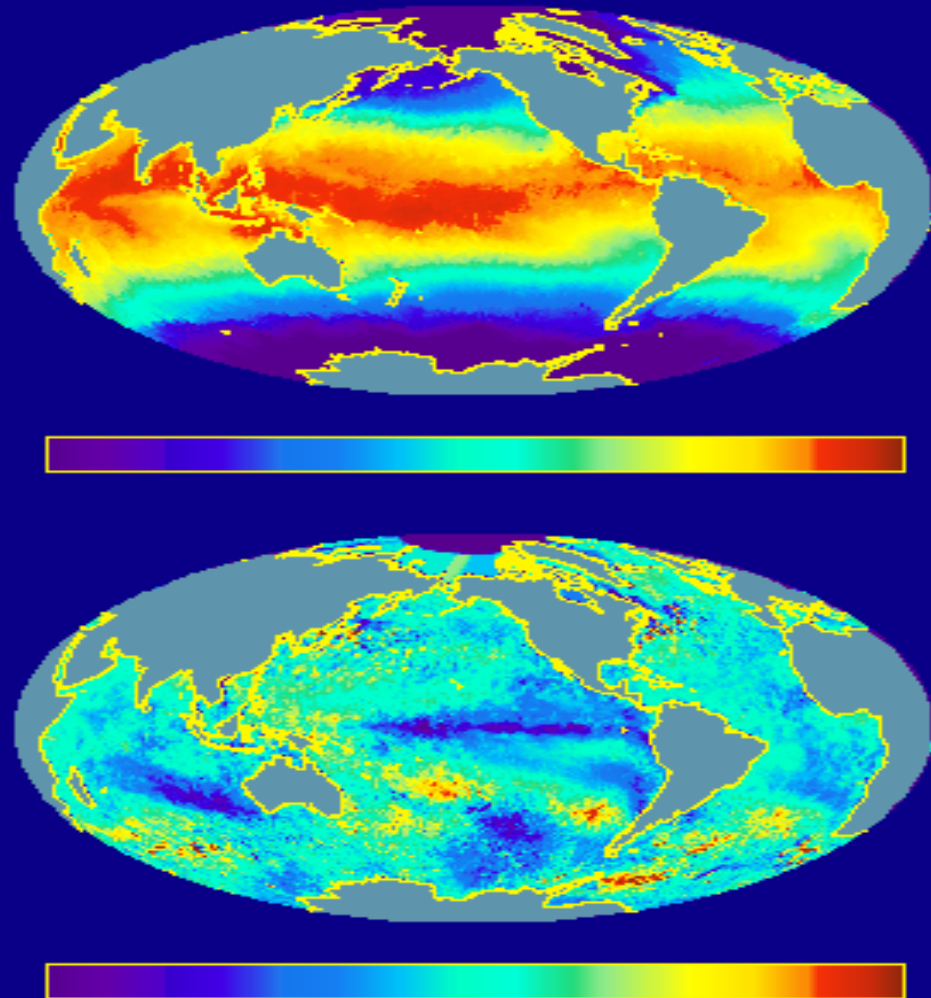
## *The Human Genome Project*

- 1. Albert Einstein College of Medicine*
- 2. Baylor College of Medicine*
- 3. Beijing Human Genome Center, Institute of Genetics, Chinese Academy of Sciences*
- 4. Center for Genetics in Medicine (Perkin Elmer/Washington Univ.)*
- 5. Gesellschaft für Biotechnologische Forschung mbH*
- 6. Genoscope*
- 7. Genome Therapeutics Corporation*
- 8. Institute for Molecular Biotechnology, Jena, Germany*
- 9. Karolinska Institute, Center for Molecular Medicine*
- 10. Lita Annenberg Hazen Genome Center, Cold Spring Harbor*
- 11. Max Planck Institute for Molecular Genetics*
- 12. Joint Genome Institute, U.S. Department of Energy*
- 13. Japan Science and Technology Corporation*
- 14. 14. RIKEN Genome Sciences Center*
- 15. 15. The Sanger Centre*
- 16. Stanford DNA Sequencing and Technology Development Center*
- 17. Stanford Human Genome Center*
- 18. The Institute for Genome Research*
- 19. University of Utah Genome Center*
- 20. University of Oklahoma, Advanced Genome Technology Center*
- 21. University of Texas, Southwestern Medical Center*
- 22. University of Washington Genome Center*
- 23. University of Washington Multimegabase Sequencing Center*
- 24. Whitehead Institute for Biomedical Research/MIT*
- 25. Washington University, Genome Sequencing Center*

## EMBL Database (Gigabases)



## El Niño Observation







# *Education and Technology Spin-off*



*The “benefit” from such large **international collaborations** may appear esoteric à-priori, (who cares about the “age of the universe”), but 2 major benefits are really substantial:*

- the **education** of the participants in the large international collaborations, and*
- the **technological spin-off** from cutting-edge science (also for the developing countries)*



# *Benefits from Participation in International Collaboration*



## *Training, technology transfer, R&D connections*

- 1. Training programmes for students (“la-main-à-la pâte”)*
- 2. Access to an international research facility, and through this facility: personal contacts to other scientists worldwide*
- 3. Worldwide access to potential industrial partners for R&D, prototyping and mass production of high-tech items*
- 4. Technology transfer to their home country*

## *Technological spin-off*

- 1. Medical physics, nanotechnology, astronomy, astrophysics..*
- 2. Information Technology: the handling of large amounts of data within a global collaboration promotes computing*



# *CERN as an example for Training of young Scientists*



*CERN provides an opportunity for young scientists from all countries to work on peaceful basic research in a fully international environment*



# Contacts through International Collaboration



Sensor's QAC

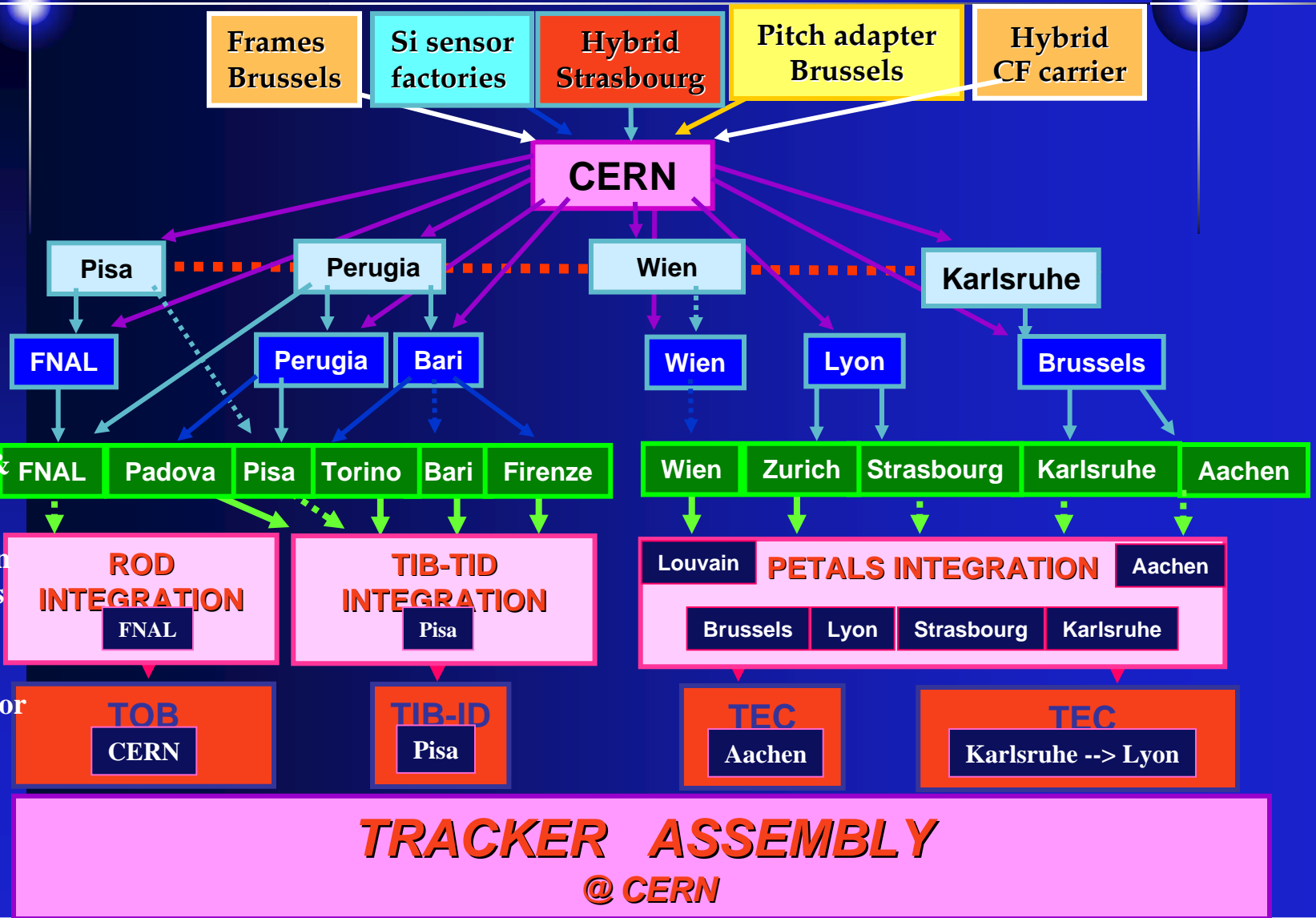
Mmodule assembly

Bonding & testing

Integration of modules into mechanics

Sub-detector assembly

Tracker assembly



## TRACKER ASSEMBLY @ CERN





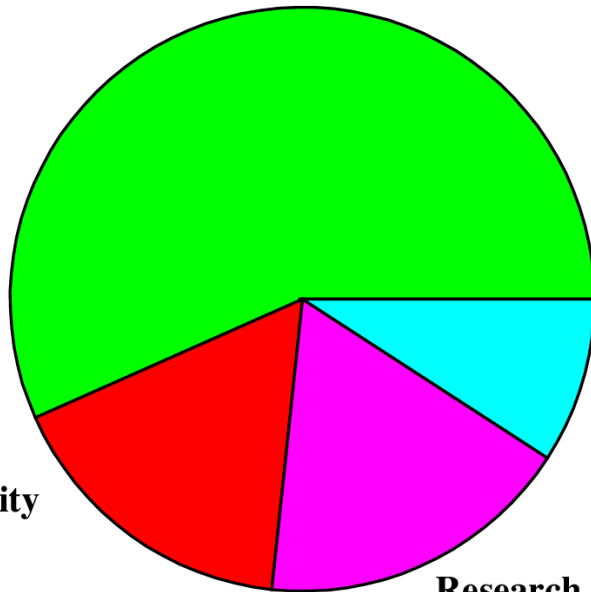
# What happened to all the PhD's from a CERN experiment (OPAL) ?



Status of 1998 (120 PhD's total)



Industry



Other

University

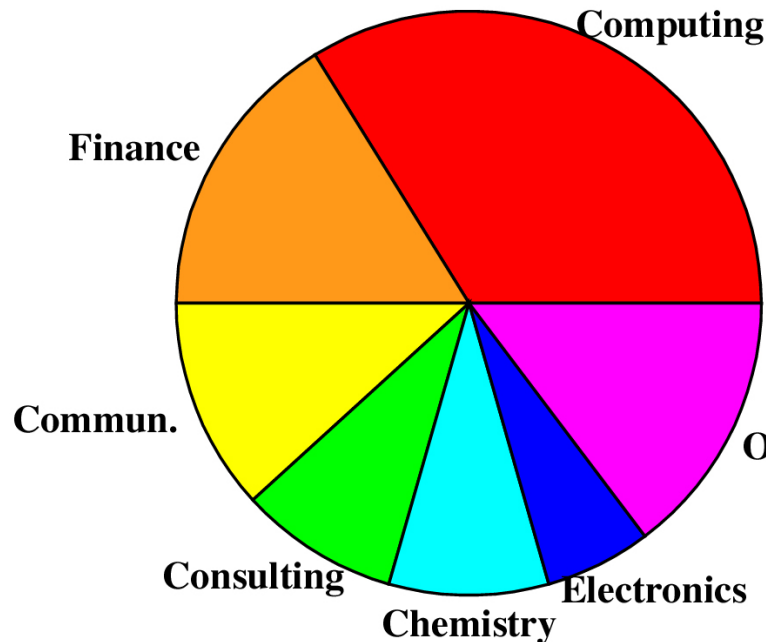
Research Centre

### Whereabouts of PhD's

Status of 1998 (68 PhD's total)



Computing



Finance

Commun.

Consulting

Chemistry

Electronics

Other

### Whereabouts of PhD's in Industry



*Some of these PhD's went to work on the software for well-known banks...*



Equity  
Research

Global  
Technology

29 June 2000

## New Economy

Forget the Web, Make Way for the Grid

Deutsche Bank



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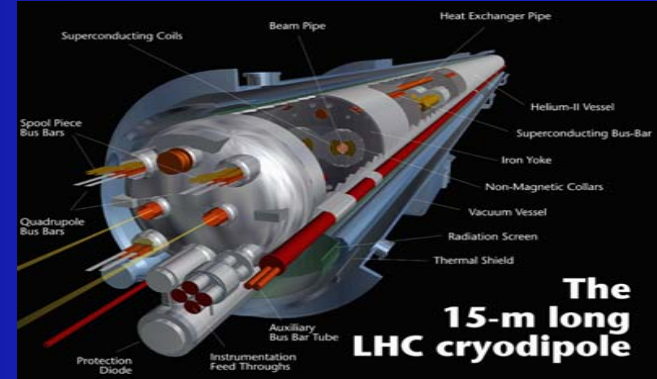
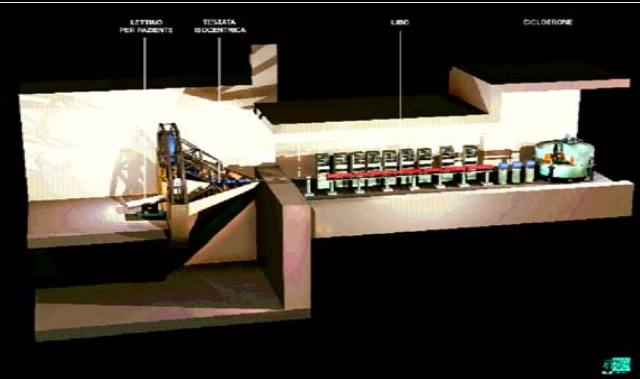
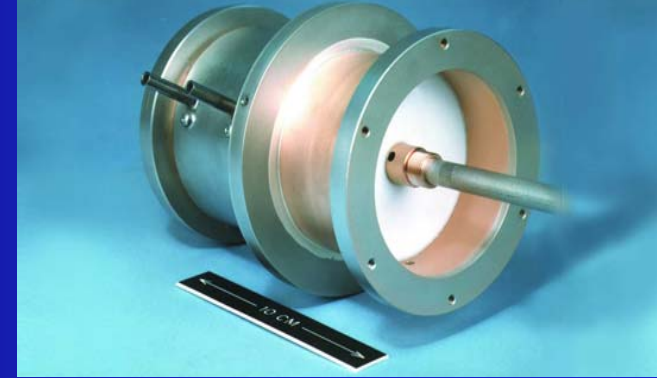
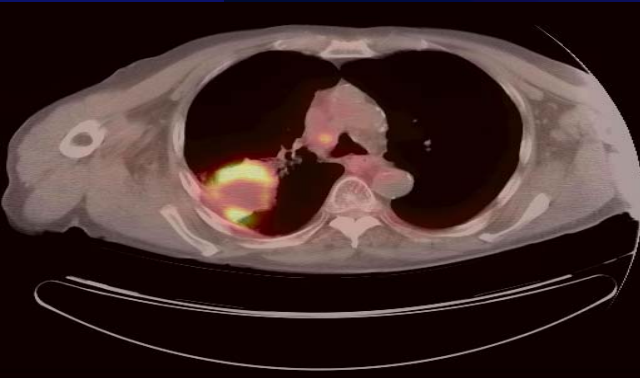
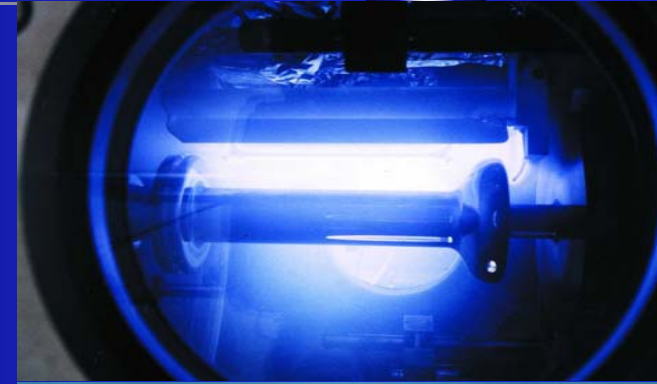
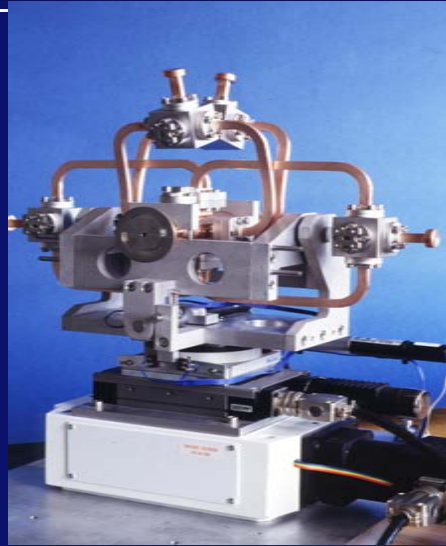
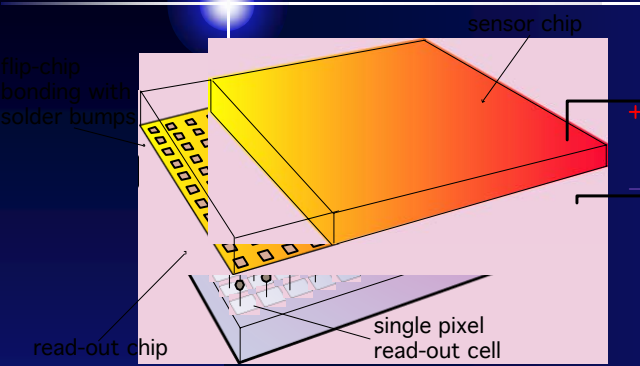
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In conjunction with the  
Deutsche Bank Global Technology Team.



# Technology Transfer





# Heavy Technology Transfer







# *Ensure Transfer of Know-how and of products to “Developing Countries”*



*A “Developing Country” should*

*- enable its young scientists to **participate** in international collaborations*

*- improve its research infrastructure “at home” to encourage its scientists to stay, or to return home from abroad*

*- ensure that **innovations** resulting from such collaborations are considered for “local” R&D and commercial exploitation*



# *Keep in touch with emigrated Scientists*



*Use the WWW/GRID, for "research@home" to **keep in touch with emigrated scientists**, to gain their participation for work on the tasks that exist in their home countries*

*Establish and maintain an **operational computer network** to link emigrated scientists with their colleagues and with the students at home*



# *Start-up with affordable Investments*



*Education is expensive, especially for a developing country - but the also the (“hard currency”) cost of appropriate investments in **science and technology infrastructure @ home** are often seen as prohibitive on a short time scale*

*However, there are more and more fields where **affordable investments are possible and useful**, such as data communications, software and data base development, engineering, electronics design, for example*



# *The Grid is an excellent Infrastructure Investment*



*Investments by “Developing Countries” into Grid Computing are surely affordable and possible investments into the education, science, health care, environment, and commerce sectors will be of great benefit on long term.*

*Almost all that is needed is to begin with it - there are surely enough talents in Pakistan to make an entry for their home country into the books of science history.*





# *The GRID*



*The GRID is  
a good investment into  
the future*



# *The GRID*



*The GRID is  
the future*