- It is an honour for me to be here at APS meeting and invited as Marshak lecturship
- Thanks a lot to the organizers for the invitation

Scientists in Developing Countries: is there an effective way to support meaningful research?

Z. Ben Lakhdar-Faculty of Sciences-University el Manar, Tunis- Tunisia

APS Meeting -March 13-17 , 2006, Baltimore-USA

- Developing Countries in the world
- Scientists in developing countries
- Research in Developing countries
- Which way for research development in developing countries? An example
- Conclusion

Increase of population (I.P)

World Population in 2004: 6,134 billions

2050 world Population : 9,3 billions

European Pop. x 0,91
China Pop. x1,10

Pop. developed countries increase 4%
Pop. developing countries 55%
In 2050 Pop. developing countries ~85% of the world population
Population in both developed and developing countries will be older than today

The future ?

Science shows that The world is one and leads to the conclusion that the future is common !

Situation of African Countries As example of Developing countries situation in the world

-Africa has the poorest nations in the world

-Africa Population: 900 millions (2005),

In 2050; African Population will be x 2,21

-Actually ~45 % less than 15 years old

- in some countries, only 5% of children study science

-illiteracy, illness, poverty

--no vision for the future

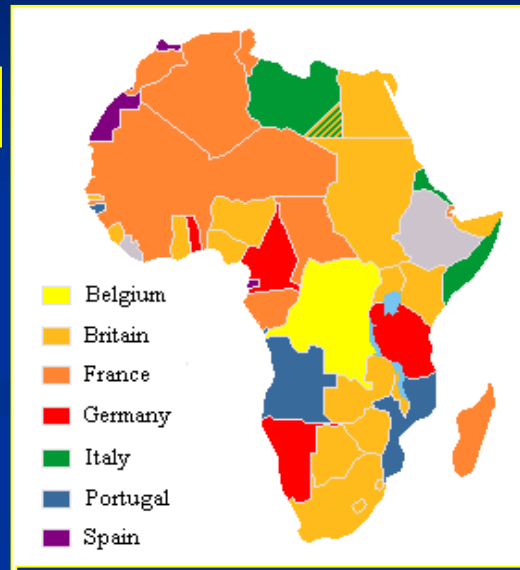
- high bureaucracy

-Incoherent policy of the local authorities

-All African countries has been colonized for ~one century and get Independence in sixtees

-Countries have many dialects such As Official language in poorest ones is French or English

LanguageFamilies



Africa colonised!
Independence ~1960

- **At independence, each nation, except South Africa, is in « mean age »**
- **They have never known industrial revolution, and yet in the civilization of new technology!**

- **How can Africa be involved in the new revolution, adopt the new civilization ?**

In 1990 → digital revolution- new economy, new society, new life, …

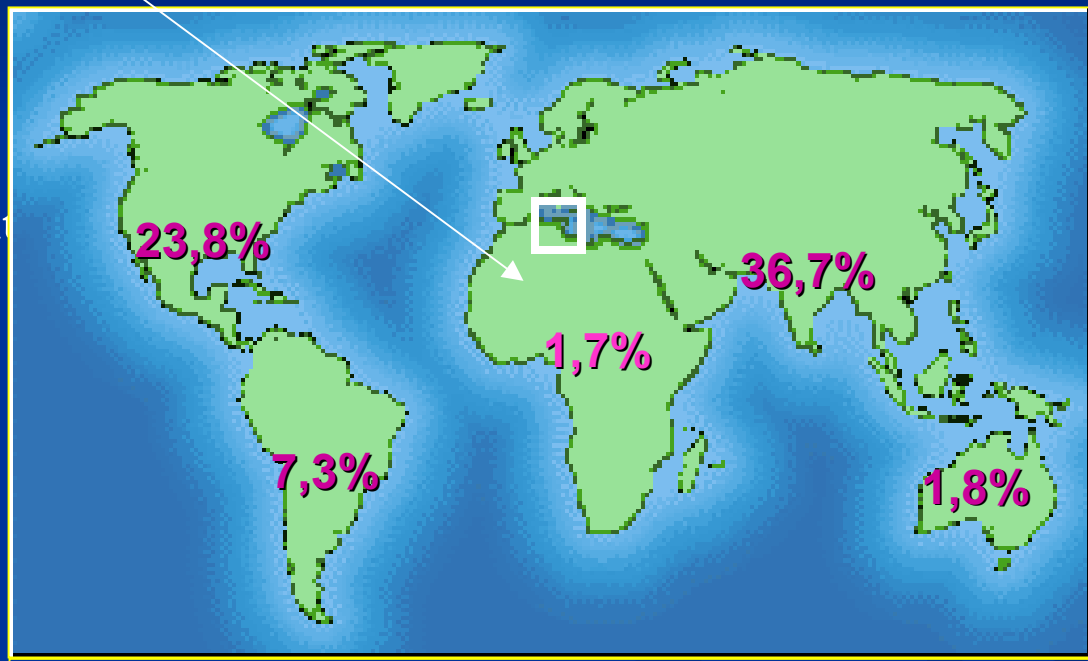
- In 10 years, in 2000 ~ 15% of the world population use internet

(~1 Billion internautes), Africa use : 1,7%

- In 2005: foreign direct investment

flows to Africa is the lowest*

(2,8% of the world investments)



Distribution of Internet per continent: (~2004)

Scientists in Developing countries - Scientists in Africa:

In East Africa, for a population of 250 Millions, total active PhD Physicists is ~140 !
East Africa,~12 countries, from Sudan to Swaziland,
Population~250Millions, ~140 research active PhD!
even in South Africa, ~1PhD physicist / 140.000people; in US:1PhD/8000

(in 2004)~ 200 scientific researchers / Million of hab. in North Africa
for 2500 to 3000 / million of hab. in developed countries

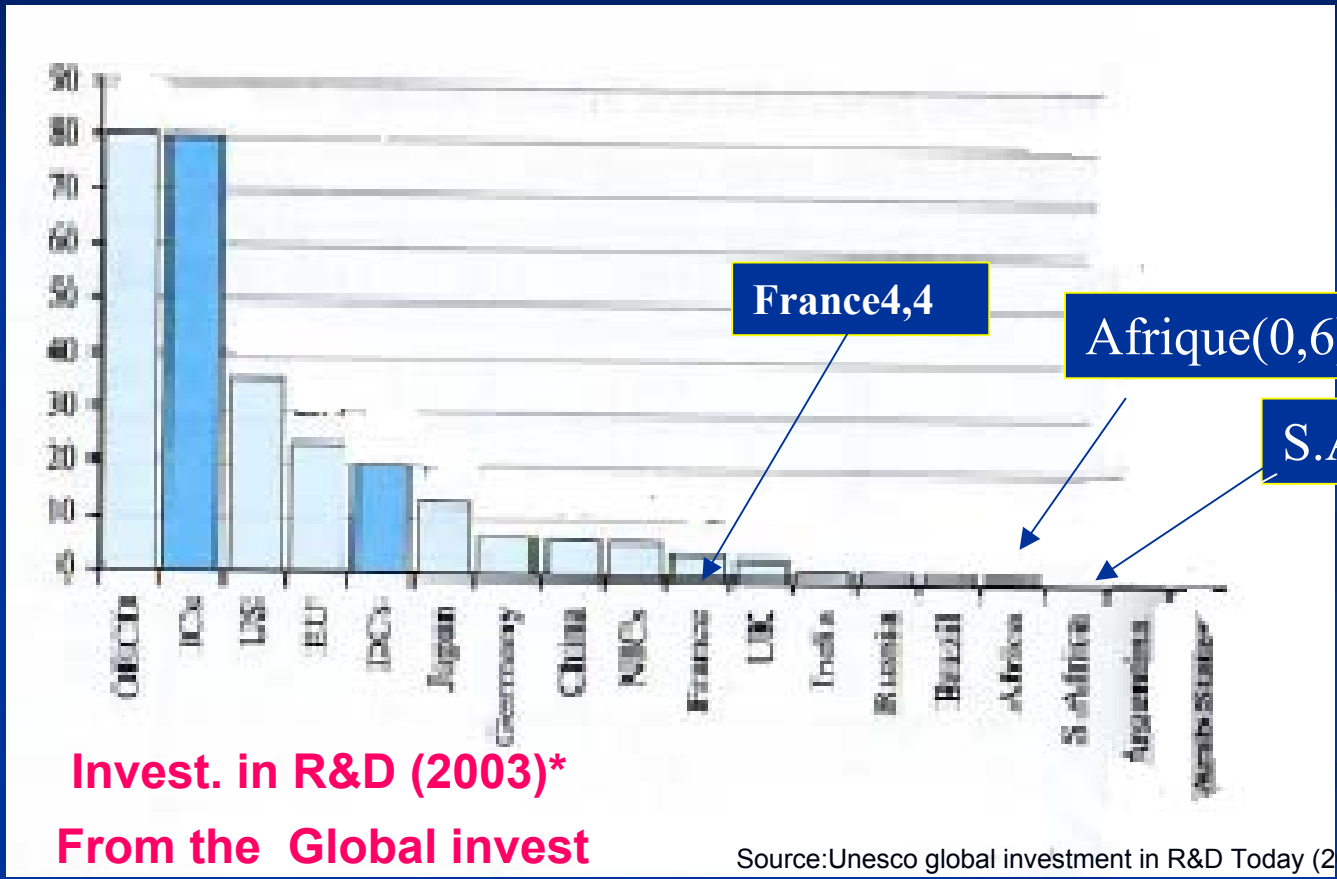
For each country, the total number of scientific papers published worldwide is ~ the rate of its contribution to the world economy
Africa scientific contribution is less than 3 % over the 5 last years!

Africa has **No**

- **Technology**
- **Development**
- **Research**
- **knowledge**

Research in Developing Africa – Investment R&D?

Research and Development is connected to **the investment**, this figure is an index of Africa undevelopment. Africa invests 0,6% with 0,3% is for South Africa!



Source:Unesco global investment in R&D Today (2003)

So Is there an effective way to support meaningful research?

-- African countries can be classified in regions:
North Africa, West Africa , Central Africa, East Africa, South Africa wit different levels. The development of which is different andis increasing, so possible and leads to a hope for Africa.

-The future is common
(In 2050 Pop. developing countries ~85% of the world population, sustainable development needs contribution of all people)

- The oil of to morrow is intelligence, is young people

- Many associations, different structures (regional or International) look for the Africa Development (look at sites ref.) but the development is through science -→ This is the mission of scientists

➢Which way for research development in developing countries?

- **To develop research in developing countries suppose:**
- **to begin from nothing :**
  absence of equipment, of infrastructure, of technology, of environment! of tradition; of language of research
- **to accept to work with bureaucracy, with no cohernt politic!...so to look for solutions**
- and **to realise at each time that**
  the know how acquired overseas (scientists get PhD in developed countries) needs to be actualised, you need
  training; knowledge evolutes very fast, research "way" changes!

Which way for research development in developing countries?

We are in:
New world , world of a new revolution induced by:

Digital language (new langage) + new technologies (optics, photonics, ..)
Characterized by : Speed, Universality, Competitivity, Globalization

Research is done by - computer in all areas of science
- new kind of equipment: Not heavy, not expensive,
(or very huge one for multinational communauty)
- and connexion by internet

This new world , is *world of intelligence (knowledge) ! And concerned by Sustainable development*

Is it Possible to Africa to be in this revolution and take the train!?

The answar is Yes

- It is easier than before , digital revolution gives a chance to developing countries: researcher is no more isolated ! Scientists can help and and Exist potentialities ready for research development in many countries in Africa.

Which way for research dev^{t}. in developing countries?

I will present an example of way research dev^{t} choice in Tunisia as developing country-

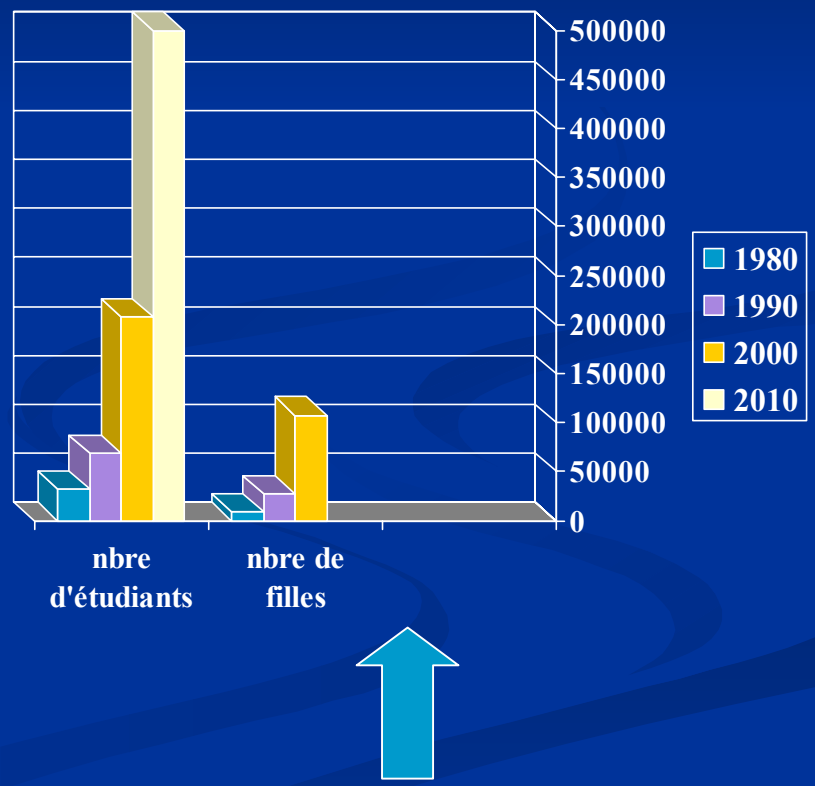
➢Which way for research development in developing countries?

Tunisia research development

- 1956 Independence, the government priorities: wome becomes equal to men in law in 1956 , investment in education! The result of that is seen below!

- **~1960:** Tunisian University creation
- - 1 Faculty of Sciences,
- - ~500 students; 3% (female)
- - 2 PhD over the population!
- **1967:** ~ 10 PhD over the population (~6 Millions)
- **Students future?**

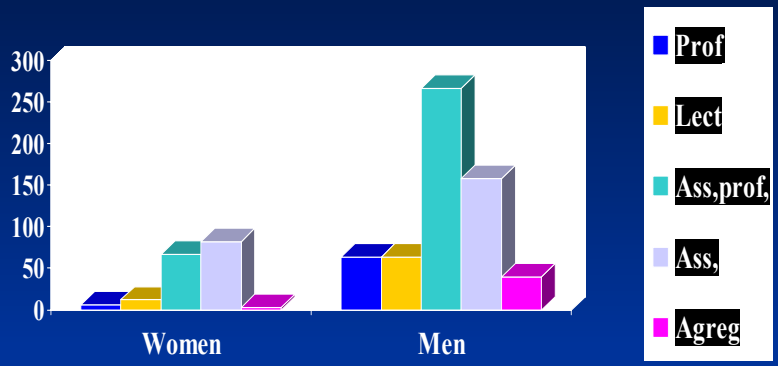
  ???????
- **1999,** Creation of the first structure for research



investment in education, in women

- Research in Tunisia has in 2005 an investment of 1% of its GDP and is actually strudtured with laboratories, units of research, presence of women in all economic areas and particularly in education, centres of research for desertification, biotechnology, telecommunications, .. And an increasing of the number of researchers .

Present distribution of women in academic positions in Physics (2004)



Position	Prof.	Lect.	Ass. Prof.	Ass.	Agreg
Women/Total	6/70	12/76	67/334	82/240	3/43

units

years	2001	2002	2003	2004	2005	2006
number of units	328	408	494	594	703	842
financing foreseen to the 10th plan	56.700 M.D					

laboratories

years	2001	2002	2003	2004	2005	2006
Number of laboratories	98	107	132	140	155	170
financing foreseen to the 10th plan	50.079 M.D					

Laboratorie's number and research unities objectives of the 10th Plan

Country	Researcher's number	Researchers /1000 actives
GRECE	14748 (1999)	3.30
Portugal	17584 (2001)	3.10
TUNISIA	8515 (2001)	2.59 (2001)
	11265 (2003)	3.26 (2003)
	19400 (2010)	4.83 (2010)

Recent years evolution of researchers

year	1998	1999	2000	2001	2002	2003
Researchers and assimilated	6563	6911	7516	8515	9980	11265
(Researchers /1000 actives)	2.14	2.20	2.34	2.59	2.94	3.26

Position of Tunisian researchers compared with other countries and their équivalet i n full time / 1000 actives

Years	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
Registred in Masters	6430	8620	10600	11250	13518	12750	13500	14250	15000	15000	15000
Registred in Doctorates	2220	2350	2450	2600	3000	3500	4000	4500	4800	5300	5600
P h D	97	107	140	190	200	210	220	230	240	250	260
Total number of registred	8650	10970	13050	13850	15000	16250	17500	18750	19800	20300	20600

Evolution of Masters and DoctoratesPhD –in Tunisia

- This situation of research development in Tunisia could not take place if there were not an effort of scientists who came back from overseas with there PhD and tried to develop research laboratories.
- I will focus on an eample , the development of research of our laboratory at the begining in eightees in Tunisia which will gives an idea of obstacles that a researcher has when he likes to do research in his country-

- **Students overseas?**

Good students have fellowships to prepare PhD

Overseas ? it should be Everywhere in developed world, but

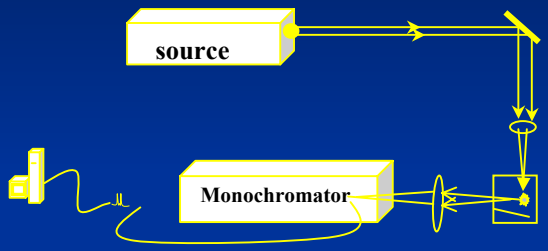
tunisian students, because of langage go to France!

➢Which way for research development ?

- I get my Master, PhD (Pierre Marie Curie University - Paris)

Field of research :

Atomic & molecular physics - spectroscopy.



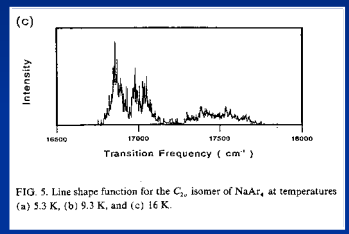


FIG. 5. Line shape function for the C_{2v} isomer of $NaAr_4$ at temperatures (a) 5.3 K, (b) 9.3 K, and (c) 16 K.

It was experimental research: analysis of collision between atoms from experimental spectra

I return to Tunisia in 1978

How to develop local research? My superviser told me: it needs 20 yeras to put on a lab!

Which research? which approach?

- begin from subject mastered: I liked to reproduce my set up!

Equipment? I need a Monochromator first- 1/Look locally (in each university of developing country we may find *some donation!*), I found one monochromator 30 yeras old!I tried to use it, but how to change some elements? *Wrong way!*

2/ I get money for a New one : wait 5 years, pay 3 times the price, bad infrastructure (heat of climate is bad for optics, current stability, ..) *Wrong way!*

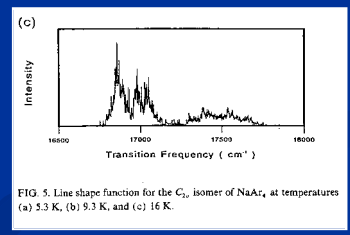


FIG. 5. Line shape function for the C_{2v} isomer of $NaAr_4$ at temperatures (a) 5.3 K, (b) 9.3 K, and (c) 16 K.

1/ I had to be Independent from bureaucracy!

I Changed the approach of research: I will take spectra from astrophysicists, use theoretical analysis!

Needs: -Computer, -Software,-Training

- knowledge : Understanding and mastering of computational simulation of ab inition electronic structures

- Patience!

-No library (no books, no review)
-No conference participation,
-No research understanding from politics or society!

2/I did many Contacts and ask ***for help inside*** (87, IRSIT, SOTUTEL,TMI,..) to get computer
and outside (friends in France , ..) *for books,bibliography, some training*
3/ which subject of research? ***We need To belong to the scientific international community, (Publish or perish!)***
but subject with interest should be with ~ no concurrence and the research schould lead to paper in international review
Who can advice ? no environment ?

Each step seems as big as a mountain!

4/ How to get Understanding and mastering ? That needs

Environment and Training , for that → involvement in all kind of Projects of research between Tunisia and France-(this scientific cooperation began ~1985) 1 month for training + one, two visitors per year for one week! When Communication and interaction are the lifeblood of science!

→ Which researcher can accept such situation?
→ Which research group accept to cooperate? Situation was *Too early for cooperation with developed laboratories,*
Without perseverance, optimism and confidence,
we would make no progress ,*10 years for the first paper!* And thanks to my colleagues from France who helped us a lot.

But we get: Understanding and mastering , this is the first condition for development, we can then do research at ~equal level

→ we can move ahead at an advanced level – more visibility - this allows cooperation

5/ Cooperation is a kee in the development of research!

- ***Researchers accept to coopare when Competivness is save and more high, in ninghtees, our situation became better, cooperation became possible:***

  - more visits of lecturers – developped thesis in sandwich – get post doc overseas

  - develop Cooperation with Other disciplines: biologists, chemists, ..

  Developed nations can act as partners

- **We Implement all kind of cooperation with different laboratories**

  -South - North

  -South – South: we liked to help researchers from Africa and initiate computing molecular physics. We do that in Cameroon since 5 years, offer training in our lab, access by internet to our lab, actually there is a group developed in cameroon and we have the second thesis in sadwich –Thanks to ICTP for finance

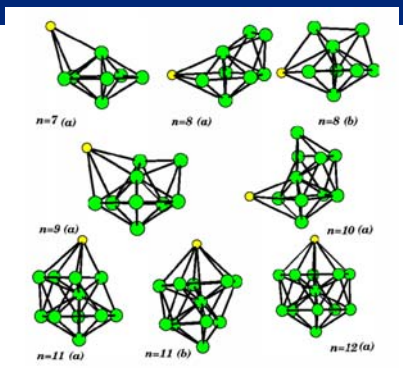
  -Local cooperation : with chemists, biologists, interdiscplinarity

- **We develop a Network in computing molecular physics between: cameroon, Morocco, Tunisia, France-Thanks to AUF**

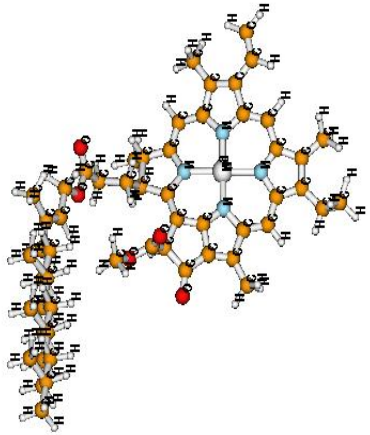
- **We Call Diaspora , Expatriates researchers to come and coopere- this is developed and financed actually by the government to encourage diaspora to assist local laboratories**

Development of research?

First Research Activity (First group)

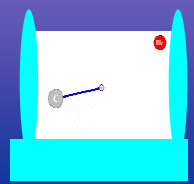


Molecules



Energy States

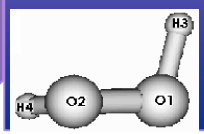
Interactions

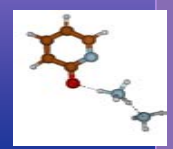


Kinetic of reaction

$H_2O_2 + H \rightarrow H_2 + HO_2$

Structures





- **Computing physics, applied mathematics** is a product of digital revolution, researcher is no more isolated –

  Internet → change life of researcher ,

  (ubiquitous, variety, interactivity)

  Africa can access to Digital revolution

  So These are kinds of research to be developed in African countries, not expensive, with big impact in all areas of economy actual and for the future .

  needs : good Education, training

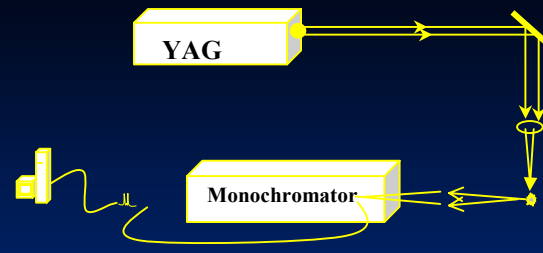
  Example : the network developed

……

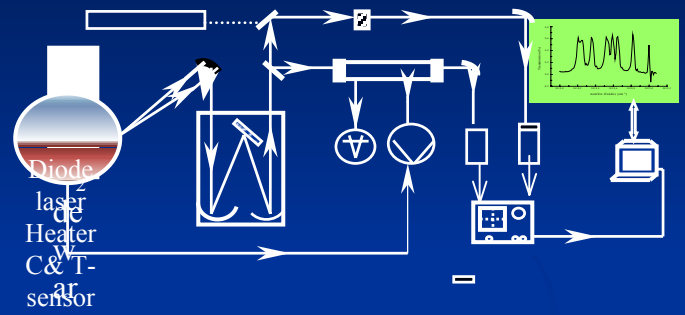
Second step: development of experimental research – We learn physics by doing- For visibility to young student

Development of research? Technology development?

Experimental Research (second step)



-Why? → - Learning, Teaching,
-How? → - PhD for engineer who is technician at the same time, so less experimental problems
Money?→ - Look for Research project on environment



Equipment ?: not sophisticated

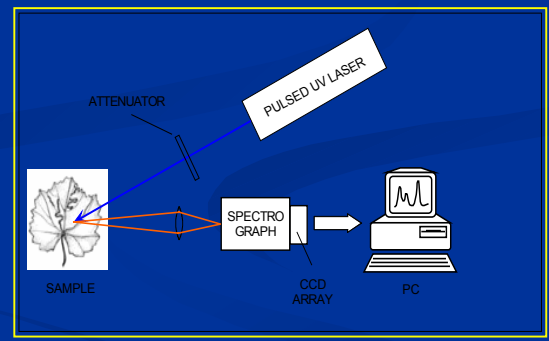
Development: extend to different kind of techniquesin spectroscopy, TDLAS, LIF, LIBS, CRDS

-PhD in sandwich with France

-Frequent Visits of technicians and co-supervisors

- Frequent visits of retired scientists from France

Th research is on fundamental aspect but with Applications (for more visibility, to get money)



Arc, diode laser, Nd YAG , THR, ..PM, PC, labview, software

- **Experimental research development is possible with no sophisticated and new kind of equipment**

- **learning by doing is to implement in developing countries ,**
  allow visits for students , for high schools , open windows for young, Young feel more connected to their country, ..

- **Do basic research with applications –visibility-** for the government -the sponsor- who asks for rapid impact?

- **Basic research? Is** *To develop , Is needed for The future***?**

- **Experimental research Needs of basic know how,** *this can be obtained by training in developed laboraties in the frame of sandwich PhD program + local training which presence of supervisers locally for short periods, (retired scientists can bring their support ;*
  succeed group from Africa can help each other also)-

6/ How to assure local Training ?

By Organization of Workshops and schools: National, regional and international level

- **Oct. 92** **Transfert des connaissances en Sciences et Techniques**

→We need not a transfer of technology but to receive good education, to built good knowledge, to develop talent → training of teachers

- Sept. 97 Laser and Applications in Industry, Medicine and Environment
- Déc. 2002 Laser et Applications
- Jan. 2002 Plasma Physics and LIBS
- Nov. 2005 Quantum Physics and Chemistry Systems -QPCSX
- Déc. 2005 Plasma Physics and Applications

Schools for Training of Trainers (national and regional level) with appropriate educational material

- Avril 2004 Ecole de Physique-Chimie Quantique
- Mars 2005 Active Learning in Optics and Photonics
- Sept. 2005 Ecole de Physique Moléculaire – FST

-Schools for training young : optics, laser, astrophysics,..

-Training locally is good but it is necessary to add a Training as that of ICTP?

- High quality Training ; fresh your mind, actualize knowledge, offer stimulating research environment

- Lecturers, International communauty
- Facilities,
- interactions, with different researchers,
- Meet people with similar bacgrounds and problems

- fellowships,
- Through ICTP- network projects → South – South cooperation

- LAM network
- ICTP helps you to continue research at home

(Researchers from Developing countries need outside help if they hope to make progress)

To get this kind of training ne need to develop a centre as ICTP in Tunisia

7/ we like then to built an international centre like ICTP for optics photonics

Such centre like ICTP will give possibility of training, of interaction and connection between scientists from different with different culture from developing as well as developed countries.

Science becomes increasingly a collaborative entreprise, such centre will contribute for that dev.

Connecting scientists to work with one another on an equal footing in a collaborative way is basic for the development of common future. This centre will enhance locally the development of research and will enhance cooperation at regional level .

«

Conclusion

Scientists in Developing Countries:
is there an effective way to support meaningful research?

Situation in developing countries – in Africa for ex- is different from one region to the other one: North Africa, West Africa, East, ..

Research needs High quality education talent people. These people exist,

Most countries in Africa are actually aware of the role of research for the development, so the strusture exists or is coming

The problem is the absence of scientific environment-need of superviser , of advicer , of tradition of research, This could be done . Scientits from developed as well as from developing countries can help.

- **Is there an effective way for research development? Yes -there is**

the scientific community has a crucial role to play →

We need each other – scientits from developed countries can use their expertise to initiate, follow and supervise young researchers in Africa ; Connexion with internet exists or will exist- Retired scientits are less in competivness and can help
(To develop local research laboratories **is not more difficult than to extract minerals or oil, money will come later)**

1/ look for Independence from bureaucracy

2/ **help for research orientation** , for **Publish or perish!, for involvment in project of research**

3/ Training- for Understanding and mastering

4/ Cooperation- partnership **Diaspora researchers like to help**

Africa can access to Digital revolution

Computing physics, applied mathematics
Experimental Research (light equip.)
Basic research

6/ to built an international centre like ICTP

Thank you

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