
Title	Science transfer through research initiation: Concept and experience
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Source	Colloquium of the Alexander Von Humboldt Foundation, 14 – 16 November 1994, Bangkok, Thailand

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Citation: Lee, S. (1994, November). *Science transfer through research initiation: Concept and experience*. Paper presented at the Colloquium of the Alexander Von Humboldt Foundation, Bangkok, Thailand.

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EP 514

RAT-2008

**SCIENCE TRANSFER THROUGH RESEARCH
INITIATION - CONCEPT AND EXPERIENCE**

Lee Sing

Paper presented at the Colloquium of the Alexander Von Humboldt Foundation,
held at the Imperial Hotel, Queen's Park, Bangkok on 14-16 Nov 1994

30/11

SCIENCE TRANSFER

through

RESEARCH INITIATION

CONCEPT

and

EXPERIENCE

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I Need for Training Programmes to initiate/strengthen research

- increased opportunities for South-South and South-North scientific interactions in the 1980's.
- Example: activities sponsored by ICTP (International Centre for Theoretical Physics) and its Office of External Activities:

Year 1989

387 Federated Agreements

(each providing 3 visits to ICTP, Trieste, Italy).

500 Associates

40 Scientific Colleges and Conferences at Trieste.

139 External activities, Workshops, Colleges,

Conferences, Training Programmes, Physics &

Mathematics Teaching Programmes.

9 Affiliated Centres (ICAC's)

4 Networks.

- These ICTP activities alone sponsored an estimated 5000 South-South and South-North visits for Third World physicists in 1989.

With all these exchange activities, timely to
look for methods

to optimise results

achieve lasting effects

beyond the conference Halls

beyond laboratory visits

Question : What can we do back
home?

One answer : Training Programme for
South-South transfer of
experimental research and
research activity

II Training Programme for South-South Research Transfer

(i) Aim: To initiate/strengthen experimental research in a specific area in several developing countries.

Method: By transfer of an integrated package of expertise, components and equipment.

Concept:

SOUTH	SOUTH
Centre for Training Programme for Research Transfer of specific technology/facility	Recipient Group building up specific technology/facility
<u>Contribution</u>	<u>Contribution</u>
1. Manpower and infrastructure.	1. Man-power and commitment.
2. Planning and organisation.	2. Basic mechanical and electronic workshop facilities.
3. Design of specific facility.	3. Basic laboratory equipment and space.
4. Detailed course content.	
5. Teaching - Open Box approach.	
6. Construction of facility.	
7. Follow-up equipment and expertise.	

NORTH

International Organisations
<u>Contribution</u>
1. Living and travel expenses for recipient participants.
2. Cost of parts and labour and freight.
3. Cost of follow-up visits and scientific exchange.
4. Coordination and technical expertise.

(ii) Identification of a Centre for Research Transfer

The Centre shall have:-

- 1. specific and specialised research activity in the area of physics it is offering.**
- 2. sufficient experience and productivity in that area of physics including: development of undergraduate courses, production of post-graduate theses (preferably to doctoral level) and research papers.**
- 3. a self-contained technical infrastructure for the research.**
- 4. evolved the technical infrastructure at the centre itself so that the technical infrastructure may be adapted to another developing country without excessive cost in equipment and funding.**
- 5. a willingness (enthusiasm) to take the initiative to prepare a comprehensive program to teach, in one package, all the technology required to carry out research in the designated subject area.**

(iii) Role of the Centre

The Centre should on its own initiative:-

1. identify a facility (modelled on its own experience) that may be built and on which research may be carried out fruitfully.
2. plan a breakdown of the facility into its basic technical sub-systems.
3. define the major technical requirements (related to the working principle) of each component so that its design and building may be adapted to suit local technical capabilities and individual needs.
4. plan the basic theory and model needed to optimise the parameters of the parameters of the facility, and on which the behaviour of the facility may be studied fruitfully and with possibility of extension.
5. plan for computation and numerical modelling to be done with modest computing facilities like microcomputers.
6. plan the building of the power and control systems and basic diagnostics so that these may be built in simple (preferably modular) forms in the local environment.

7. plan a comprehensive series of experiments and lectures to demonstrate all the above in modular as well as in assembled working form.
8. identify the basic equipment that may not profitably be home-built in the framework of the particular program, such as, for example, vacuum pumps, oscilloscopes, electronics and power components.
9. select the participants (bearing in mind the suitability also of the environment of the home institution).
10. conduct a course (from 3-6 months as necessary) based on the above for a group of 2-8 participants.
11. provide facilities for construction of facility to be transferred.
12. oversee the design, construction and testing of the facilities by the participants.
13. arrange airfreighting of facility.
14. provide follow-up.

III Training Programmes in Plasma, Laser and Pulse Technology

(i) Asian African Association for Plasma Training

Formed as a network of the International Centre for Theoretical Physics to coordinate the initiation/strengthening of experimental plasma physics.

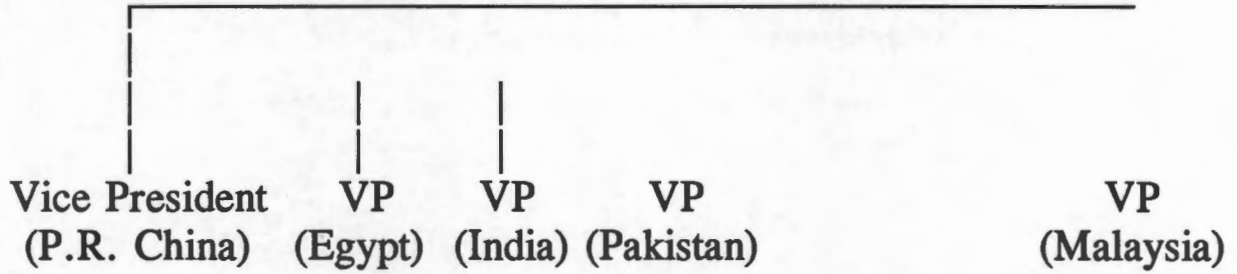
Scope of Activities:

- Training Programmes in Asia and Africa.
- Development of research packages for transfer.
- Exchange of scientists.
- Newsletters.

Structure of AAAPT

President
(Singapore)

|



Hon Secretary
Hon Treasurer

Coordinators

29 institutions from 19 countries

Association for
Plasma Studies
of China, 18
Major Institutes
in China

(ii) Programmes

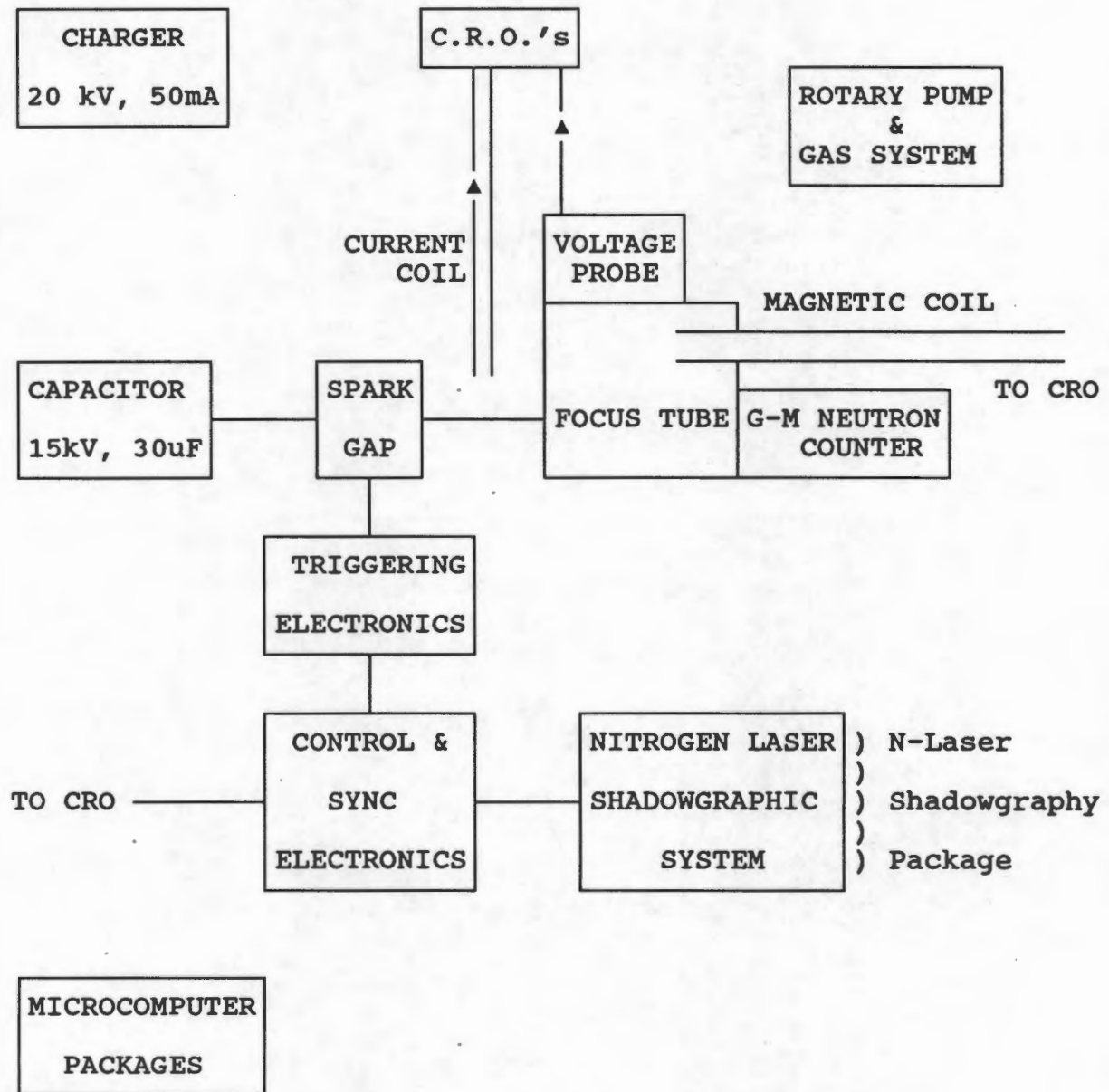
1985/86 (6 months)	(1st) UNU/ICTP Training Programme on Plasma and Laser Technology, Kuala Lumpur, Malaysia	8 UNU Fellows
1986 (3 weeks)	*Second Tropical College on Applied Physics, Kuala Lumpur	70 participants
1988 (3 weeks)	*Third Tropical College on Applied Physics, Kuala Lumpur	80 participants
1988 (June)	Formal Inauguration of AAAPT during Third Tropical College, Kuala Lumpur	40 participants f r o m 2 2 countries
1988 (5 months)	(2nd) ICTP (UNU) Training Programme on Plasma and Laser Technology, Kuala Lumpur	7 ICTP/TWAS Fellows
1989 (Oct-Nov)	Beijing College on Plasma Diagnostics, Beijing, P.R. China	50 participants
1989/90 (6 months)	(3rd) ICTP Training Programme on Plasma and Pulse Technology, Kuala Lumpur	9 ICTP/TWAS Fellows
1990 (Jan)	Regional College on Plasma Applications, Songkla, Thailand	60 participants
1990 (May-June) (3 weeks)	*4th Tropical College on Applied Physics, Kuala Lumpur	80 participants
1990 (Aug)	3rd Summer School on Plasma Physics, Tsingdao, P.R. China	110 participants

1990 (Sept-Nov) (3 months)	Basic Course on Plasma Physics - Theory Islamabad, Pakistan	8 participants
1990 (Oct/Nov) (1 month)	Nitrogen laser training programme, Kuala Lumpur	5 participants
1991 (April/May)	5th Training Programme on Plasma Laboratory Techniques, Beijing	5 participants
1992 (May/June)	Plasma Focus Experiments at ICTP, Italy	18 participants
1992 (Mar/Apr)	6th ICTP Training Programme on Plasma Focus and pulsed x-ray technology, Kuala Lumpur	4 participants
1992	Regional attachment programmes at University of Delhi, India and Quaid-I-Azam University, Pakistan	6 participants
1992	Scientific exchange programme of Association for Plasma Studies of China	10 participants
1992 (October)	*6th International Working Group Meeting of the proposed International Centre for Dense Magnetised Plasmas Tsinghua University, Beijing	20 participa
1992 (November)	*International Symposium on Laser- Plasma Interactions, Shanghai	
1993	4th AAAPT College on Plasma Technology - Training Programme in Diagnostics, Cairo, Egypt	

(iii) Facilities For Transfer

A facility should be carefully packaged. Each package is made up of carefully designed sub-systems.

UNU/ICTP PFF
 Plasma Fusion Facility Package



Research/PhD
 Ideas/projects

Fig. 16 Sub-systems for the UNU/ICTP PLASMA FUSION FACILITY

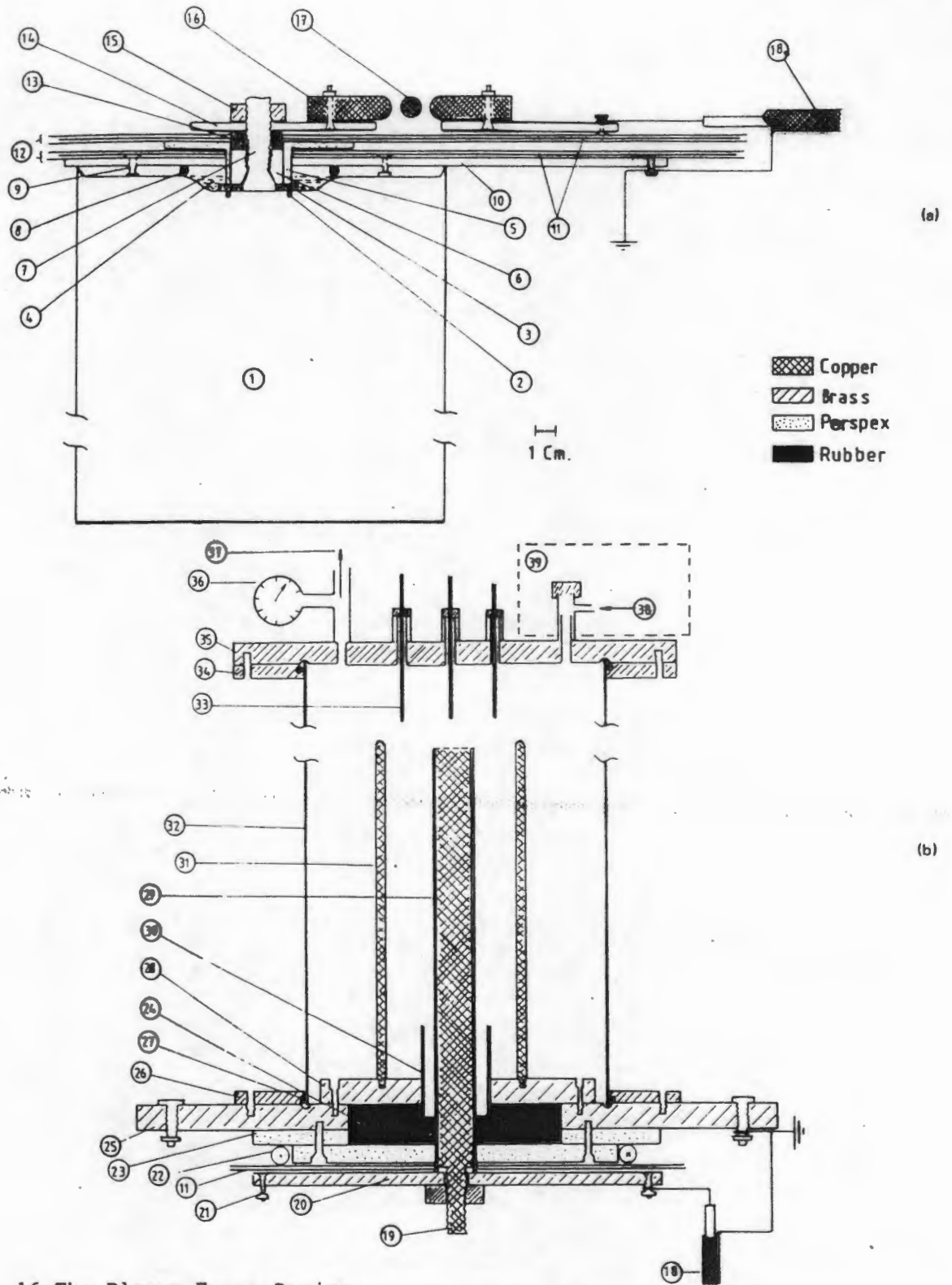
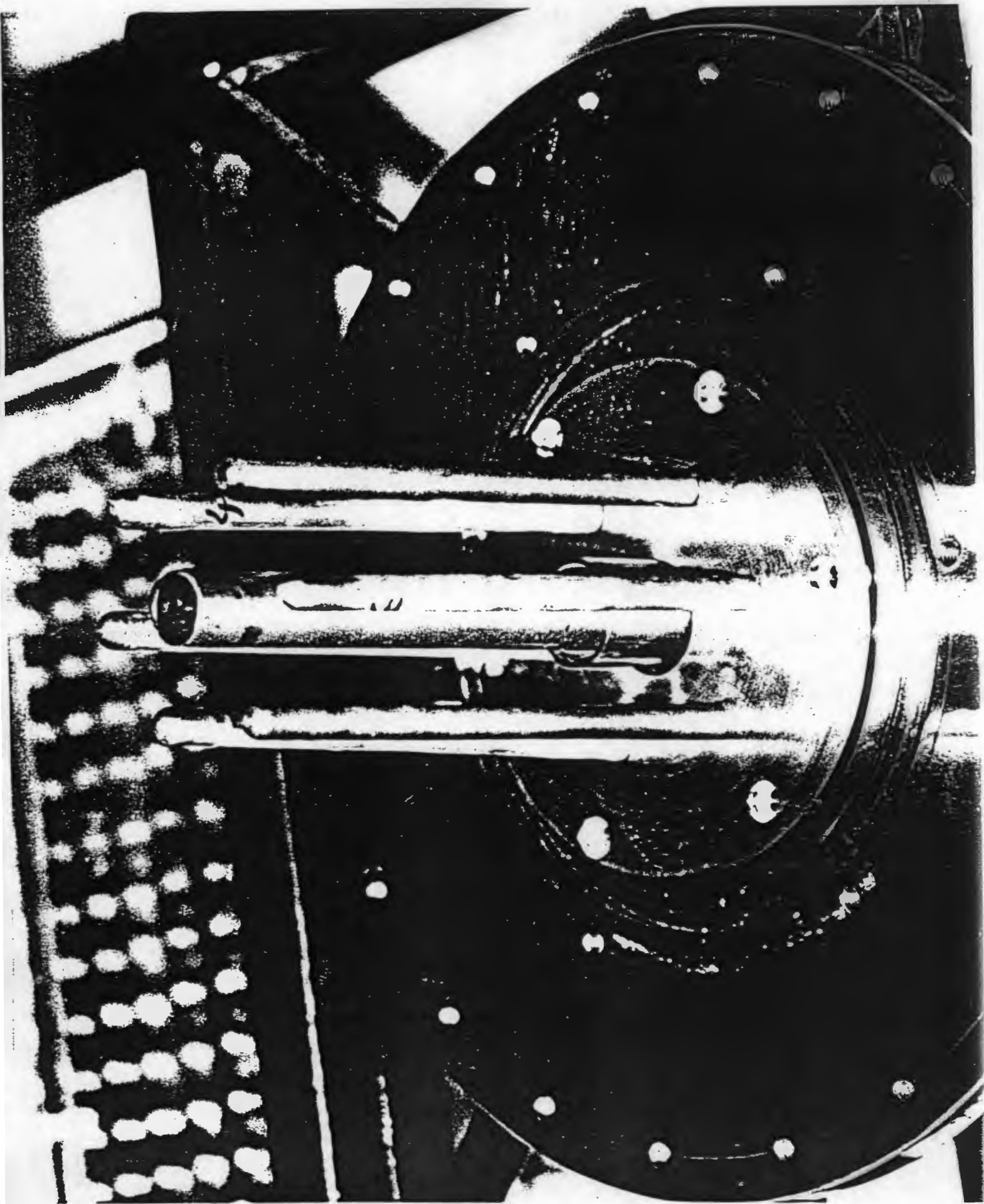
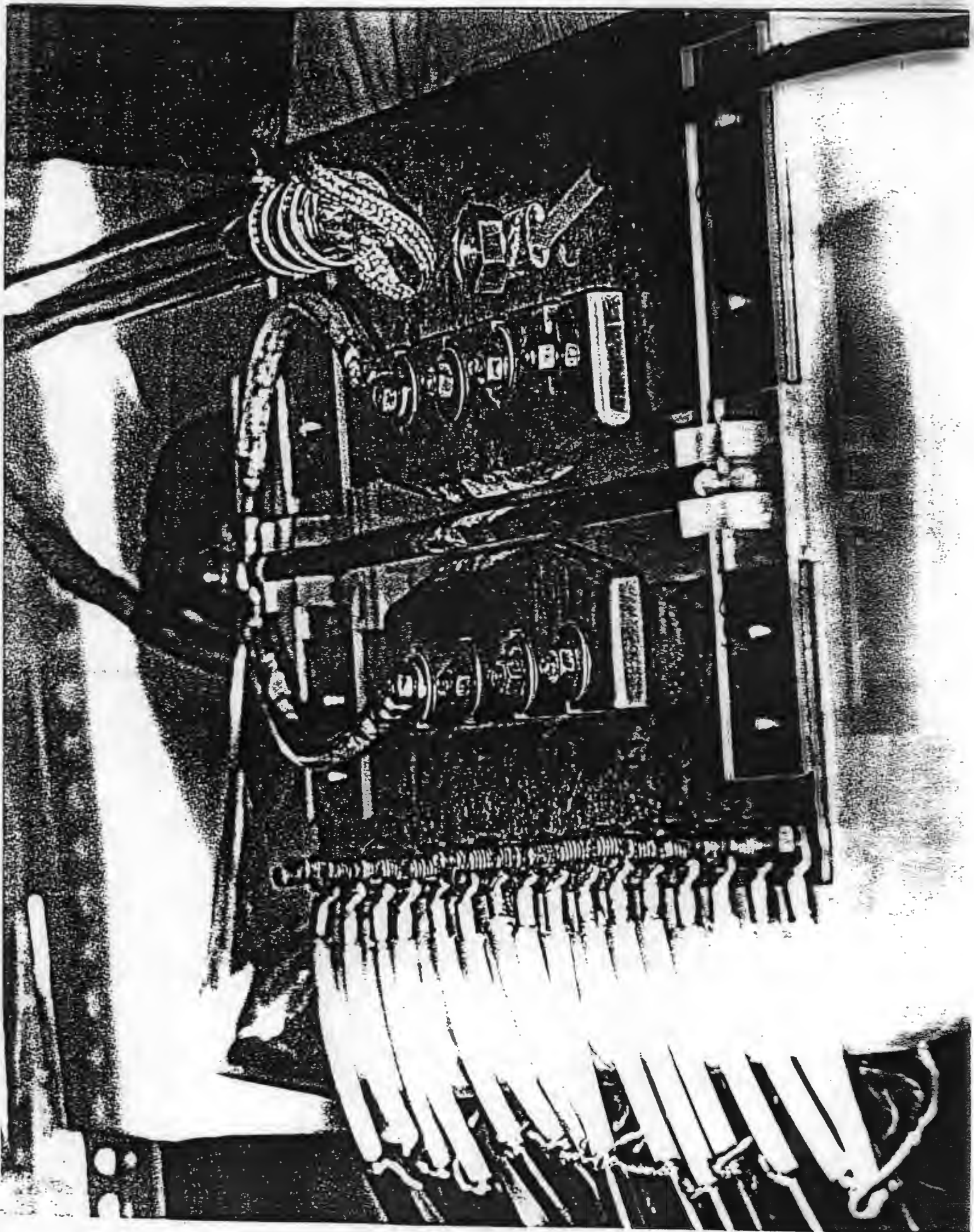
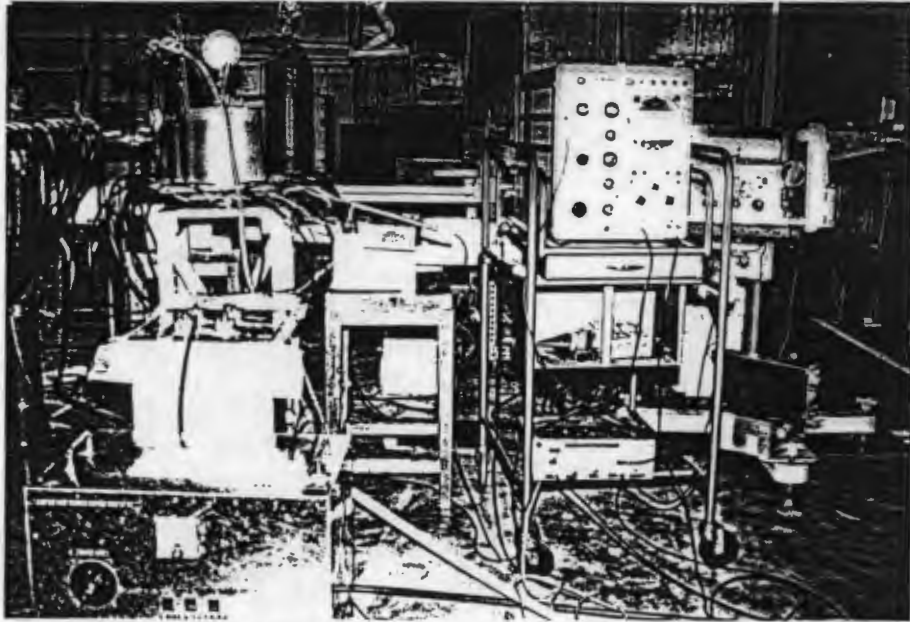


Fig. 16 The Plasma Focus Device.

(a) The capacitor connecting plates, the spark gap, and output coaxial cables. 1 = 15-kV, 30- μ F capacitor; 2 = capacitor O-ring seal; 3 = washer; 4 = oil; 5 = nylon cap; 6 = steel nut; 7 = capacitor output seal; 8 = O-ring seal; 9 = Earth stud; 10 = Earth plate; 11 = 5-mil Mylar film; 12 = polyethylene film; 13 = copper ring HV connector; 14 = capacitor high-voltage (HV) output plates; 15 = lock nut for HV plate; 16 = HV electrode for swinging cascade spark gap; 17 = trigger electrode; and 18 = output coaxial cables (16 in parallel). (b) The plasma focus tube. 18 = input coaxial cables (16 in parallel); 19 = stud of anode; 20 = anode collector plate; 21 = connecting points for coaxial cable HV lead; 22 = Rogowski coil; 23 = perspex spacer; 24 = rubber holder; 25 = cathode collector plate; 26 = mild steel flange; 27 = O-ring seal; 28 = focus cathode support plates; 29 = focus anode; 30 = glass insulator; 31 = focus cathode (6 rods); 32 = mild steel focus chamber; 33 = movable magnetic probe in glass jacket; 34 = flange; 35 = back flange; 36 = diaphragm gauge; 37 = outlet to vacuum pump; 38 = inlet for test gas; 39 = wax container with indium foil and PM-scintillator activation counter.





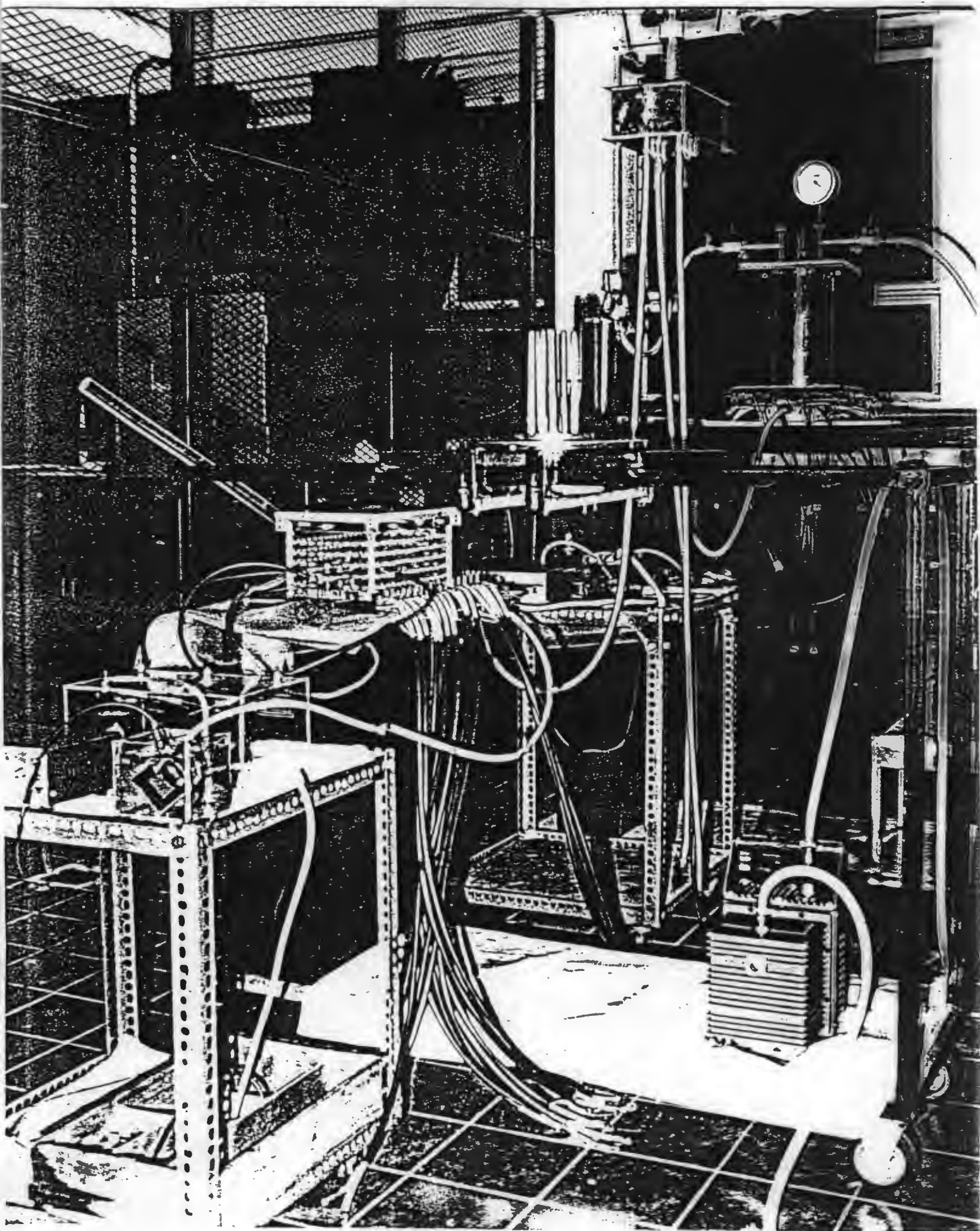


QPVAT



QPVAT

UNU/ICTP
PFF



UTM

(iv) **Structure of Training Programme**

6 month intensive training programmes - 2 parts

Part I : Basic training (3 months)

- (a) familiarisation with several plasma and laser experiments.
- (b) modules of learning : pulse generation, pulse control, high power switches, power supplies, delay systems, soldering, microfabrication, electrical wiring, use of multimeter and oscilloscopes, data acquisition systems, vacuum systems, leak detection, safety procedure, high voltage and current techniques, insulators, capacitors other basic skills needed for designing, building, maintaining and operating pulsed plasma facilities.
- (c) designing, constructing and testing magnetic, current, high voltage and photodiode probes.
- (d) computation and computer models for L-C-R circuit, EM shock tube modelling, plasma focus modelling.
- (e) design, construction and testing of sub-systems of the plasma focus.
- (f) assembly of sub-systems to form functional plasma focus.
- (g) testing operation and maintenance of the plasma focus.

Part II : Research training

1st month: Join research team for on-going research work.

2nd month: Carry out extension of several aspects of this research work on a nearly independent basis.

3rd month: Writing of research report and paper. Preparation of shipment of facilities and diagnostics.

During these 3 months, the trainee is in constant preparation for the shipment back home and to foresee how components parts and sub-systems may be maintained back home. Also preparation to launch future research work.

IV Results

(i) Experimental Plasma/Fusion/Laser research has been initiated in 7 Third World countries, Sierre Leone, Nigeria, Pakistan, Bangladesh, Nepal, Thailand and Indonesia.

(ii) Facilities transferred include the following:

	UNU/ICTP PFF	EMST Flow Simulator	Nitrogen Laser System	Laser Shadowgraph System	Glow Discharge	Soft x-ray spectro- meter
Cairo, AL Azhar U.	X		X	X		
Jaipur, Rajathan U.	X*		X*			X
Delhi, Delhi U.	X**		X*	X*		
Srinaga, SP Coll.			X			
Jakarta, LAPAN (Space research)		X**				
Yogyakarta, PPNY (nuclear research)	X**		X	X	X	
Islamabad, QIAU	X**		X*	X*		
Port Harcourt, US & T	X**		X**	X*		X
Njala, S.Leone, NUC	X**					
Songkia, PSU	X		X			
Shanghai Institute of Optics & Fine Mechanics (collaborative project)	X					
ICTP, Italy (display Centre)	X		X	X		X
Tsinghua University, P.R. China (collaborative project)						X

* Also used for MSc and PhD theses programme.

+ Have produced PhD/MSc theses from these facilities.

Total 32 packages worth US \$700,000/-

(iii) Major Research Results of Training Programmes

- fusion package for research transfer.
 - * A Simple Facility for the Teaching of Plasma Dynamics and Plasma Nuclear Fusion
Amer. J. Phys. 56, 62 (1988)

- S. Lee, T.Y. Tou, S.P. Moo, M.A. Eissa, A.V. Gholap, K.H. Kwek, S. Mulyodrono, A.J. Smith Suryadi and M. Zakaullah.

- Nitrogen Laser Development
IEEE J. Quan, K.H. Kwek, T.Y. Tou, A.V. Gholap and S. Lee.
J. Fiz. Mal. 6, 165 (1985).

- S. Lee et. al.

New Devices

- * Sequenced Nitrogen Lasers
J. App.1 Phys. 65, 4133 (1989)
 - S. Lee, K.H. Kwek, Jalil Ali, M.V.H.V. Prabhakar, Y.S. Shishodia and A.G. Warmate.

- * Cascading Plasma Focus
 - IEEE J. Plasma Science
 - S. Lee

- * Effect of Targets on Plasma Focus
 - IEEE J. Plasma Science
 - S. Lee, M.A. Alabraba, A.V. Gholap, S.Kumar, K.H. Kwek, M. Nisar, R.S. Rawal and J. Singh.

(iv) **Proposed Plasma and Laser Technology Resource Network**

**Aim: To assist development of equipment packages.
To assist distribution of equipment packages.**

Concept

Technology 1 2 3 4

Recipients

**Transfer of:
Packages,
Sub-systems,
Components**

**PLTRC Display,
Documentation and
Coordination Centre**

Technology

Producing 1 2 3 4

Centres

Fig. 14 Structure of Technology Resource Network

Proposal

PLTRC be established at ICTP to benefit as many Third World scientists as possible.

Funding and contributions: ICAC's AAAPT, ICTP, TWAS, etc.

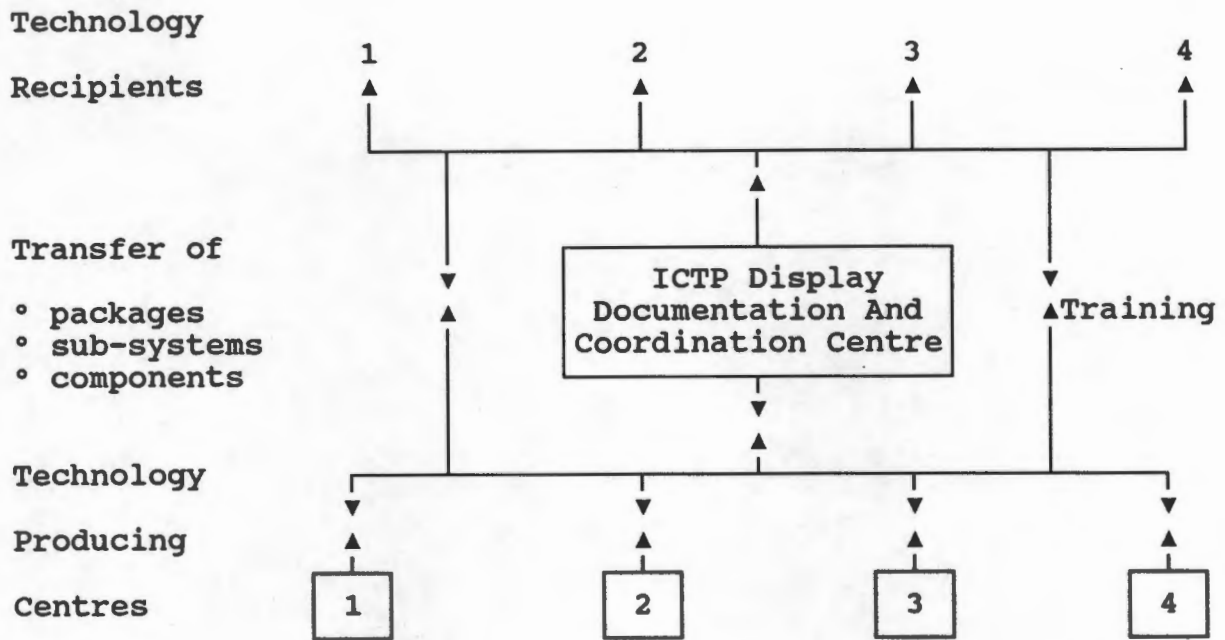


Fig. 14 Structure of Technology Resource Network

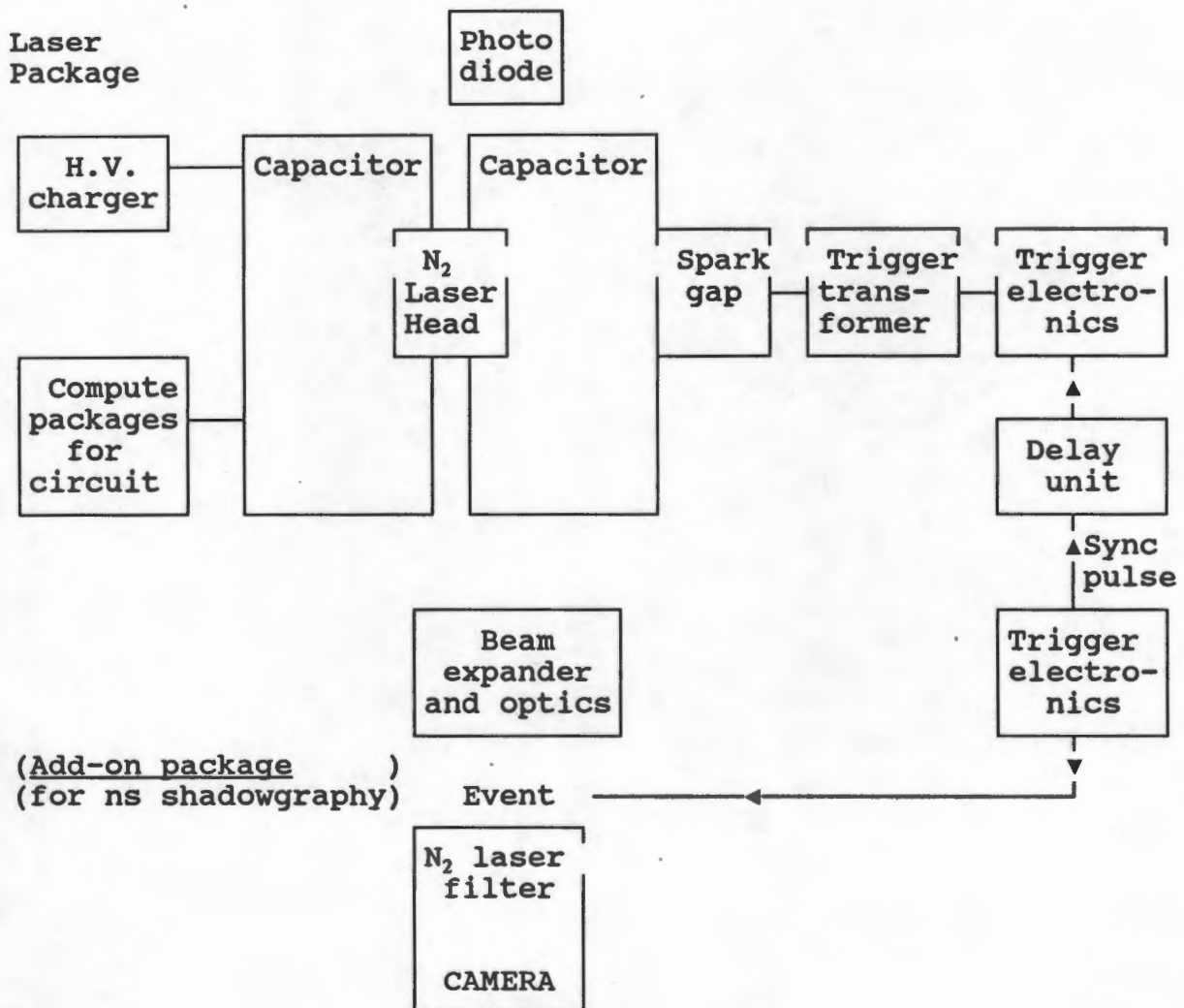


Fig 15 Nitrogen laser package and add-on Shadowgraphy package

Actions taken : Nitrogen Laser education and Application package already installed at ICTP (contributed by ICAC-UM).

Optical Fibre Monochromator (OFMS) package already completed and sent to ICTP (contribute by AAAPT, project of Plasma Physics Division, Chinese Academy of Science, Beijing).

Multi-purpose plasma devices, pinch and glow discharge device completed, donated to University of Cairo (contributed by AAAPT, project of Egypt Atomic Energy Authority, Plasma and Nuclear Fusion Division).

UNU/ICTP Plasma Fusion Facility) installed

Laser shadowgraphy System) at the ICTP.

Other packages being planned include:

Theta Pinch

Transistorised Rotamak FRC System

YAG Laser Package

Hologram System

Conclusions

- * Training Programmes for research transfer have been set up with proper S-S-N interaction criteria.**

- * Basis of transfer: research facility package with comprehensive hands-on training programme and equipment follow-up**

- * Results: transfer of significant research activities to 10 institutions in 7 countries.**

- * Results: Research papers and postgraduate theses up to PhD level.**

- * Out of these programmes has grown the AAAPT bringing expertise of more advanced South countries contributing 8 activities in 2 years.**

- * AAAPT attempts to open up the technology resources of the more developed South countries to other South countries through the PLTRN.**