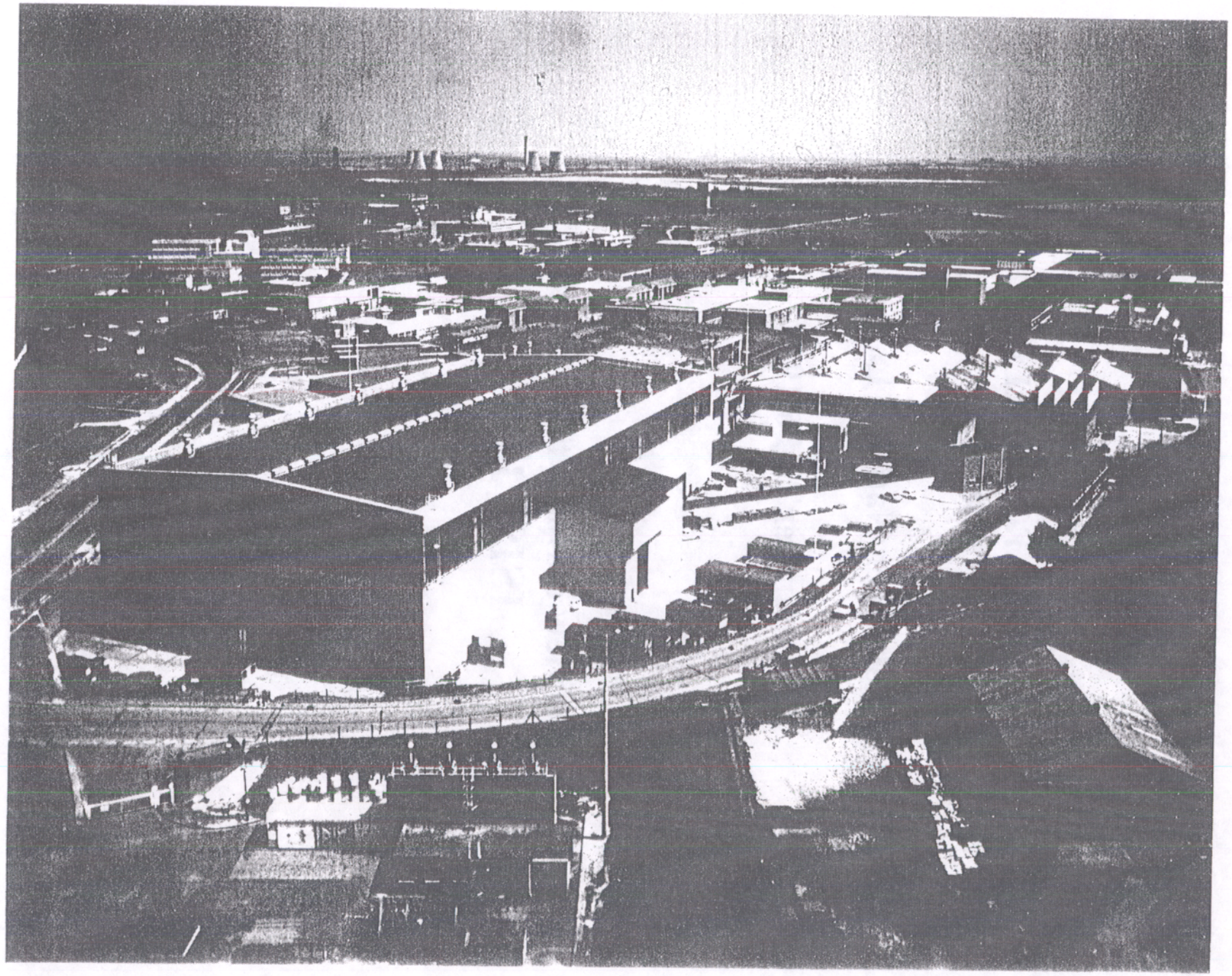
WORKSHOP OF NEUTRON DETECTORS FOR SPALLATION SOURCES

Brookhaven National Laboratory

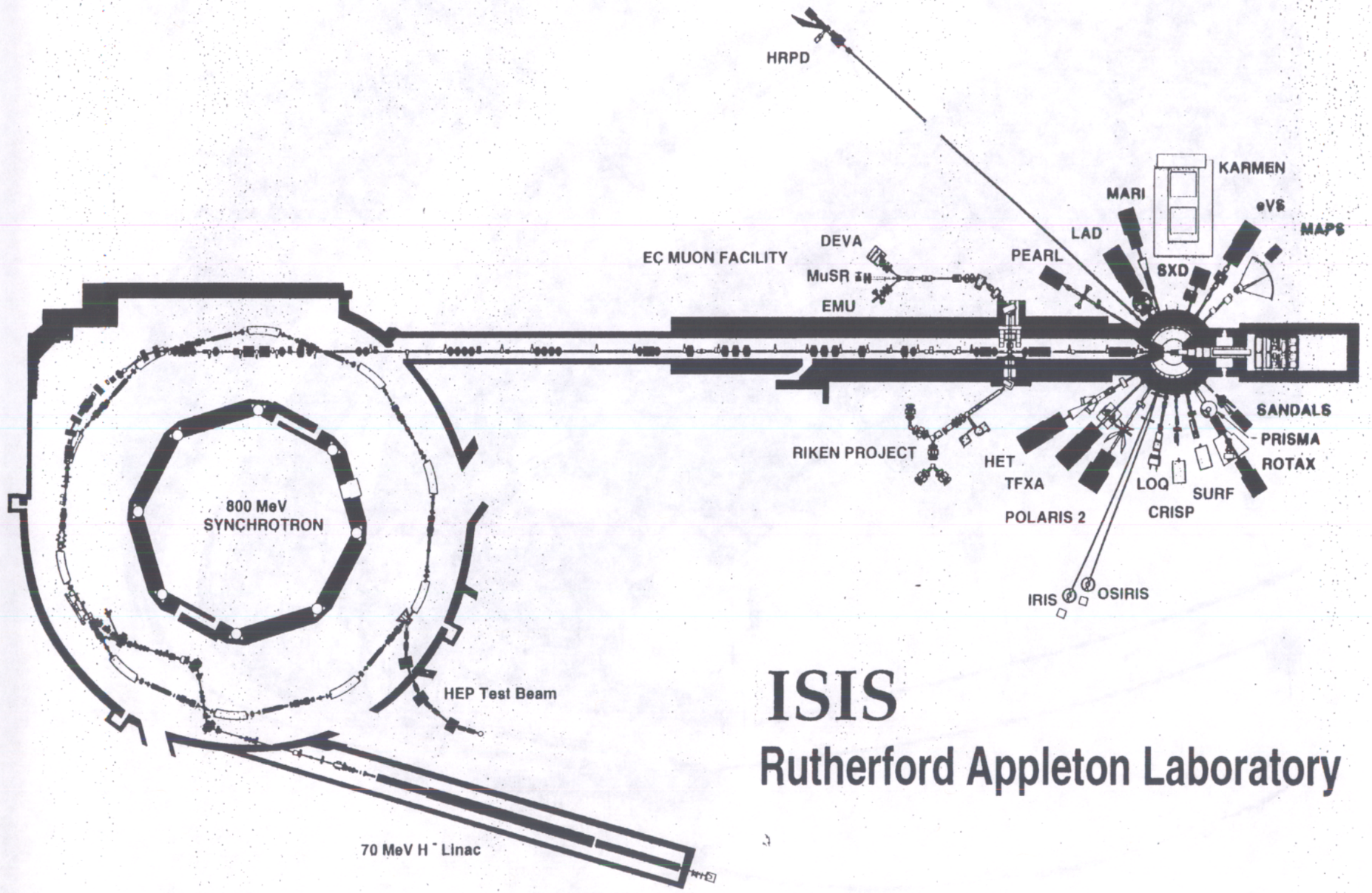
September 24-26 1998

Overview of Spallation Facilities
ISIS / ESS

N.J. Rhodes

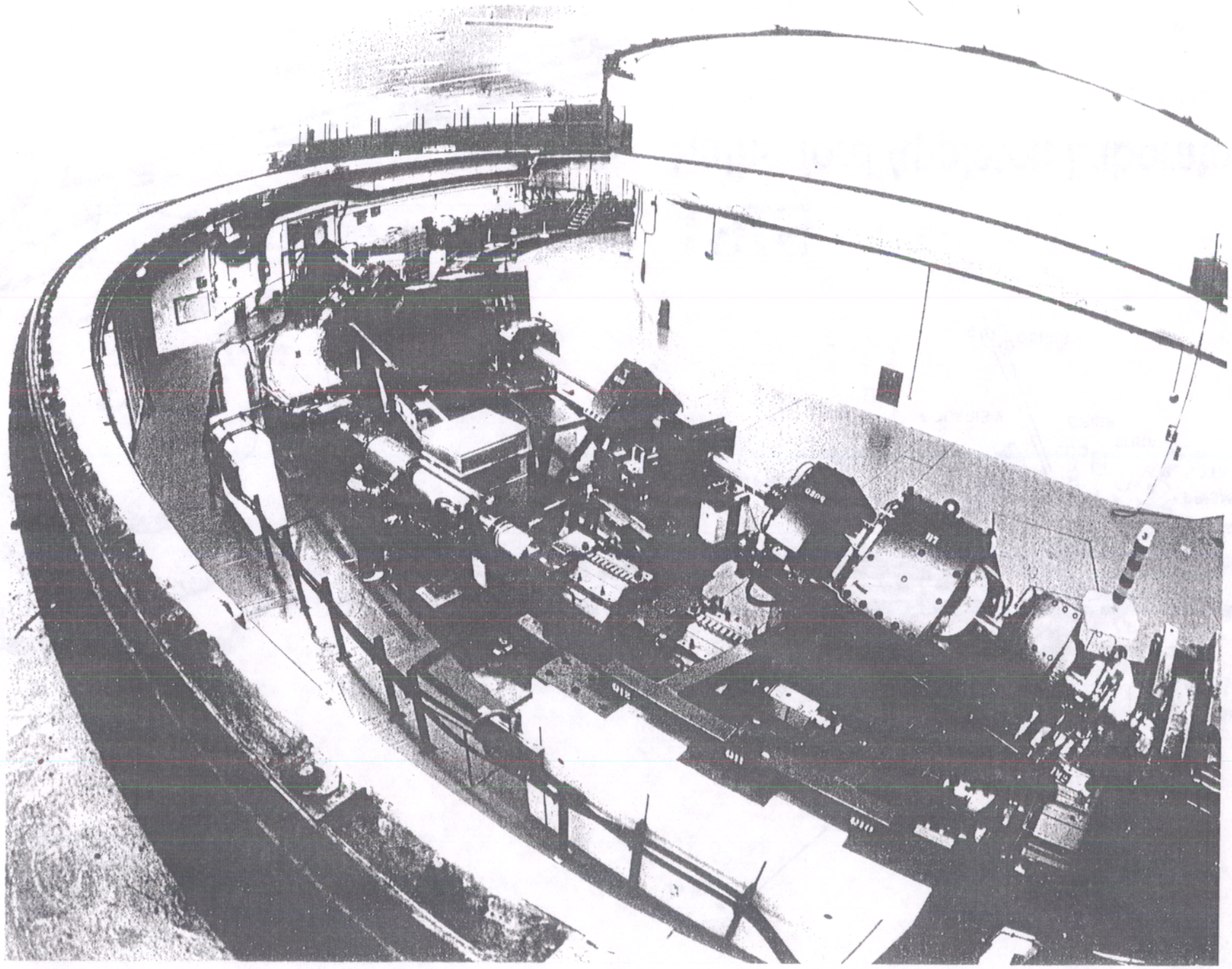


SLIDE NO. 42-3-70
RAL-CHILTON



ISIS

Rutherford Appleton Laboratory



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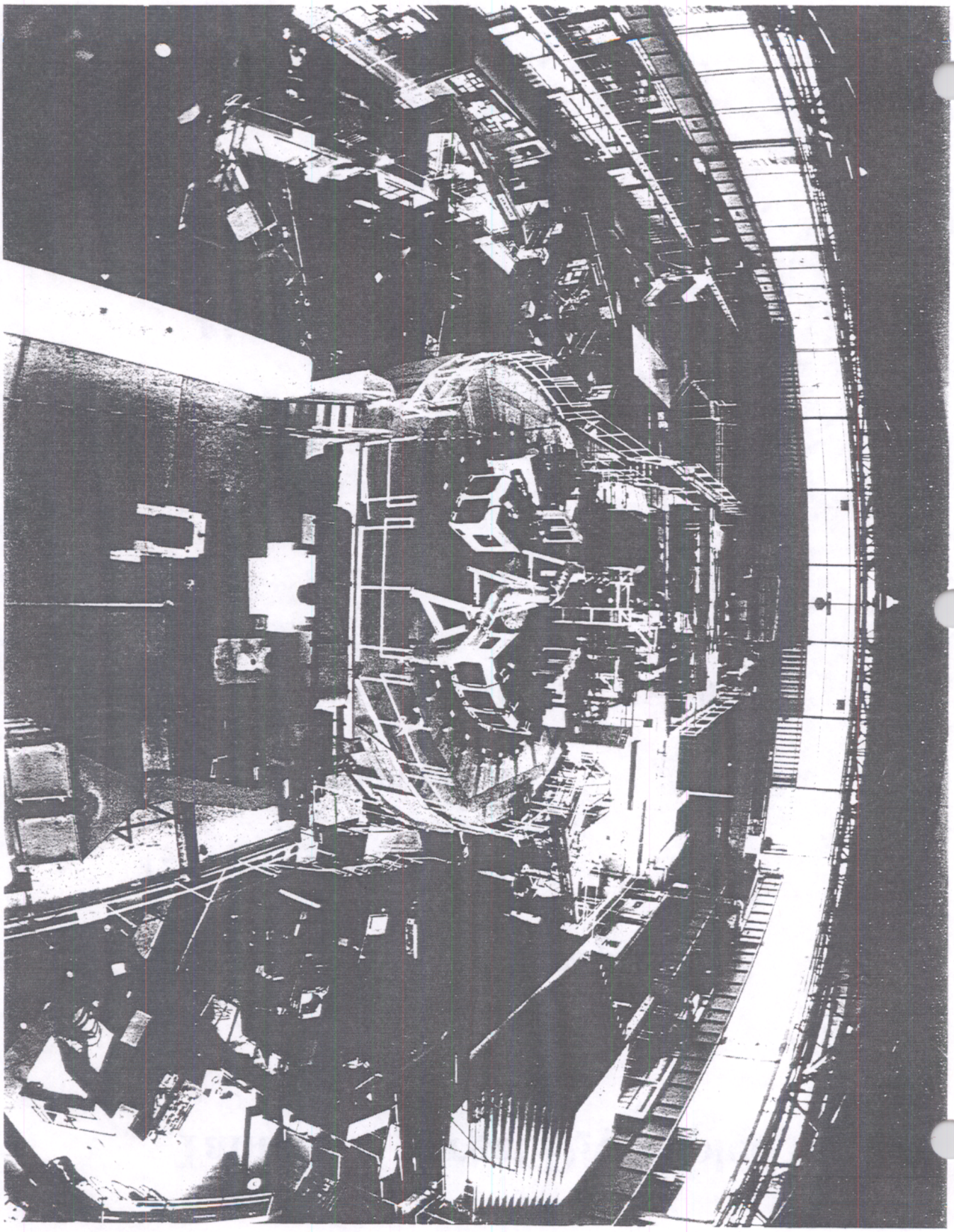


SLIDE NO. 92RC3079
RAL-CHILTON

Tantalum Target D_2O cooled

200 μA = 2.5 x 10^{13} protons per pulse

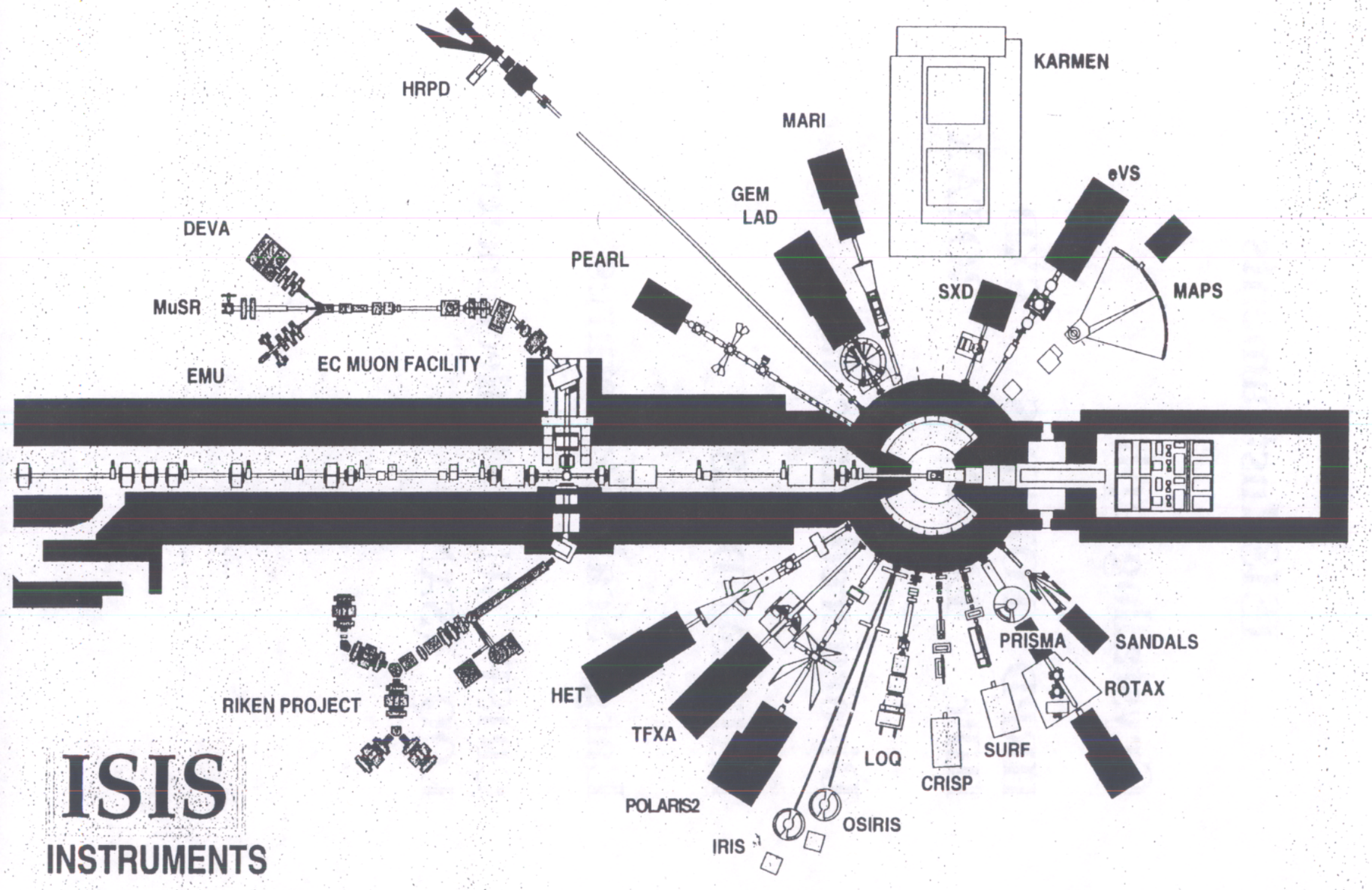
12 neutron per proton

50 Hz repetition rate

Neutron Flux = 1.5 x 10^{16}

Moderators

H_20	316 K
Liquid Methane	100 K
Liquid Hydrogen	20 K



ISIS
INSTRUMENTS

ISIS Instruments

Crystallography

HRPD POLARIS SXD
HiPr ENGIN ROTAX

Disordered Materials

LAD SANDALS

Large Scale Structures

CRISP SURF (Reflectometers)
LOQ (SANS)

Excitations

HET **MARI** **(Chopper spec)**

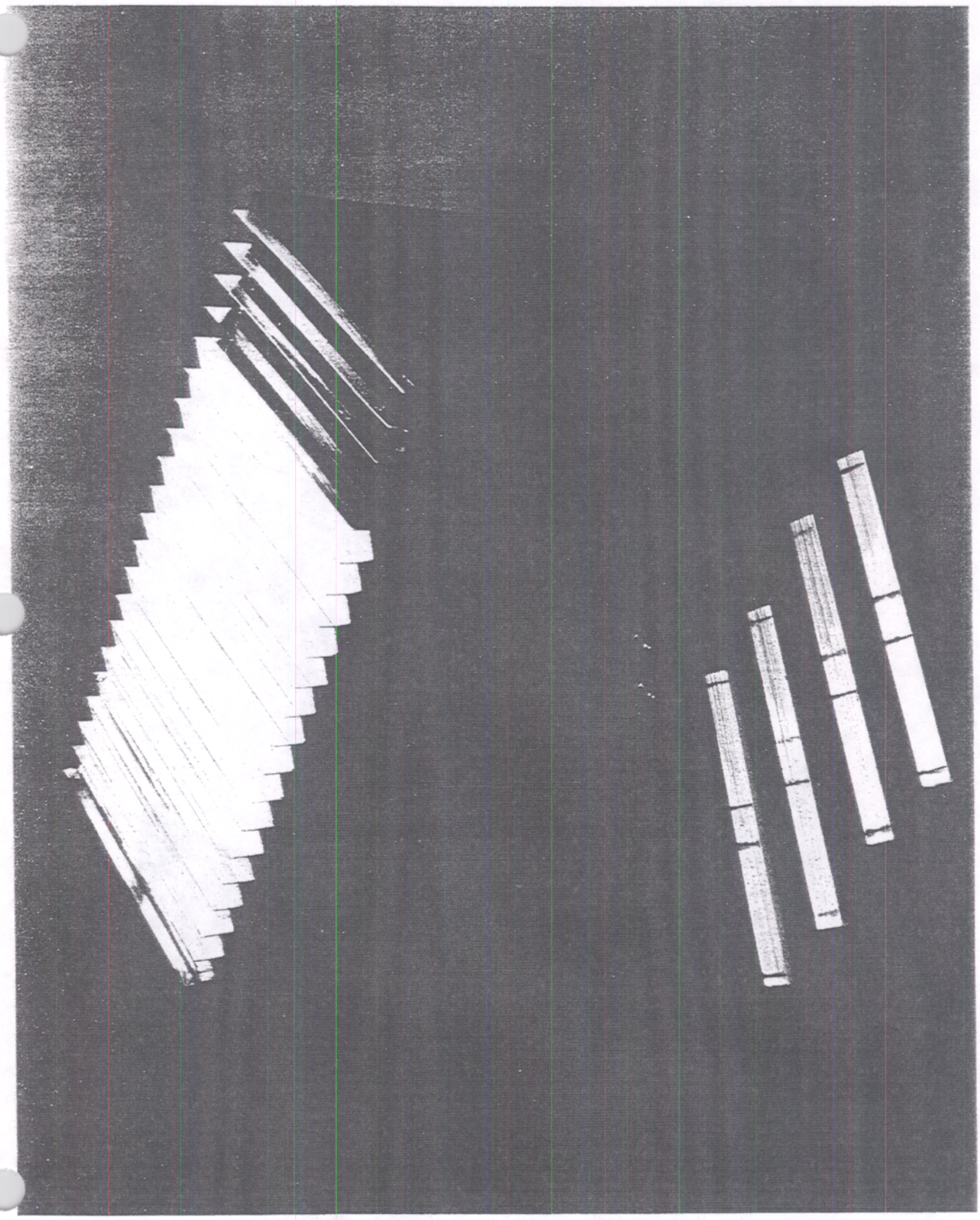
PRISMA **(Indirect)**

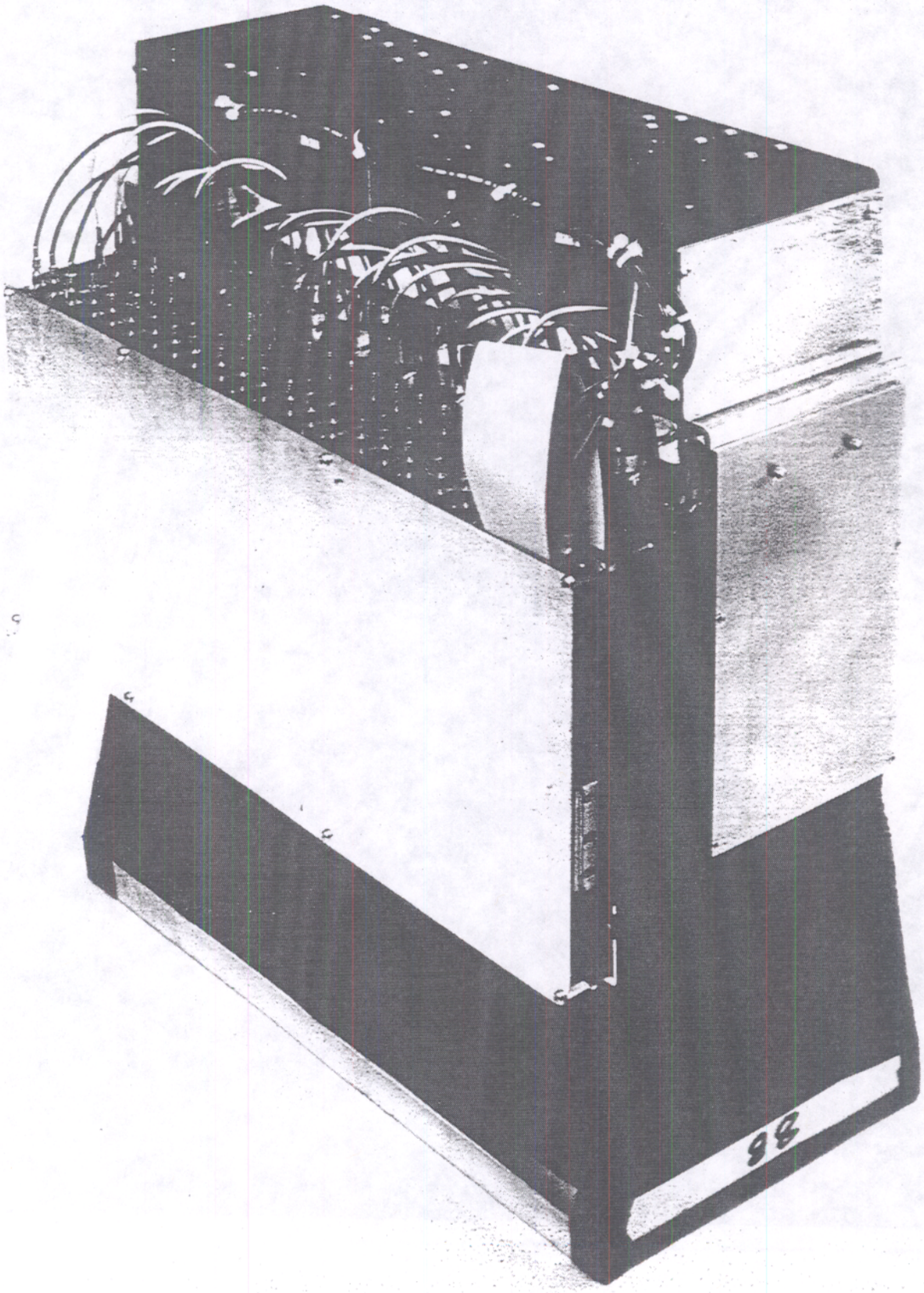
Molecular Spectroscopy

IRIS **OSIRIS**

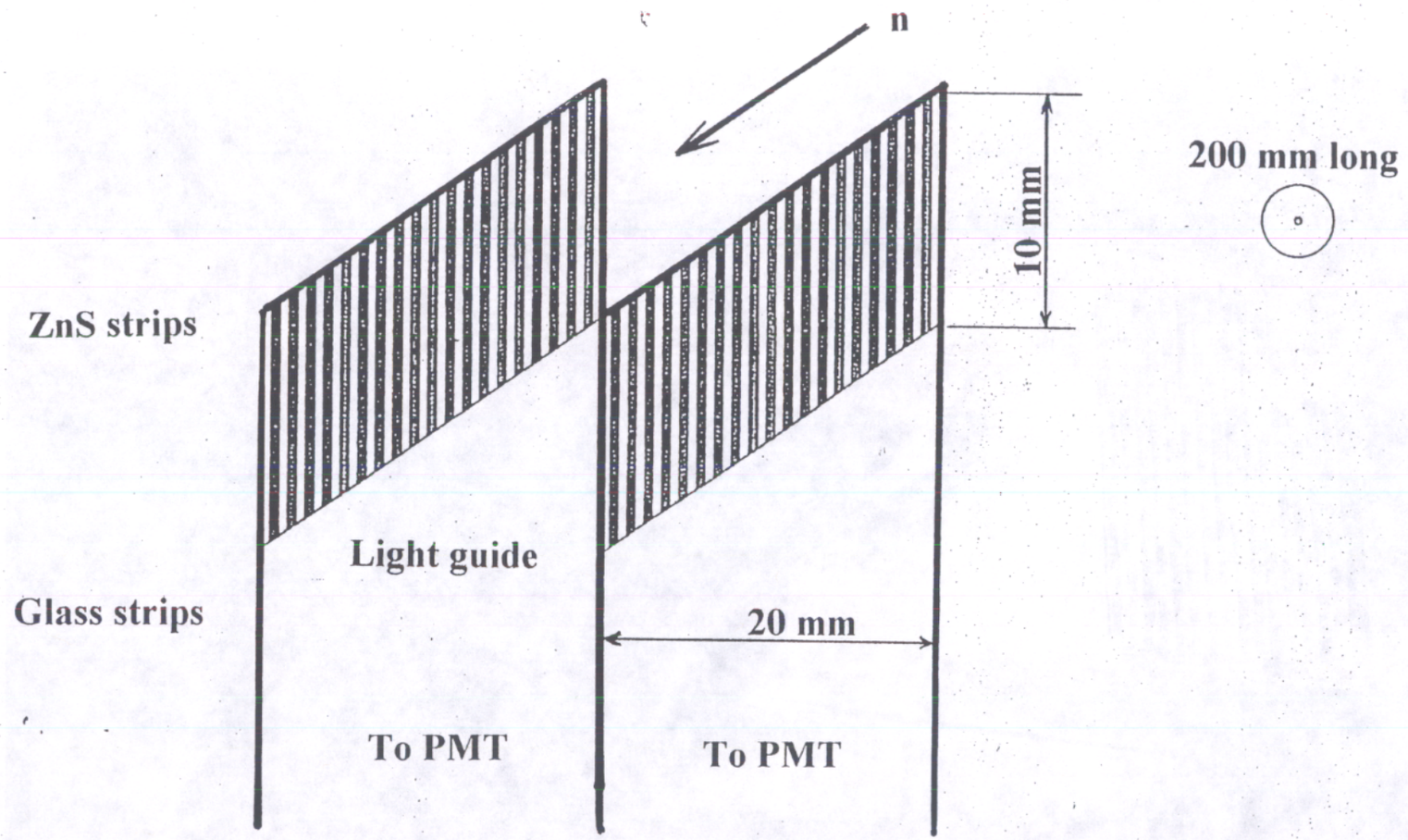
TOSCA **EVS**

MARI
RICHARD COLEMAN



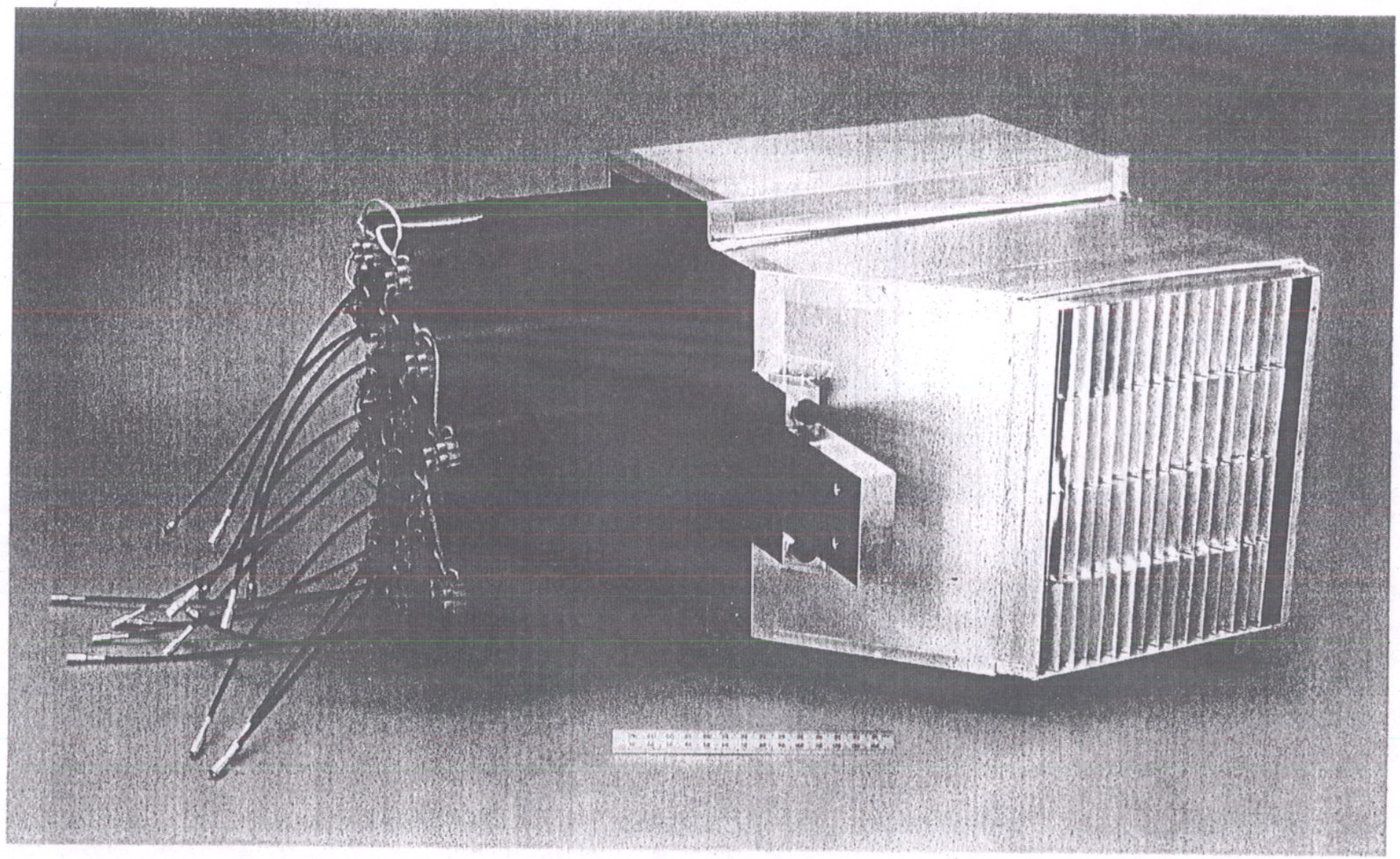


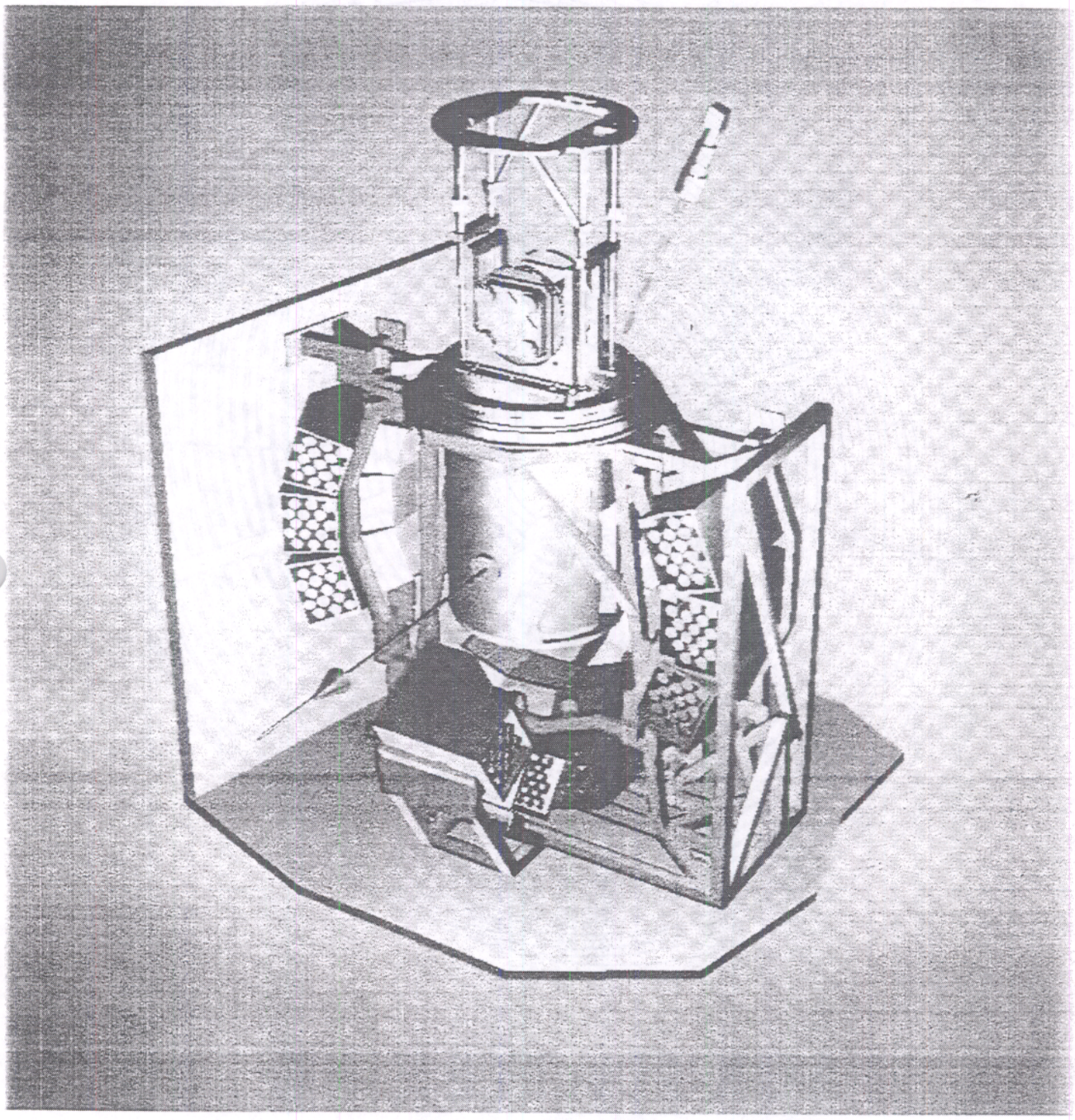
RUTHERFORD APPLETON LABORATORY

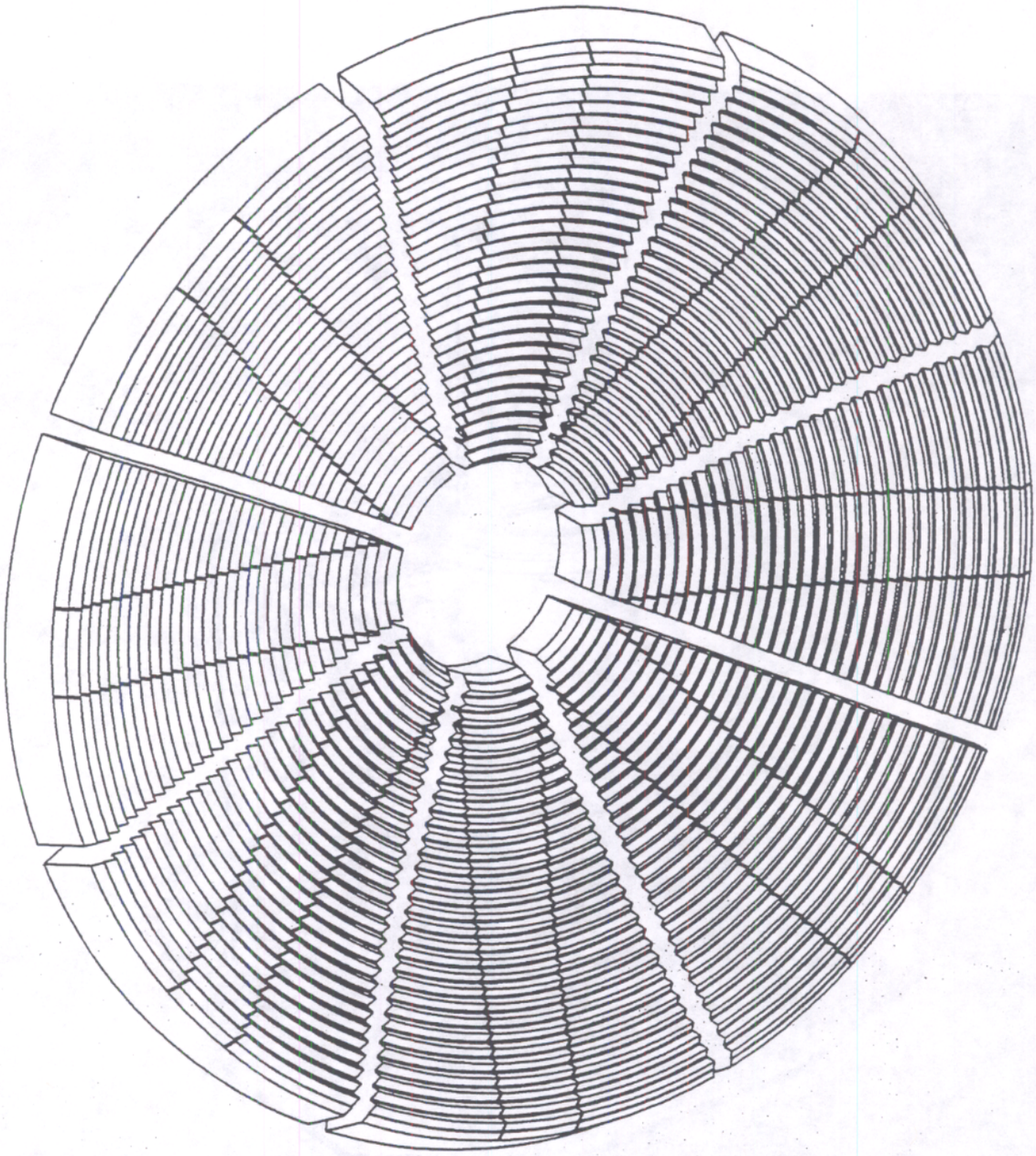


SCINTILLATOR ARRANGEMENT IN SANDALS DETECTOR ELEMENTS

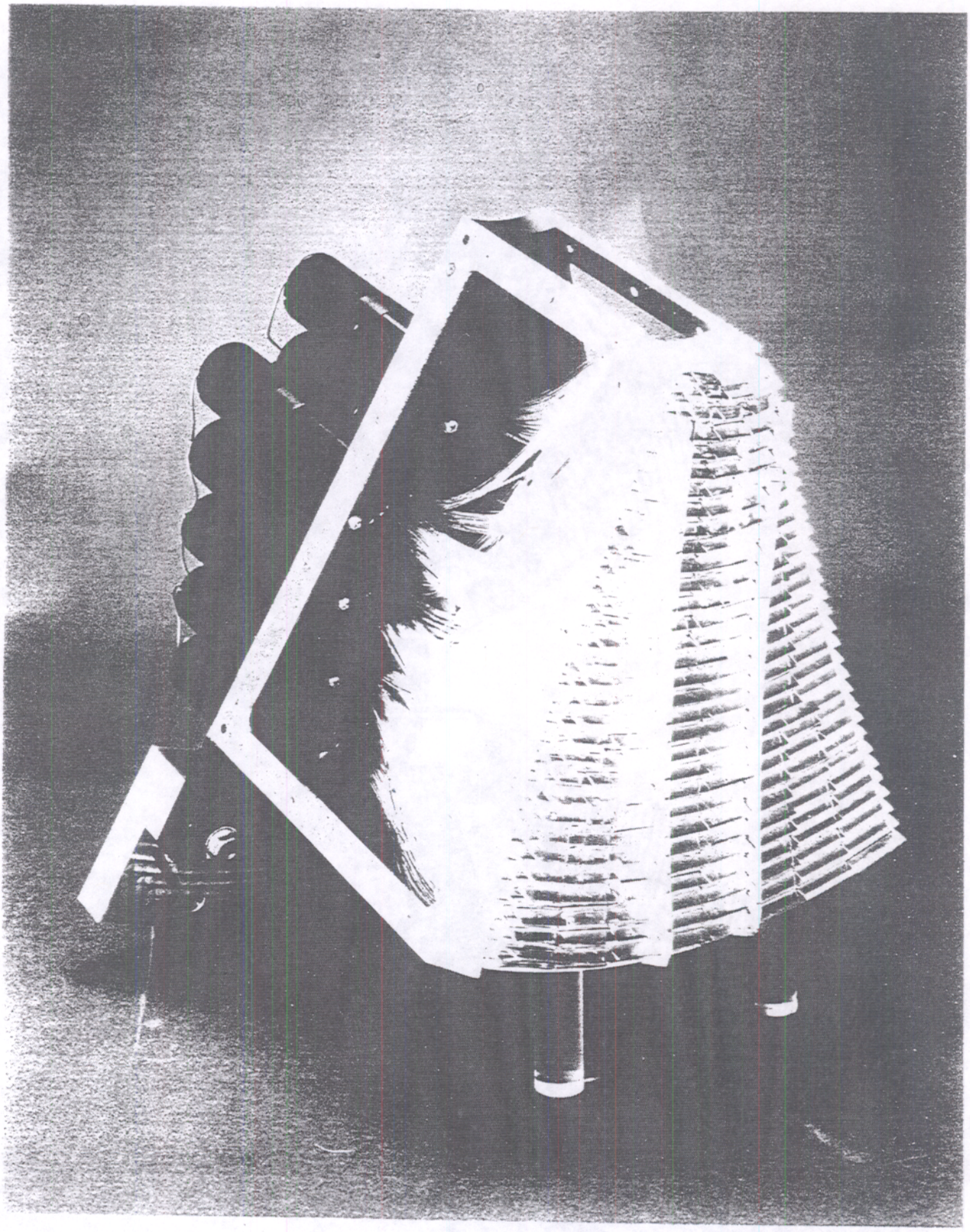
HIGH PRESSURE CELL 10 MODULES







BACKSCATTERING HRPD DETECTOR



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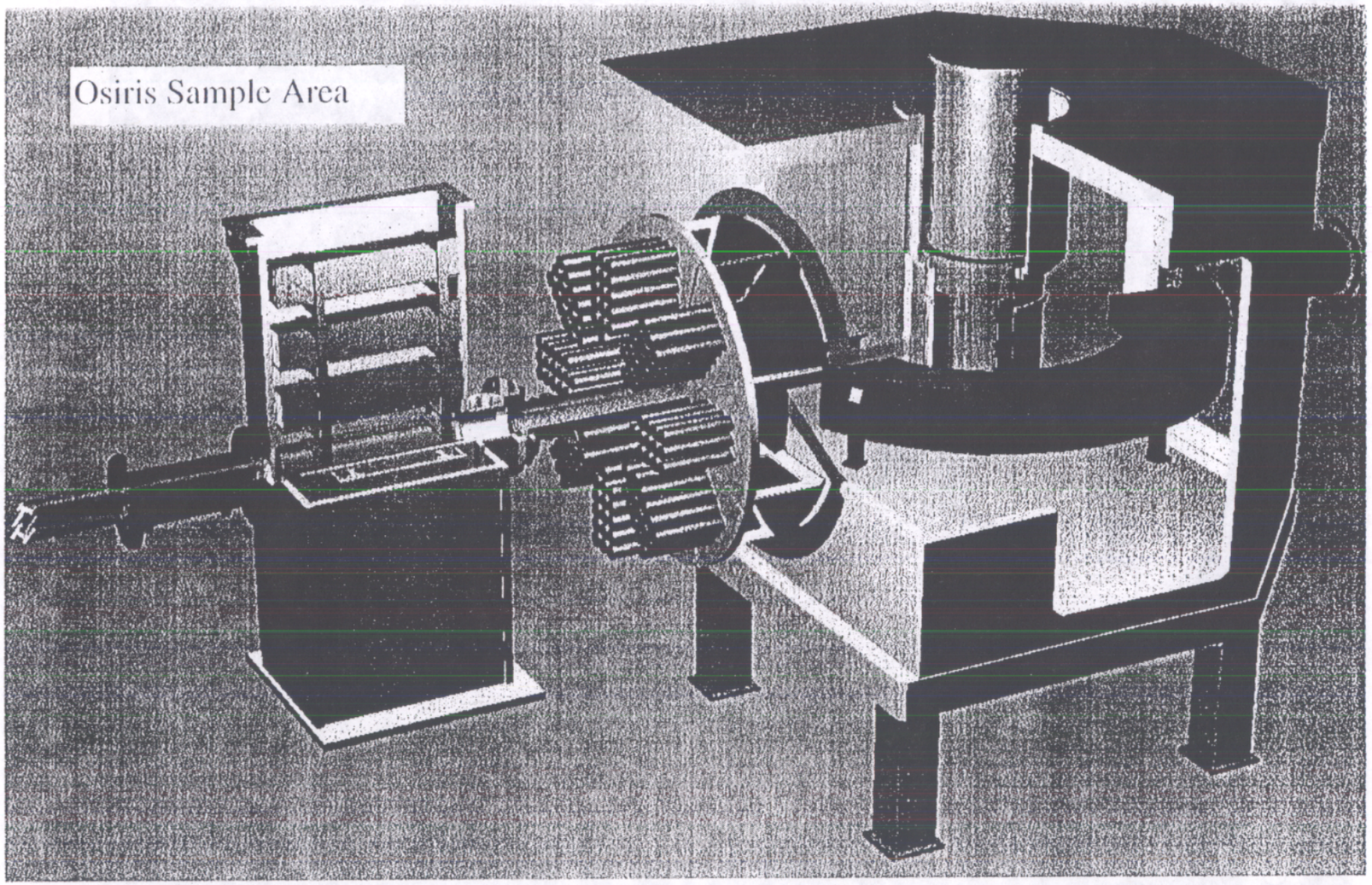
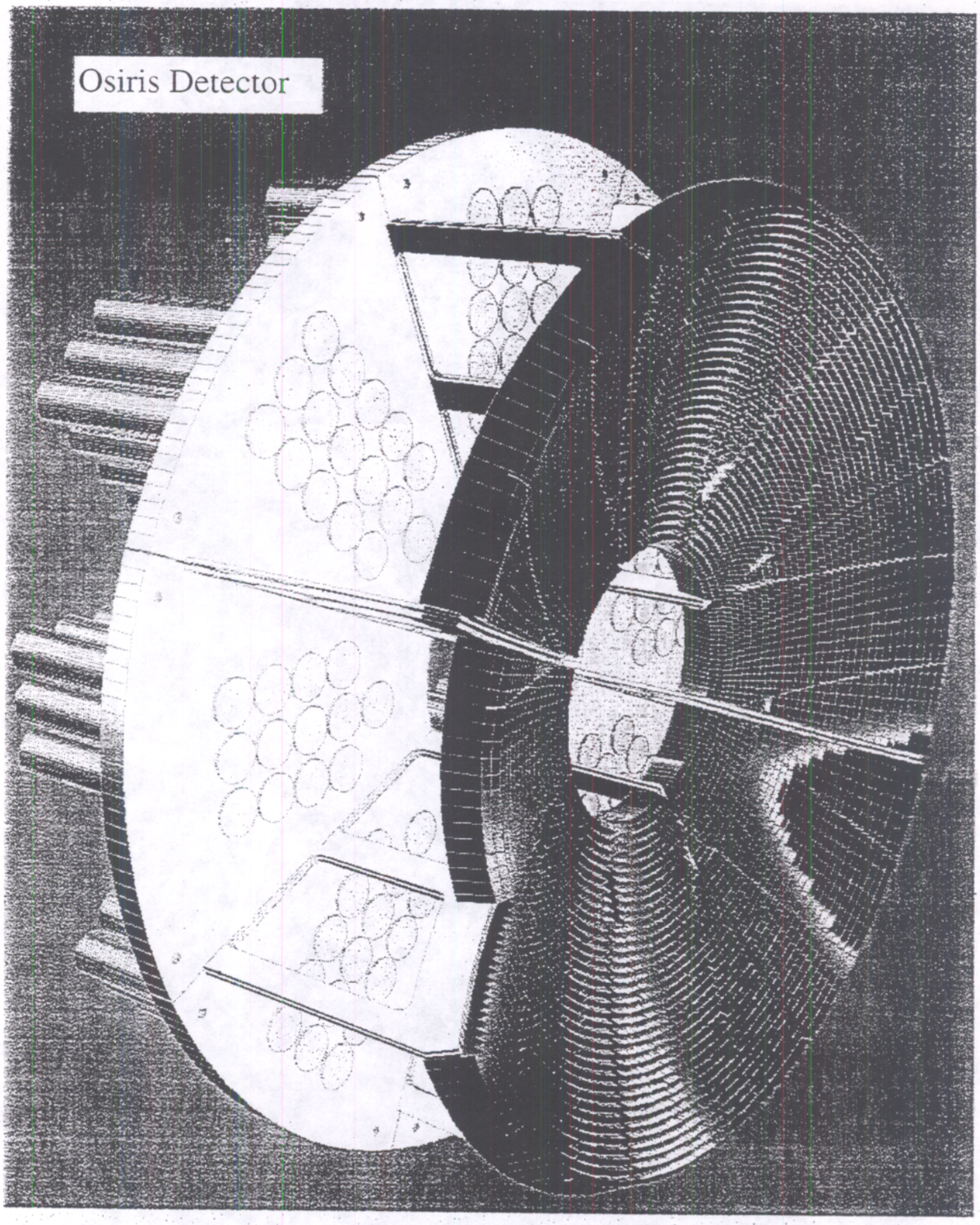
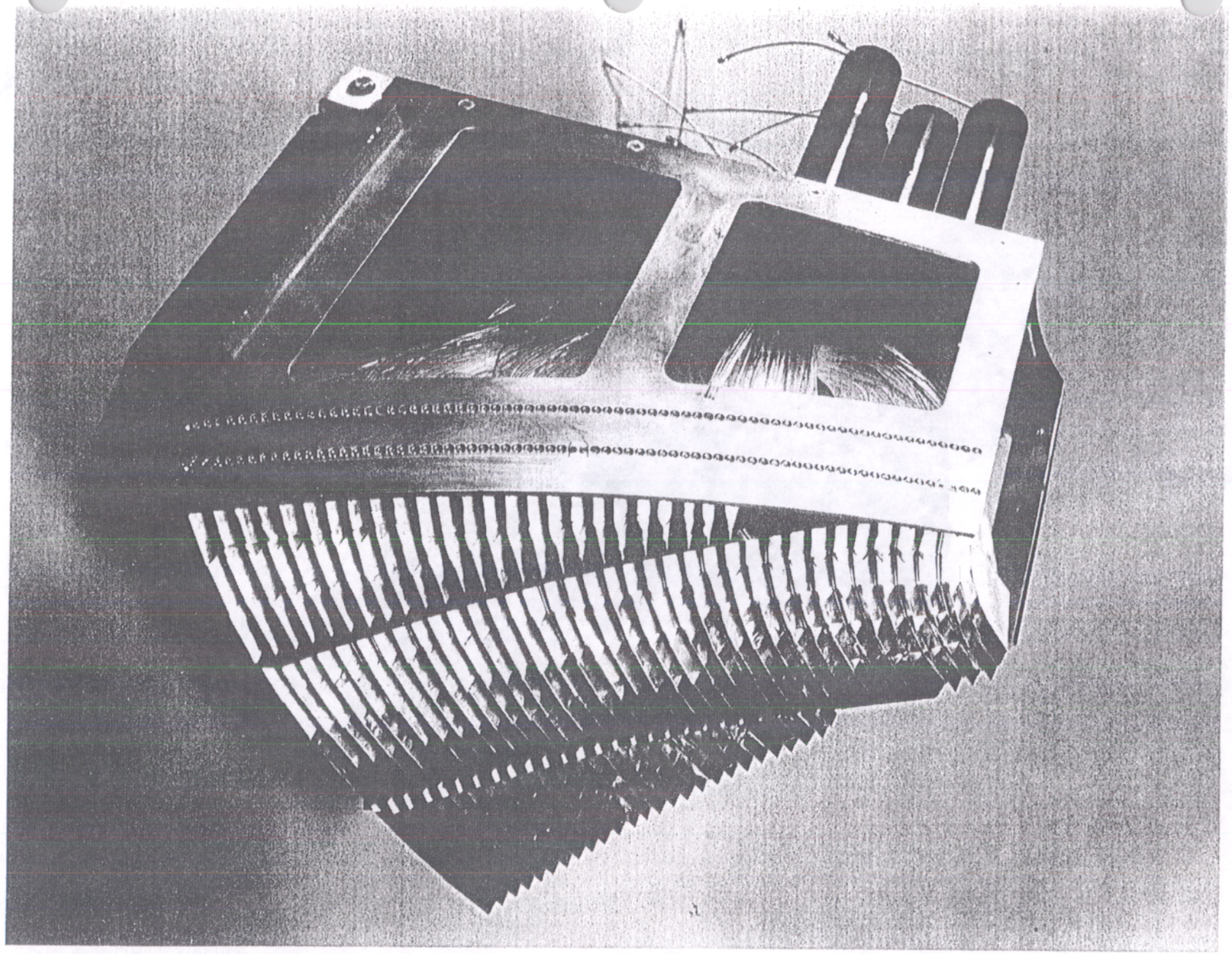
INSTRUMENT	DETECTOR	MODULES x ELEMENTS	TYPE	ELEMENT SIZE / MM	NEUTRON EFFICIENCY	GAMMA SENSITIVITY	Est. QUIET COUNT / ELE./HR.	PPR/us
MARI	HELIUM	917 x 1	Gc	300 x 25 dia.	70 % at 1 A	10-8	5	2.5
SANDALS	SANDALS	63 x 20	SZLD	200 x 10	1.7 x std He at 10 eV	10-5	360	2.5
ROTAX	JULIOS	2 x 256	SGsD	25 x 2.9	65 % at 1 A	2 x 10-4	2	1.0
SURF	SURF	1 x 1840	SZTF	2.5 X 2.2	20 % at 1 A	10-8	0.006	2.5
CRISP	CRISP	1 x 440	SZTF	5.0 x 2.2	20 % at 1 A	10-8	0.006	2.5
LOQ	LOQ	4 x348	SZTF	12 x 12	20 % at 1 A	10-8	0.1	2.5
OSIRIS	OSIRIS	1 X 70	SZLF	45 deg x 5.0	50 % at 1 A	10-7	12	2.5
IRIS	IRIS	2 x 51	SZLD	52 x 12	36 % at 1 A	10-8	< 2	2.5
POLARIS	BRICK	4 x 20	SZLD	150 x 5.7	45 % at 1 A	3 x 10-8	23	2.5
	90 DEG	6 x 36	SZLF	300 x 3.5	32 % at 1 A	10-7	12	2.5
eVS	eVS	4 x 8	SGsD	200 x 25	3 x std He at 6 eV	2 x 10-2	150 / min.	0.3
SXD	SXD	3 x 4096	SZTF	3.0 x 3.0	20 % at 1 A	< 10-8	0.006	2.5
HRPD	90 DEG.	6 x 66	SZLF	200 x 3.0	36 % at 1 A	10-7	3 to 10	2.5
HRPD	HIGH ANGLE	8 x 60	SZLF	45 deg x 5.0	50 % at 1 A	10-7	12	2.5
PEARL	HIPR	11 x 120	SZLF	52 x 5	50 % at 1 A	10-7	12	2.5
	ENGIN	6 x 45	SZLF	100 x 5.0	50 % at 1 A	10-7	12	2.5

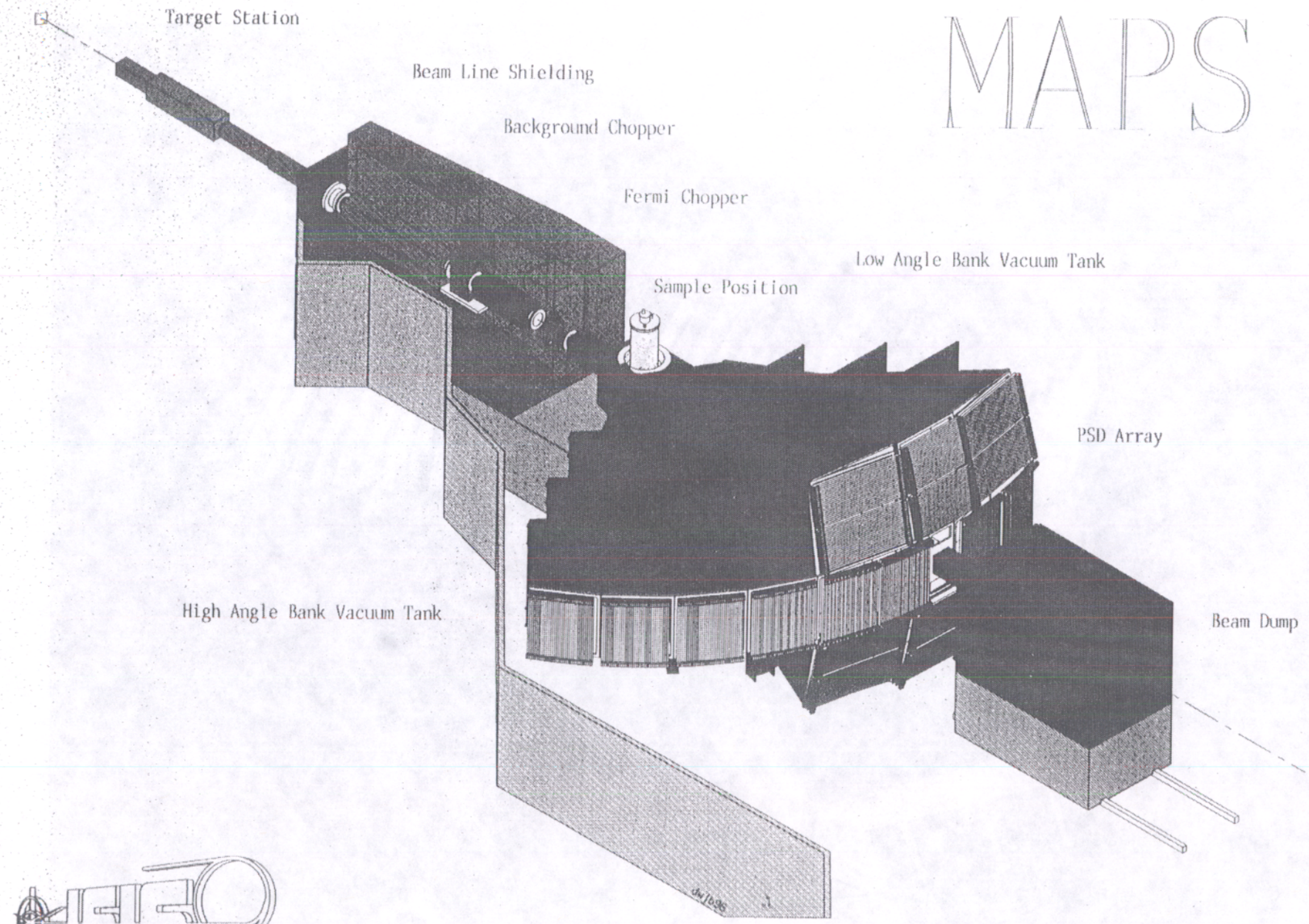
TABLE 1. Detector characteristics of scintillator detectors operational on ISIS compared with characteristics of MARI ^{3}He gas proportional counters. Gc = gas proportional counter, S = scintillator, Z = Zinc Sulphide, L = linear, D = directly coupled, F = fibre coupled, T = two dimensional, G = glass, s = single.


Osiris Sample Area

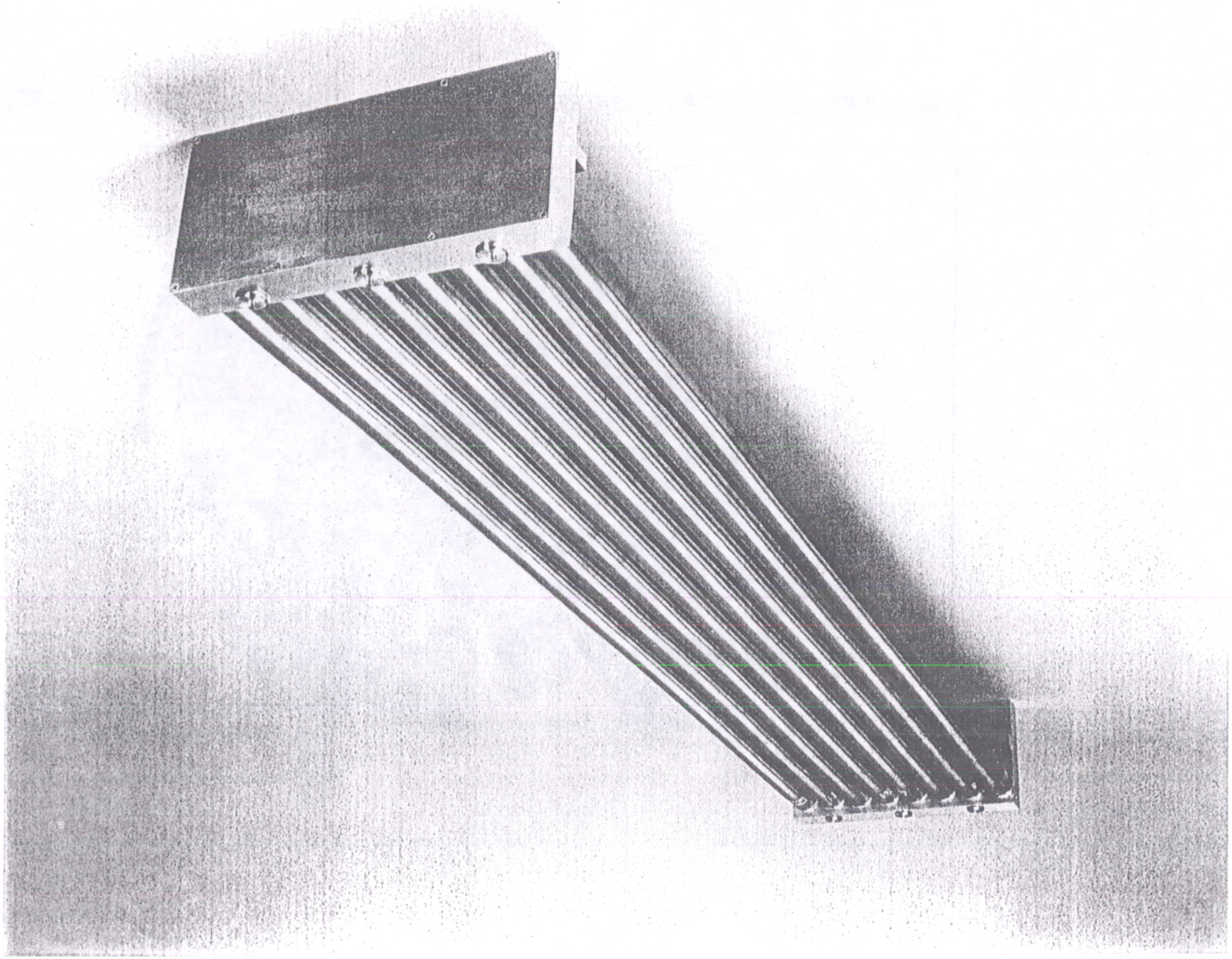

Osiris Detector

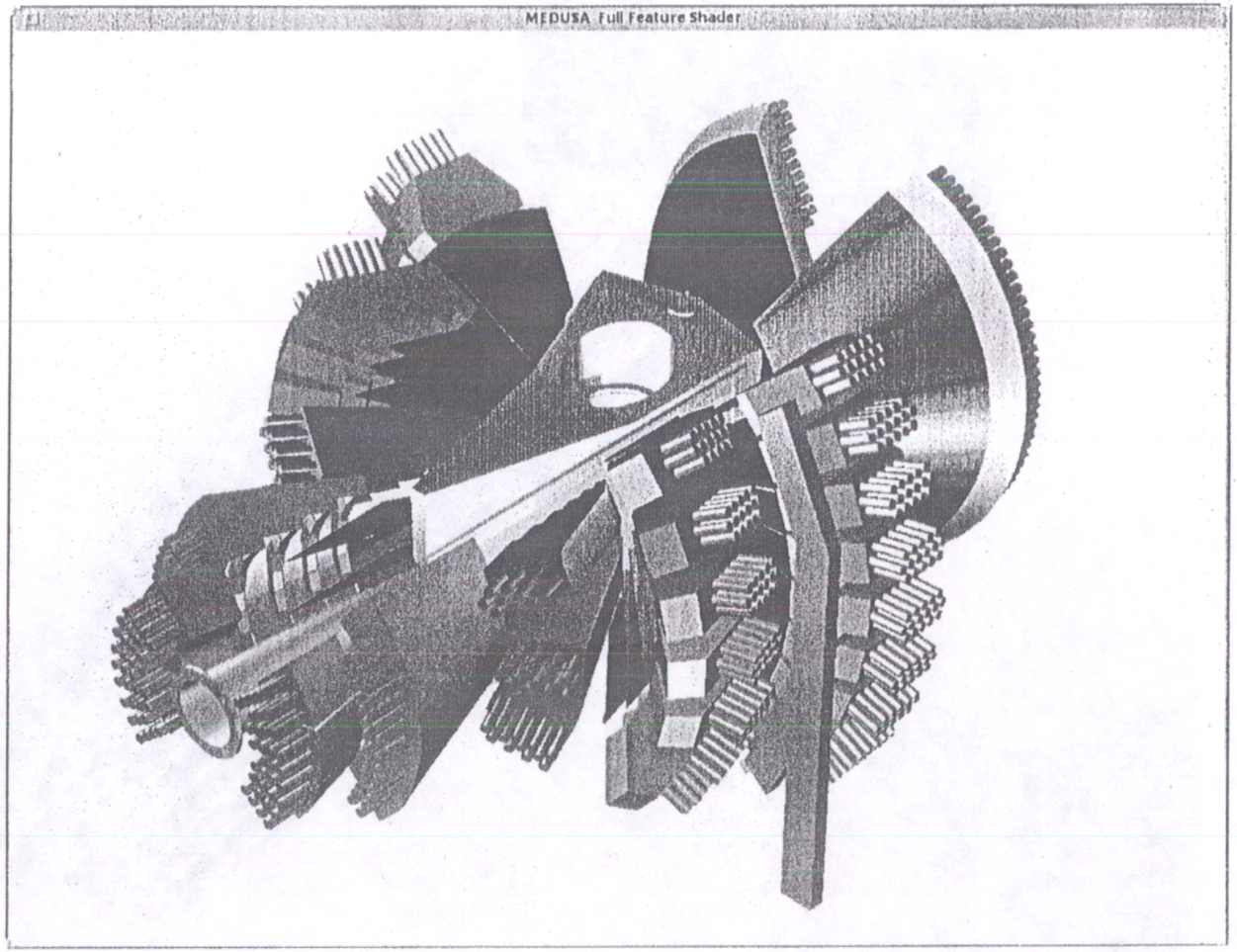


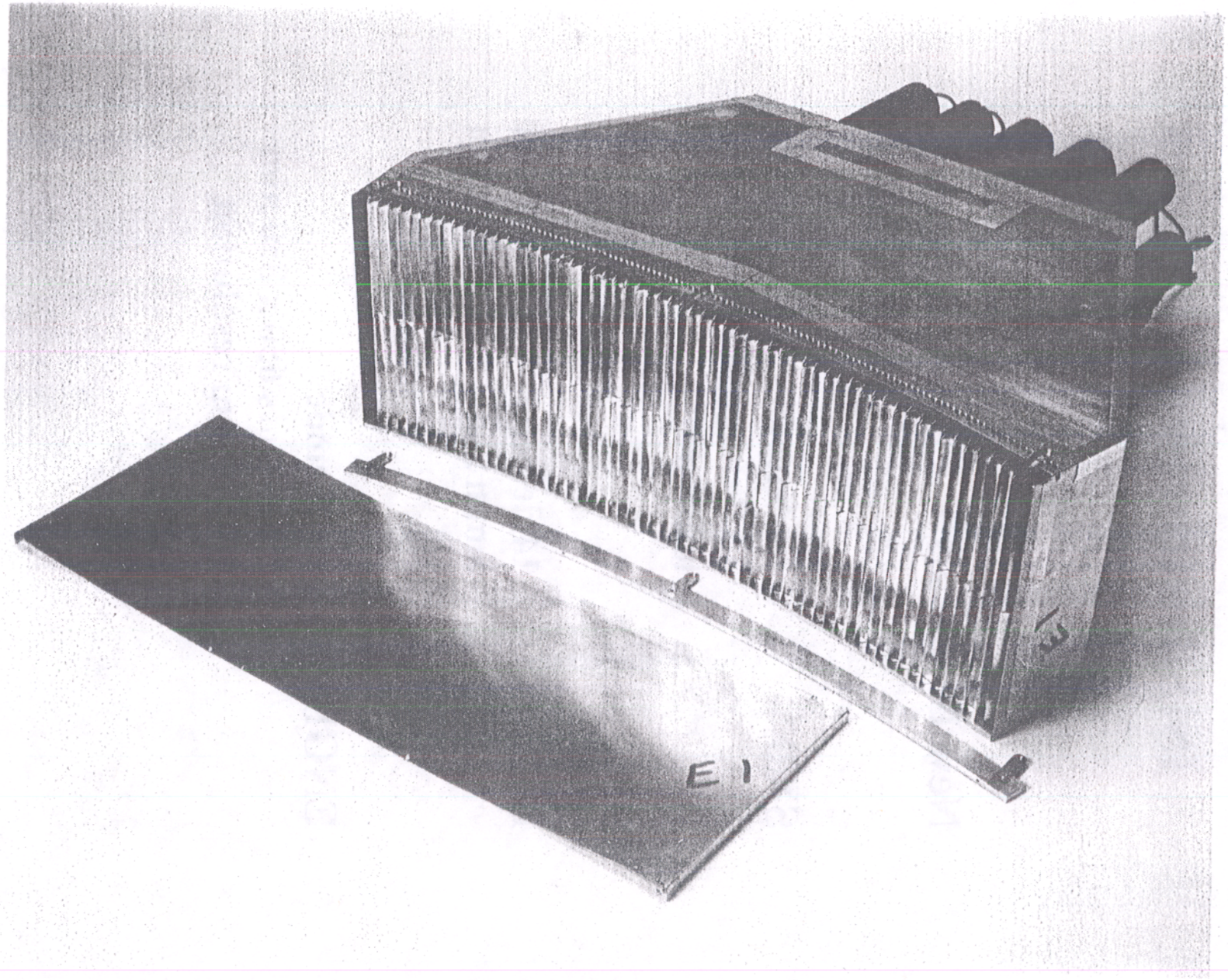
MAPS


Target Station
Beam Line Shielding
Background Chopper
Fermi Chopper
Low Angle Bank Vacuum Tank
Sample Position
PSD Array
High Angle Bank Vacuum Tank
Beam Dump

U




MEDUSA Full Feature Shader

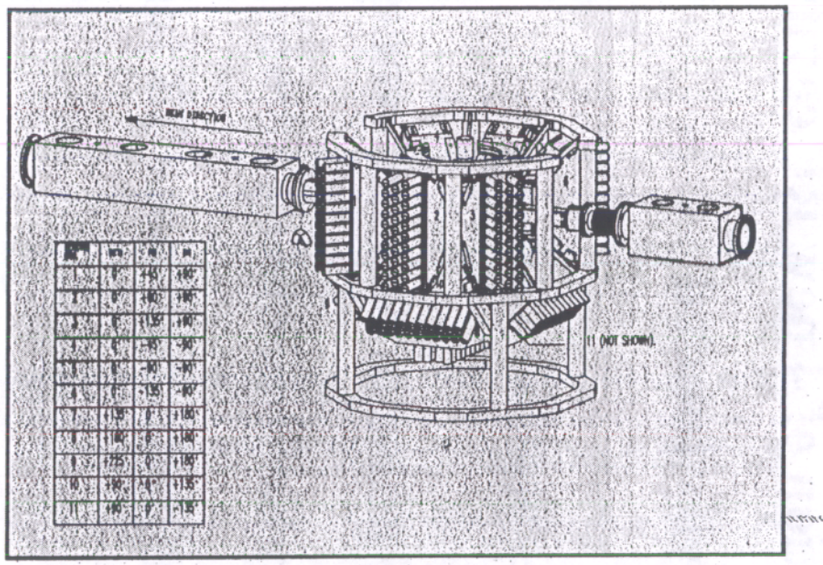

E1

ISIS Instrument Upgrades

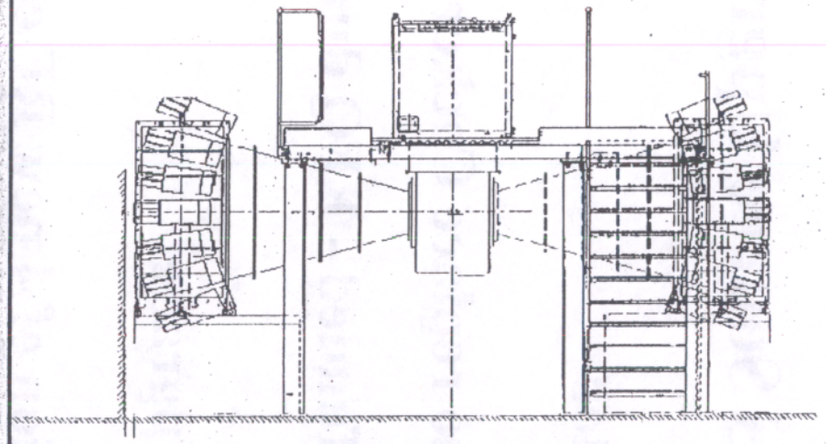
New Proposals

SXD	11 detectors 200 x 200 mm 3 x 3 mm resolution low parallax
HRPD	14 detectors 200 x 600 mm 5 mm x 200 mm resolution
ENGIN X	50 m guide 2 detectors 650 x 850 mm 3 x 280 mm resolution

Two proposed upgrades to ISIS Crystallography instruments
SXD detector array and HRPD-90° bank



SXD
11 detector modules cf 2 at present
+ higher efficiency
= 10 x Count Rate



HRPD-90°
14 GEM-type detector modules
= >10 x Count Rate,
matched to backscattering

Proposals for funding submitted, September 1998

ISIS

ISIS Source Upgrades

Pre injector

RFQ to replace Cockcroft Walton

Fully funded - RFQ due October

300 μA Upgrade

Addition of 4 new RF cavities

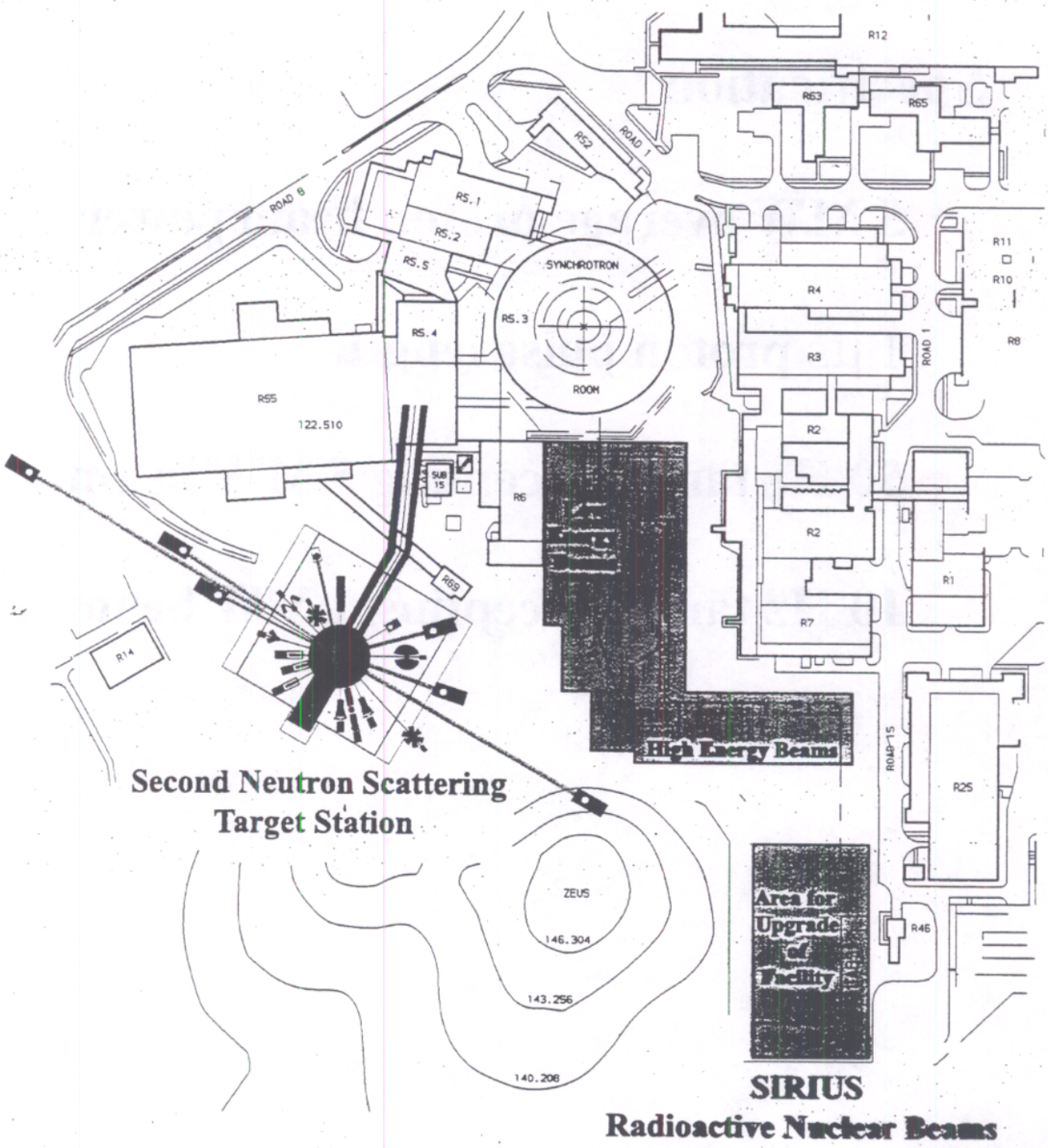
1st cavity funded

2nd target station

Use 1 pulse in 5 from synchrotron

Optimise for cold neutrons

> x 20 gains for some T1 insts.



ISIS

Rutherford Appleton Laboratory

CLRC

European Spallation Source

Specification

5 MW average proton beam power

1 μs proton pulse length

50 Hz target accepting 5 MW beam

10 Hz target accepting 1 MW beam

European Spallation Source

Current Status

Preliminary discussions	√
Feasibility study	1996
R & D Phase	3
Engineering Design	2
Construction	6
Commissioning	2

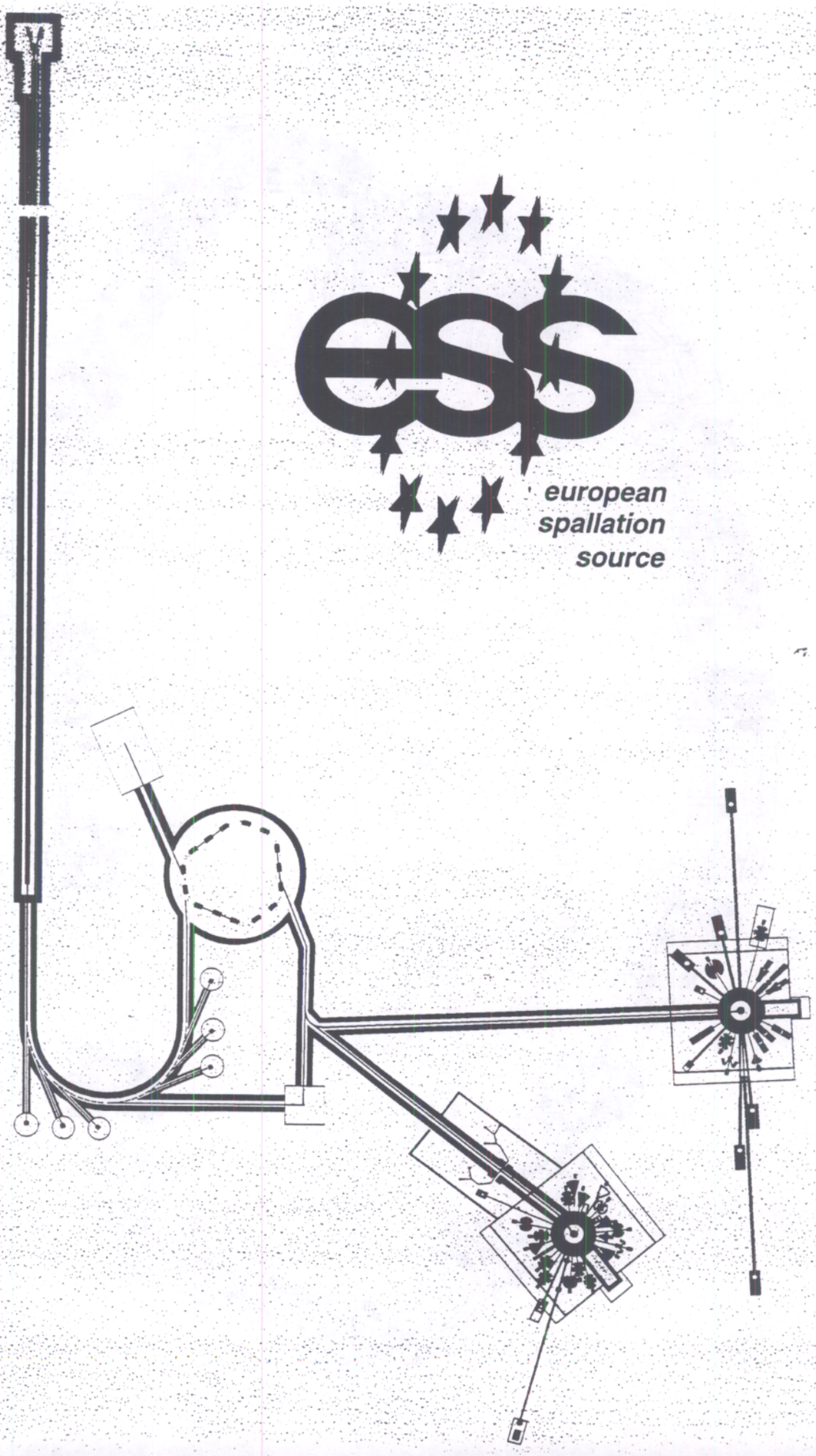
European Spallation Source

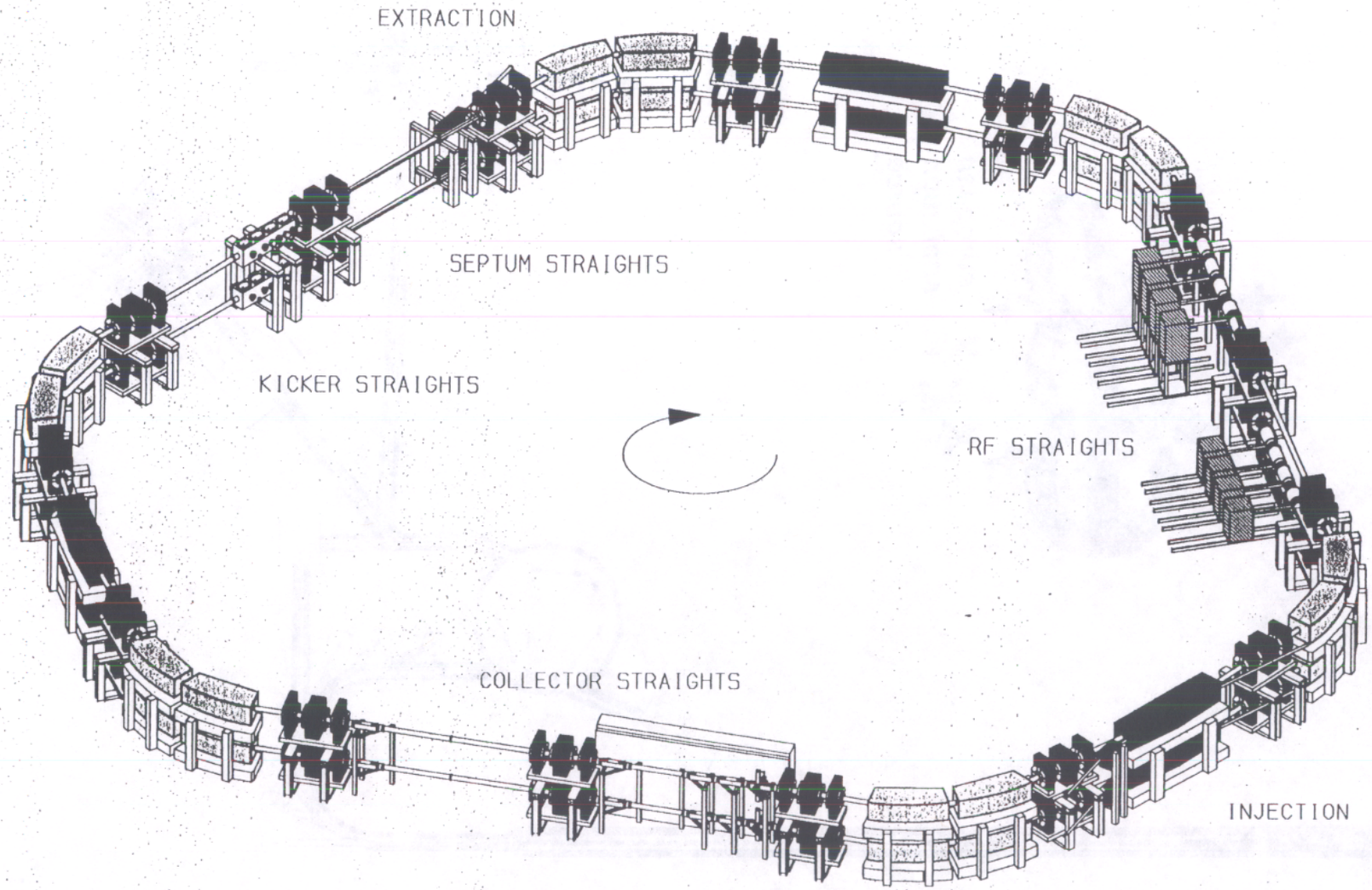
Memorandum of Understanding

RAL	UK
RISØ	Denmark
CEA	France
PSI	Switzerland
Julich	Germany
CIEMAT	Spain
INFM	Italy
HMI	Germany
Univ. of Frankfurt	Germany
IRI	Netherlands

ess

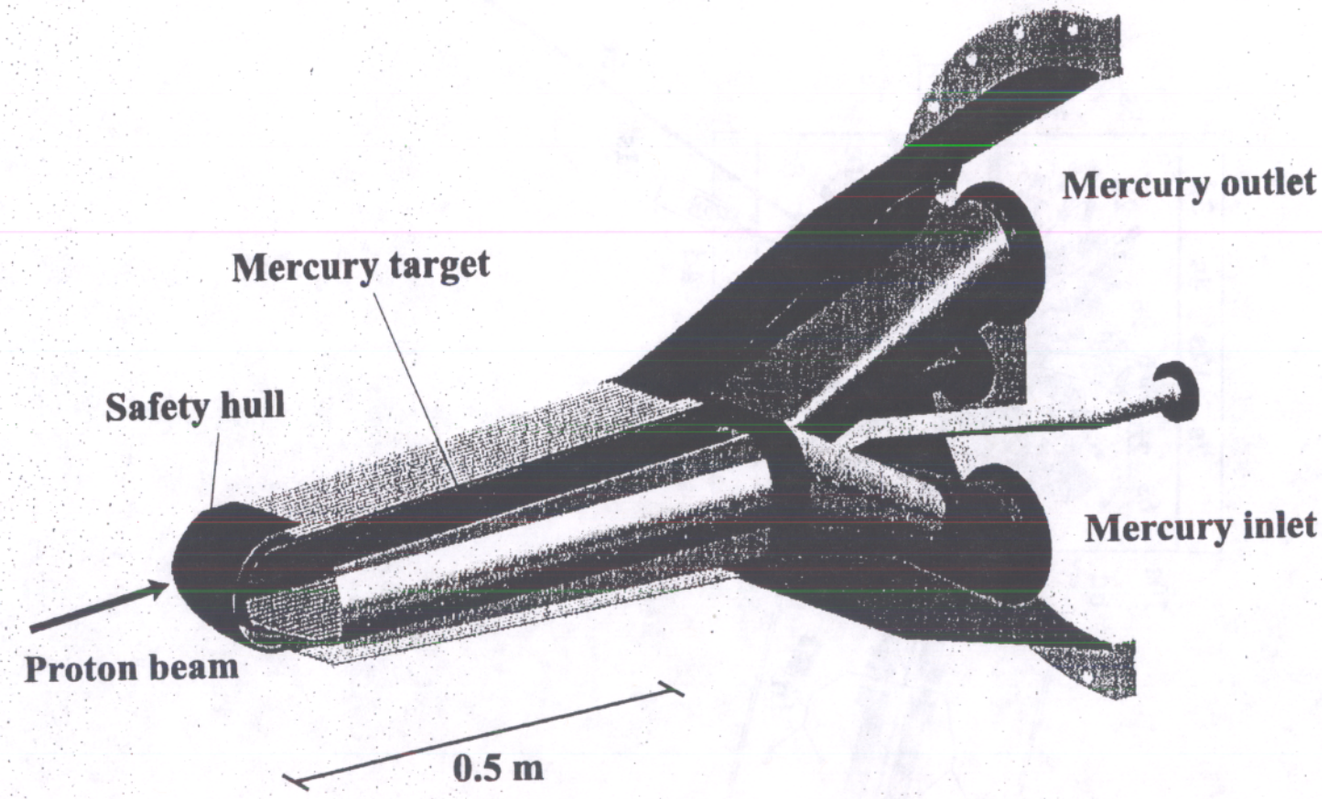
european
spallation
source

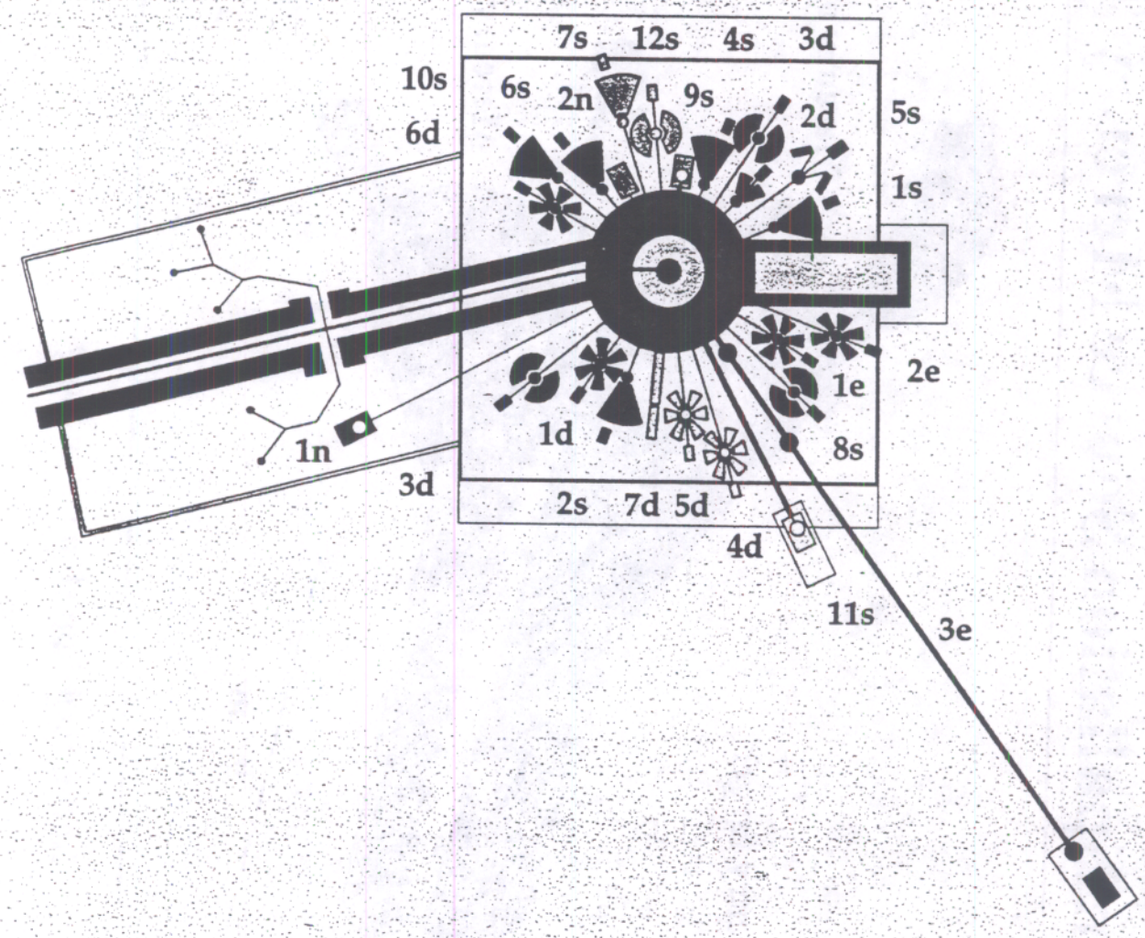


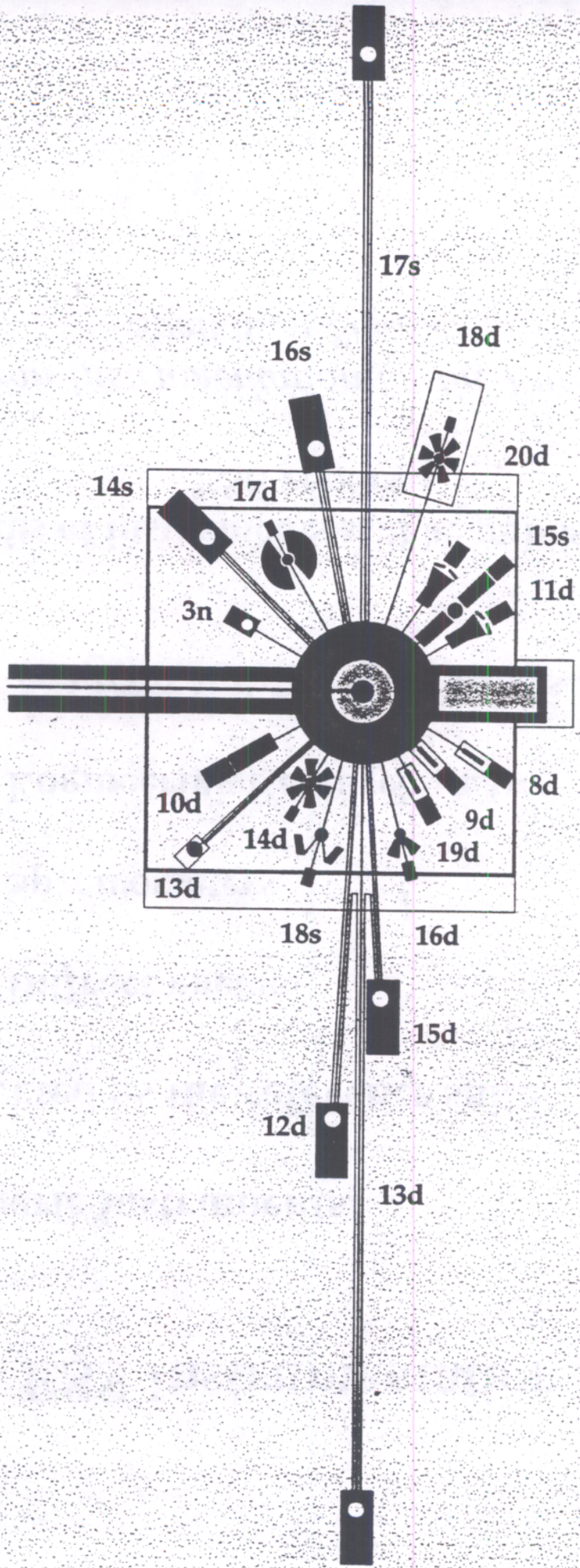


ACCUMULATOR RINGS PERSPECTIVE

The European Spallation Source Mercury Target




7s
12s
4s
3d
10s
6s
2n
9s
2d
5s
6d
1s
2e
1e
1d
8s
1n
3d
2s
7d
5d
4d
11s
3e


17s
18d
16s
20d
14s
17d
15s
11d
3n
8d
10d
9d
14d
19d
13d
18s
16d
15d
12d
13d

ESS Instrumentation

62 generic instruments

44 selected as the reference suite

- 20 Diffractometers
- 18 Spectrometers
- 3 Engineering Research Insts.
- 3 Neutron and Nuclear Physics Insts.

Details of instruments will be published:
ESS report

Neutron Instrumentation for the European Spallation Source.

Future detector requirements

Efficiency	30 eV to 0.1 meV	
γ Sensitivity	ZnS 10^{-7} to 10^{-8} Gas 10^{-8}	
Backgrounds	$\Rightarrow$ 1 c/h / cm^2	
Geometry	Large areas	MAPS 16m^2 GEM 10 m^2
	Flexible geometry	
Spatial resln.	25 x 25 mm^2 $\Rightarrow$ 2 x 2 mm^2 or less	
Rates	GEM on ESS 60 kHz / element SXD on ESS > 10^6 c/s / pixel	
Stability	Stats ~ 0.1 % / several days	
Ease of Maintenance		
Costs		

Detector Dominates Instrument

$$E_{\gamma}Qf_{R}FSM_{c}$$