Detector Research Areas

Rob Lewis

Development Methods

- Do It Yourself
  - Gas detectors

Reasonable price

Long term

Custom design

- Off the Shelf
  - a-Si:H, CCD

Low price

Short term

You get what is offered

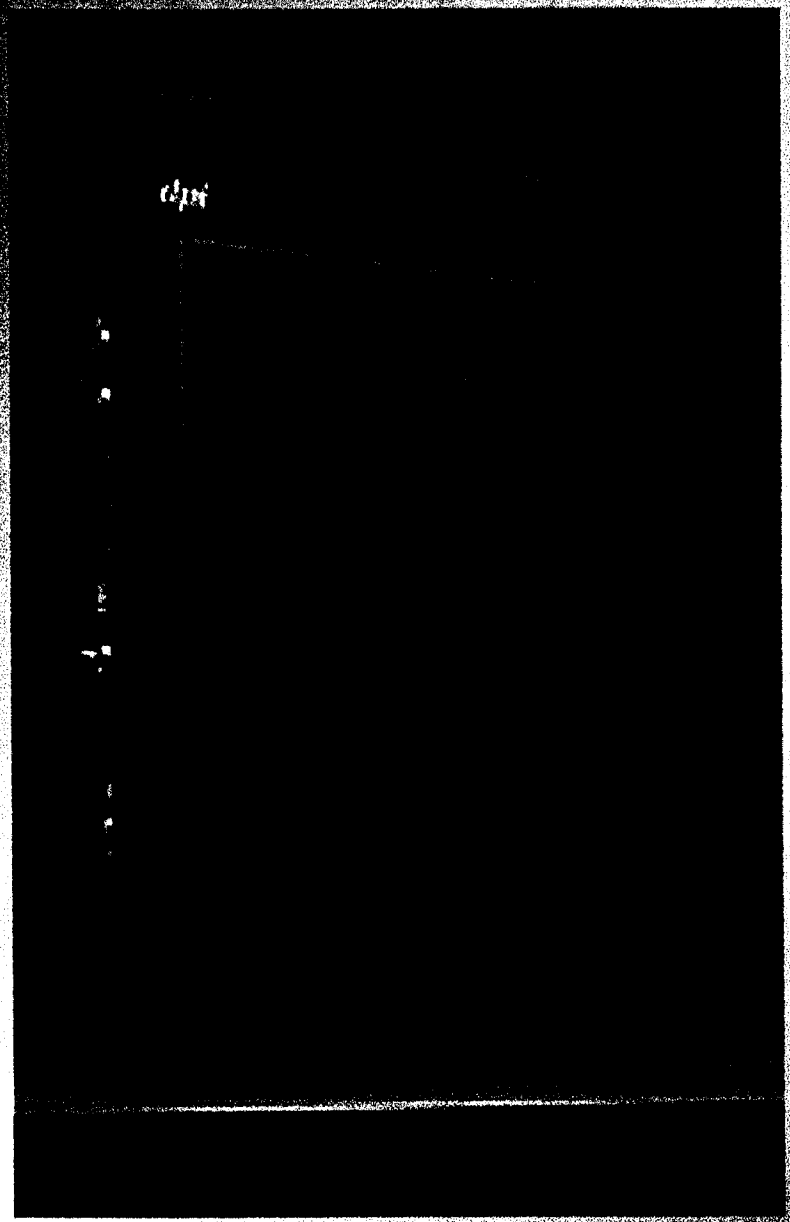
- Collaborate with Industry
  - IIT/CCD, Pixel Devices

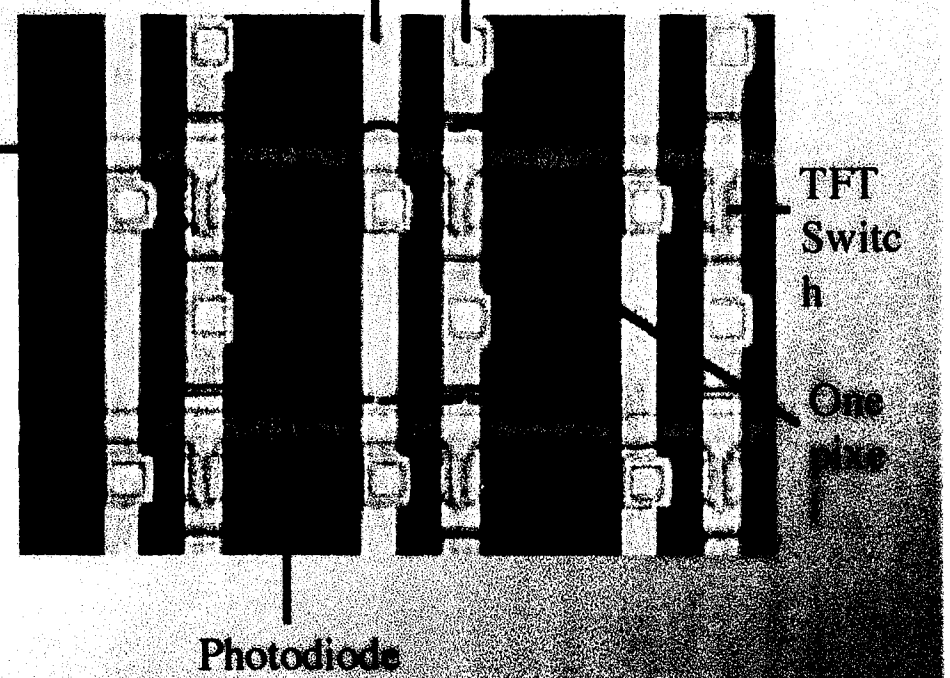
High price

Long term

Custom

a-Si:H Array dpiX - Flashscan 30

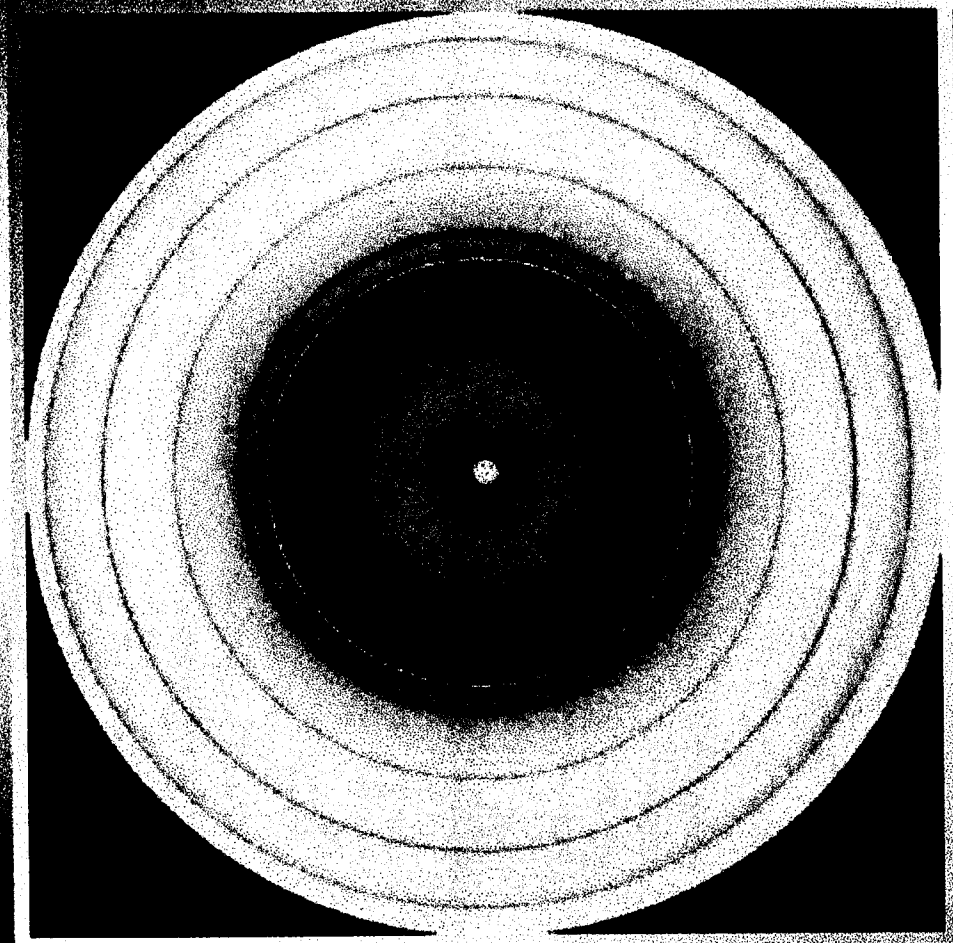




dpiX Flashscan 30 PaxScan 4030

Flashscan 30 - Performance

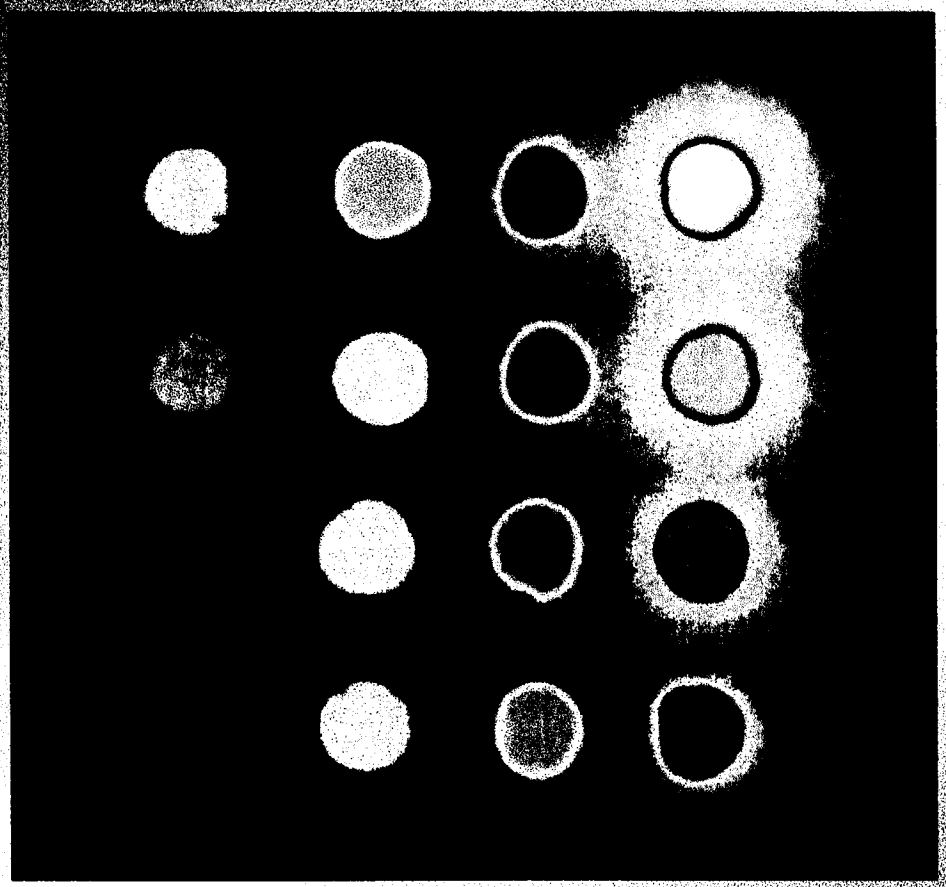
Mar Image Plate

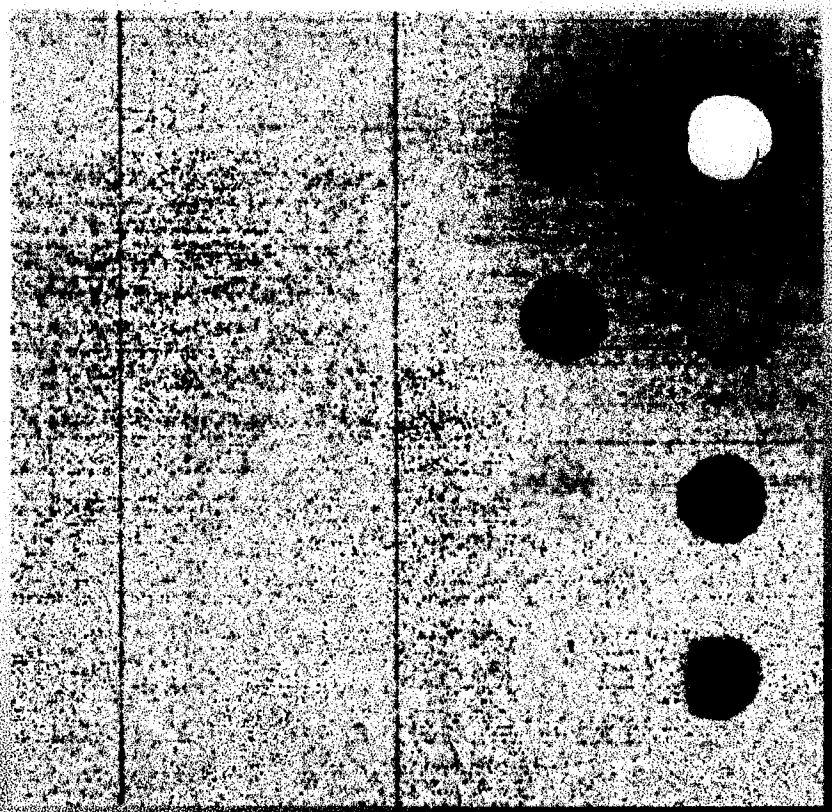


Flashscan-30

t_{int}=30s

Flashscan 30 - Performance





Flashscan 30 - Image Lag

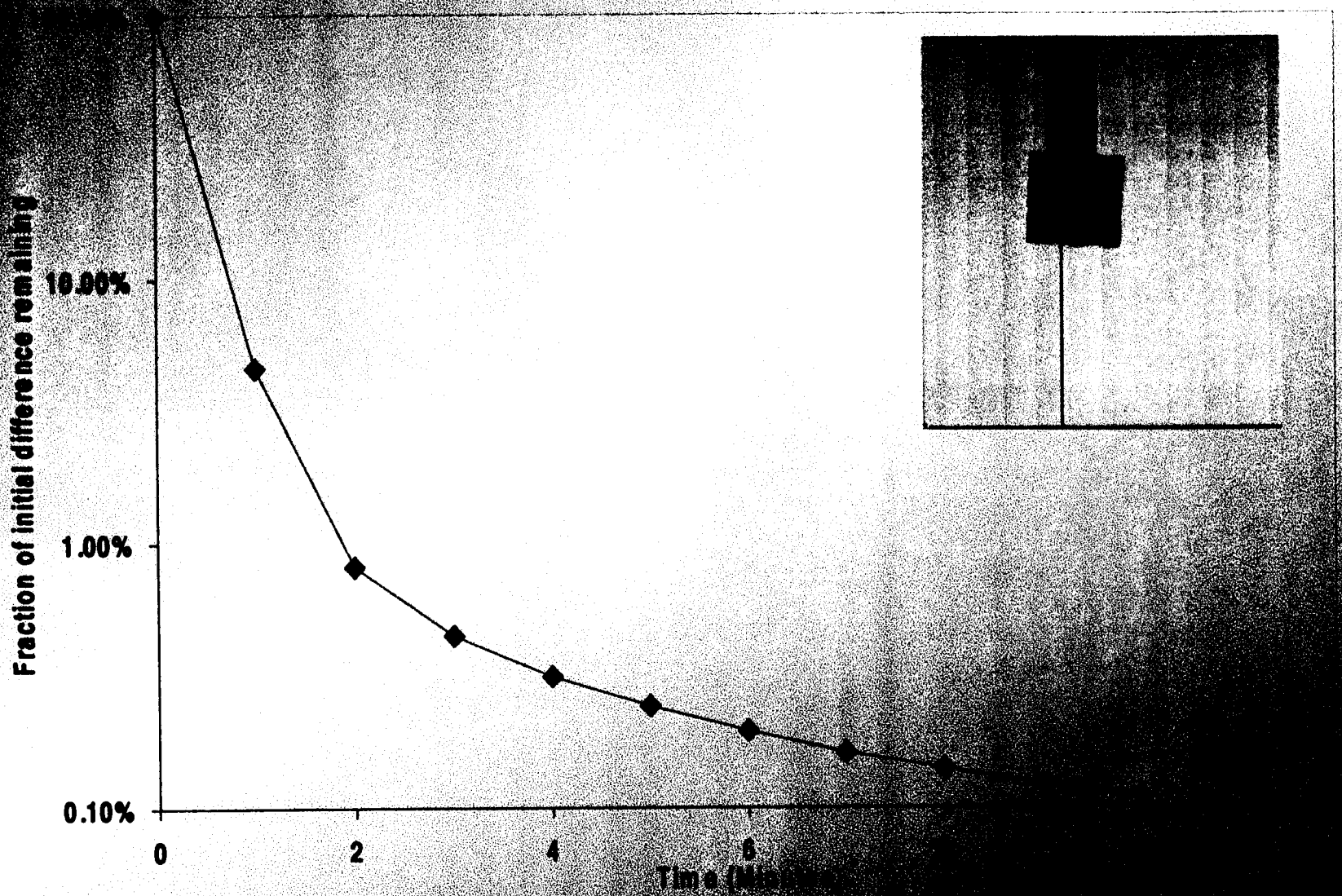
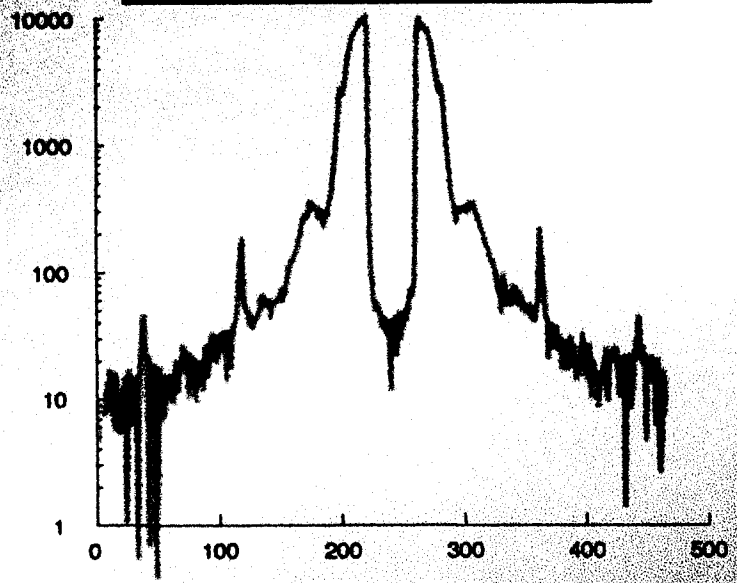
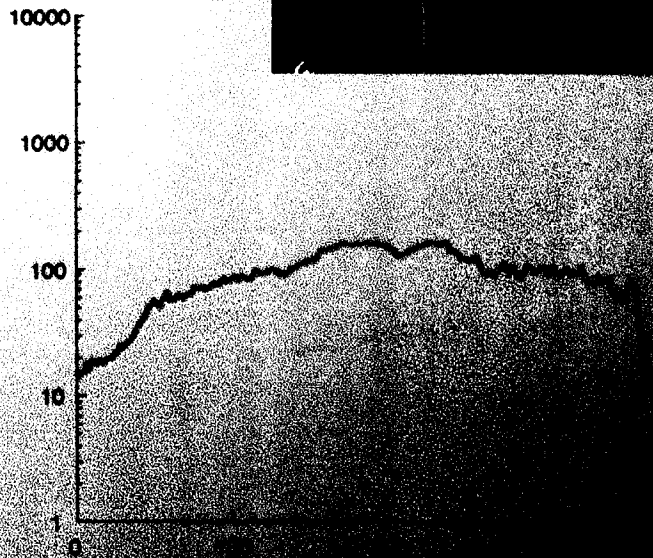


Image Types





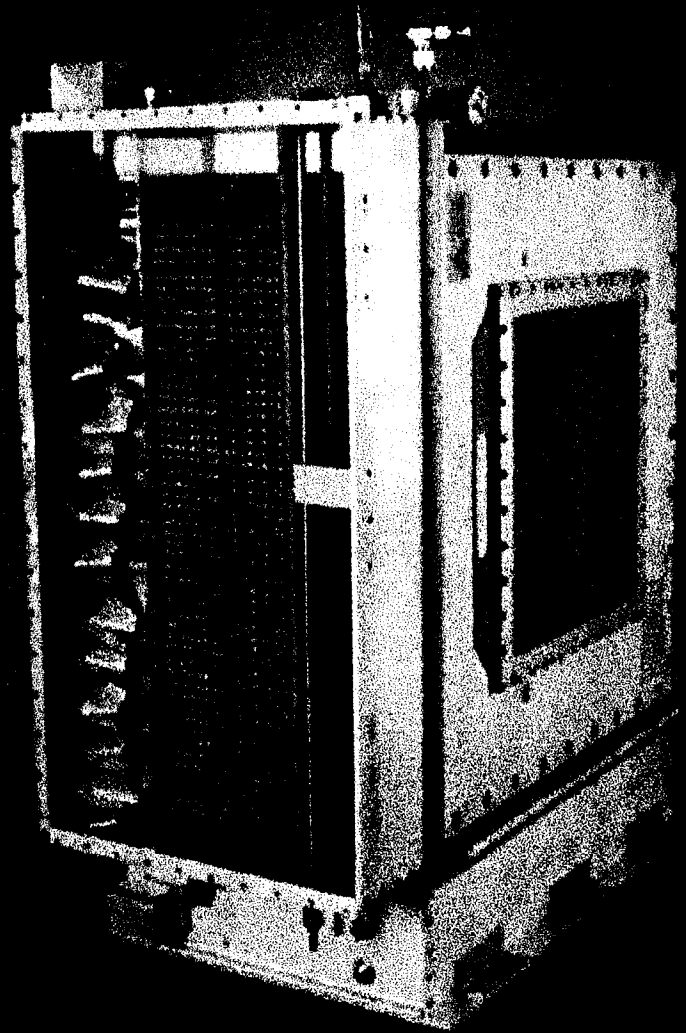
Application Requirements

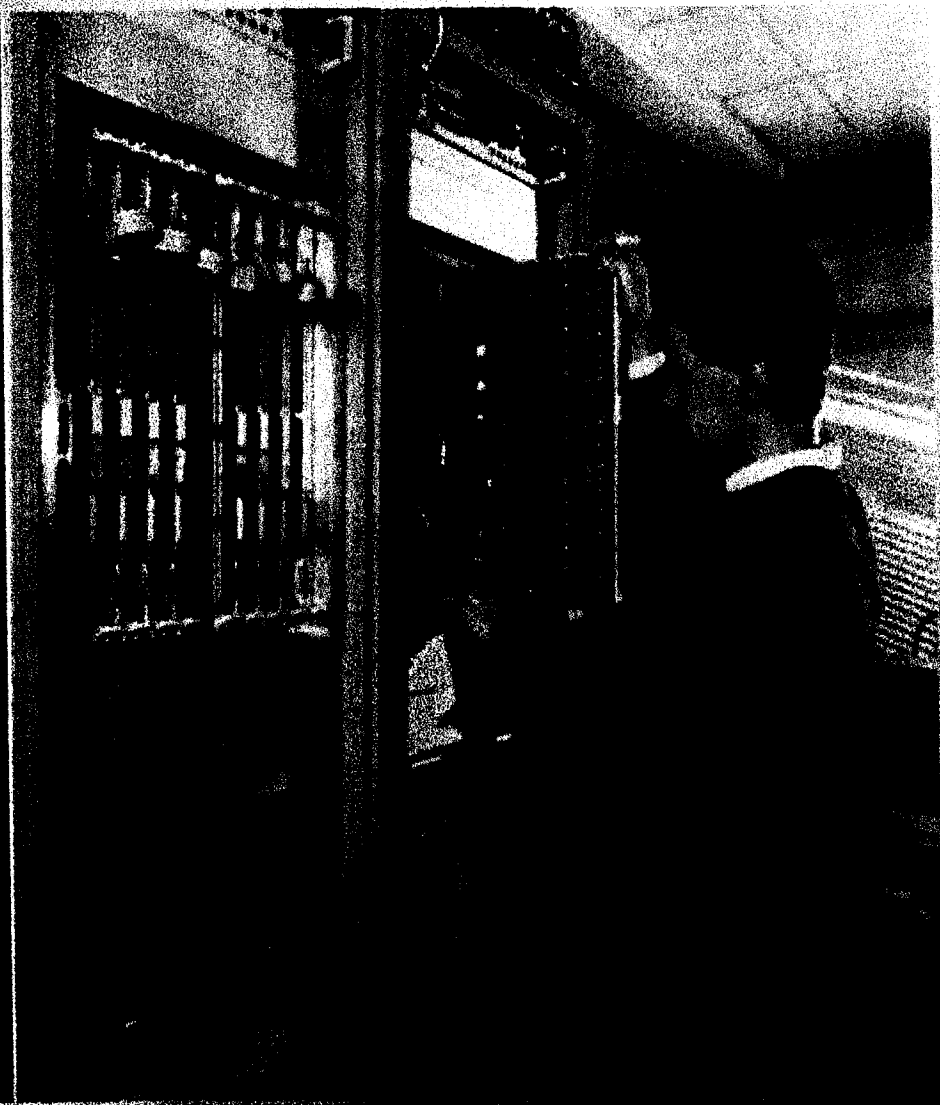
	Diffraction	Medical Imaging
Required size	30cm ÿ	30 x 40 cm
Spatial resolution	50-100μm	50-100μm
Energy range	6-50keV	15-70keV
Frame rate	Crystallography 1Hz SAXS 10^6Hz	Radiography 1Hz Fluoroscopy 50/60Hz
Dynamic range in image	10^4	10^2
Fraction of pixels near saturation	5%	95%
Exposure time	Range μs to 10s of s	

Off the Shelf Summary

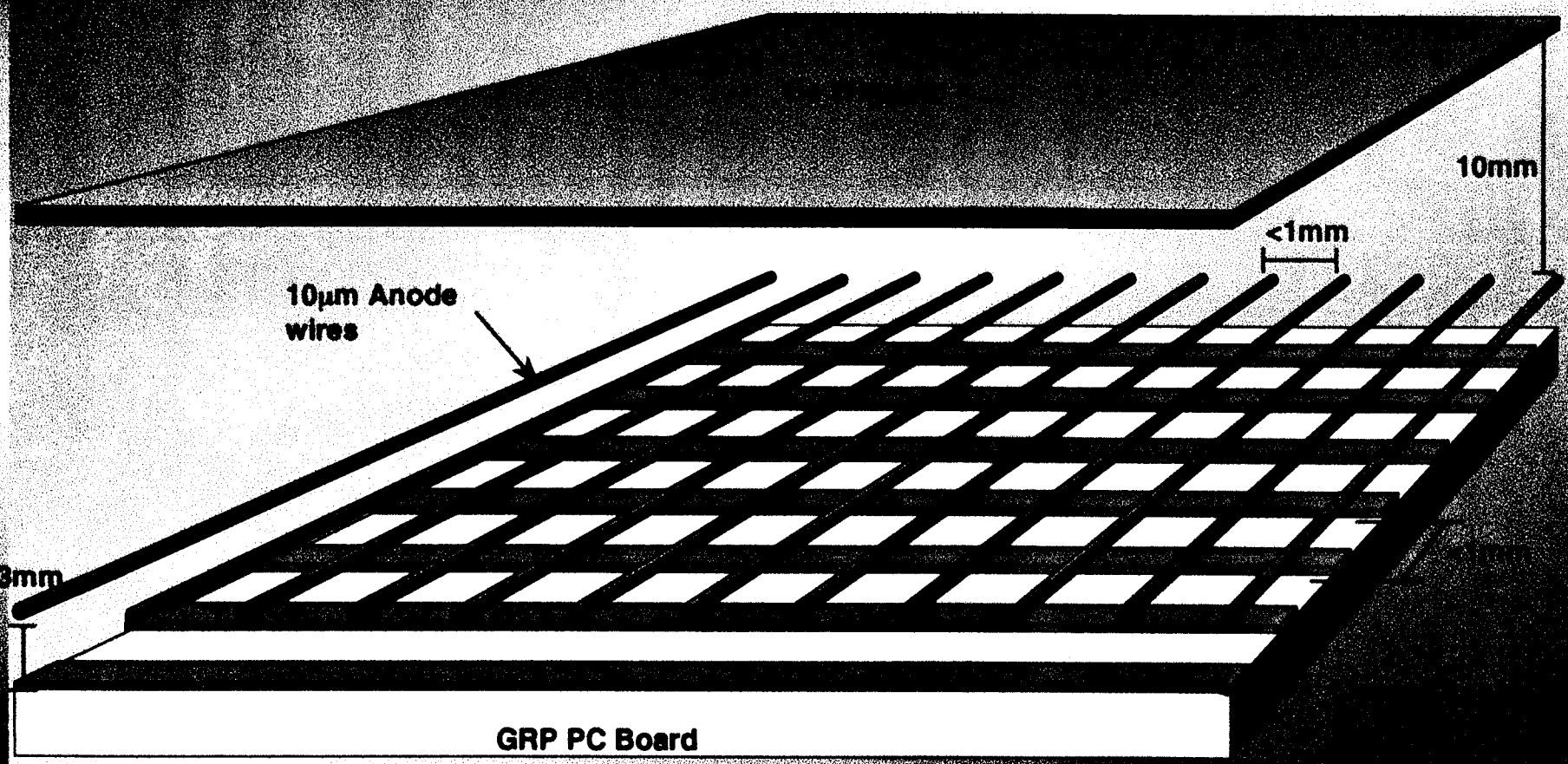
- Detector available in a very short time
- Very cheap
- Requires a detector specialist to interpret specifications
- Detector specialist MUST understand scientific requirement
- No expertise on site
- Little or no control over future improv

RAPID

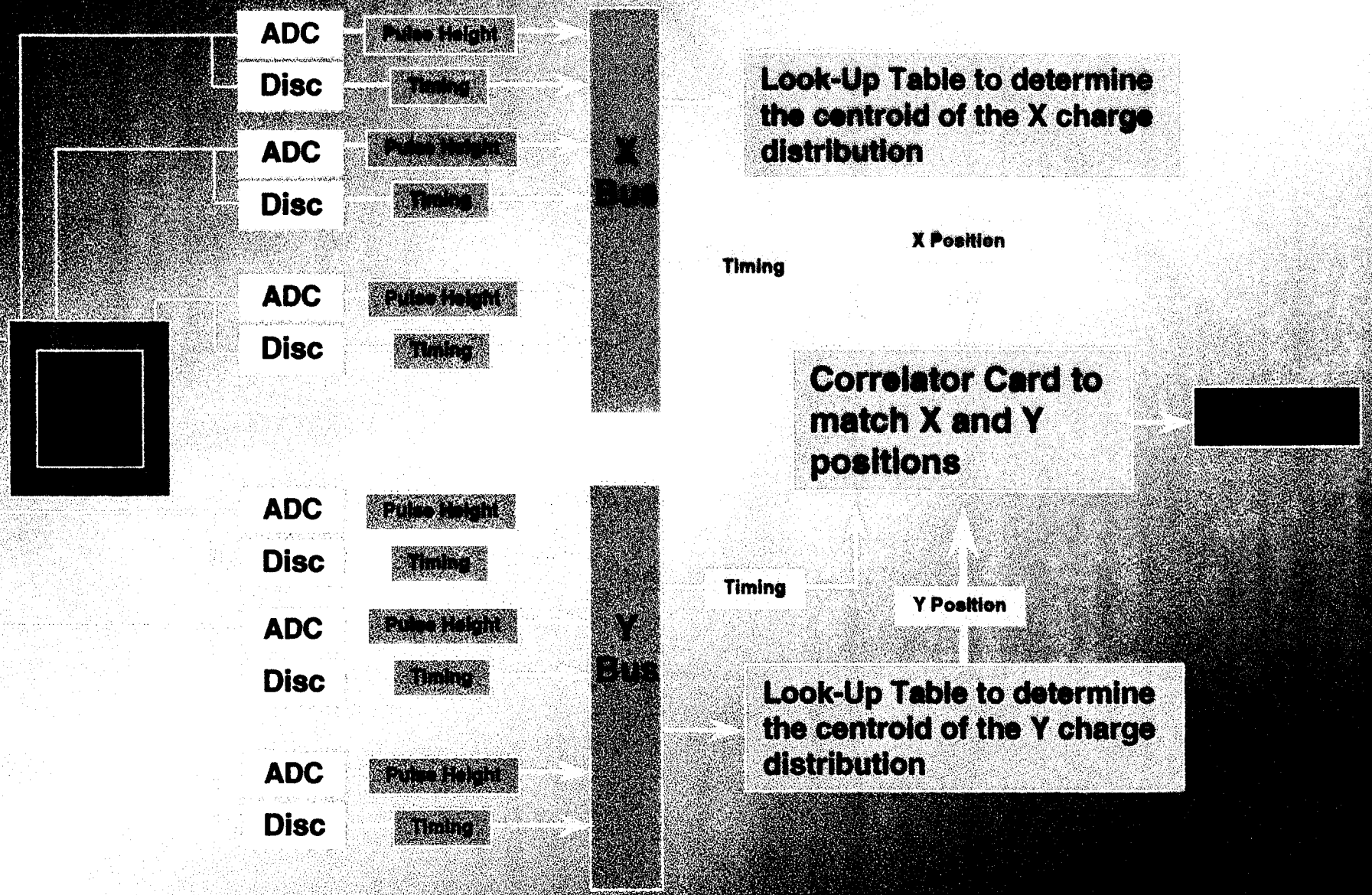




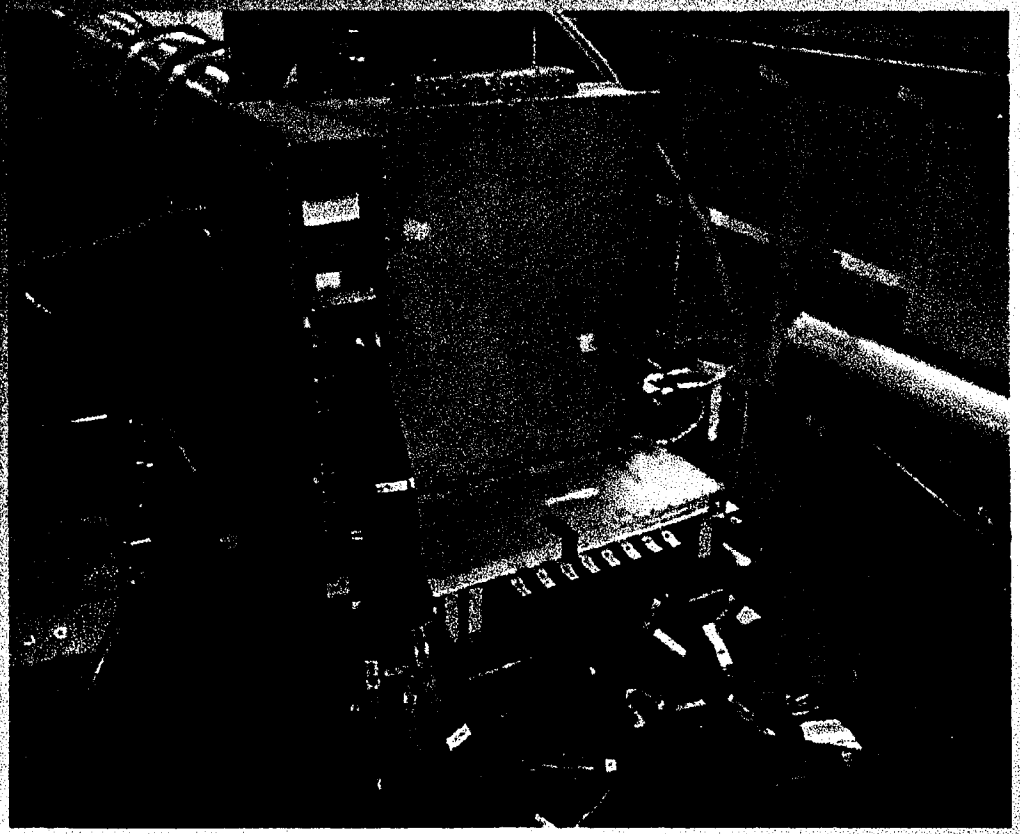
Wire MicroGap Detector

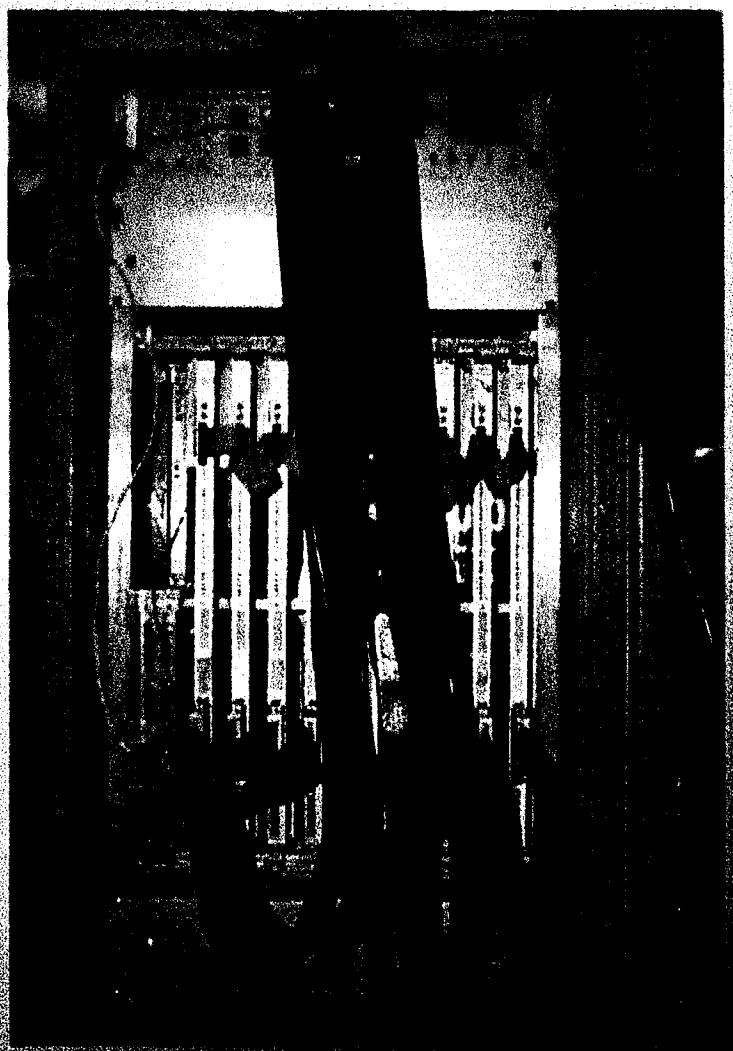


Data Acquisition System



RAPID on 16.1

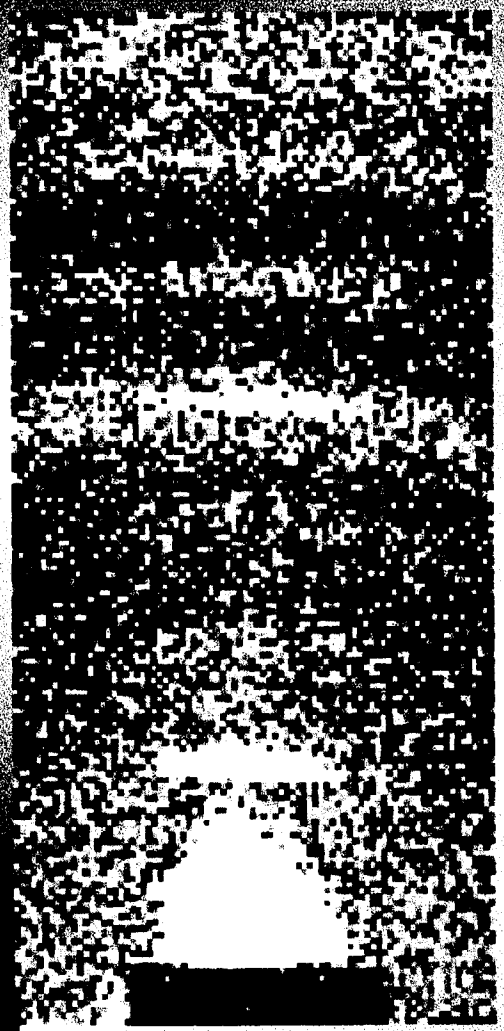




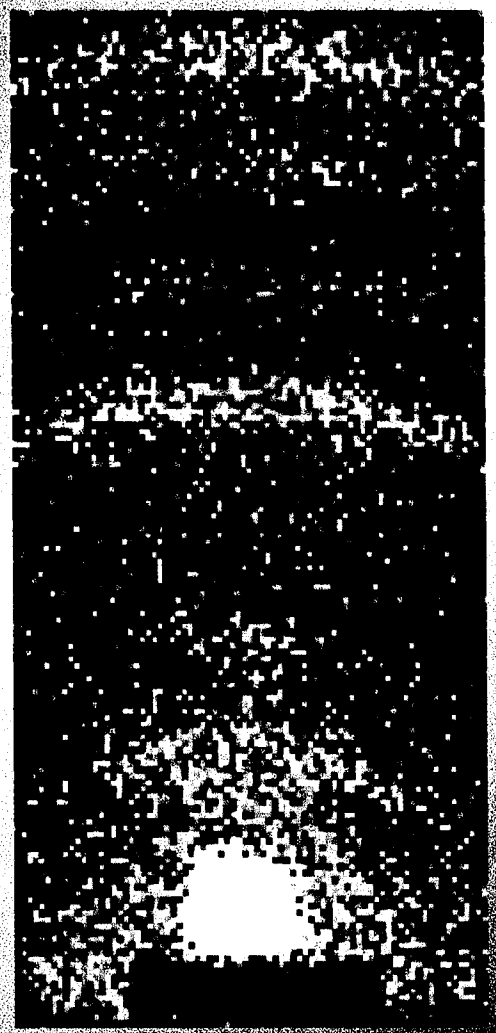
Complex cabling

Collagen 1s exposure 16.1

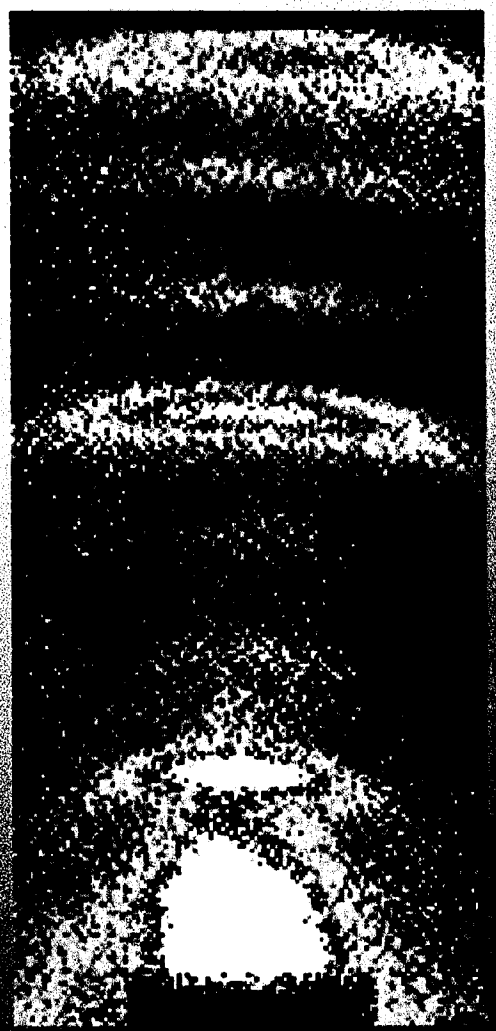
No attenuation



8.7 x attenuation



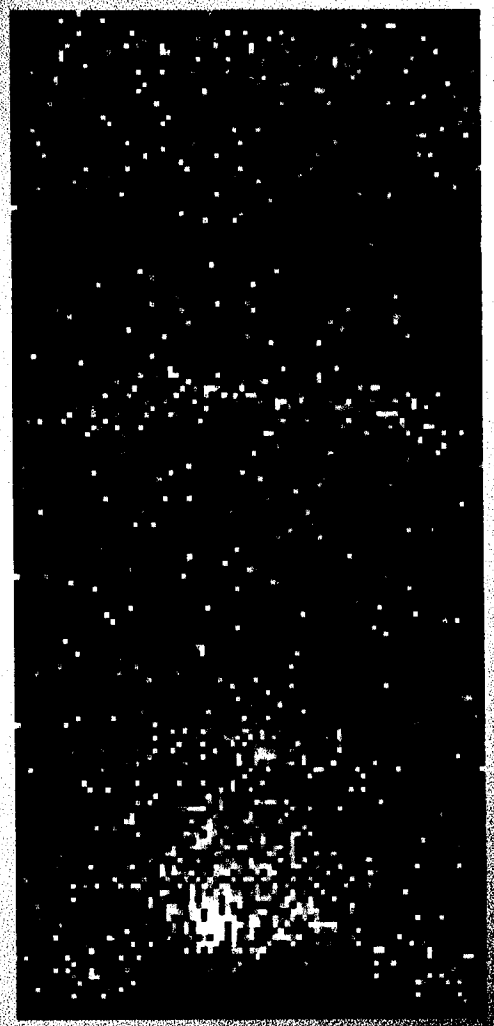
No attenuation



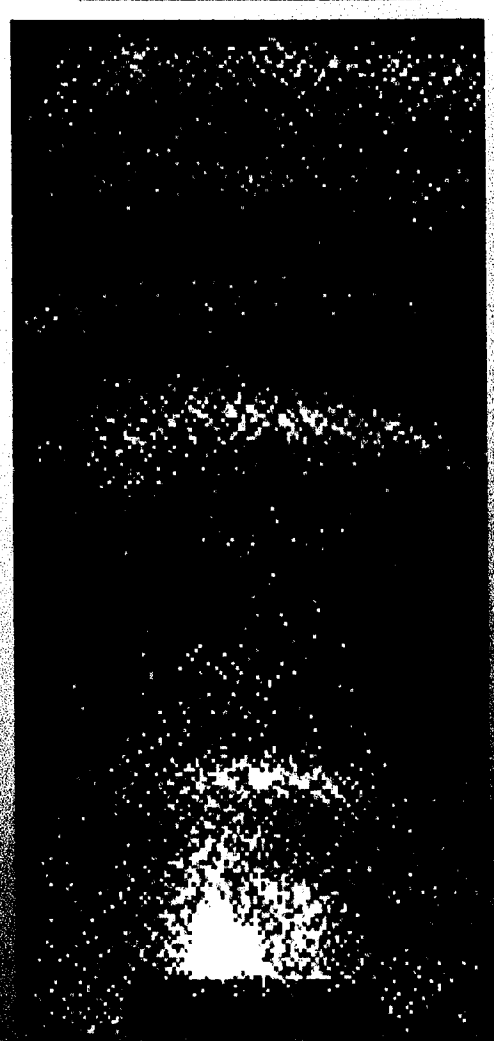
Collagen 100ms exposure 16.1

No attenuation

8.7 x attenuation

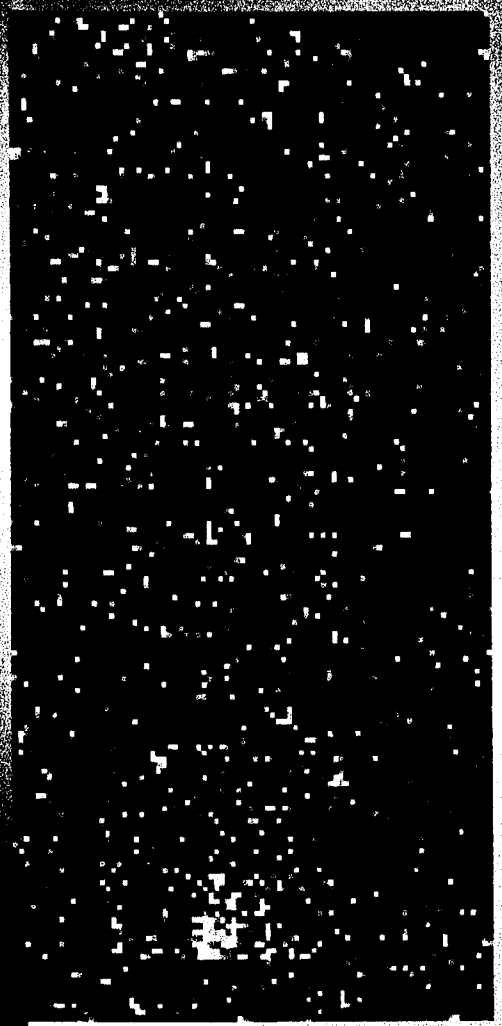


No attenuation

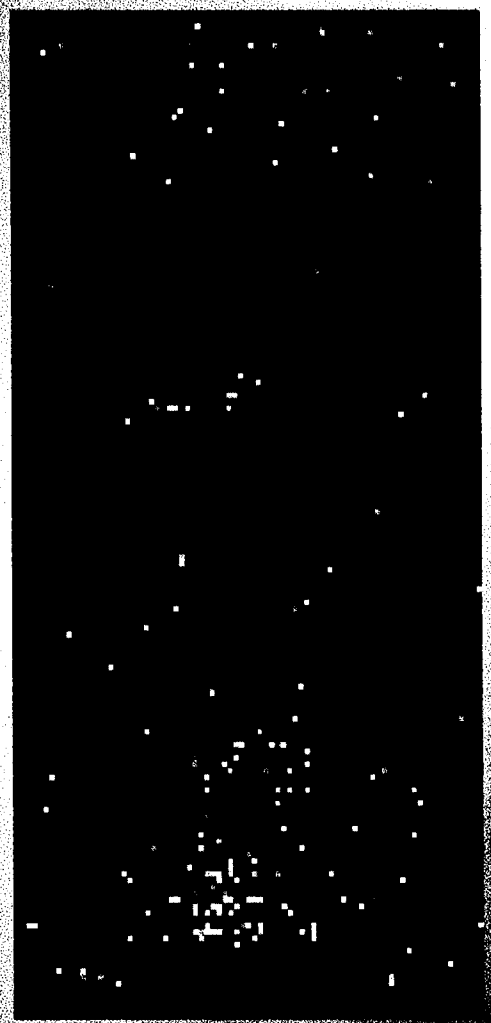


Collagen 10ms exposure 16.1

No attenuation

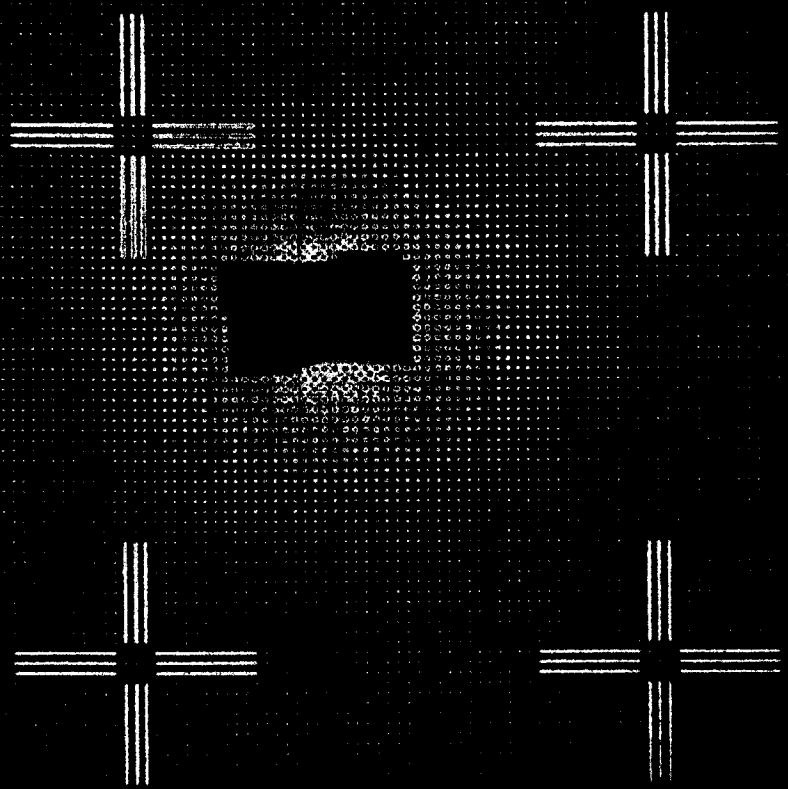


9 x attenuation

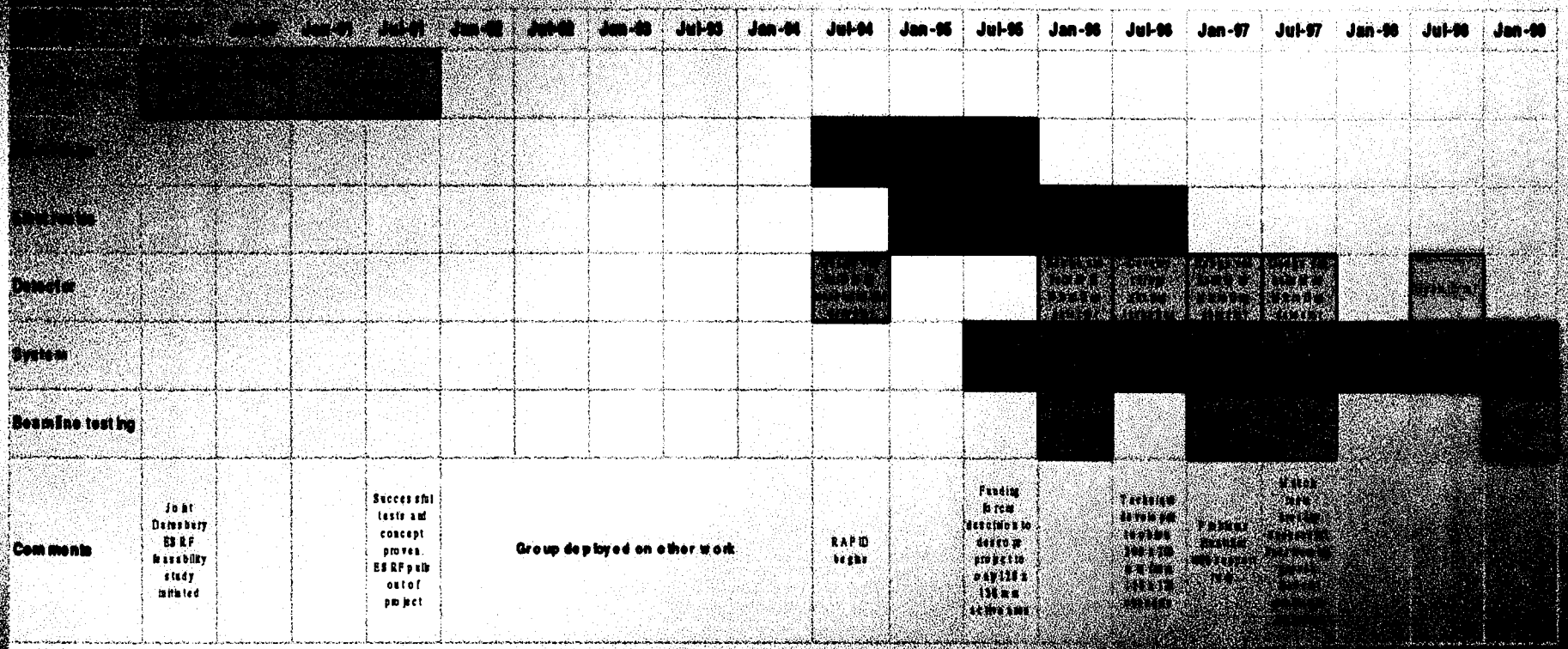


No attenuation

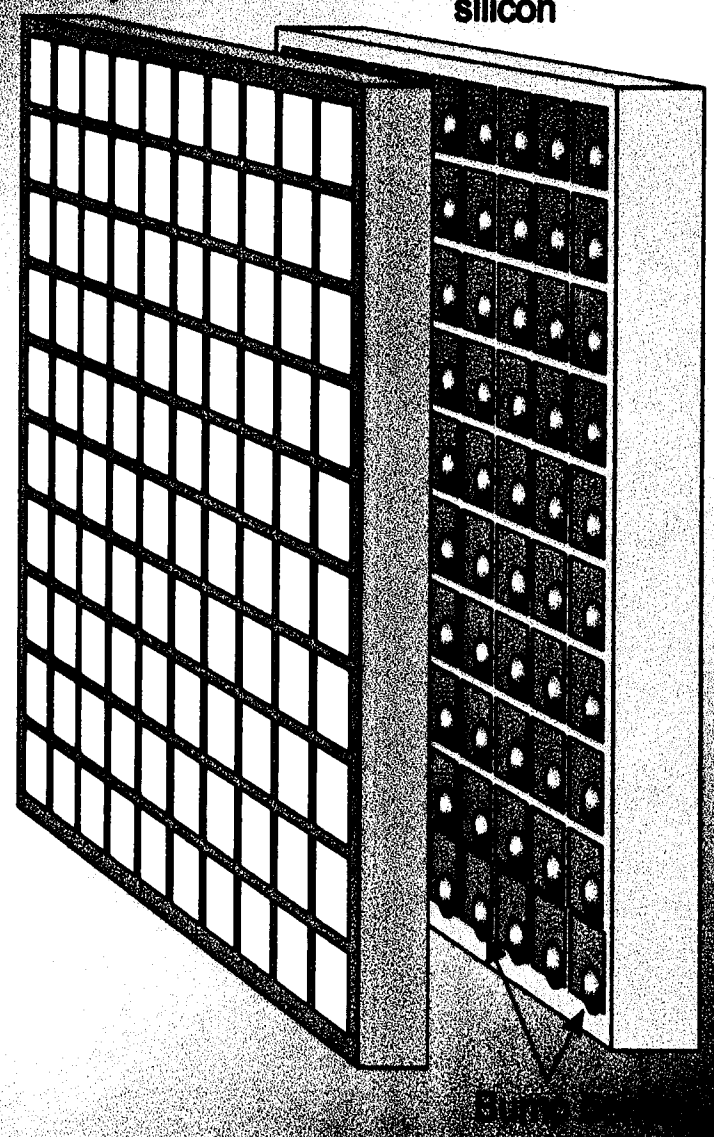
Spatial Resolution



RAPID 1 History



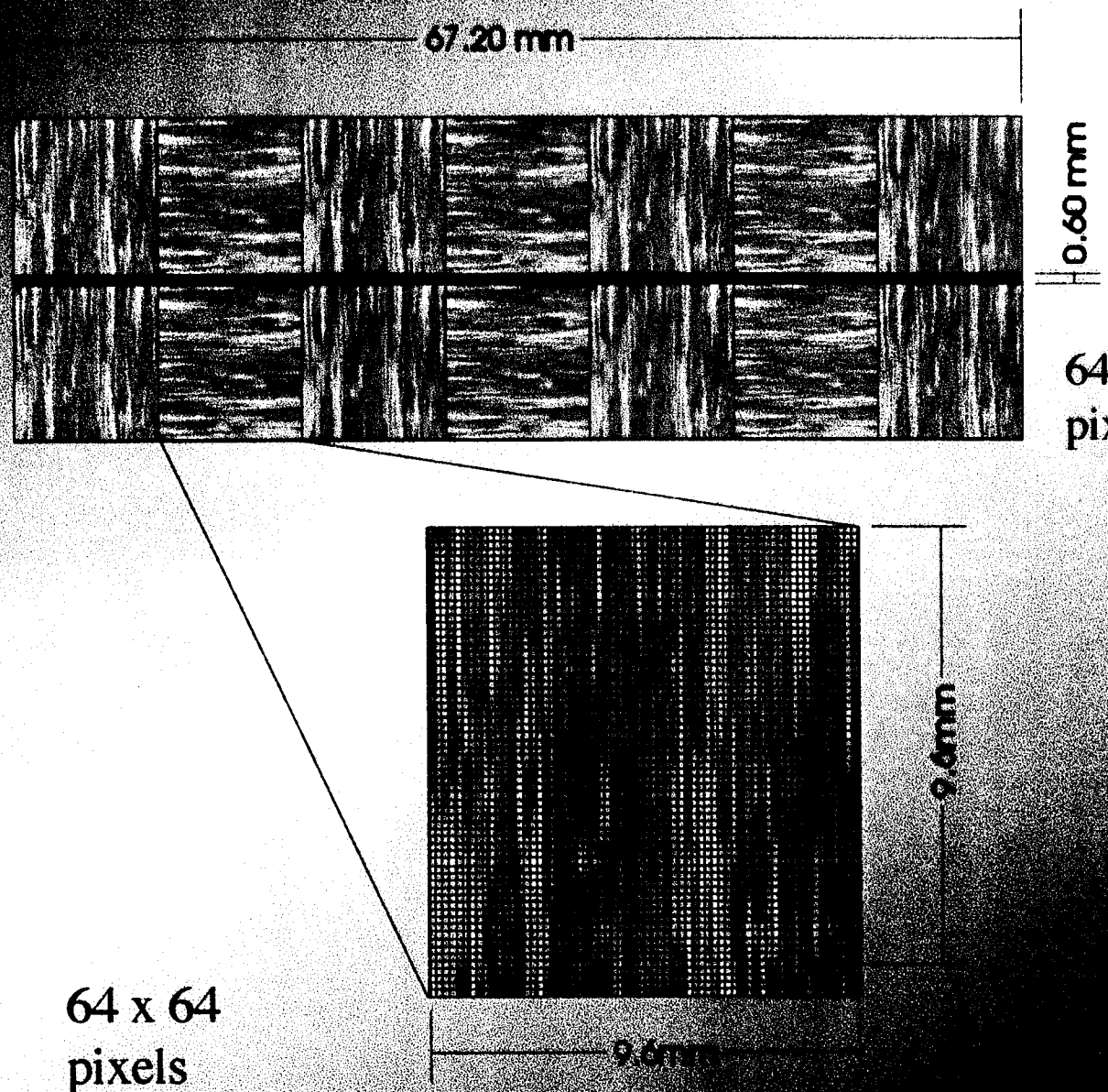
Pixel Detector



IMPACT Programme LAD1

- Silicon pixel detector bump bonded to Aladin chips
- Active area 300 x 300 mm
- 2000 x 2000 150μm square pixels
- Rate 10^6 cts $pixel^{-1}$ s^{-1}
- Readout 1000 frames s^{-1}

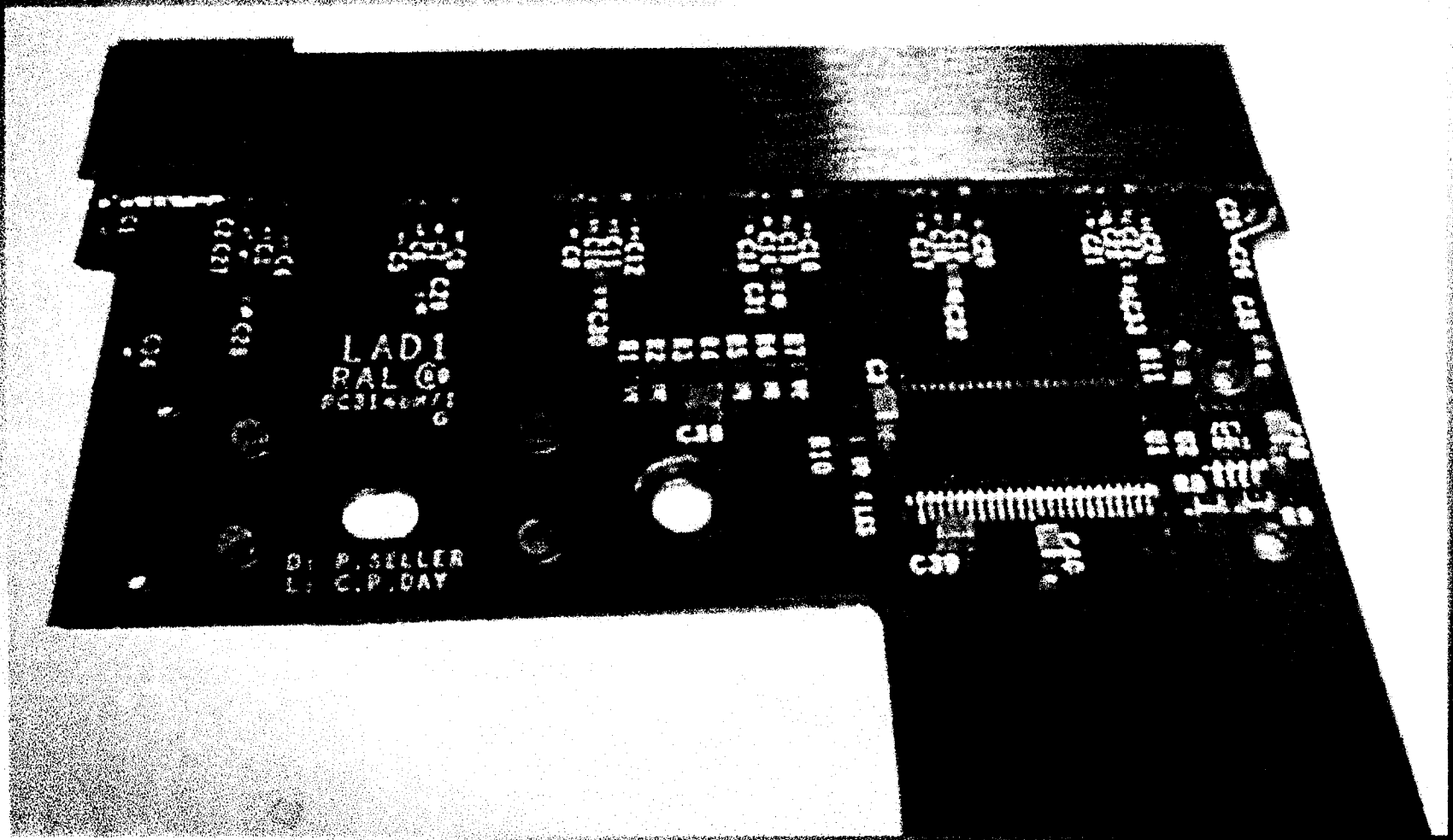
LAD1



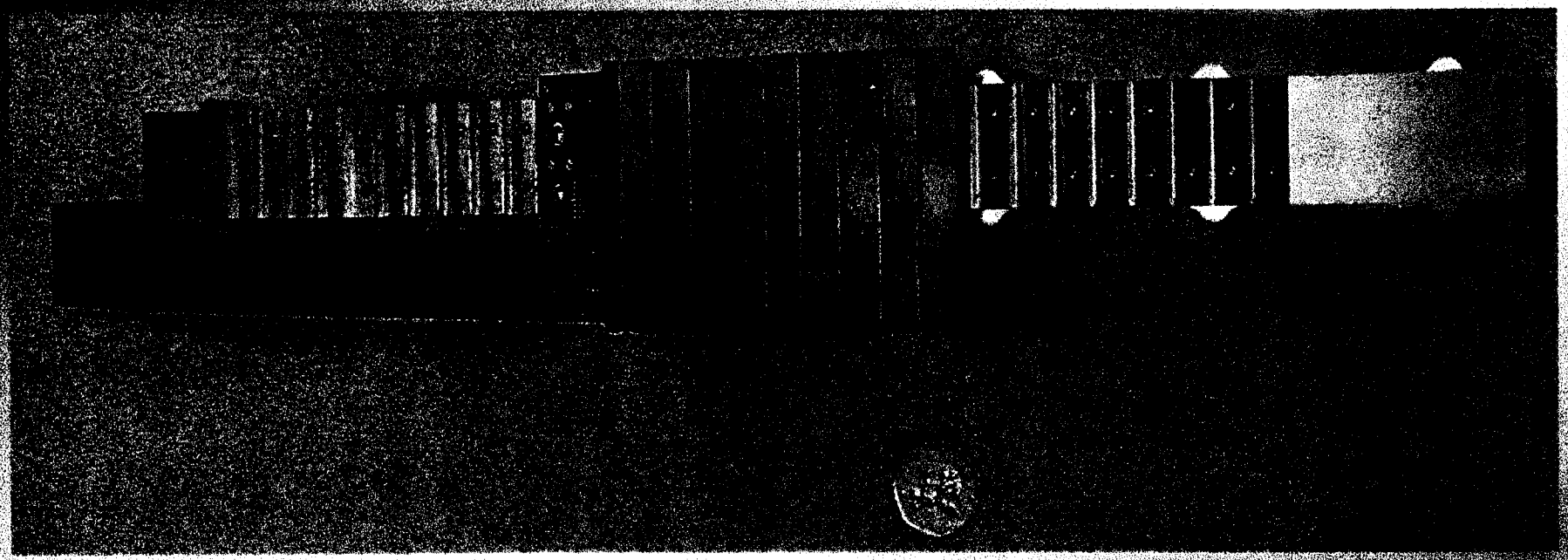
64 x 448
pixels

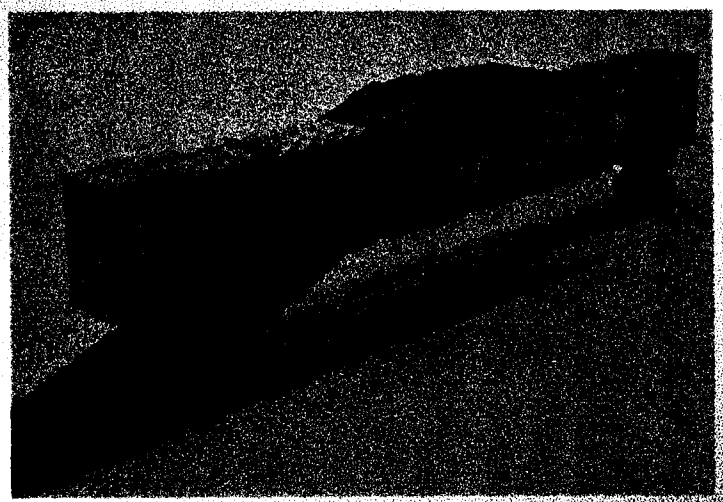
64 x 64
pixels

Current Progress

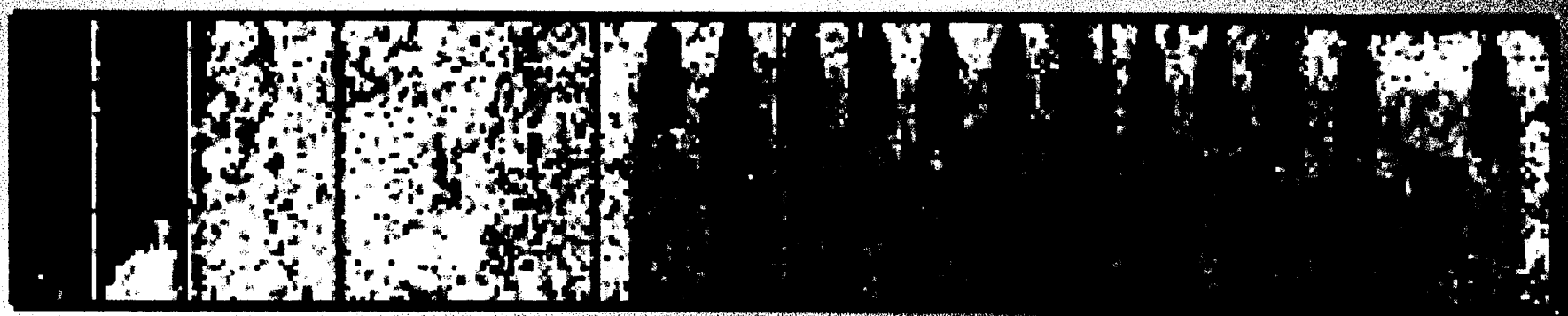


LAD 1

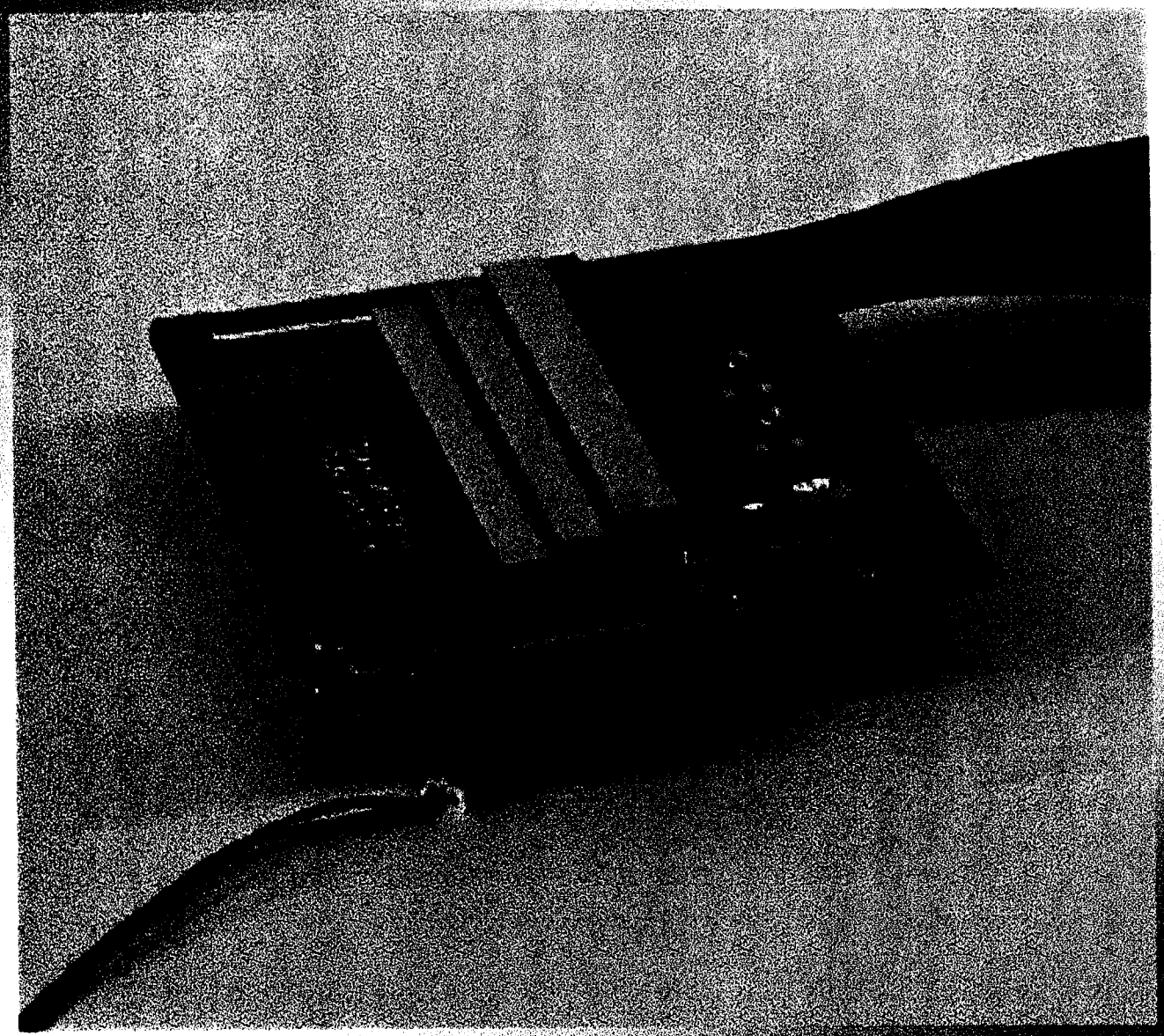




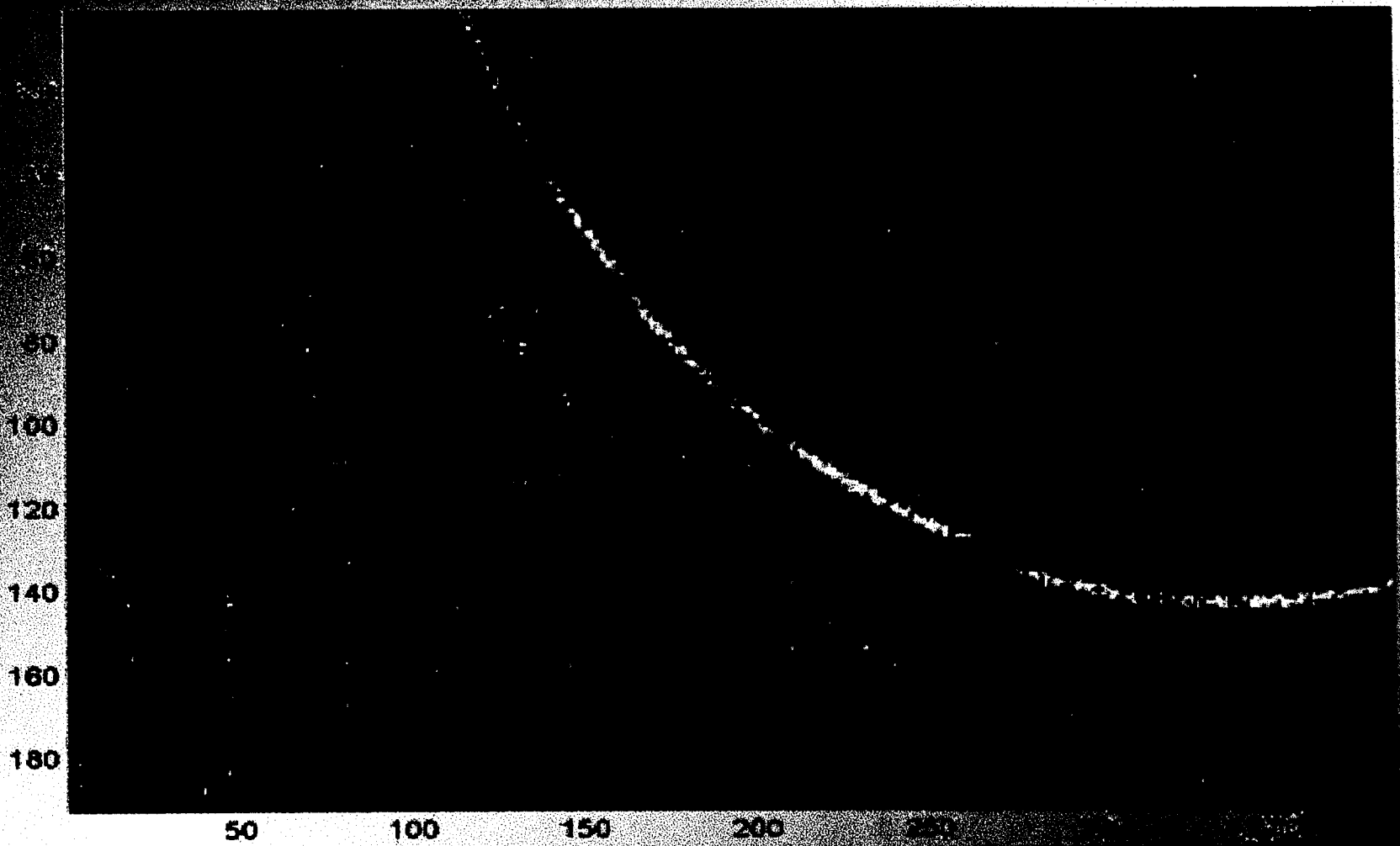
First Images LAD1



LAD1: 3 Ladder module

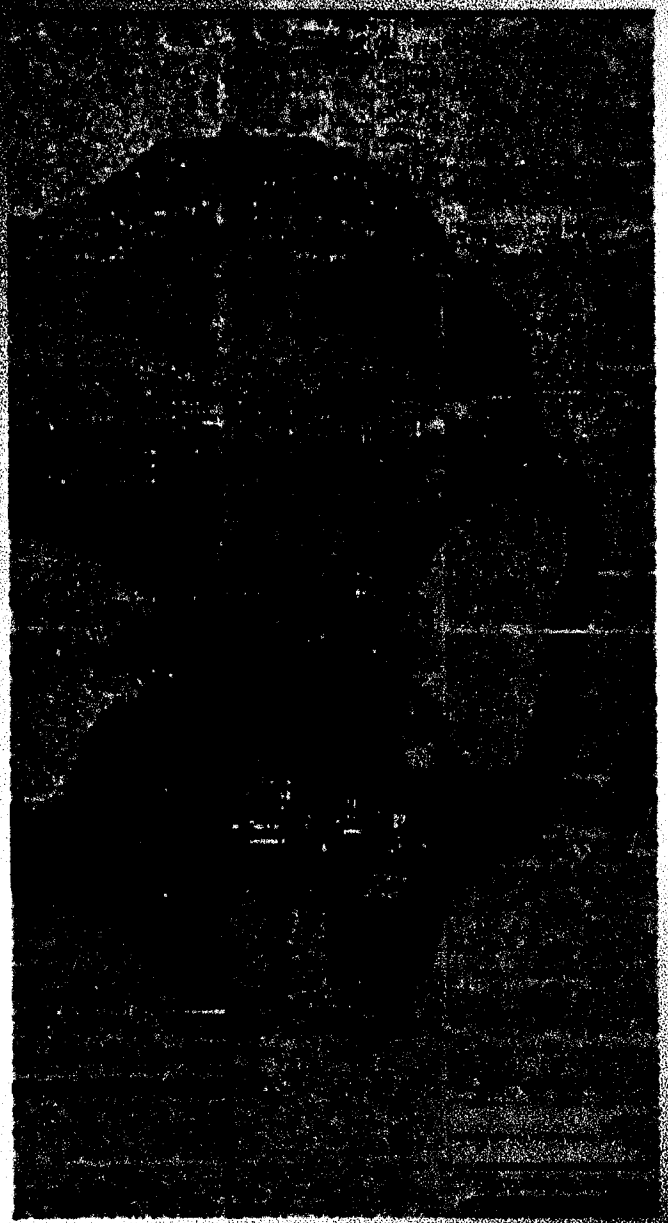


LAD1 Diffraction Image



3-module system (192 x 448)
Inner ring has 10 photons per pixel for the 20ms exposure
Up to 20,000 photons per pixel with the same low

LAD1: Mouse Skull



Pixel Detectors

- Aussios 1991
  - In conclusion SR diffraction requires ë2-D pixel detectors based on crystalline silicon pixel detectors connected to smart readout chipsí
- ESRF Workshop on Pixel Detectors 1999
  - As a conclusion it was agreed that several x-ray analysis techniques, among which SAXS, PX and time-resolved diffraction, could actually benefit from this technology as soon as detectors with larger area become available

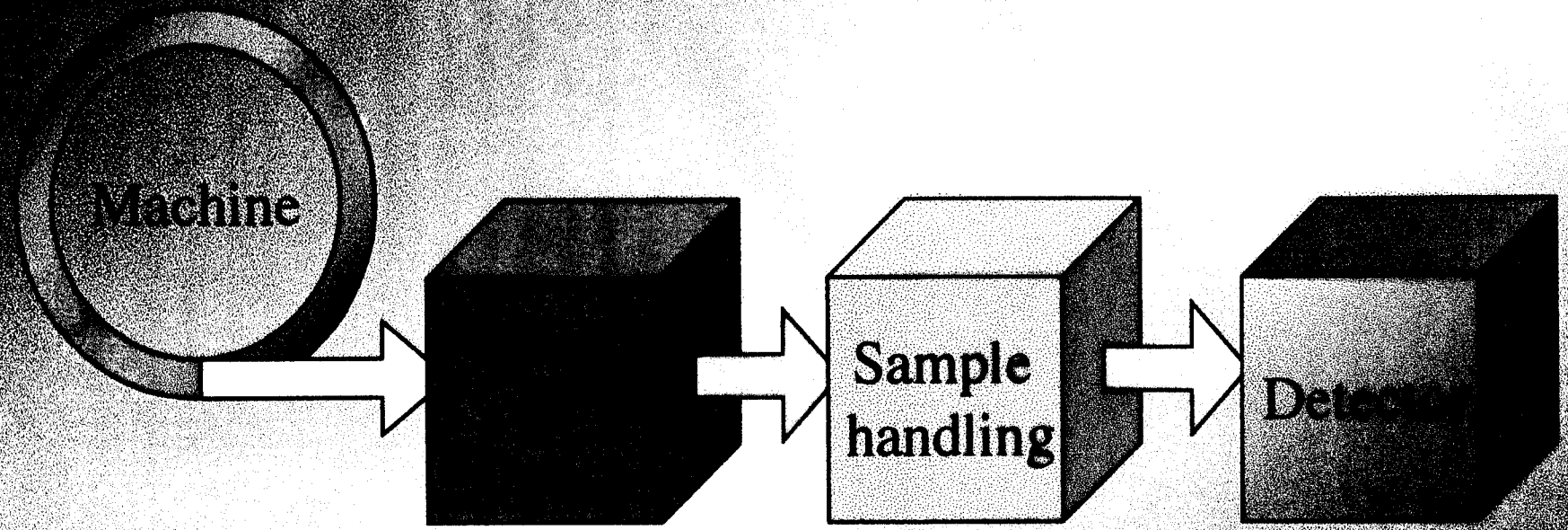
Collaborate Conclusions

- Took a very very long time. Still some way off
- Might become exactly what <u>was</u> required
- Cost was high (but distributed over time)
- Expertise on site
- Customising takes time
- Future expansion possible

Why are Detectors Inadequate?

- Tendency to start from wrong place
  - My beamline can produce 10^{13} photons s^{-1} and I would like to detect changes in 100ns.
  - I therefore must have a detector capable of 10^{13} cts s^{-1} and a frame rate of 10^{7} frames s^{-1}
- Better question
  - How many photons do I need to detect in (timescale) to have sufficient statistical [illegible] answer my scientific question?

Generic SR Experiment



$500M for 50 stns
$10M per station

$2M

$10

$250 k

Source

Detector

SRI July 1991

Mike Hart

- éThe division of funding between source, optics and detectors seems to be seriously out of balance. Neither optics nor detectors can fully meet the experimental requirements of even second generation bending magnet sources.í

Conclusions

- The mismatch between source and detectors is scandalous!
- SR experiments are highly diverse
- Some are challenging experiments
- Others are simple measurements
- There is no single ëcorrectí way to solve detector problem

Conclusions

- Purchase where possible
- Have a well funded detector group
- Use detector group to;
  - Develop new detectors for challenging problems
  - Procure and maintain commercial devices
- Above all; be flexible and prepared to adapt to change

Roadmap

Warning

- An out of date map is often worse than no map at all!