Operation of a variable energy RFQ accelerator system to produce intense beams of neutrons for cargo interrogation.

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Generation of intense beams of neutrons through $d(d,n)^3He$ reaction

Yield ~ 10^{10} $n.s^{-1}$ at 100 µA

To achieve this, several pre-requisites:

1. Beam of D^+ ions of defined energy.

2. Suitable deuterium target.

3. Suitable neutron detection system.

Two accelerator systems are now in operation at Necsa with the following attributes:

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Operating specifications for the two accelerator systems.

Features	ADM	D-100
operating frequency (MHz)	425	200
injection energy (keV)	25.0	35.0
output energy (MeV)	3.6 - 4.9	3.7 - 5.1
injector output current (pulsed)(mA)	12	55
booster output current (pulsed)(mA)	8	50
maximum beam pulse width (ms)	0.1	2
repetition rate (Hz)	20-200	20-100
maximum RF duty factor	1.2 %	20 %
pulsed RF power requirement (kW)	280/160	1000/200
linac length (m)	4.4	4.5
Neutron flux ($n.s^{-1}$)	10^{10}	10^{12}

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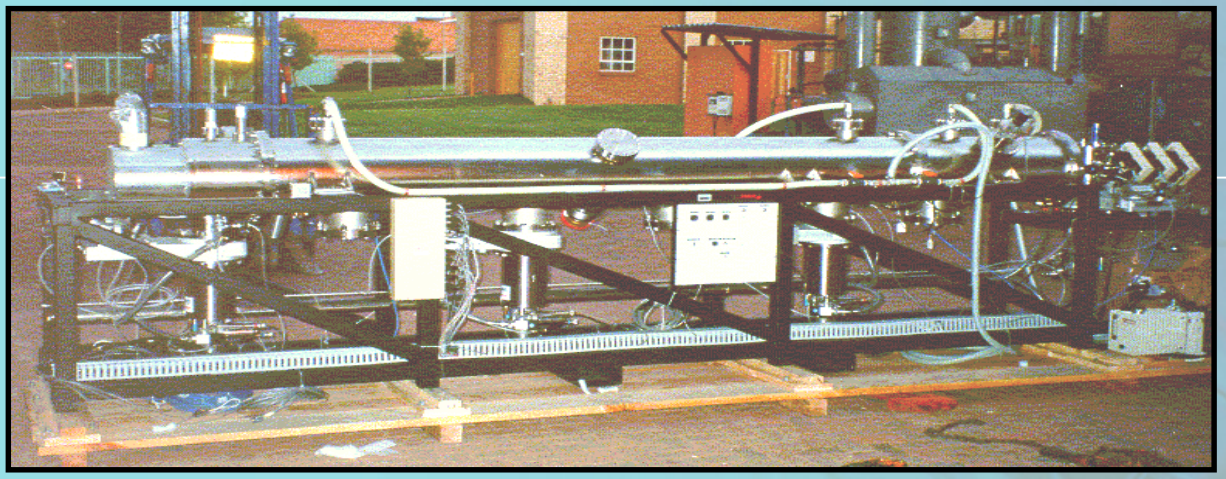
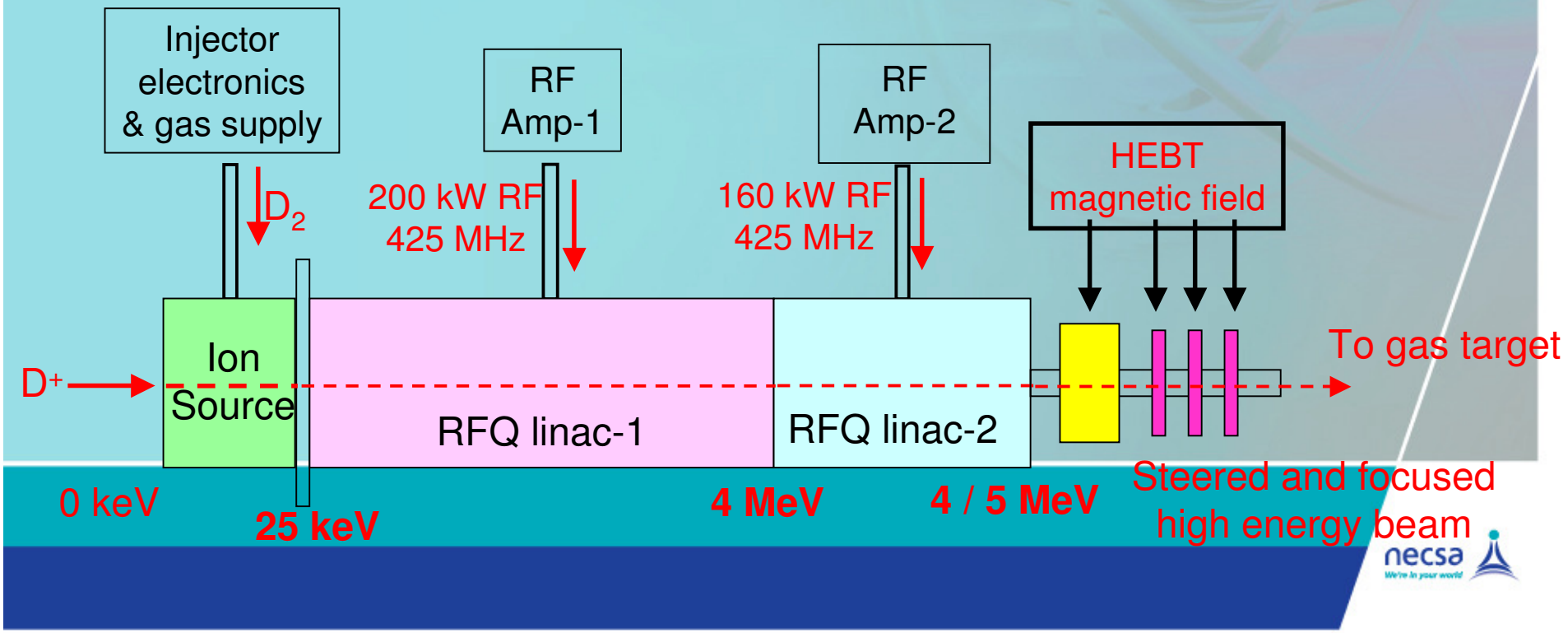
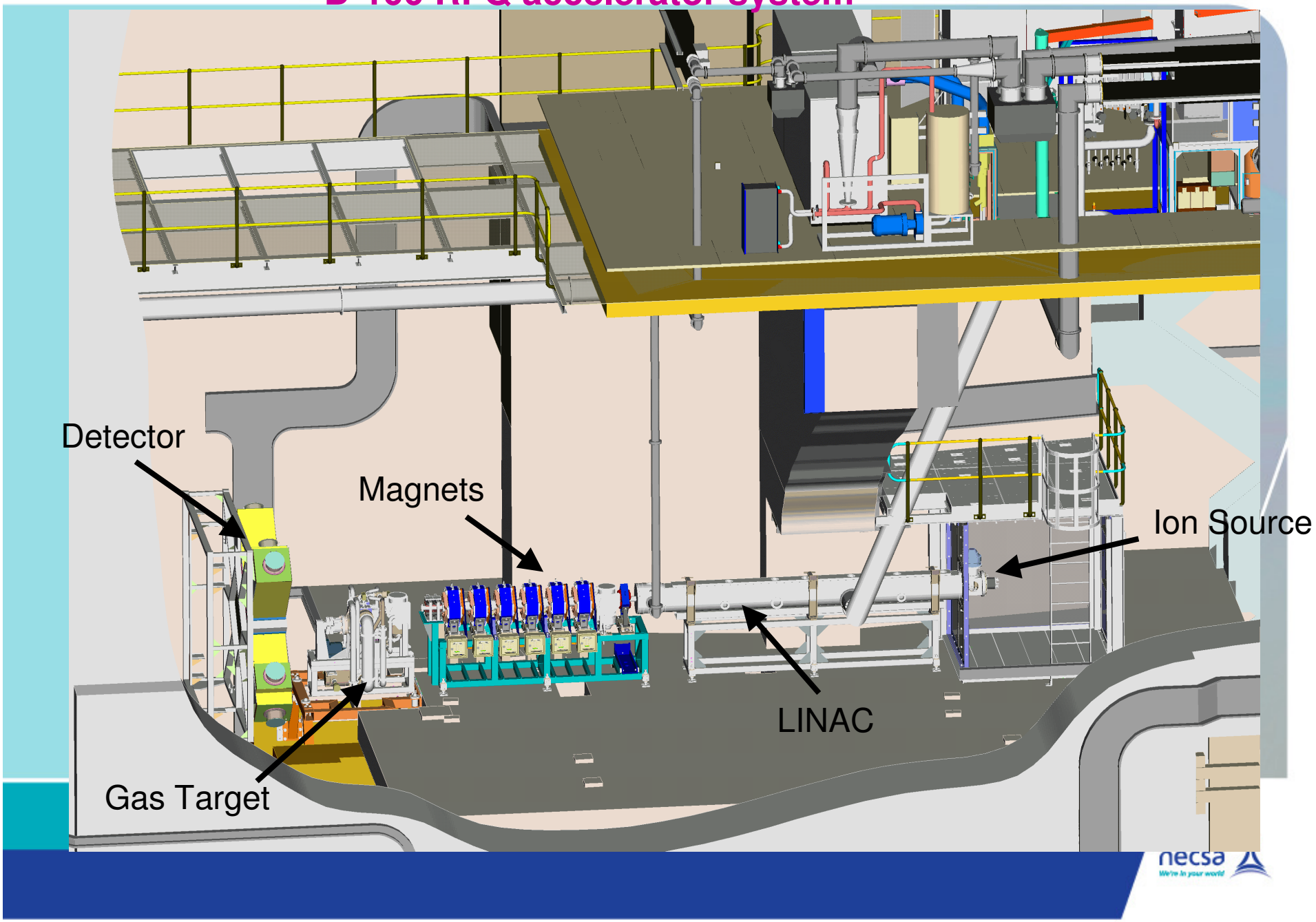
ADM RFQ accelerator system

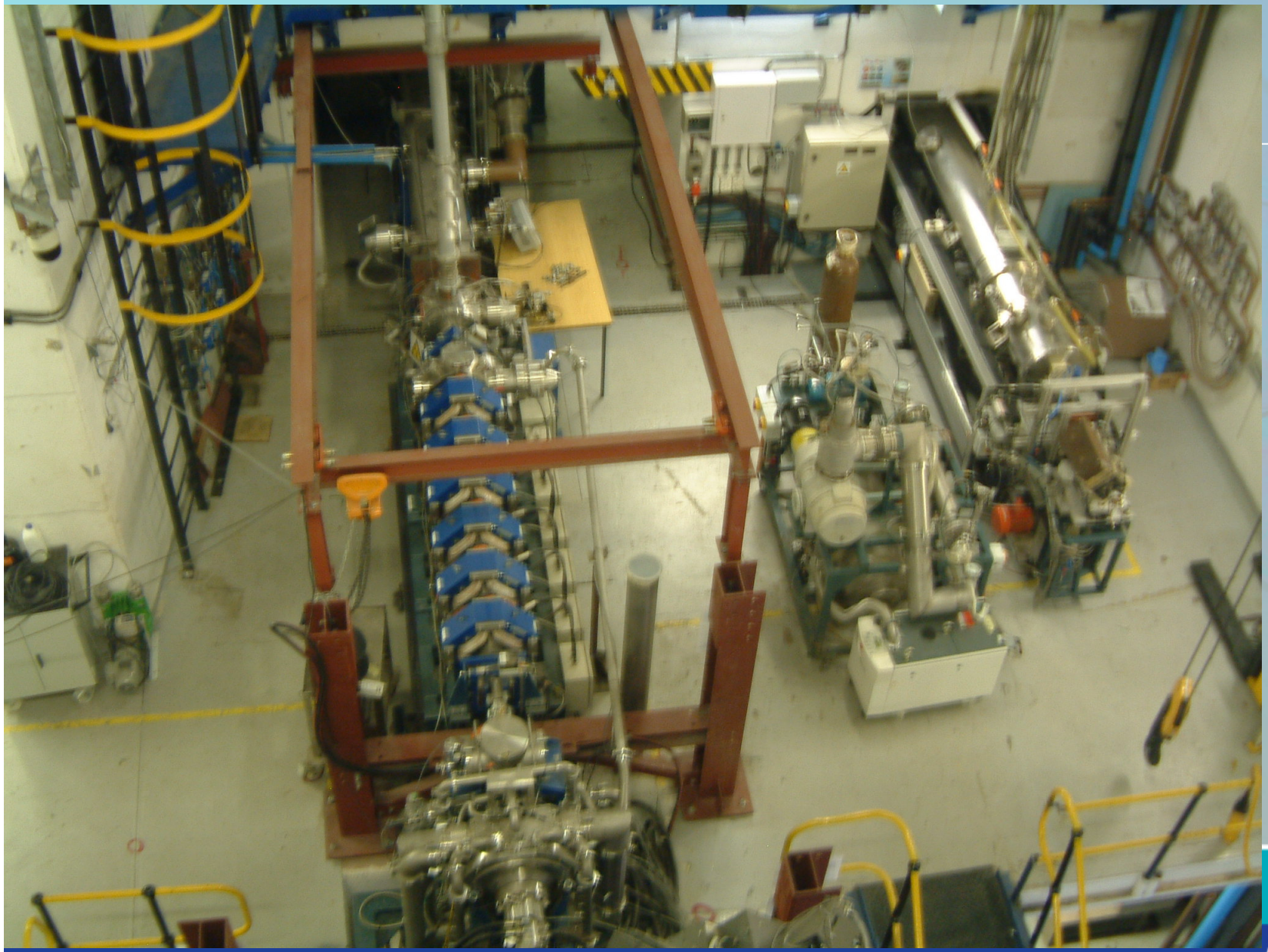




D-100 RFQ accelerator system



D-100 ADM



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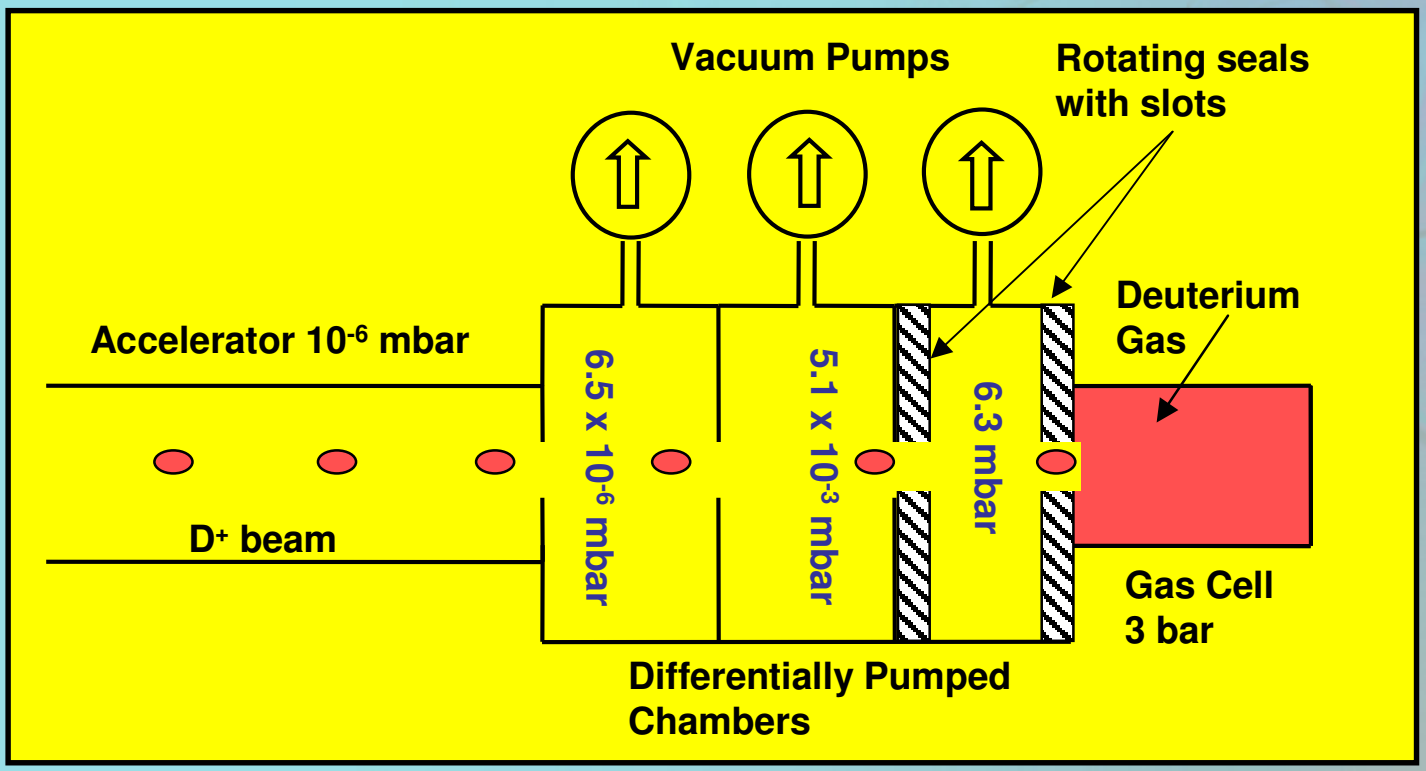
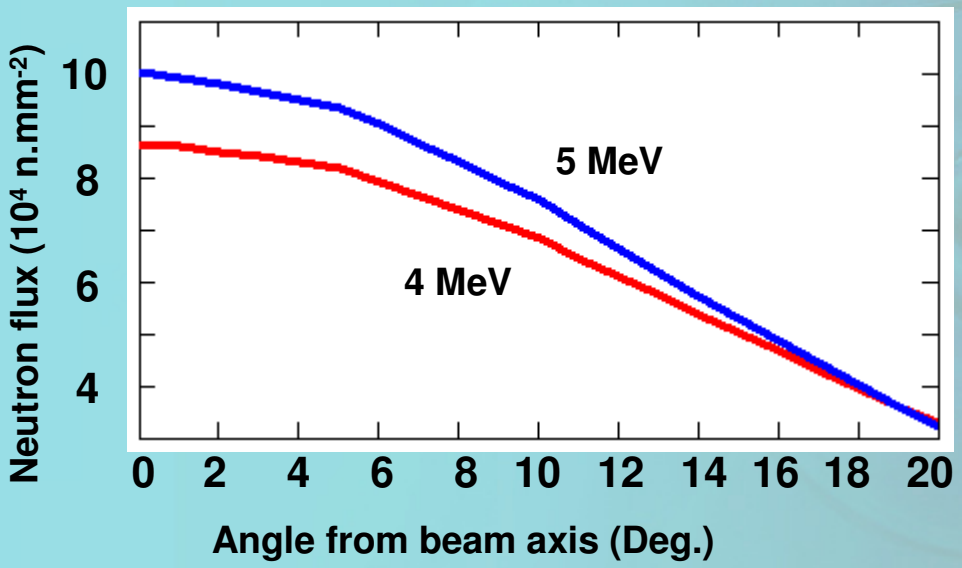
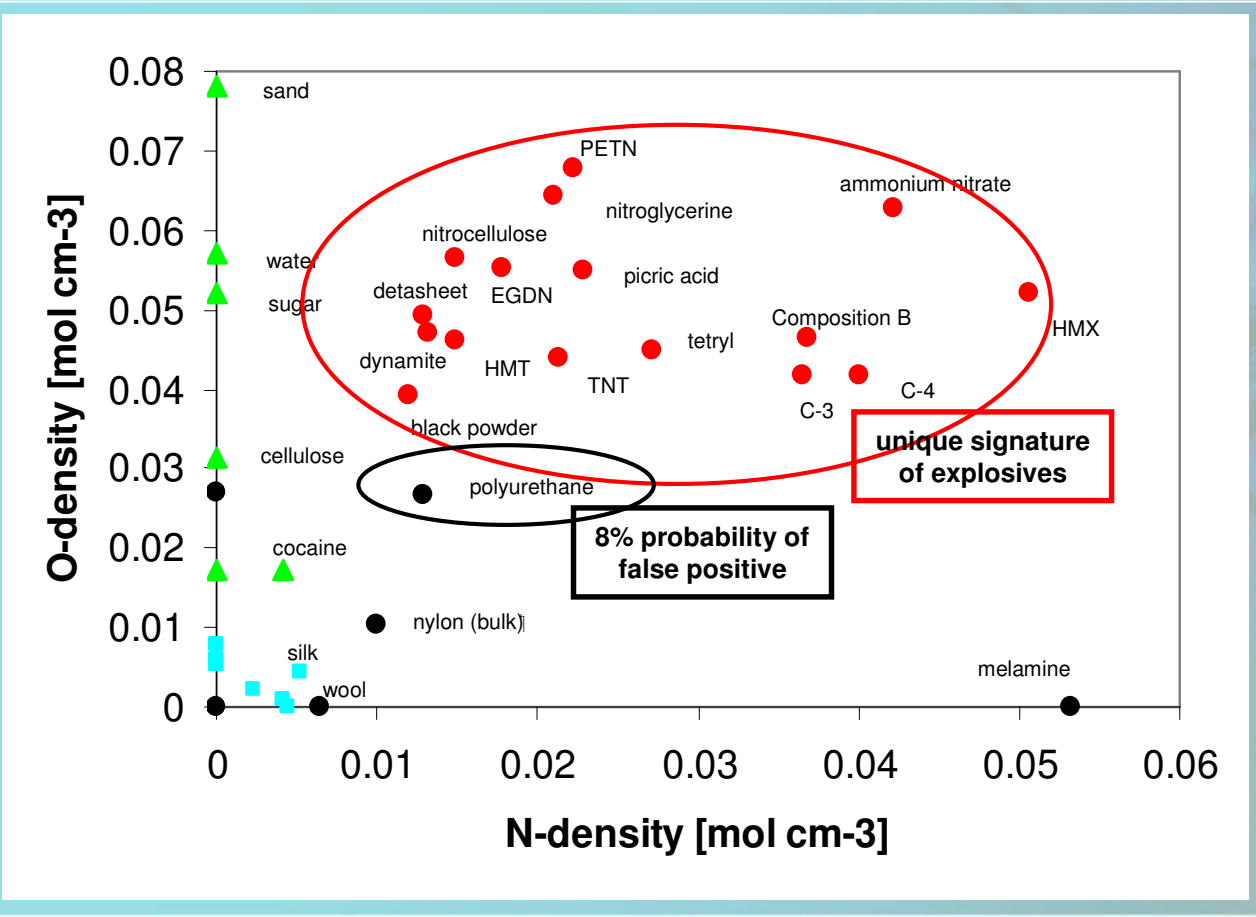
Deuterium gas target



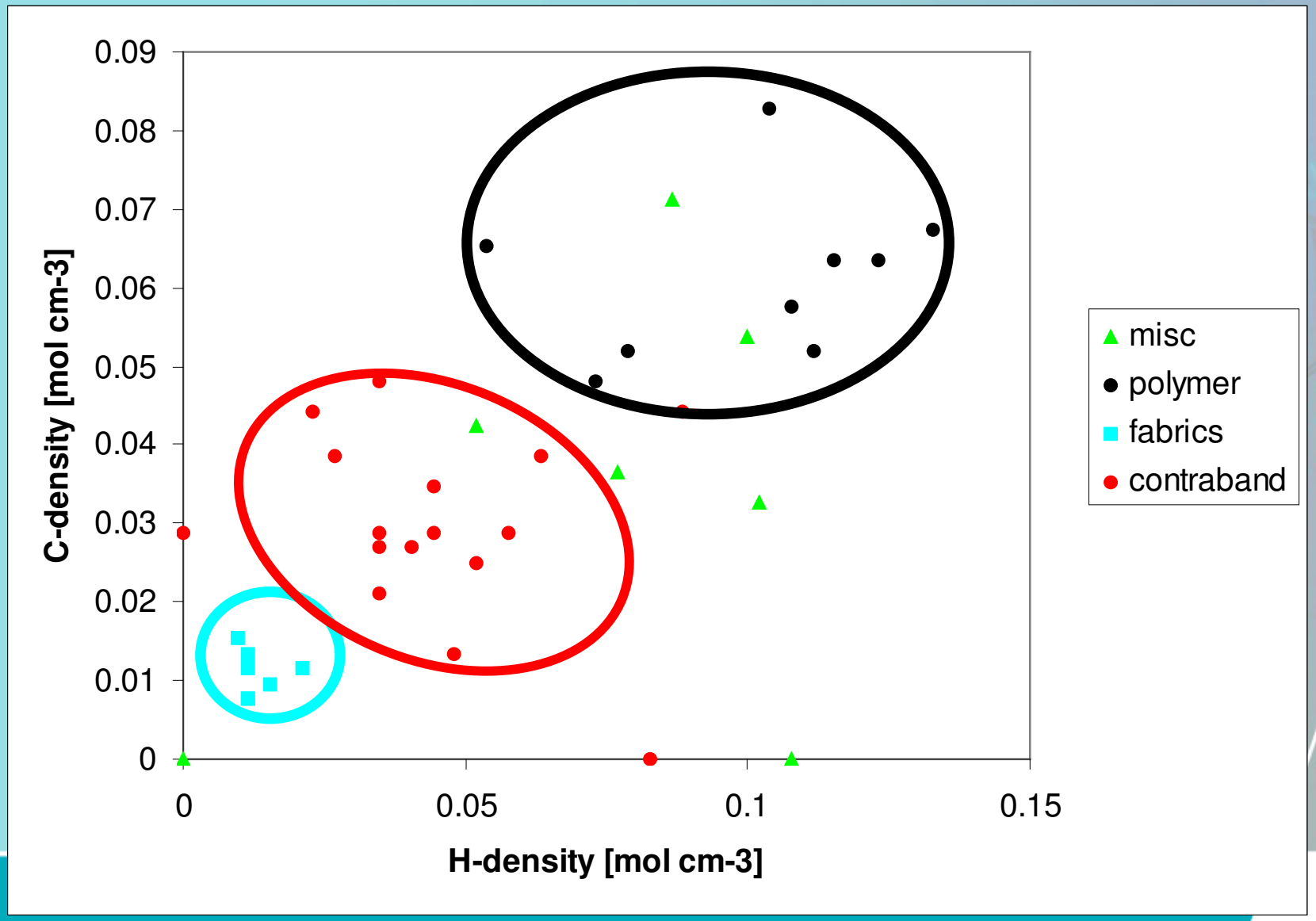
Yield for 3 cm 3 bar D_2 gas target at 100 μA



Density comparison of various common substances



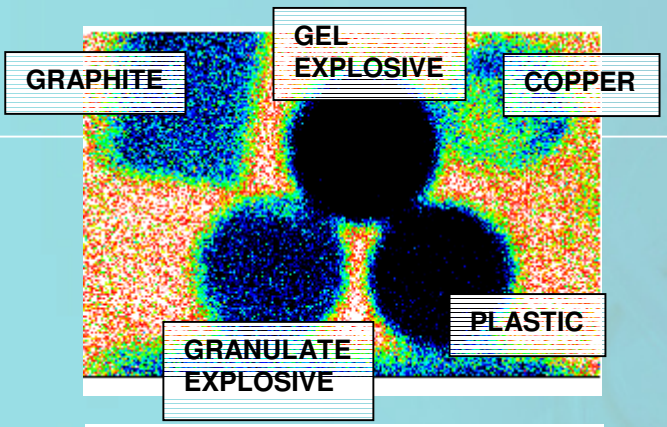
Ref. L Grodzins. NIMB56/57(1991)829

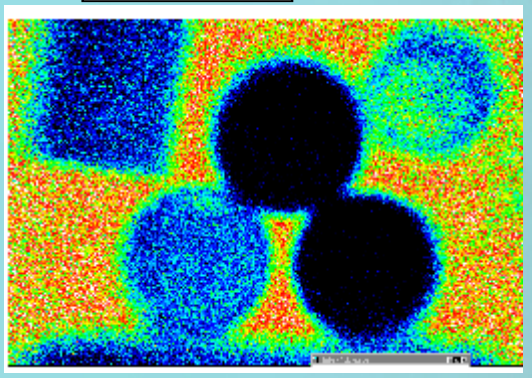

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
C-density [mol cm-3]
0
0.05
0.1
0.15
H-density [mol cm-3]
misc
polymer
fabrics
contraband

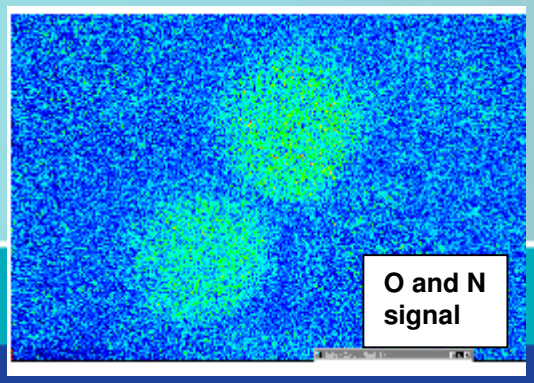
The detection system originally developed for the ADM RFQ:

A static imaging system using a single CCD camera coupled to an image intensifier to record scintillations from a 20 cm diameter scintillator.

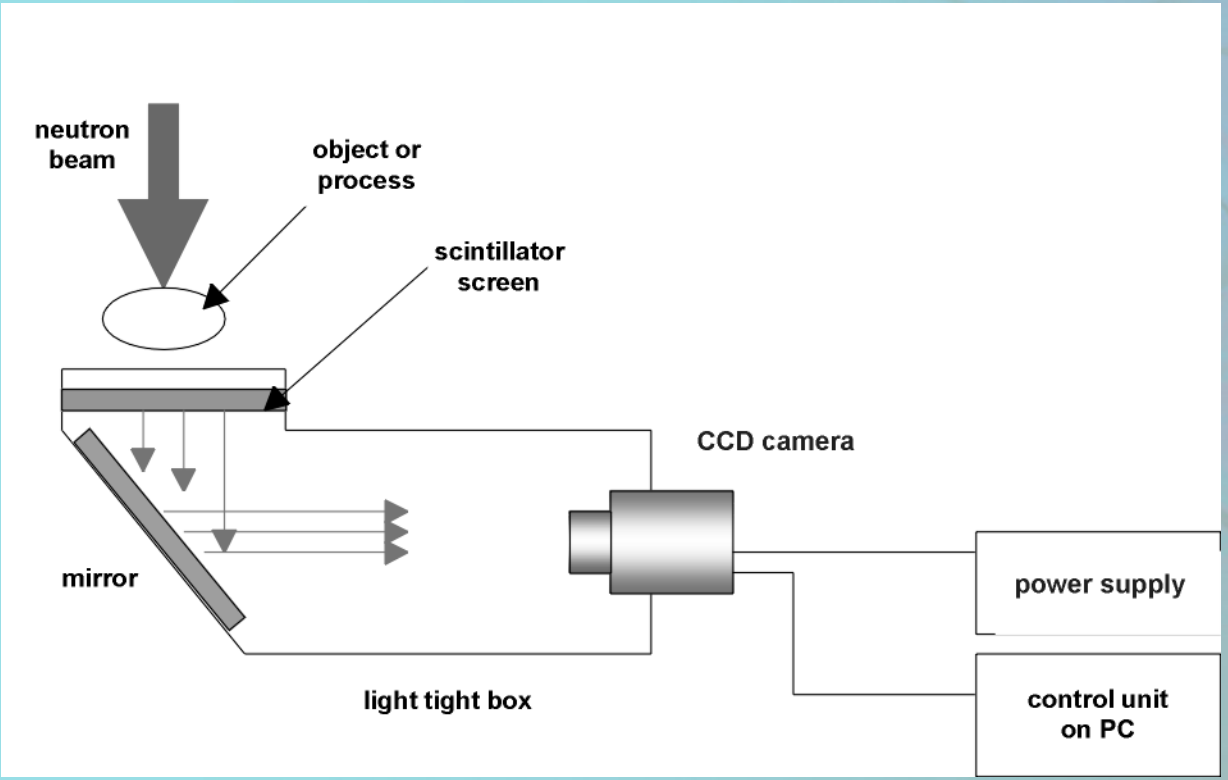
A dynamic imaging system using several CCD cameras recording scintillations from a 40 cm X 40 cm scintillating fibre bundle array.


GEL
EXPLOSIVE
GRAPHITE
COPPER
PLASTIC
GRANULATE
EXPLOSIVE

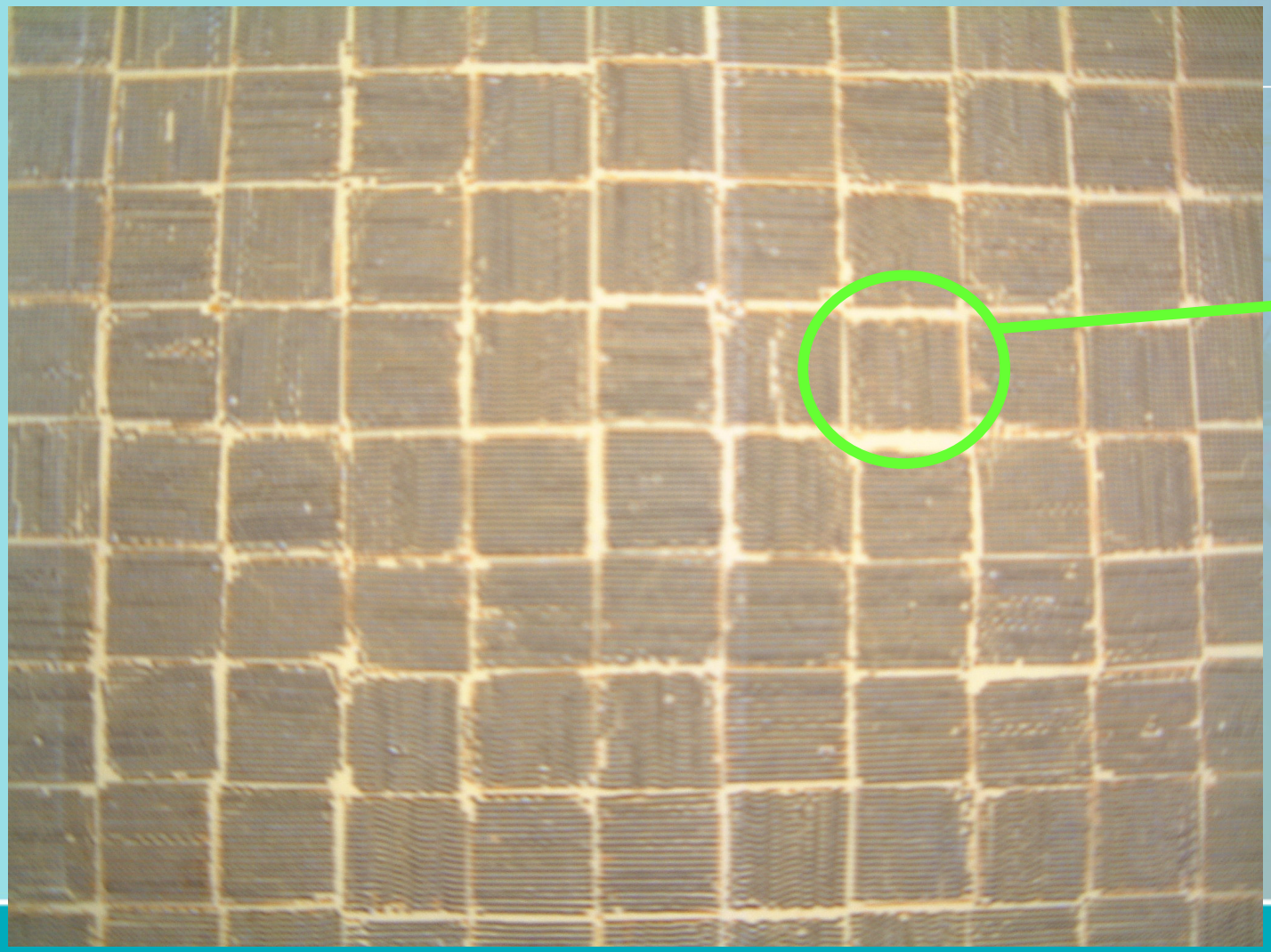



O and N
signal

Conventional radiography configuration - ADM



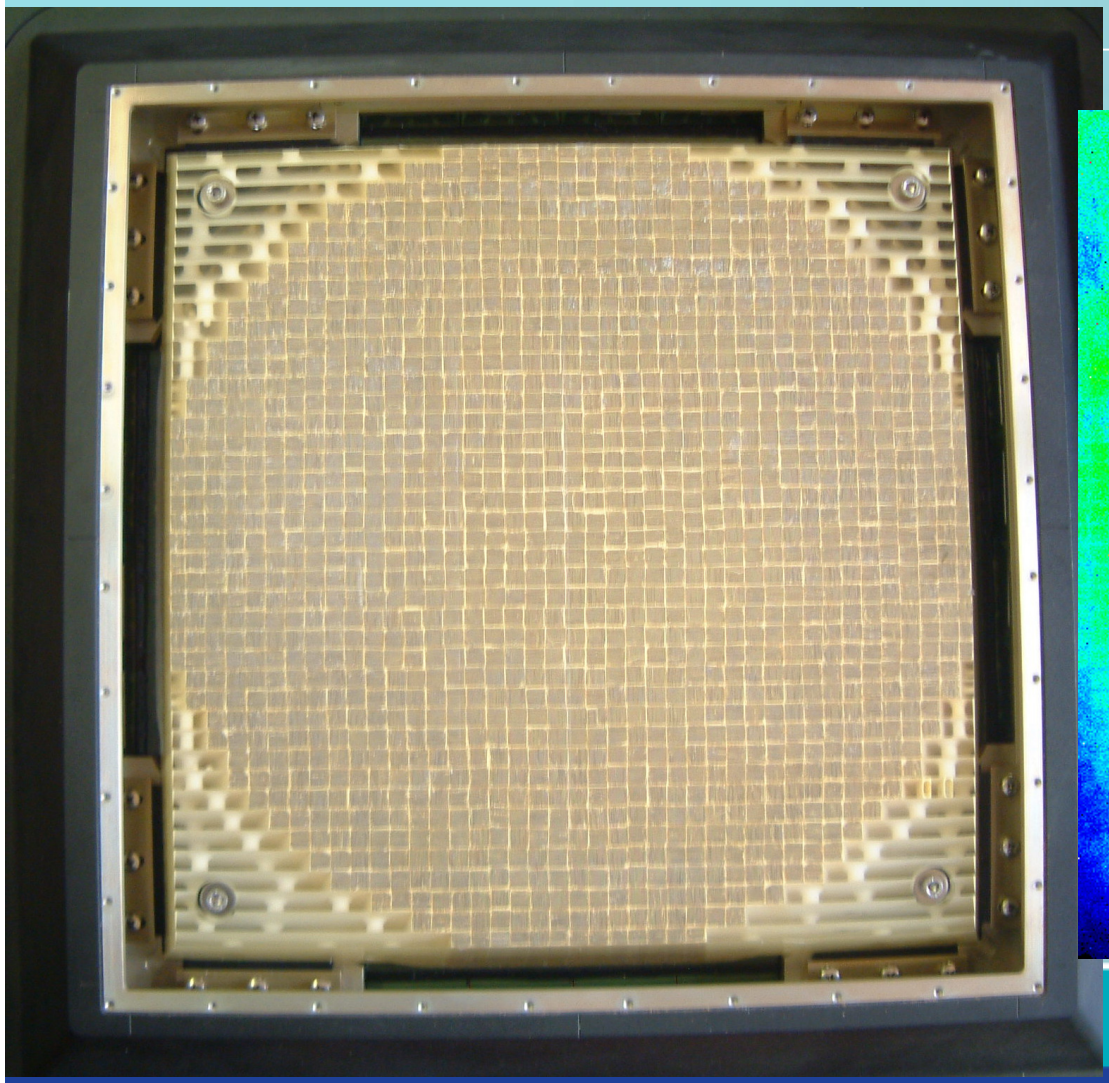
Recent work has involved extending the detection area by using an amorphous silicon detector coupled directly to an array of scintillating fibres

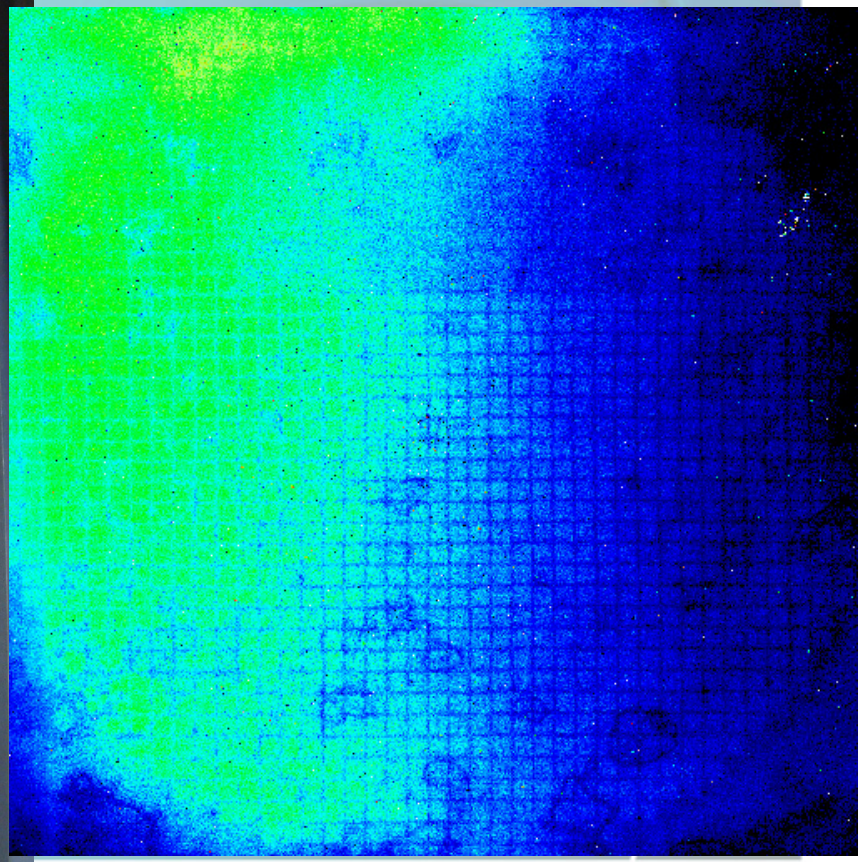


289 fibres in 10mm x 10mm block

41 x 41 blocks

Amorphous Si array, pixel size 400 µm





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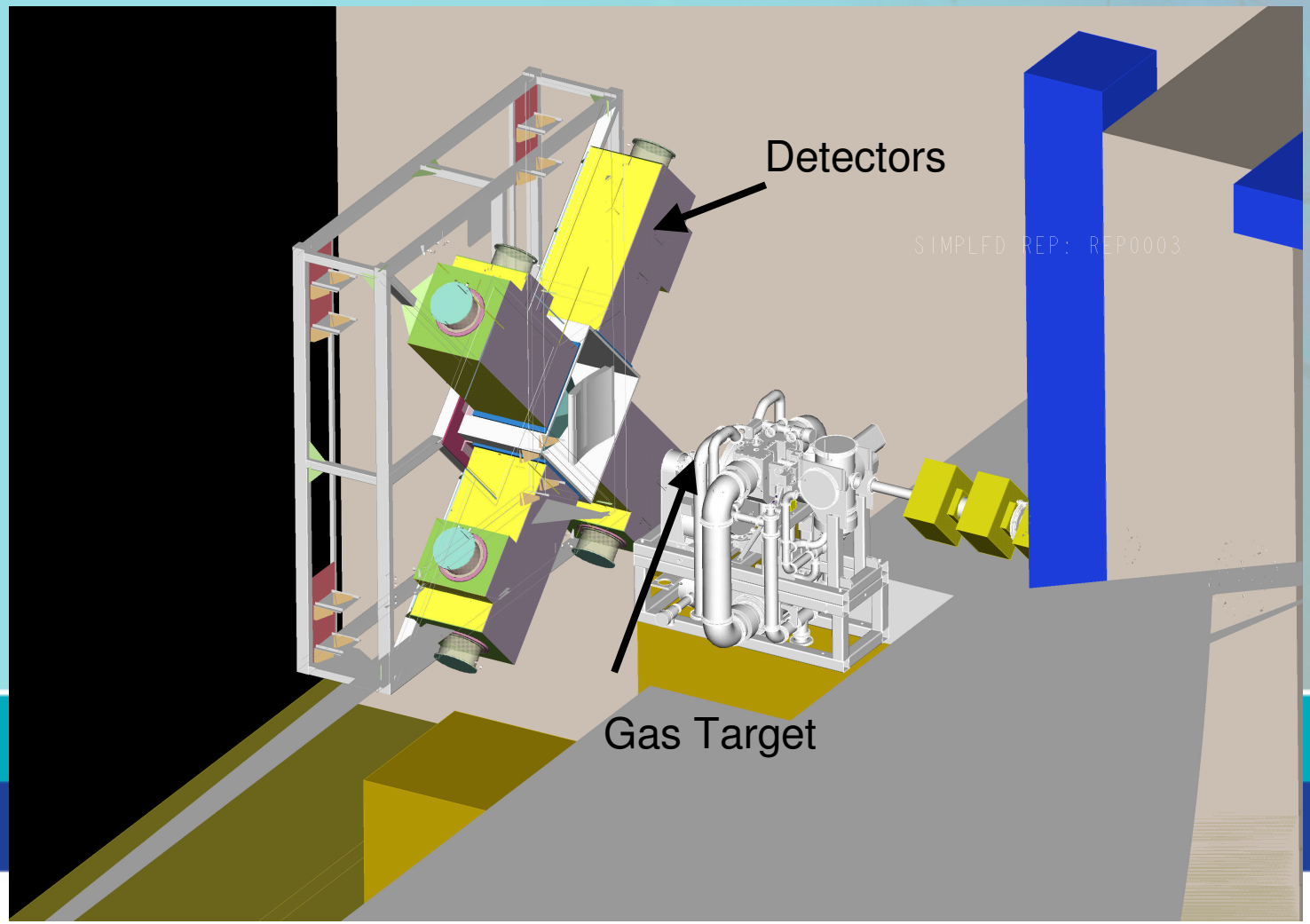
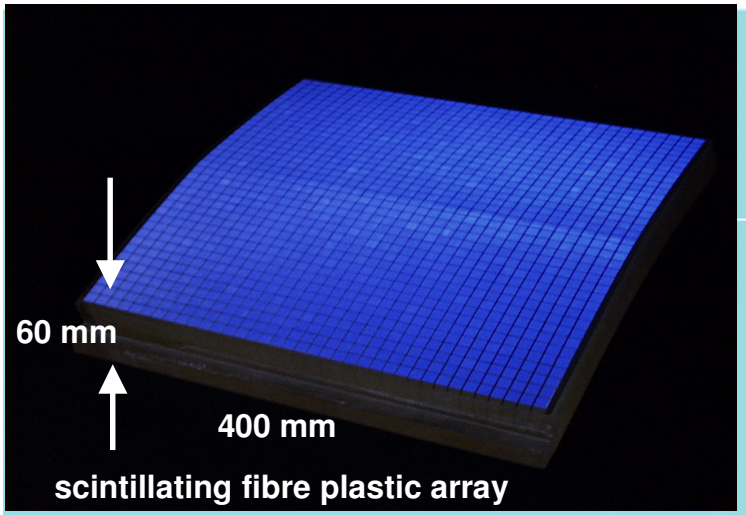
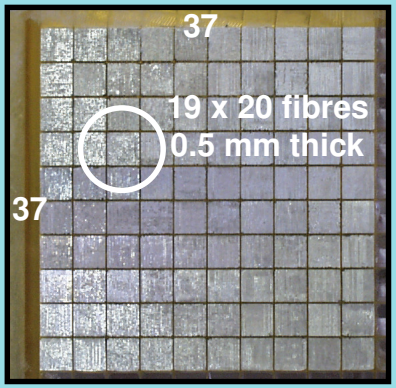
D-100 detection system

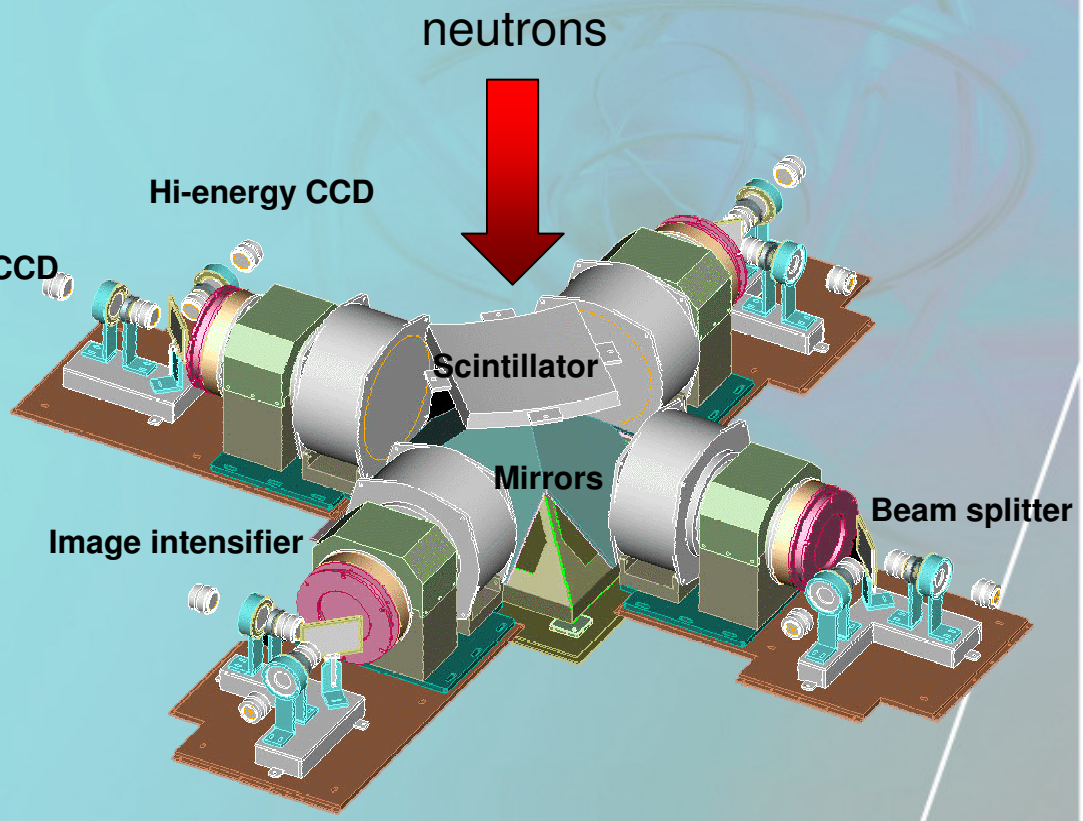
A dynamic imaging system using several CCD cameras recording scintillations from a 40 cm X 40 cm scintillating fibre bundle array.







> 31 km of fibres



Neutron efficiency: 70%

Light conversion: at least 1 photon / neutron

Image intensifier size: 150 mm

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THANK YOU !