# Radiation hardness research in Louvain

- Aims

  => Performances of particles sensors and related equipments, absolute dose measurements, dose vs fluence, dose rate, dose equivalence ( **NIEL**...)

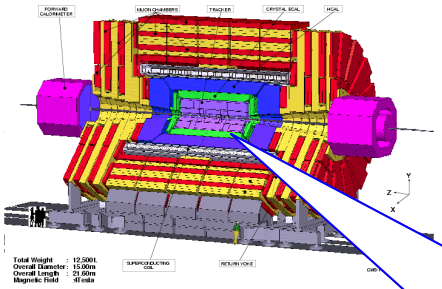
- Facilities, equipments

http://www.fynu.ucl.ac.be/themes/he/index.html

http://www.fynu.ucl.ac.be/themes/he/index.html
http://www.cyc.ucl.ac.be/

-> electronic device irradiation facilities

# Motivations

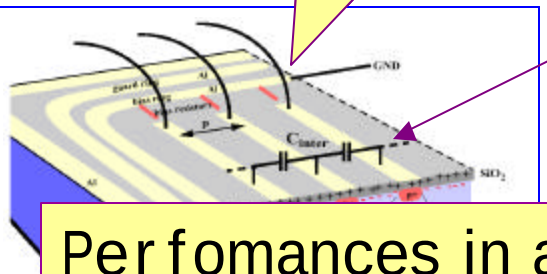


25,000 wafers

~15,000 modules with 1-2 sensors (206m$^2$)

-10°C

$I_{leak}$, $R_{poly}$, $N_{eff} \rightarrow V_{depl}$, $C_{ac}$, «pinholes»




Silicon sensors of the CMS Tracker

## Perfomances in a radiative environment

=> Low versus High dose rates ?

=> Temperature dependencies

=> Dose equivalence for $E_n$ > 20 MeV

=> Comparison neutron-proton

=> Effect of biasing during irradiation

=> Dosimetry issues (alanine, RPL, ...)

http://www.fynu.ucl.ac.be/themes/he/index.html

# Facilities

Built around 3 isochronous cyclotrons

Heavy-ion facility: **a** to $Xe^{+q}$ ; 9 to 500 MeV

Light-ion facility : protons 10 to 75 MeV

Monoenergetic neutron beam line : 25 to 70 MeV

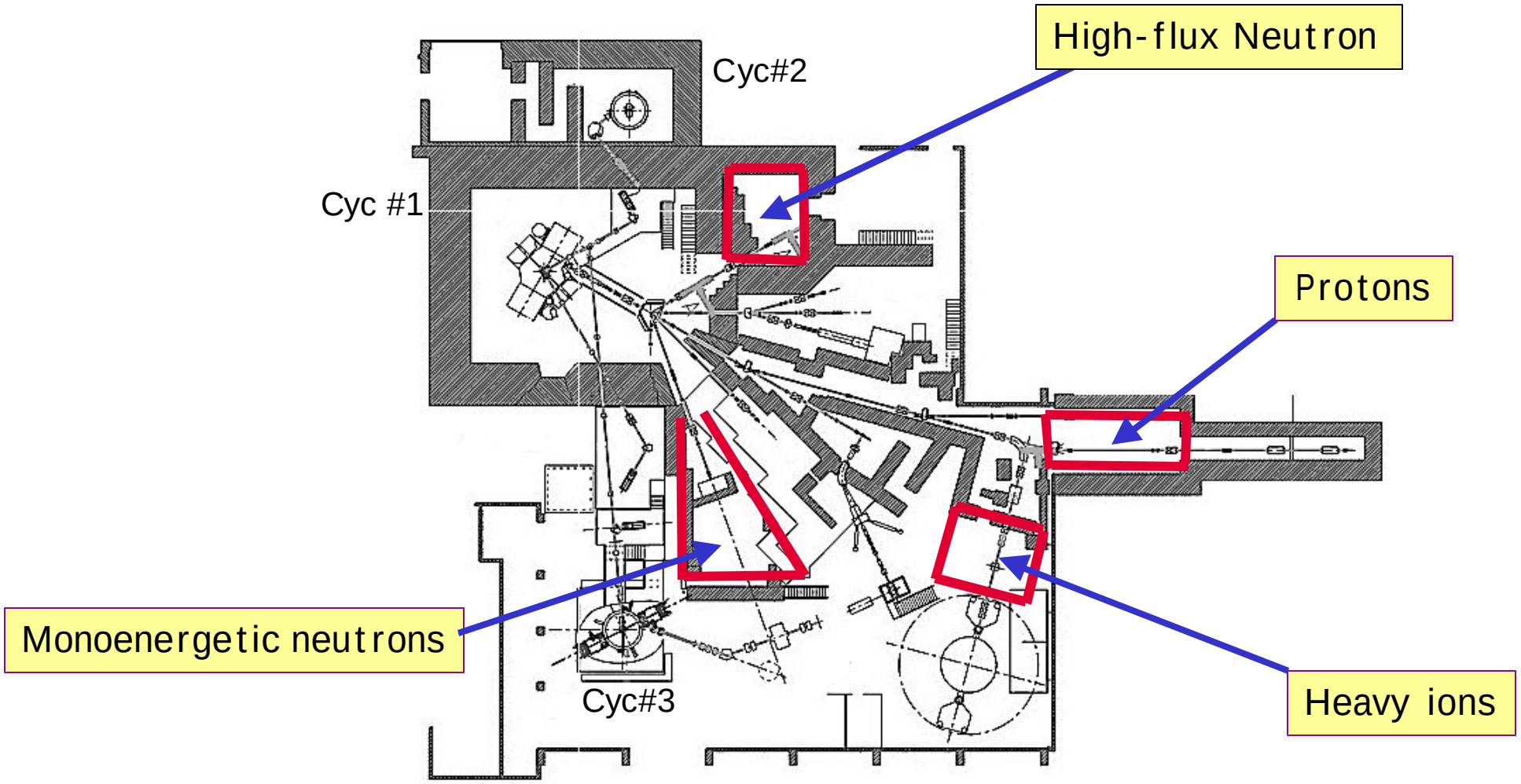
High-flux neutron beam: $4 < E_n < 50$ MeV; $< E_n > = 20$ MeV

Controlled environments: temperature, humidity, biasing, …

Dedicated analysis equipment : probe station, activation, dosimetry …

http://www.fynu.ucl.ac.be/themes/he/index.html

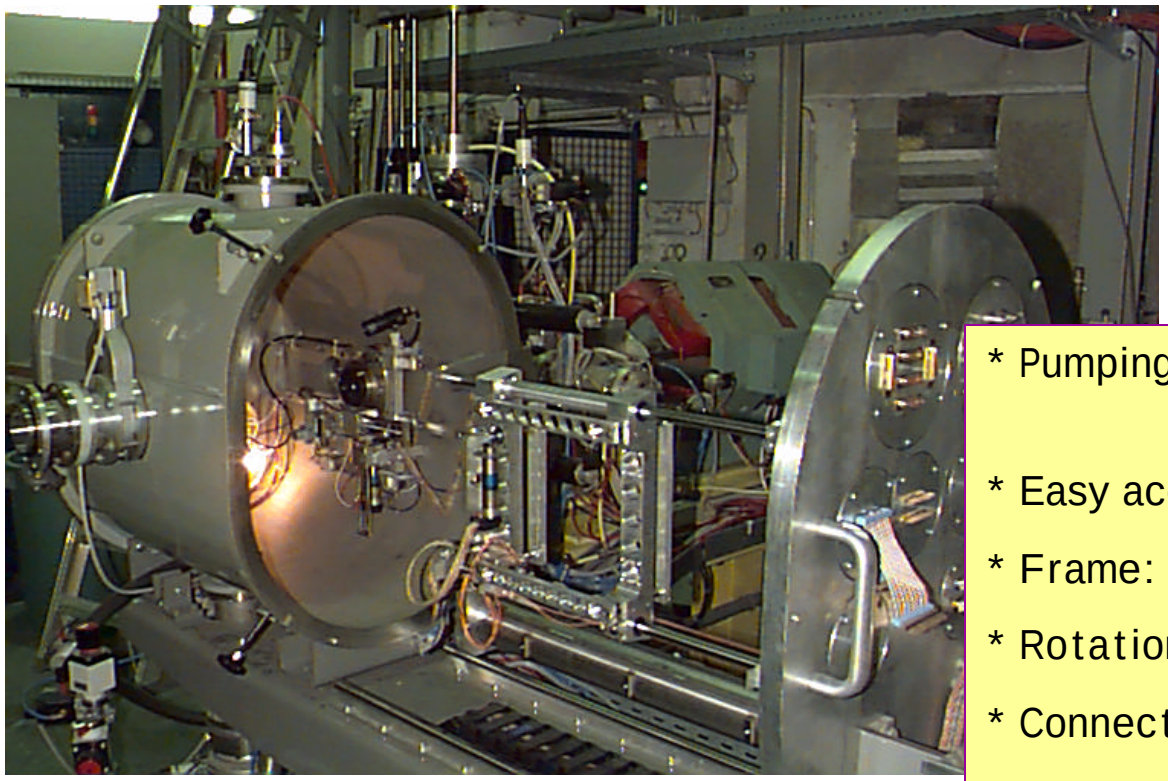
# Facilities, equipments




http://www.fynu.ucl.ac.be/themes/he/index.html

# HIF setup

## Heavy Ion Facility



(developed for the E.S.A)

* Pumping and venting times (< 10 min)
* Easy access
* Frame: 250 X 250 mm boards
* Rotation /Translation
* Connectors 3M / BNC / D25...
* Camera, light, iris
* Alignment: laser in the beam

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# LIF – Proton beam line

Light Ion Facility

| | |
|---|---|
| Proton energy: | from 10 to 75 MeV |
| Energy modulation: | Polystyrene blocks |
| Homogeneity: | ± 10 % on a diam. of 10 cm |
| Flux: | up to $10^9$ protons/cm² s |

Dosimetry:

- Profile: diode in a water phantom
- Flux monitoring: transmission chamber
- Calibration with a Faraday cup

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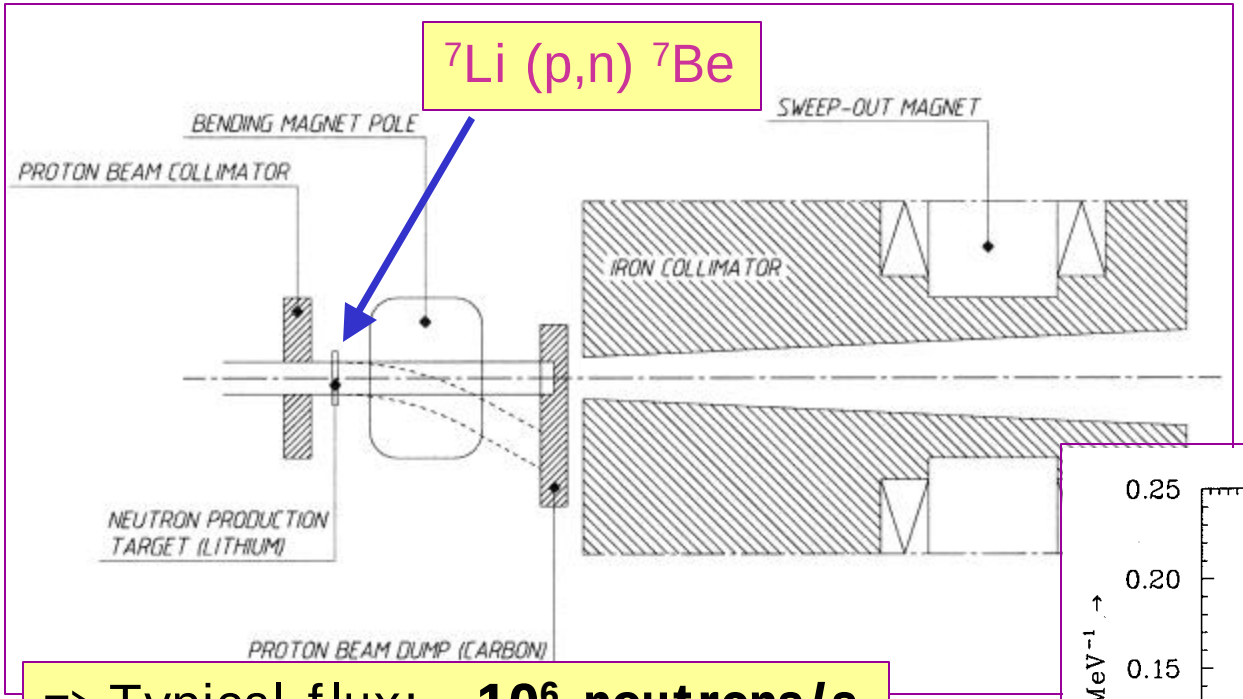
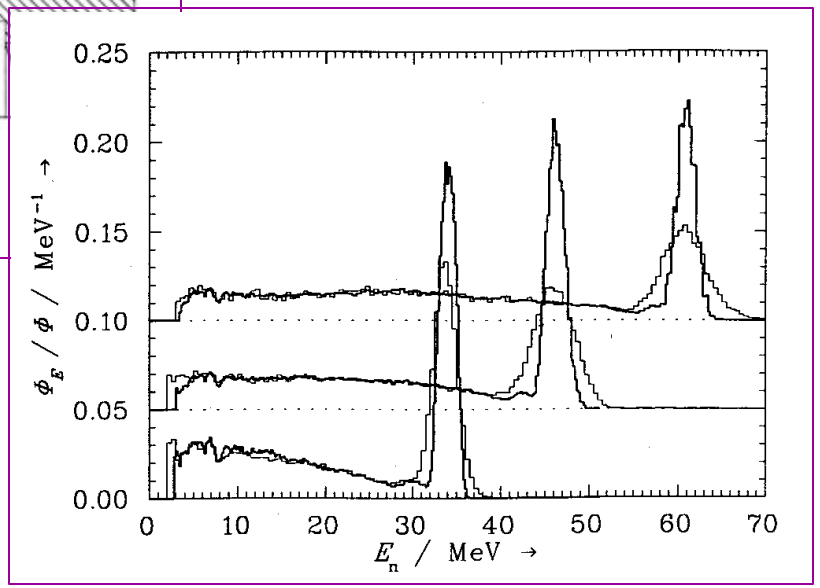
# « Monoenergetic » neutron beam




Dosimetry

=> Peak energy range:

25 to 70 MeV




=> Typical flux: **$10^6$ neutrons/s**

(30 mm Ø, 3 m from the target)

* 10µA proton beam

* 3 mm thick target

=> Homogeneity ± 10 %

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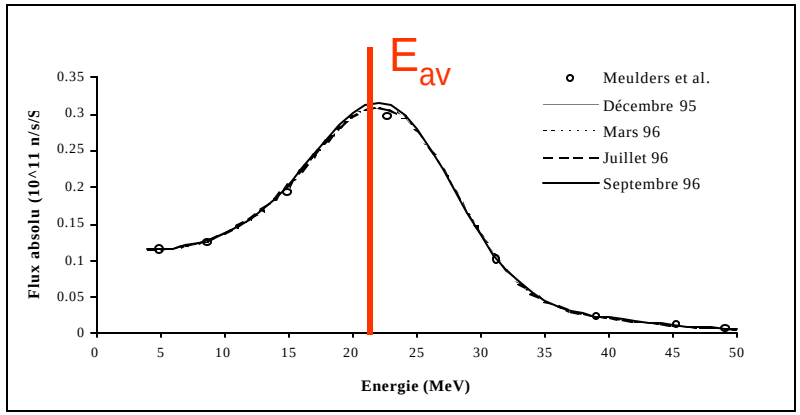
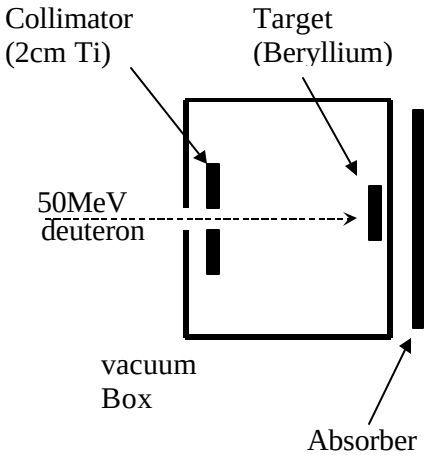
# High flux neutron beam




$\Phi_{max}$ = 6.6 x $10^{12}$ n $sr^{-1}$ $s^{-1}$

Nominal LHC fluence reached in ~6-8 h depending on sample size




$^{9}Be$ (d,n) $^{10}B$

$E_{average}$ = 20,4 MeV

$K_{NIEL}$ = 1.95

Contaminations:

Gammas => 2,4%

Charged => 0,03%

http://www.fynu.ucl.ac.be/themes/he/cms/neutron_beam/neutrons.html

http://www.fynu.ucl.ac.be/themes/he/index.html