COLLISIONS BETWEEN PROTONS AND BIOMOLECULES: ELECTRON EMISSION AND MOLECULAR FRAGMENTATION

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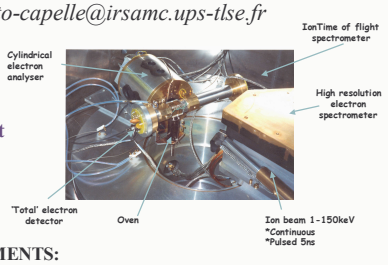
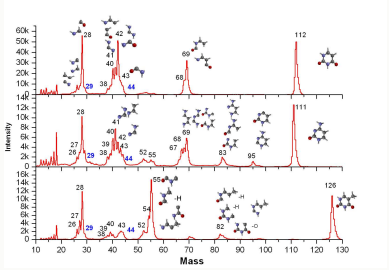
Damages induced by ionizing radiation can directly be linked to alteration of the DNA molecule. In this work, we have investigated interactions between protons and phase gas pyrimidic bases (uracil, cytosine and thymine) in the 25-100 keV energy range, the latest collision energy corresponding to the formation of the Bragg peak in biological medium.

Experimental Method:
-Electron spectroscopy
-Multistop time of flight



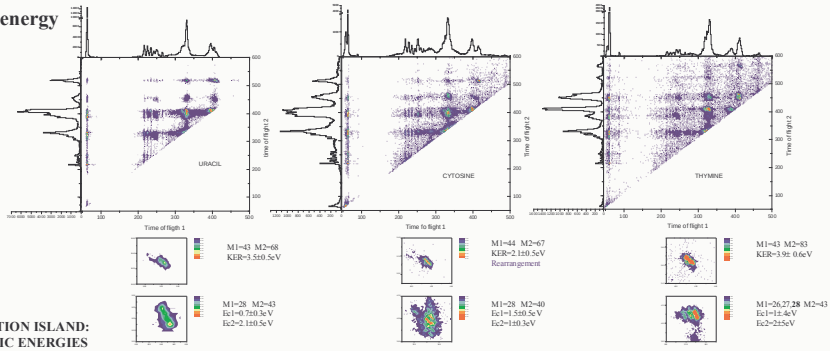
A- Direct effects: molecular fragmentation
Multistop time of flight technique

Formation of new small molecule with kinetic energy



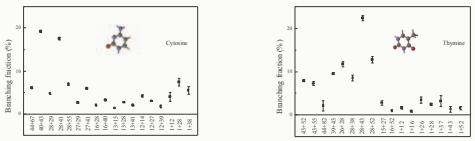
MASS 29,44 → REARRANGEMENT

CORRELATION BETWEEN FRAGMENTS:



SHAPE OF THE CORRELATION ISLAND: INFORMATION ON KINETIC ENERGIES OF THE FRAGMENTS

Correlated mass branching ratio



B- Indirect effects: secondary electron emission
Electron spectroscopy

Damages induced by secondary electron depend on kinetic energy:

Low energy (<20eV): dissociative attachment

High energy(>20eV): ionization,fragmentation

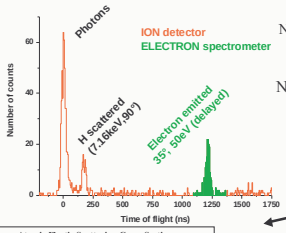
Need to know energy spectrum of the emitted electrons

BUT also the absolute yield (cross section)

Normalisation of double differential cross section: trough elastic scattering of projectile

During the same experiment we measure the number of scattered particles as well as the electrons selected by the analyser at a given energy (50eV)

Pulsed beam: H_3^+(25keV)≡ 3 H (8.3keV)



$$N_i = \frac{\partial\sigma_i}{\partial\Omega_i}.[n.\ell.\Delta\Omega]_i.\eta_i.N_{proj}$$

$$N_e = \frac{\partial^2\sigma_e}{\partial\Omega_e\,\partial E_e}(35°,50\,eV).[n.\ell.\Delta\Omega]_e.\Delta E_e.\eta_e.N_{proj}$$

$$\frac{\partial^2\sigma_e}{\partial\Omega_e\partial E_e} = \frac{N_e}{N_i}.\frac{\partial\sigma_i}{\partial\Omega_i}.\frac{[n.\ell.\Delta\Omega]_i}{[n.\ell.\Delta\Omega]_e}.\frac{1}{\Delta E_e}.\frac{\eta_i}{\eta_e}$$

Atomic Elastic Scattering Cross Sections (10^{-21}cm²/sr)
H (8.33keV) scattered at 90°

	C	N	O
*calc.P.Caffarel**			
ZBL	2.45	3.26	4.32
Bohr	2.57	3.46	4.70
Moliere	2.37	3.29	4.26
Pot.PMC	2.76	3.51	4.49
our Calc	2.72	3.70	4.81

**:IRSAMC, LCAR, TOULOUSE,FRANCE*

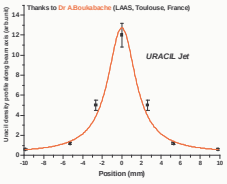
$$\frac{\partial\sigma_i}{\partial\Omega_i}_{molecule} = 3.\sum_{i=H}^{i=1}\frac{\partial\sigma_i}{\partial\Omega_i}_{atom}$$

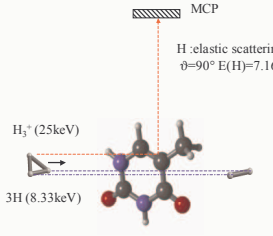
$$\frac{\partial\sigma_i}{\partial\Omega_i}_{URACIL} = 83.7e^{-21}cm^2/sr$$

$$\frac{\partial\sigma_i}{\partial\Omega_i}_{THYMINE} = 91.8e^{-21}cm^2/sr$$

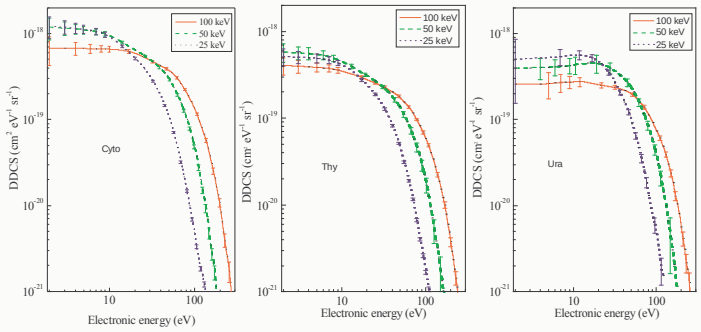
$$\frac{\partial\sigma_i}{\partial\Omega_i}_{CYTOSINE} = 80.3e^{-21}cm^2/sr$$

Monte-Carlo simulation with measured density profile





ELECTRON SPECTRA IN ABSOLUTE SCALE:



NEXT STEPS:

- PURIC BASES

-ELECTRON SPECTROSCOPY-FRAGMENT CORRELATION

-ANGULAR DISTRIBUTION OF THE EMITTED ELECTRONS

-SOLVATED BIO-MOL

(coll M&B FARIZON)