

# Reporting JWST – WP4 –juin 2017

*X- Ice Irradiation by CR in external disk in relation with UCAM: IAS-CSNSM*

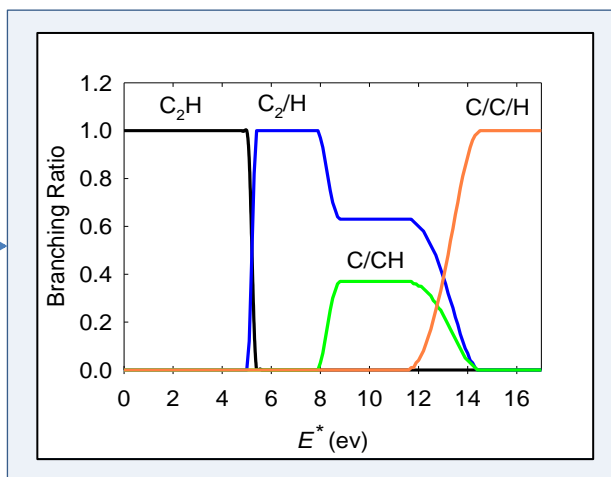
*X- Coulomb explosion of PAH by CR : IPNO-IAS-ISMO-CSNSM - soumis*

1- Gas phase chemistry (AGAT) : IPNO- ISMO- CSNSM  
(Emeline JWST) + col.

2 - Dust analogue processing by CR : IAS-ISMO-IPNO-CSNSM

# WP4- Gaz Phase - Motivations

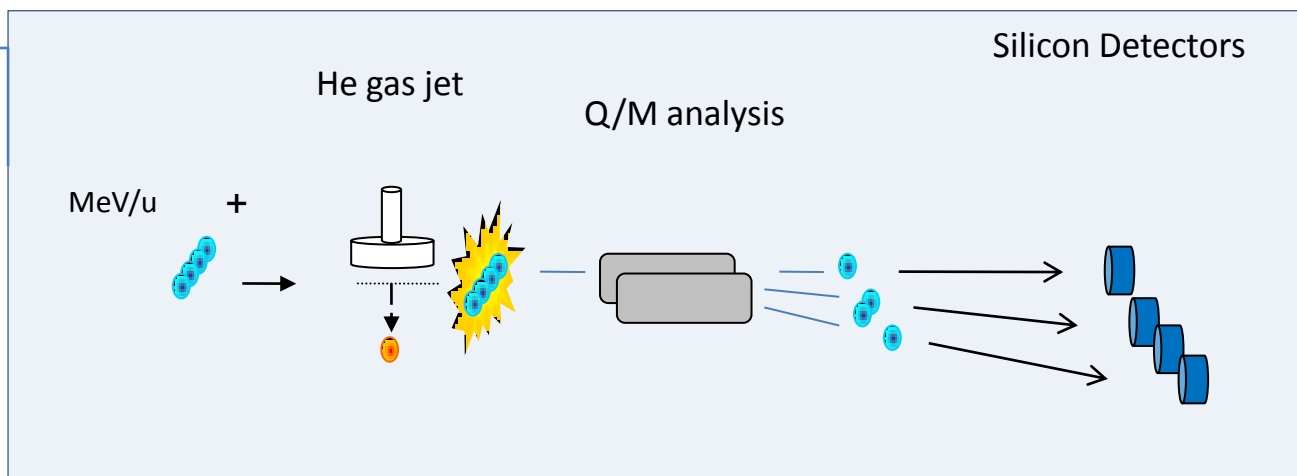
Fournir à la communauté (KIDA) des RB semi empiriques pour la chimie en phase gazeuse des espèces carbonées.



Chabot+2013

Exemple de BDC pour le complexe intermédiaire  $C_2H^*$ .

**AGAT** apparatus:



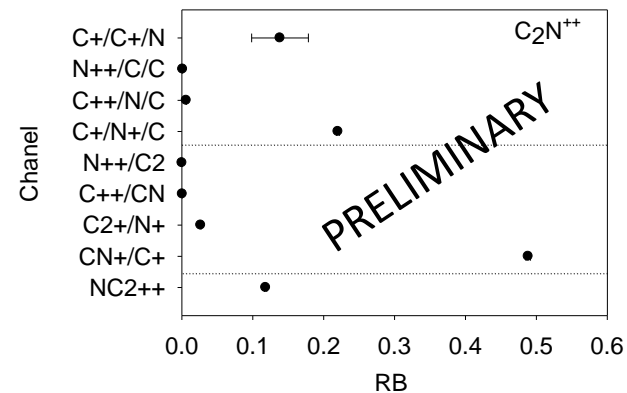
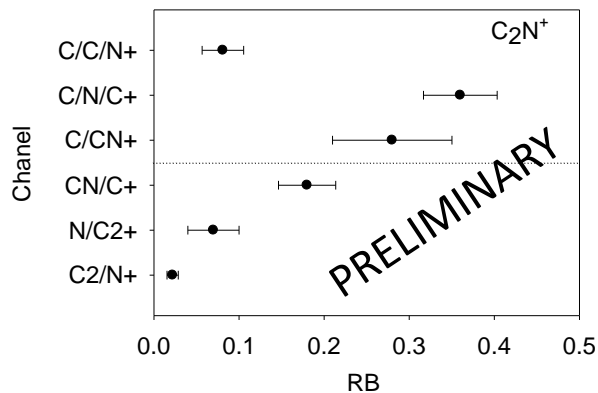
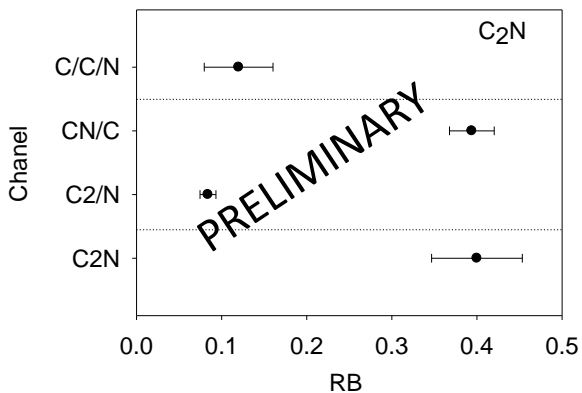
# Activités expérimentales

Octobre 2016 – fin des mesures sur les C<sub>n</sub>N au Tandem

Nov. 2016 – Avril 2017 : montage d'AGAT auprès d'ANDROMEDE ( EQUIPEX P2IO)

# Activités d'analyses

Juin 2017 – Fin des réductions des expériences C<sub>n</sub>N (i.e : section efficaces et BRs, n=1,2,3)

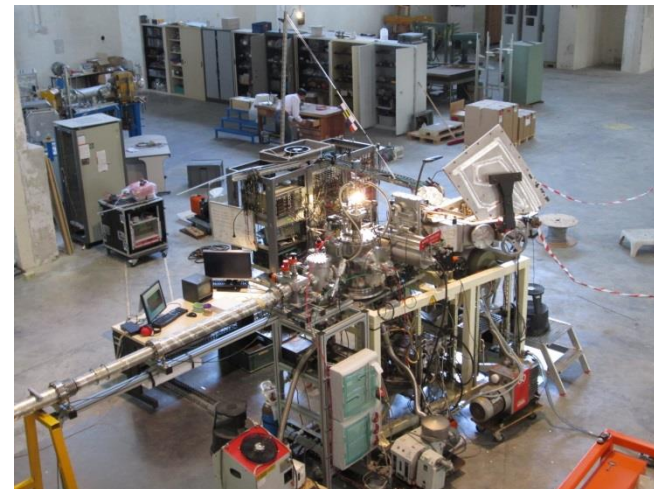
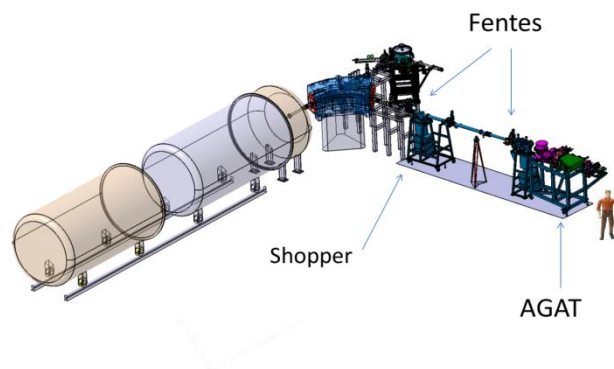


2 doctorants :

Thejus Mahajan 2015 – 2018 (ISMO K. Béroff)

Tijani Idbarkach 2016 – 2019 (IPNO M.Chabot)

# AGAT@ANDROMEDE

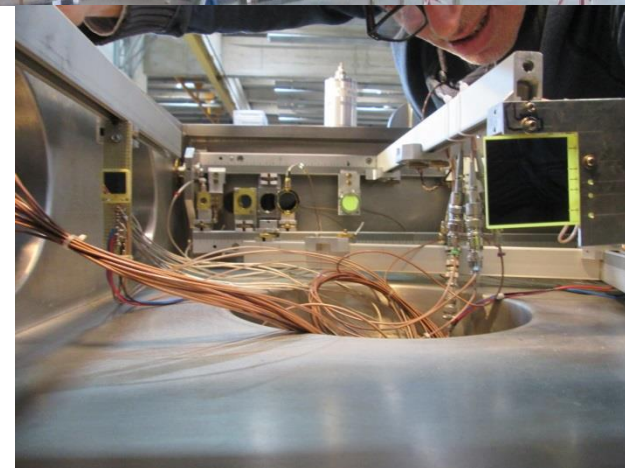


1<sup>er</sup> faisceau caractérisé et positionné – avril 2017

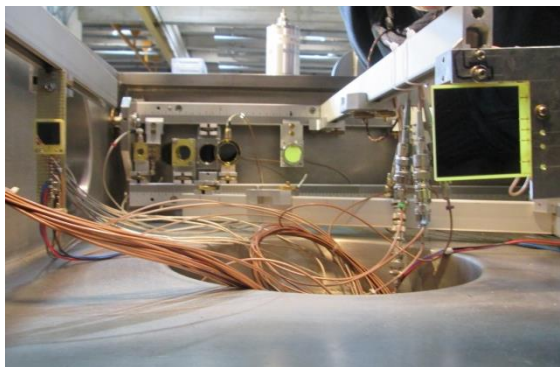
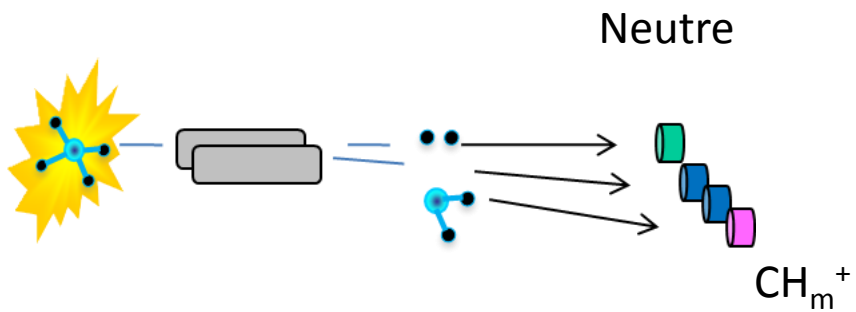
1<sup>er</sup> mesures - mai 2017 : CH, CH<sub>2</sub>, CH<sub>3</sub>, CH<sub>4</sub>

Octobre 2017 : CH, CH<sub>2</sub>, CH<sub>3</sub>, CH<sub>4</sub> (suite et fin)

Décembre 2017 : C<sub>2</sub>H, C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>H<sub>3</sub>, C<sub>2</sub>H<sub>4</sub> (exploratoire)

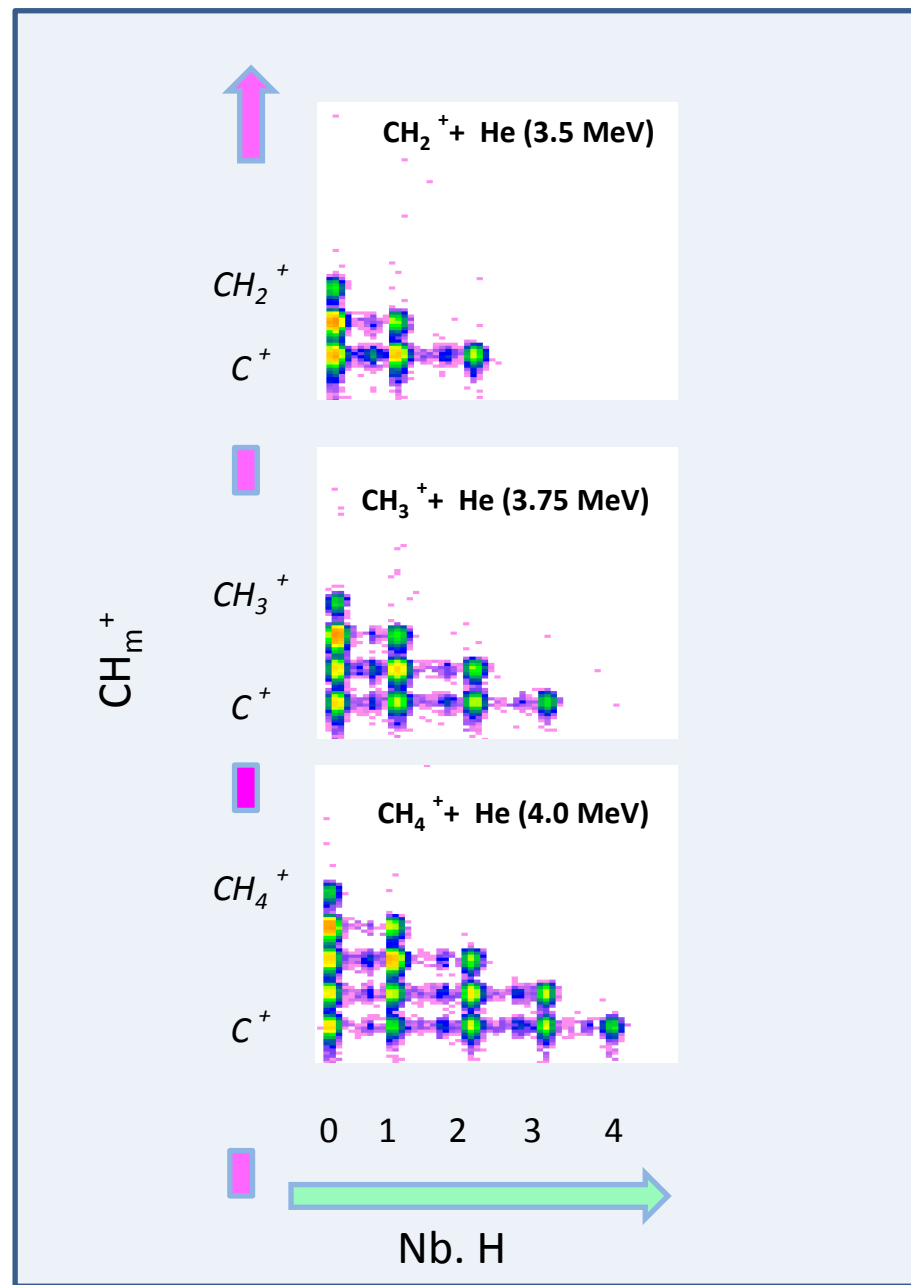


# Quelques inclusifs on line :



Début réduction juillet 2017 ...

...Thèse Tij. 2019



# WP4- Analogue Processing- Motivations

Fournir à la communauté des données quantitatives sur la modifications des grains par les champs radiatifs (UV & CR) et sur la remise en phase gazeuse d'espèces chimiques.

Expériences GSI 2013-2015 - Publication A&A JWST (☺)+1

Expériences GSI 2016 – réduction en cours (1 stagiaire dir. T. Pino ISMO )  
mais il y aurai besoin d'un étudiant en thèse avec E. Dartois.

Suite et fin programmée 2018/2019 – ( 3 x 9 mois d' interruption accélérateurs -FAIR)

# Cosmic rays irradiation of interstellar dust analogues

E. Dartois, M. Chabot, T.Pino, K. Béroff, M. Godard, D. Severin, M. Bender and C. Trautmann

IPN Orsay, France

CSNSM, France

IAS, France

ISM Orsay, France

GSI and TU Darmstadt, Germany

# Chemical reactions in ISM



Interstellar medium is everything except stars and planets.

Elementary composition : H(90%),He(9%),Others(1%)

Density: 10 to  $10^8$  H/cm<sup>3</sup>, T=10 to 1000 K

UV field : ambient ( $A_v=0$ ) to very few ( $A_v > 100$ ) (or more)

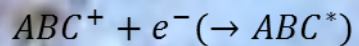
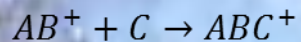
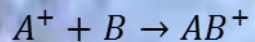
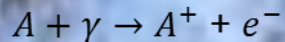
Ionizing particle field (CR) : 10-1000 MeV/u

Magnetic field : ISM is plasma !

## Diffuse medium

( $N_H=10$  -500/cc, T=(1-3)00K,  $A_v=0$ )

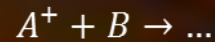
*Ion molecule chemistry:*



## Dense medium

( $N_H=few$   $10^4$ /cc, T=10-30 K,  $A_v=100$ )

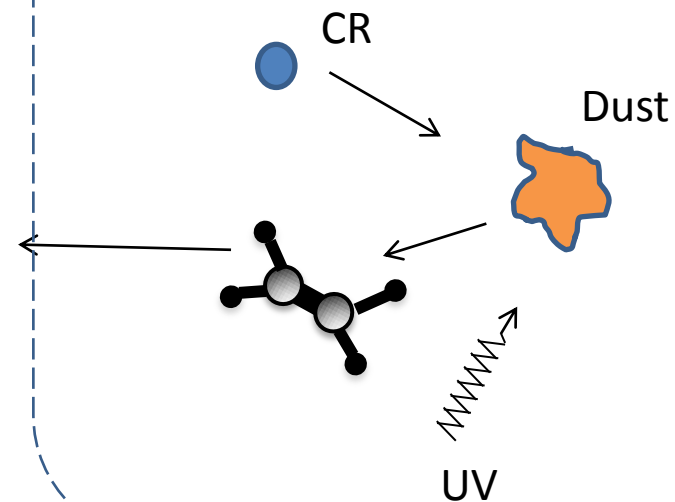
*Ion - molecule :*



*Neutral-neutral:*



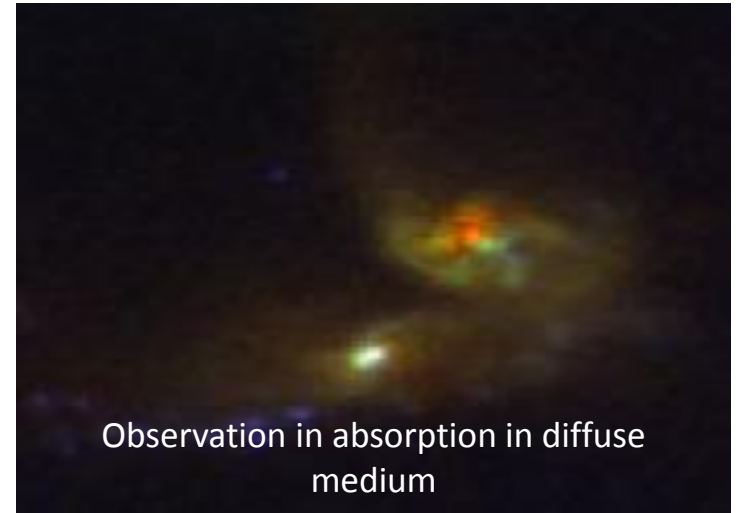
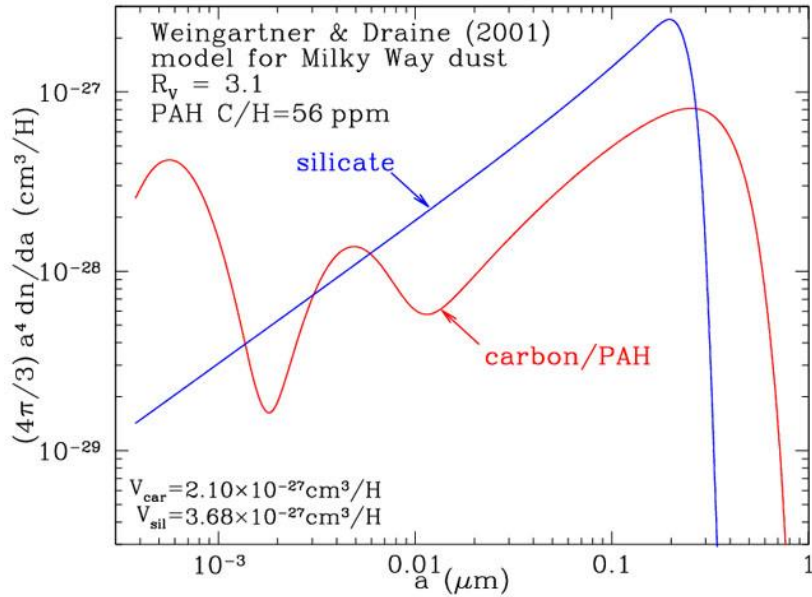
Under UV and **CR**, dusts inject molecules in the chemical « reactor » .



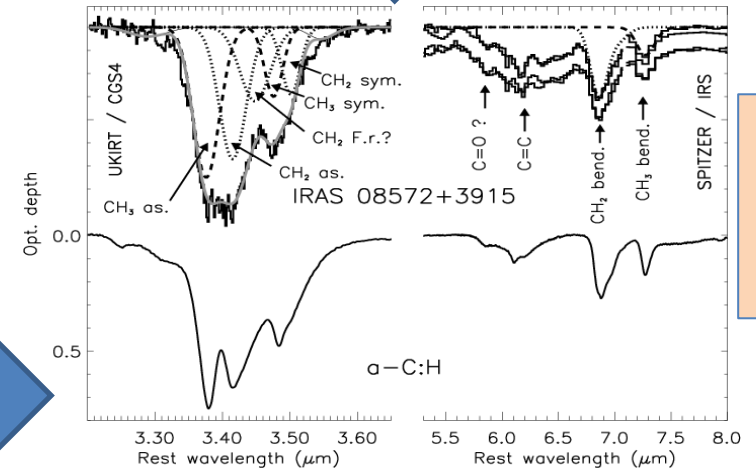
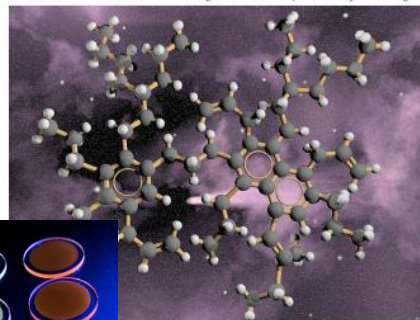
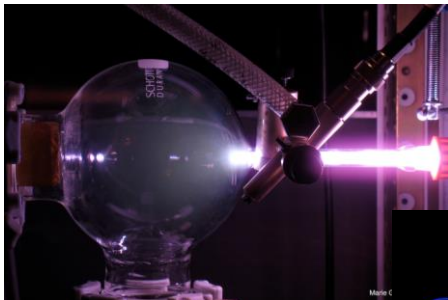




# Interstellar dust and carbon analogues

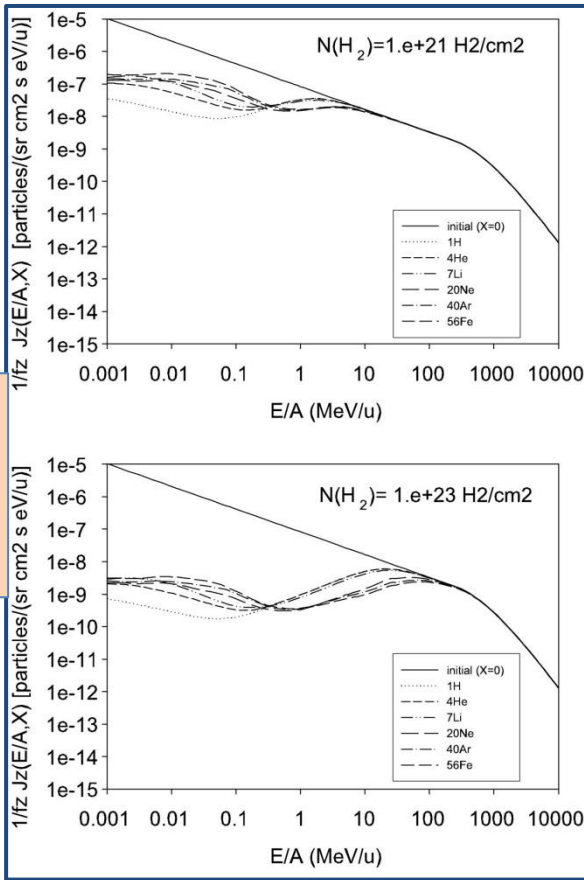


a-C:H analogue in lab (IAS).

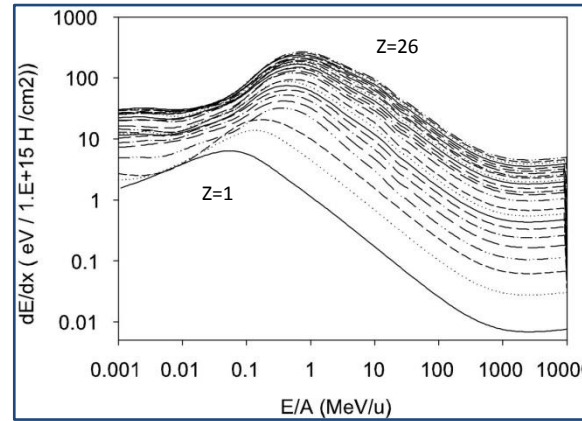


Dartois+2007

# Low energy Cosmic rays



Chabot 2016



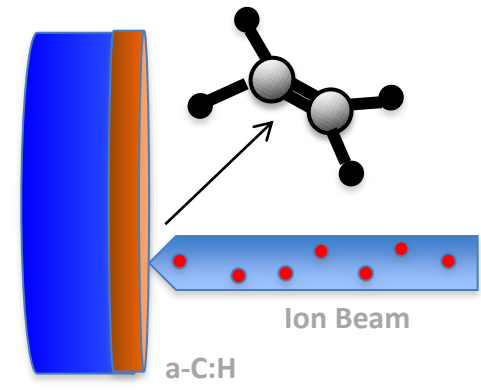
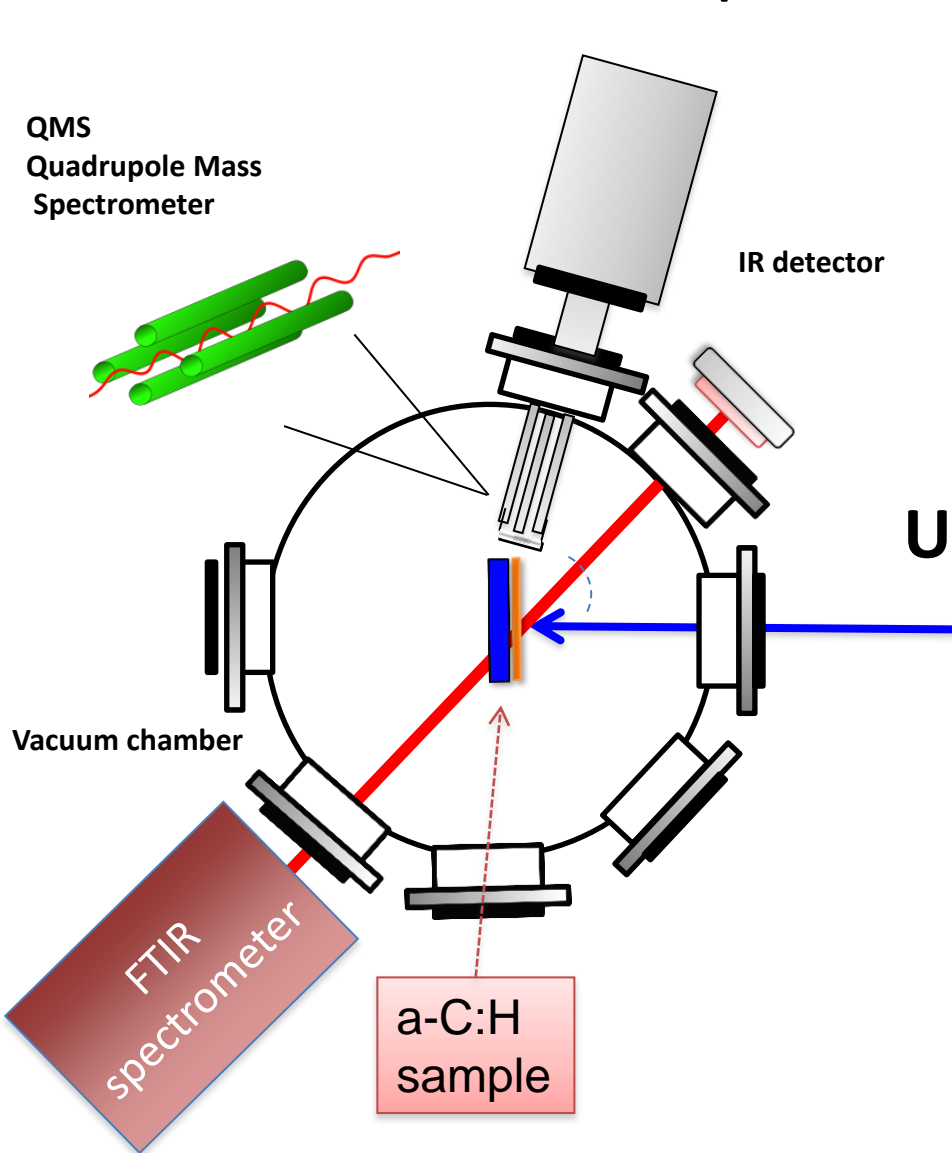
Ion matter interactions scale with  $dE/dx$

Low energy CR spectrum is determined by the propagation through the interstellar  $H_2$  gas.

CR destroy dust and produce molecular species following :

$$\tau = 4\pi \sum_Z \int j(E/A, Z) \times \sigma \left( \frac{dE}{dx} (E/A, Z) \right) dE \quad \leftarrow \text{Experimental input}$$

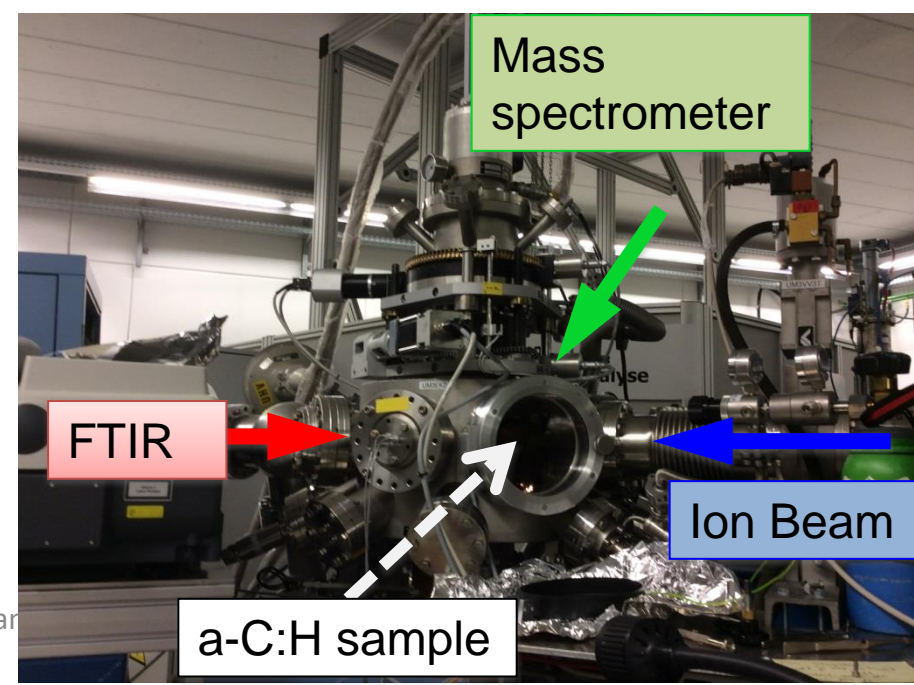
# Setup@GSI M-branch-3



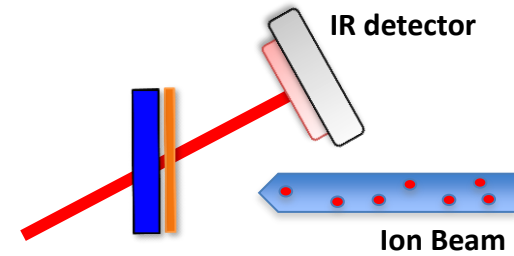
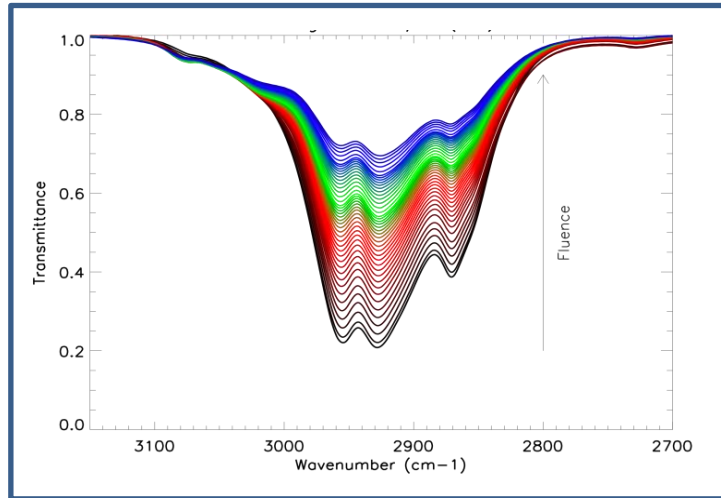
## Unilac ion beam

Irradiation at T=25-300 K

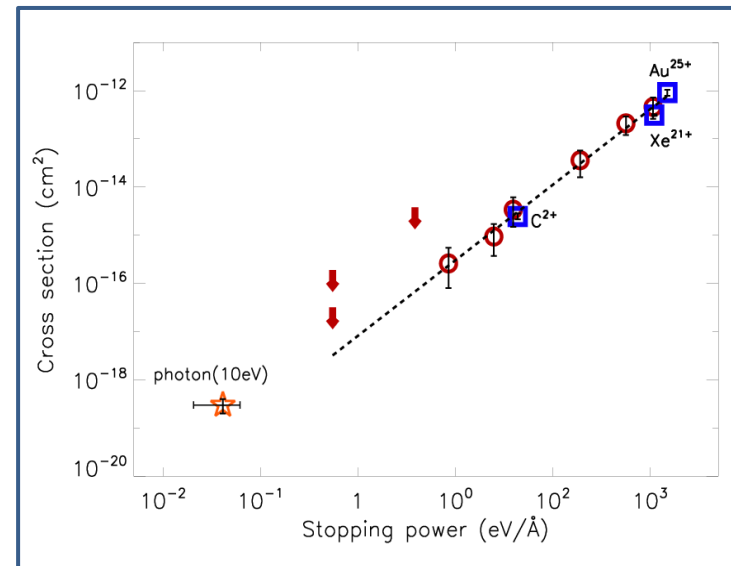
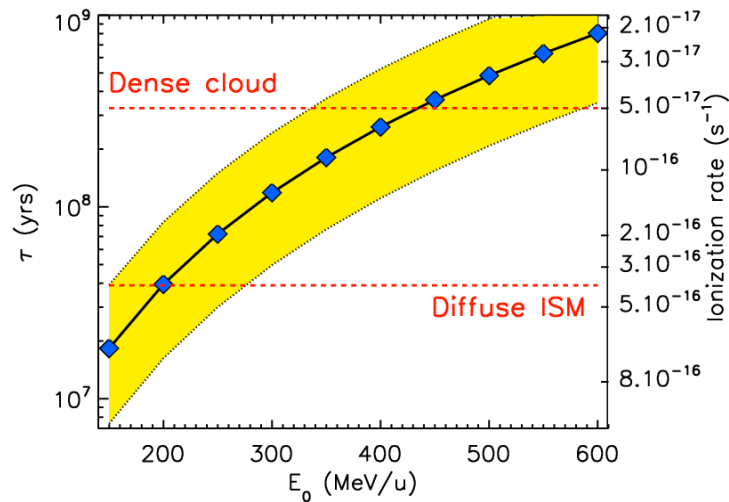
journées FAIR Fran



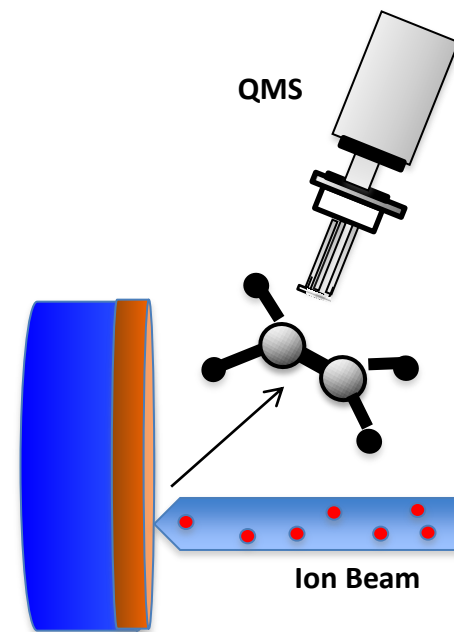
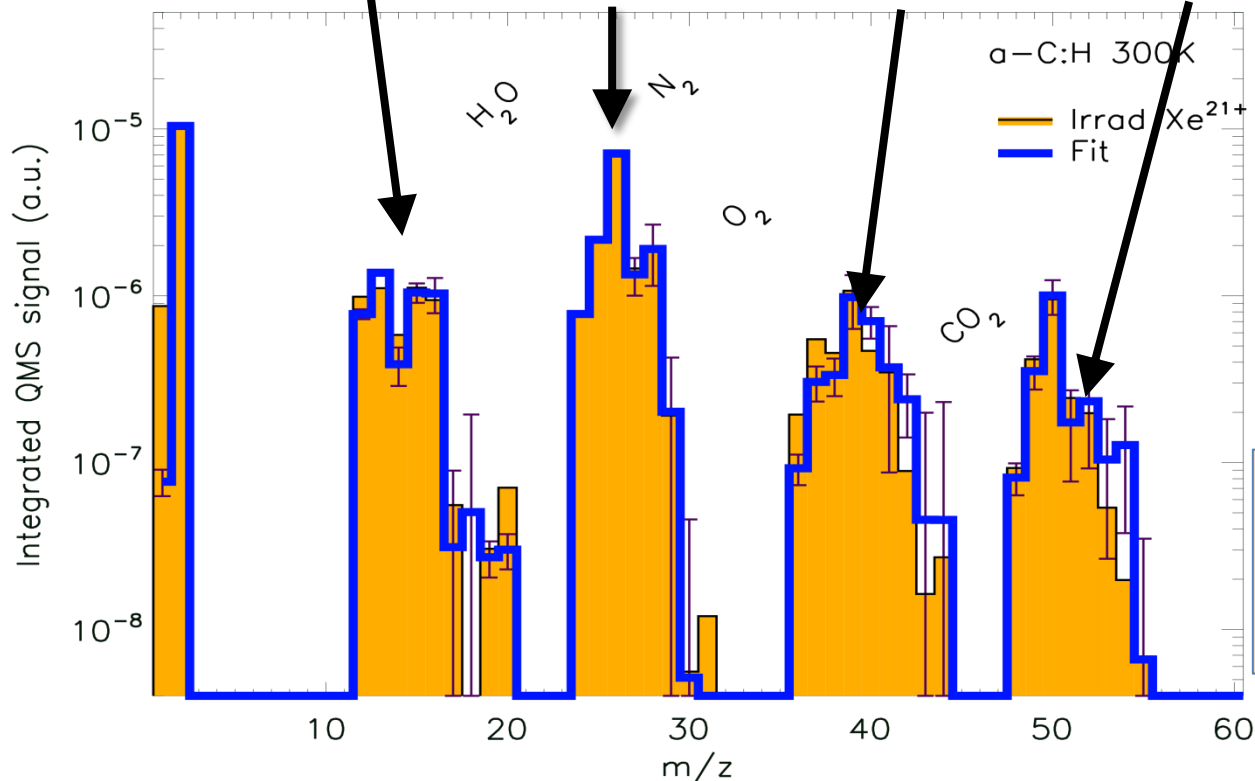
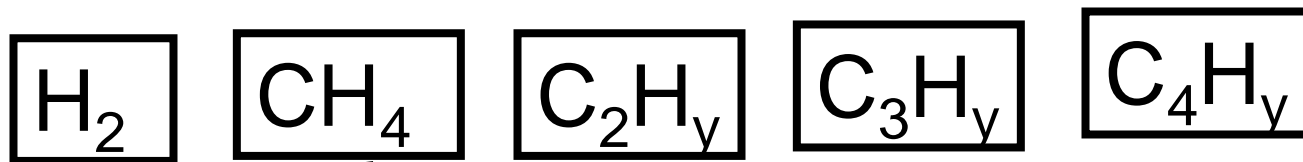
# Life time of a-CH



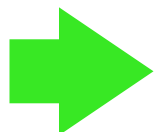
CRs lead to progressive graphitization of the a-C:H material ( C-H bond destruction).



# Hydrocarbon production



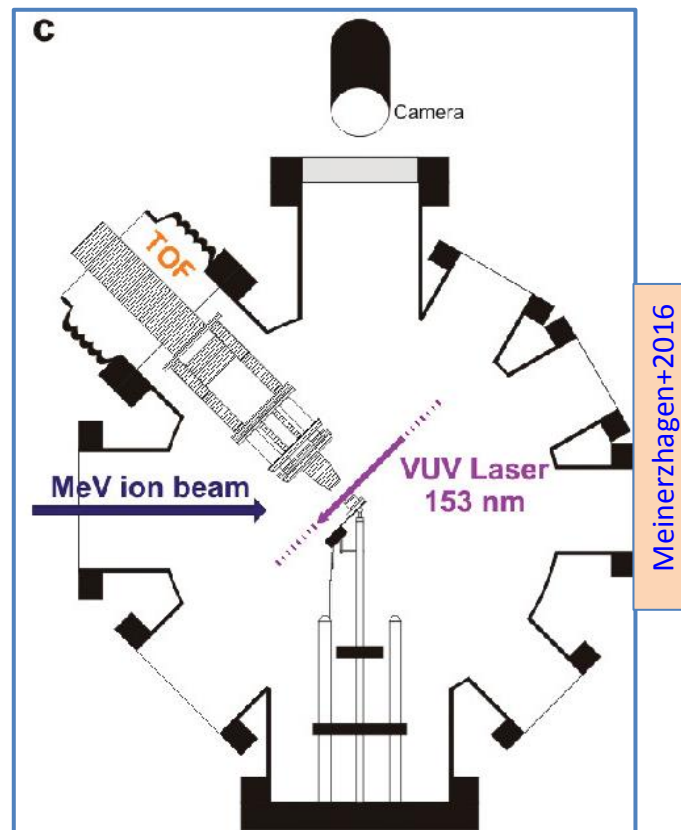
Dartois+2017



Production of small hydrocarbons by CR is negligible as compared to UV in diffuse medium but not in dense cloud.

# Conclusion & future

- QMS cannot detect reactive species.
- New series of experiment with other detection technique has been started
- Soot and a-CNH analogues are also under interest.



Thank you for your attention