Low βγ experiments at FRS:

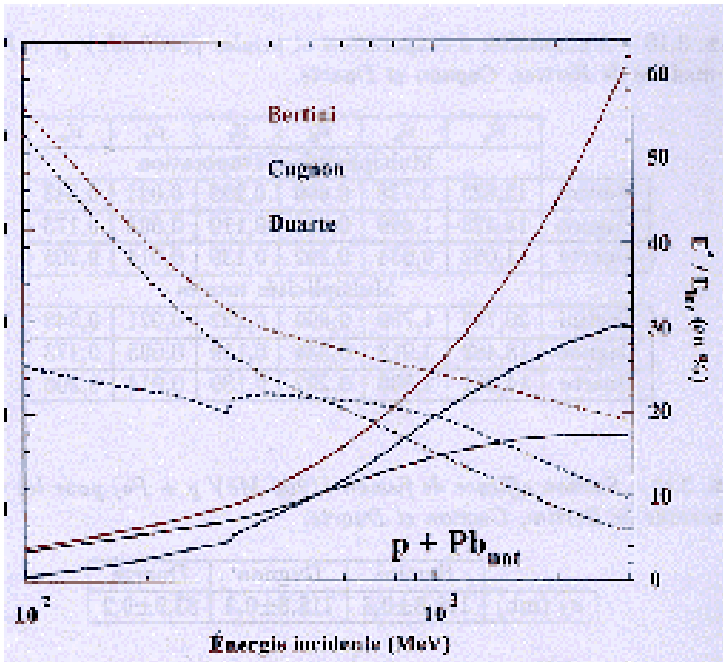
500 AMeV Pb+p experiment analysis and Xe+p perspective

Laurent Audouin – IPN Orsay

and the IPN Orsay, GSI Darmstadt, USC, CENBG, CEA SPhN collaboration

Purposes of measurements

- Evolution of excitation energy in the prefragment with projectile energy
- Crucial point for simulation of internuclear cascade in spallation sources



Discrepancies between codes depend on the projectile energy

→Experiment Pb+p at 500AMeV

Experimental specificities

- Standard H2 target with 60 mg/cm2 Nb foil
- Thick degrader at S2 to separate fragments regarding their charge state

$$\Delta B\rho = \frac{A}{q_2}\left(\Delta(\beta\gamma) + \Delta q \frac{\beta\gamma_1}{q_1}\right)$$

$$\approx kZ + ke_2 + \Delta e. \frac{B\rho_1}{Z}$$

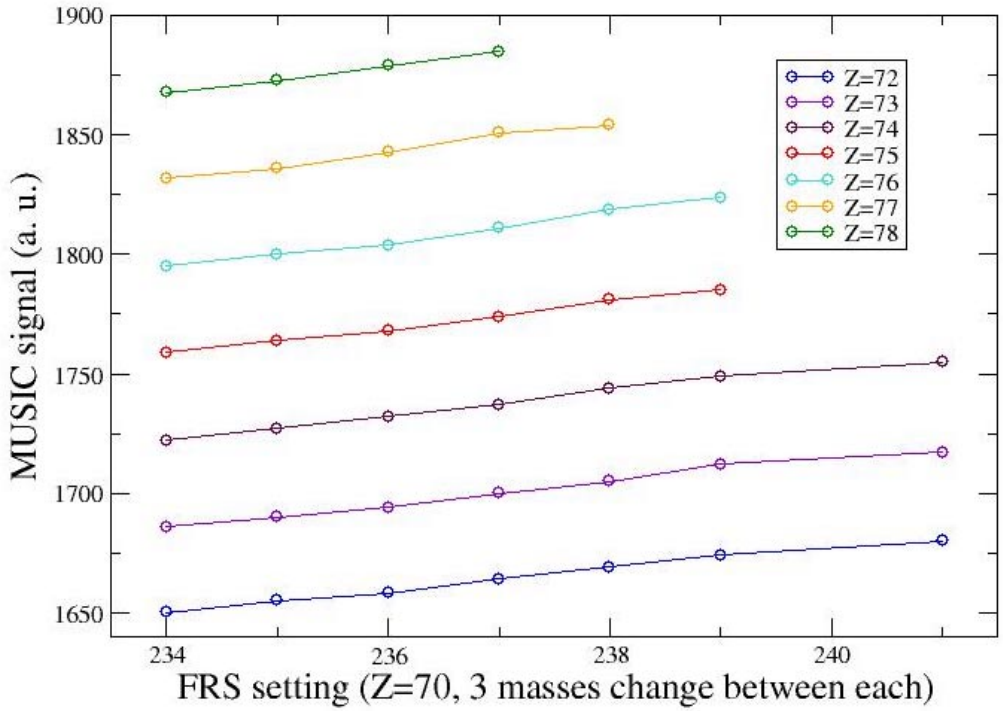
- 4 MUSICs with 2 bar gas pressure:

  - $\Delta E \propto q^2$

  - In a large width of matter the ion reaches the equilibrium charge state, leading to unambiguous Z identification

Mass effect on MUSIC response

- Ions enter MUSICs at 300AMeV and deposit 80AMeV

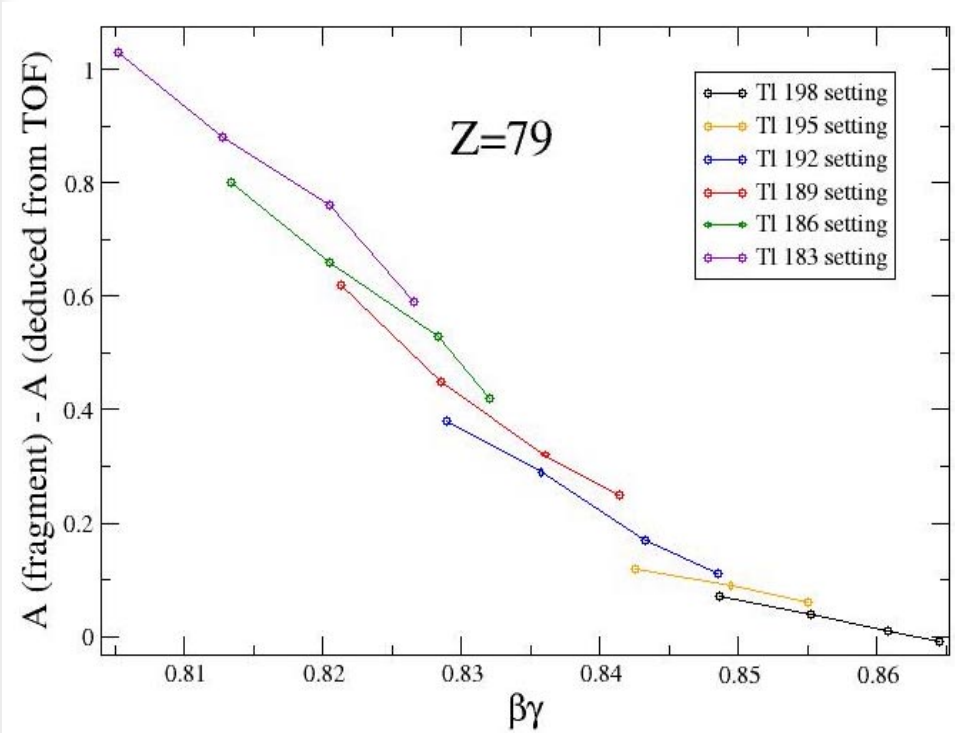


- MUSIC signal is corrected for the effect of the fragment energy, but energy loss also depends on its mass

Energy loss in MUSIC changes TOF

- Instead of TOF in the second part of the FRS, one gets TOF through FRS *and* the MUSICs !

  TOF(measured) = TOF (TOF, A, Z)



Slowing down in MUSIC

→ underestimation of β

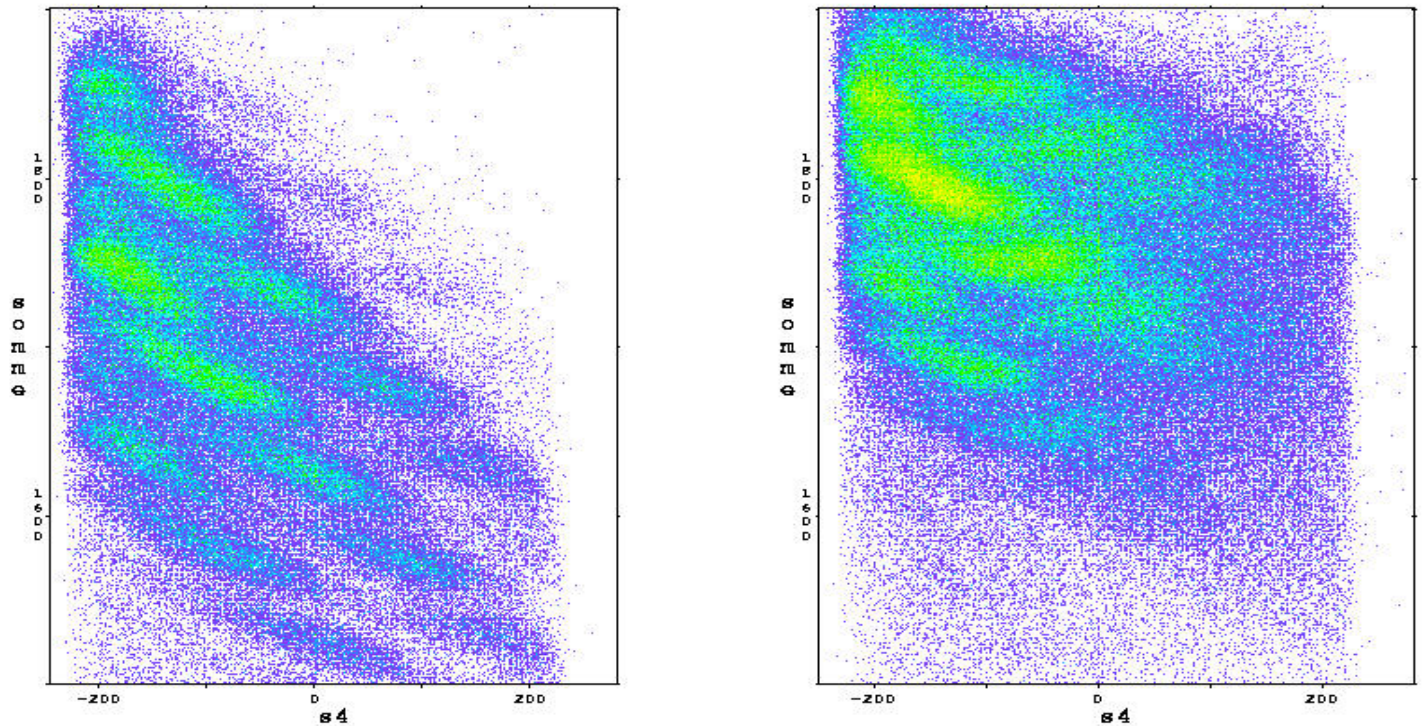
→ overestimation of A

- *For a given setting:* large range in TOF due to the degrader
- *For a given TOF:* effect of A on energy loss

Pollution in MUSIC gas and counting rate effect (1)

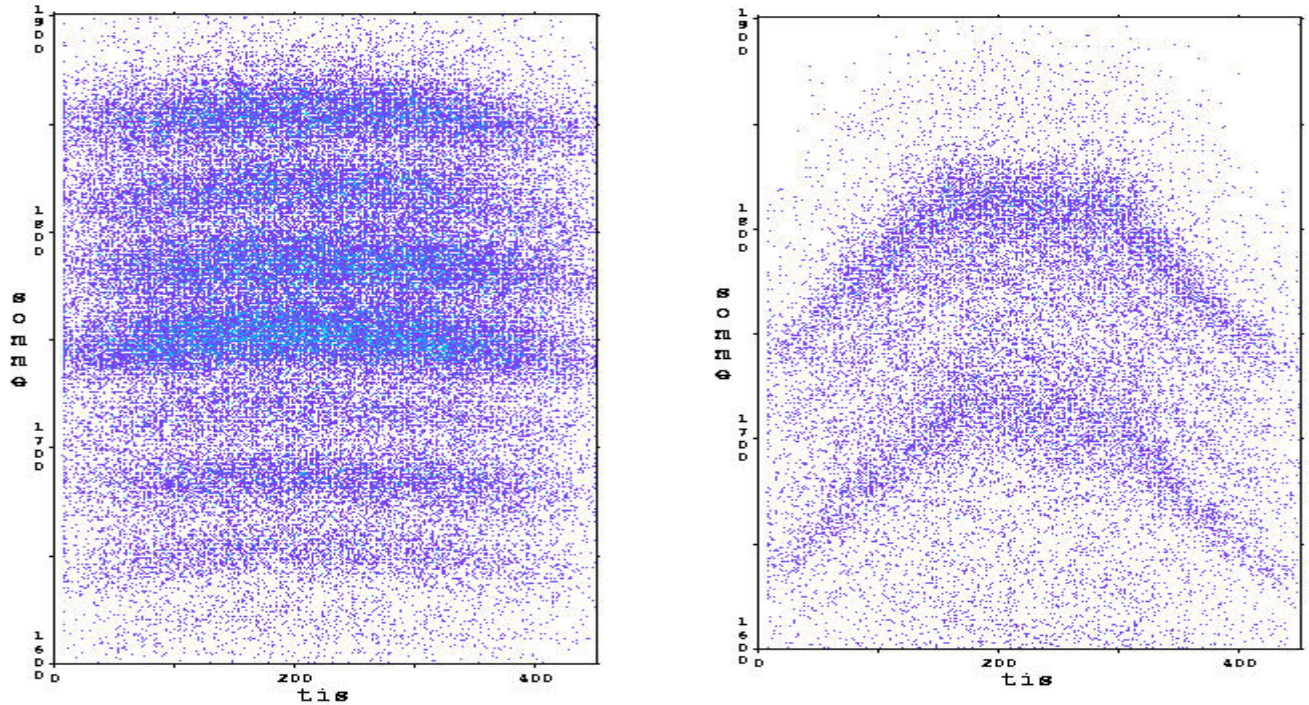
- At high counting rate (regardless of energy), signal due to ions passing far from the anodes increases

  → Reduction of the position dependence



Pollution in MUSIC gas and counting rate effect (2)

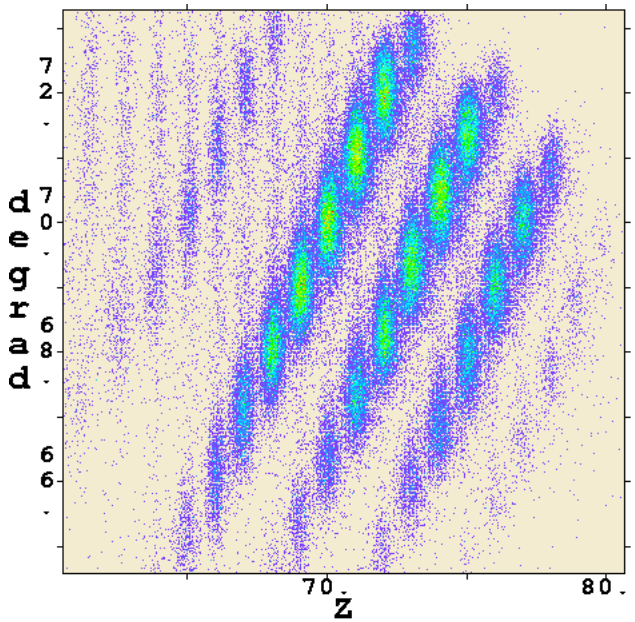
- With distance from anodes, signal varies more and more accordingly to the spill shape

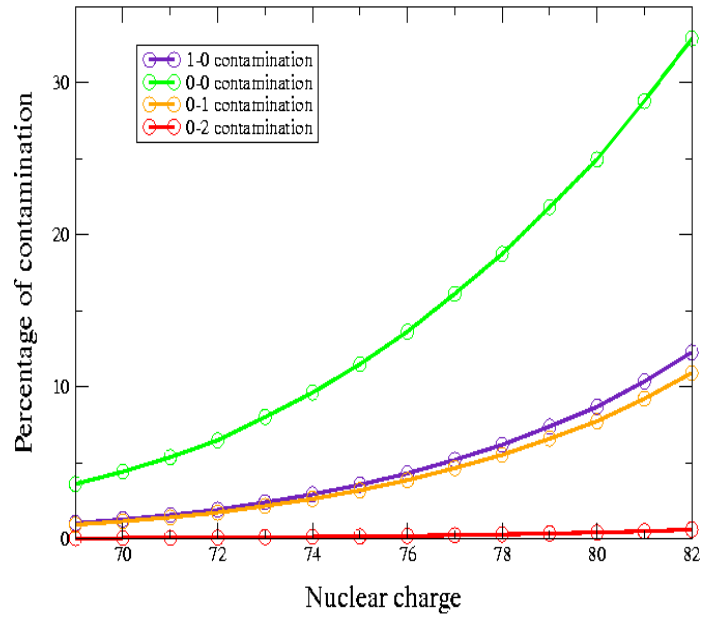


Saturation of electron catching sites (impurities) in the gas?

Charge state problem and degrader

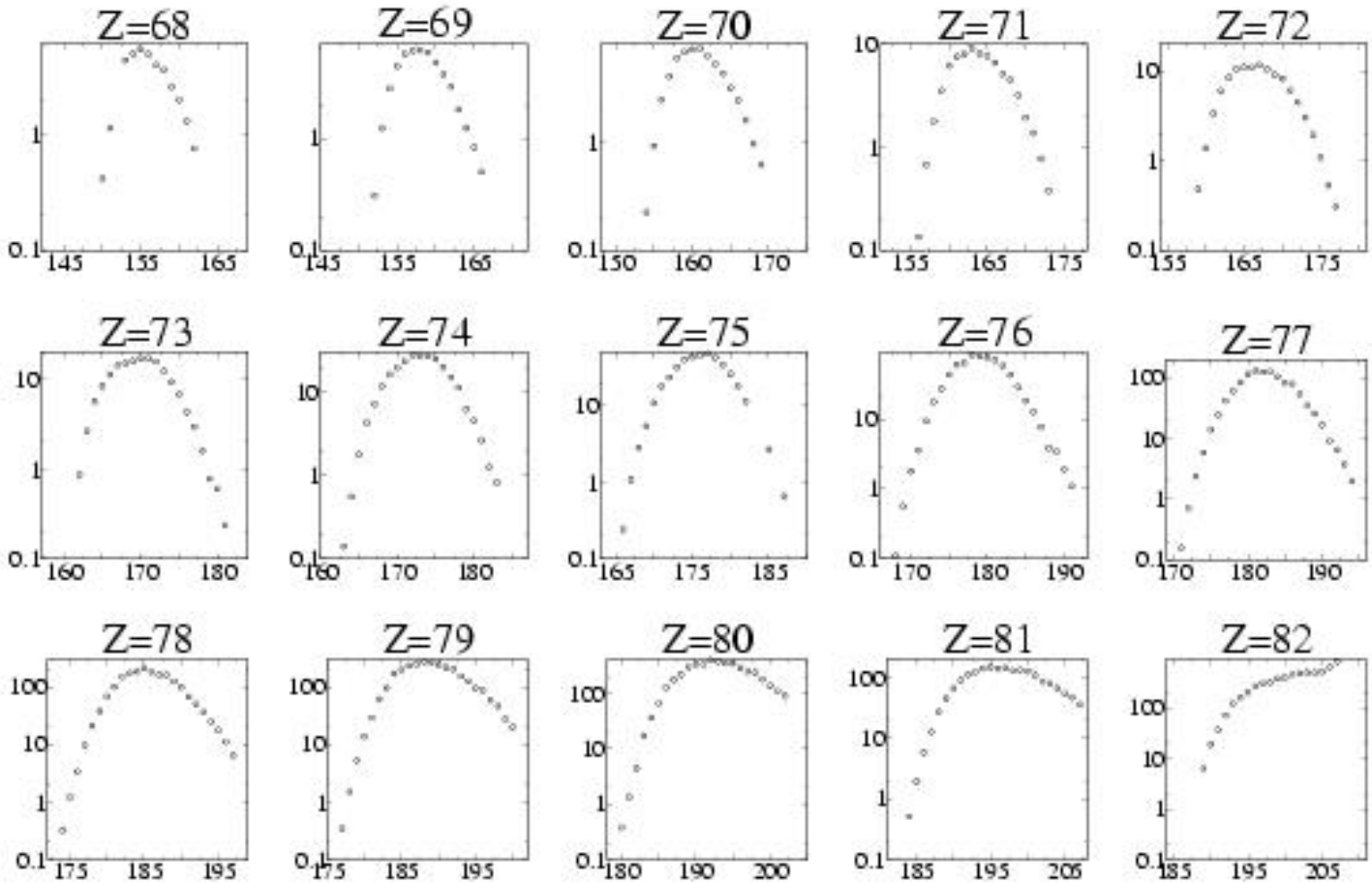
- Charge state transmitted up to q=Z-4
- Degrader and MUSIC both rely on energy loss, but MUSIC resolution is increased because of the cutting of delta electrons (short time signal integration).





- Degrader allows only $q_1 \neq q_2$ separation.
- Need for a deconvolution of charge state combination due to mixing of (A)(0,0) with (A-3)(1,1), …

Production rates in target



Data have to be corrected from reactions in dummy target, secondary reactions, and charge state probabilities.

Xe+p spallation experiments

- The test experiment Pb+p at 500AMeV is successful!
- Larger uncertainties on results than in previous exp.
- Measurement at lower energy doesn't seem feasible

- A set of experiments with Xe beam on proton target at several energies will have several advantages:

  - Possibility to reach very low energies (very small H-like ion probability: <2% at 150AMeV)

  - ^{136}Xe is a heavy and neutron rich nucleus: INC prefragment is far from the residue corridor

    → large excitation energy dynamics accessible

  - Use of both ^{136}Xe and ^{124}Xe will allow to estimate the influence of the break-up mechanism (limiting temperature) for high energy experiments

  - Most of the settings won't require a degrader