

Total Fission Cross Sections for Proton-Induced Fission of ^{208}Pb

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Fission reactions may have a significant effect on the performance of the spallation target in accelerator-driven system (ADS), in particular on the production of radioactive and/or chemically hazardous materials. Moreover, different experiments have provided the total fission cross sections for proton on lead reactions with large uncertainties or even with rather discrepant values [1]. In the present work, we report on the first results with a new generation of accurate measurements of total fission cross sections in spallation reaction on ^{208}Pb at different proton energies: 370, 500 and 650A MeV. The measurements were performed in inverse kinematics using a full-acceptance detection system, which measured both fission fragments in time coincidence.

The experiment was performed at the ALADIN-LAND cave at GSI. The number of projectiles was determined from a MUSIC, selecting ^{208}Pb beam which hits a liquid hydrogen target. The fission events were determined by the detection in coincidence of both fission fragments using a double ionization chamber (Twin MUSIC) [2], which also allowed us to reconstruct the reaction vertex based on accurate drift time measurement. In order to obtain the fission cross sections, corrections due to the beam attenuation (less than 4%) and the production of secondary reactions (less than 2.2%) were applied. Losses due to geometrical constraints were also evaluated using Geant4 simulations [3], resulting into a detection efficiency of about 88%.

The results obtained for the total fission cross section (open circles) [4] are shown in Fig.1 compared to previous measurements reported in literature for the reactions $p+^{nat}\text{Pb}$ and $^{208}\text{Pb}+p$. As can be seen in the figure, our data have in general better accuracy than any of the previous ones. Moreover, our measurement at 500 MeV is in perfect agreement with the recent measurement of K.-H. Schmidt [5] using a similar detection setup. However, the cross section obtained by B. Fernández (full square) at the FRS presents a non-negligible deviation with respect to our results and the systematics, which could be due to the limited acceptance of the spectrometer requiring large corrections. Our measurements are also in agreement with the values reported by E. Hagebo (open cross) and R. Brandt (full star) who measured in direct kinematics the reaction $p+^{nat}\text{Pb}$ at 600 and 590 MeV, respectively. The present measurements also seem consistent with the measurements between 50 and 200 MeV and with the measurements performed by V.A. Konshin (stars) if one looks at the down-

ward trend and also with the measurement performed by T. Enqvist (full circle) at the FRS if one looks at the upward trend. One can also observe a discrepancy at 1 GeV between the measurements performed by T. Enqvist and M. Gloris (open diamond) but our results are only consistent with Enqvist's measurement. Finally, the measurements performed by A.A. Kotov (full triangles down) also have a deviation, but these were performed in direct kinematics with a proton beam impinging on a ^{nat}Pb target, which could prevent fission fragments to escape from the target reducing the total fission cross section if one does not apply the accurate corrections.

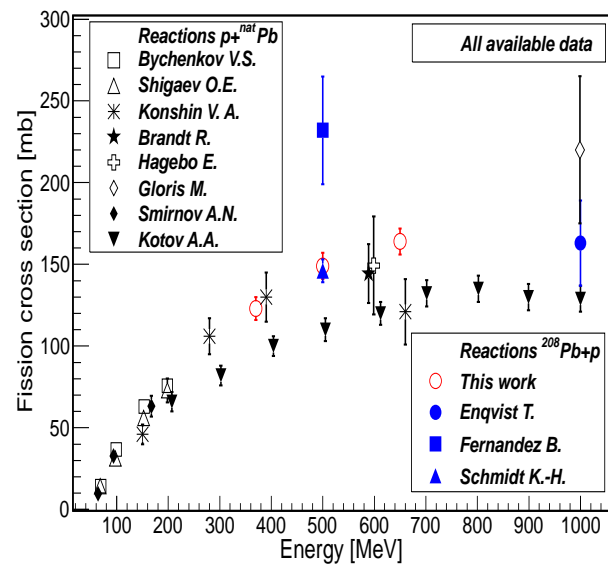


Figure 1: Total fission cross sections for $p+^{nat}\text{Pb}$ and $^{208}\text{Pb}+p$. The red open circles represent our data.

References

- [1] A.V. Prokofiev, Nucl. Inst. Meth. A 463 557 (2001).
- [2] B. Voss et al., GSI Scientific Report 2011, p.184-186.
- [3] J.L. Rodríguez-Sánchez et al., "SOFIARoot: Simulation of the SOFIA/ANDES Setup" in this annual report.
- [4] J.L. Rodríguez-Sánchez et al., EPJ Vol. 62 07009 (2013) and references therein.
- [5] K.-H. Schmidt et al. Phys. Rev. C 87, 034601 (2013).