

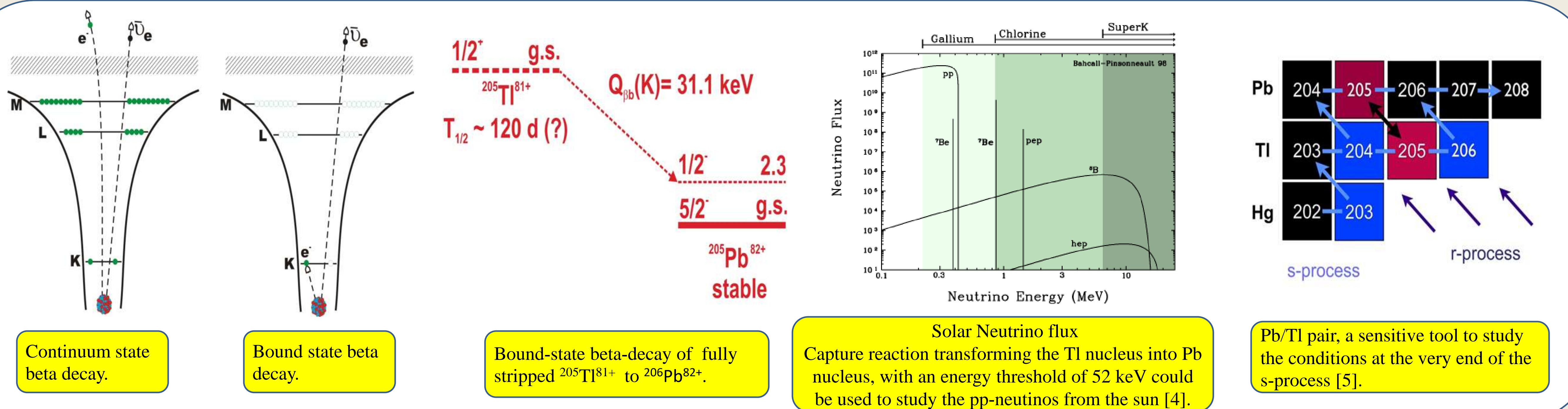
Preparation for the measurement of the bound-state beta-decay of bare $^{205}\text{Tl}^{81+}$ ions at the ESR

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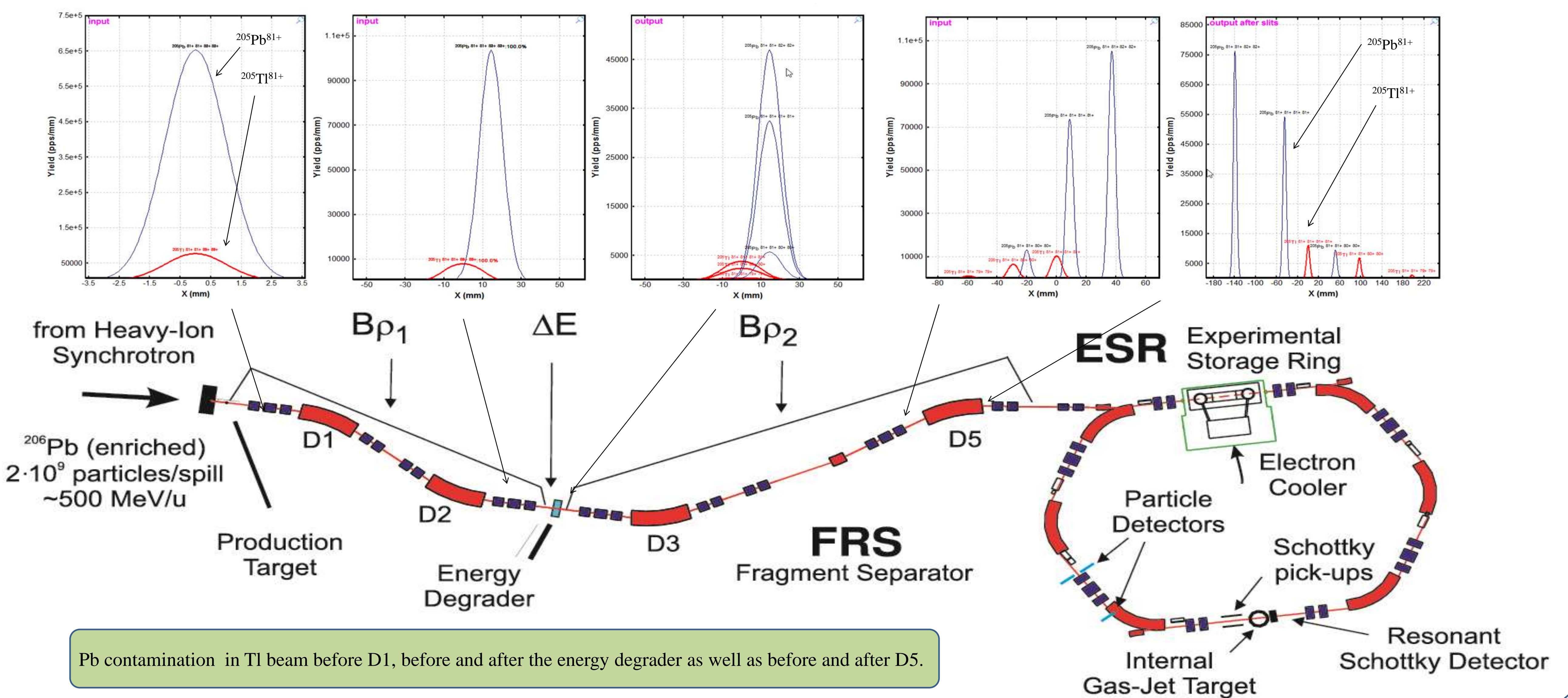
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Abstract

Bound-state beta-decay (β_b) accompanied by the emission of a monochromatic antineutrino, was first predicted by Daudel et al [1] in 1947 and then discussed in detail by Bahcall [2]. The first direct observation of the bound-state beta decay (β_b decay) was done in 1992 by Jung et al [3] with the use of bare $^{163}\text{Dy}^{66+}$ ions stored in the heavy ion storage ring ESR at GSI. In the present study we aim at measuring the bound-state beta-decay rate of fully-ionized ^{205}Tl , which is needed to determine the matrix element for the electron capture decay from the 2.3 keV excited state in ^{205}Pb to the ground state of ^{205}Tl . This matrix element is important for constraining of neutrino capture probability into the 2.3 keV state of ^{205}Pb [4] and for modelling of the s-process [5] in the Hg-Pb region. The experiment proposal has been approved by the GSI program advisory panel. We aim at conducting the experiment in 2018, when the accelerator complex of GSI will restart its operation.



Preparation of bare $^{205}\text{Tl}^{81+}$ beam and its separation from the contaminant $^{205}\text{Pb}^{81+}$:



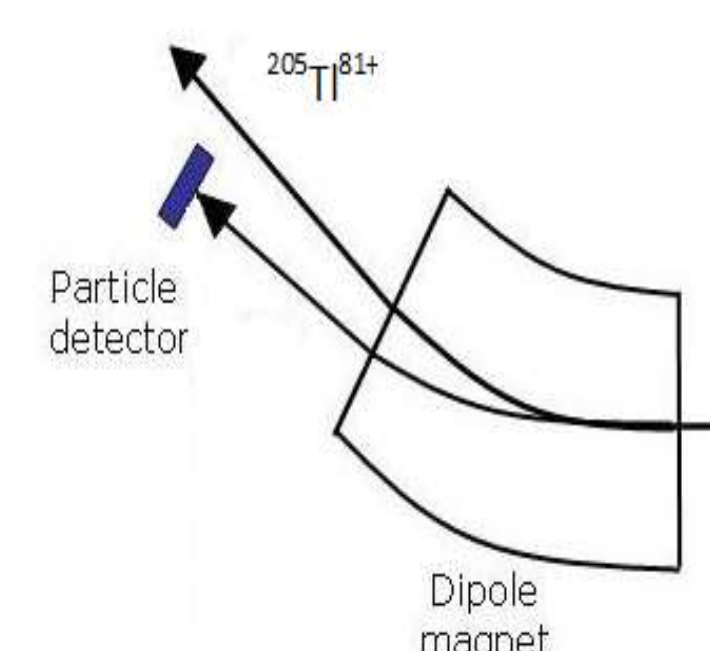
Decay of $^{205}\text{Tl}^{81+}$:

- For the design value of stored bare Tl ions and a very cautiously estimated bound-state beta decay half-life of 1 year, we expect about 40 bound-state beta decays within a storage time of 1 hour.
- $^{205}\text{Tl}^{81+}$ and $^{205}\text{Pb}^{81+}$ have a mass difference of 52 keV and cannot be directly resolved by mass spectrometry.
- After some waiting, a strong Ar internal gas jet is used to strip off the electron from Pb daughter ions.
- Experiment to be done similar to the one on $^{187}\text{Os}/^{187}\text{Re}$ [6].

Separation of $^{205}\text{Tl}/^{205}\text{Pb}$:

$^{205}\text{Pb}^{81+}$ ions produced in the β_b decay of $^{205}\text{Tl}^{81+}$ can be separated in magnetic rigidity by removing the bound electron from the $^{205}\text{Pb}^{81+}$. For the latter an internal Ar gas-jet is switched on for a short time.

Detection:



The ions can be identified either by a particle detector installed after the dipole magnet downstream the gas-jet or by non-destructive Schottky mass spectrometry. The latter has a very high sensitivity down to single stored ions.

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