SPES BEAM TABLES

How to read them

Abstract

Information on predicted SPES Beam Tables are given, matched with some more information on SPES scheduled phases and major technical hypothesis on the Target/Sources and ALPI transportation system.

SPES Scientific Support

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BEAM TABLES: How to read them

New **Beam Intensity Tables** have been created to provide information to **SPES USERS** on the predicted values for non-accelerated and accelerated beams in the various SPES stages:

SPES Phase 1 will work with **5µA** proton current and only **UCx** target.

SPES Phase 2 will work with up to **200µA** proton current on **SiC** and **B4C** targets**.**

SPES Phase 3 will work with up to **200µA** proton current on all targets (**mainly UCx**).

For this reason a number of different **TABLES** have been prepared:

- one *general* TABLE
  - ➔ **BEAM_SPES_ALL** which list all possible beams which will be available @SPES, both low energy (40 keV) and re-accelerated.
- two *1st day* TABLES
  - ➔ **1st_day_UCx_5µA** which list all possible beams available in the 1st SPES phase with **reduced proton current**
  - ➔ **1st_day_light_beams** which list all possible beams available in the 2nd SPES phase with up to **200µA** proton current on **SiC** and **B_4C** targets
- a *4th* TABLE
  - ➔ **UCx_200µA** which list all possible beams available in the 3rd SPES phase with full proton current on UCx – in this case only **n-rich** from **fission** and **accelerated beams** with **I > 10^4** are listed in this case.

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In those **TABLES**:

- ✓ column **F & G** refers respectively to *non accelerated* and *post accelerated* intensities (with a proton current of **200μA** in all TABLES **except** Table **1st_day_UCx_5μA** for which the proton current is **5 μA**)
- ✓ column **H & I** refers respectively to *non accelerated* and *post accelerated* intensities with a proton current of **5μA** **only** in TABLES **BEAM_SPES_ALL** and **1st_day_light_beams.**
- ✓ column **J** in TABLES **BEAM_SPES_ALL** or **1st_day_light_beams** and column **L** in TABLE **1st_day_UCx_5μA** or **UCx_200μA:** *legenda* →

  - △ * Feasible but possible reduction of Max Energy
    → ***Max Intensity vs. Max Energ to be defined***
  - ● ** Feasible
  - ▦ *** Feasible with higher RFQ field
  - ● **** Feasible with possible lowering in intensity

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Target & Beam selection options

1. Target/Source Systems:

- ✓ With the **Plasma Ion Source** (PIS – FEBIAD), beams of almost all isotopes can be easily produced but this resulting beams will be contaminated due to the low selectivity of the PIS ionization source. Information on the kind & relative intensities expected of contaminants can be obtained asking specific information to the **SPES Scientific Support** group (gramegna@lnl.infn.it , valiente@lnl.infn.it). Evaluation of the contaminants for the most requested beams is in progress taking into account relative efficiencies, lifetimes etc. & will be published on request.
- ✓ With the **Laser Ion Source** (LIS) → developments are needed for each isotope. The first developments will be devoted to the **Sn isotopes** and **Ge beams** will be studied as a second step.
  However, USERS requirements will determine the **final scheduling priorities** of new developments. Typically, one or two years may be needed to develop new beams.
- ✓ When using **SIS** or **LIS** sources, the **Cs** and **Rb** contaminants are always present unless the HRMS is used. This contamination may be discriminated by the **Wien Filter** + **Dipole** or (more likely) by the **Medium mass spectrometer** (**MRMS**), when selecting a region far from the Cs and Rb masses (for example Ge, Zn, Cu). In all the other cases the contamination have to be evaluated (see PIS source).
- ✓ It has to be noted that**,** in order to enhance the efficiencies of the source, **current developments** on **Surface Ion Sources** are under study:
  - → use of Rhenium in the SIS to enhance the ionization efficiencies for the desired isotopes is forseen
  - → on the contrary this is not the case of **LIS**, where the ionization efficiencies of unwanted isotopes has to be minimized.

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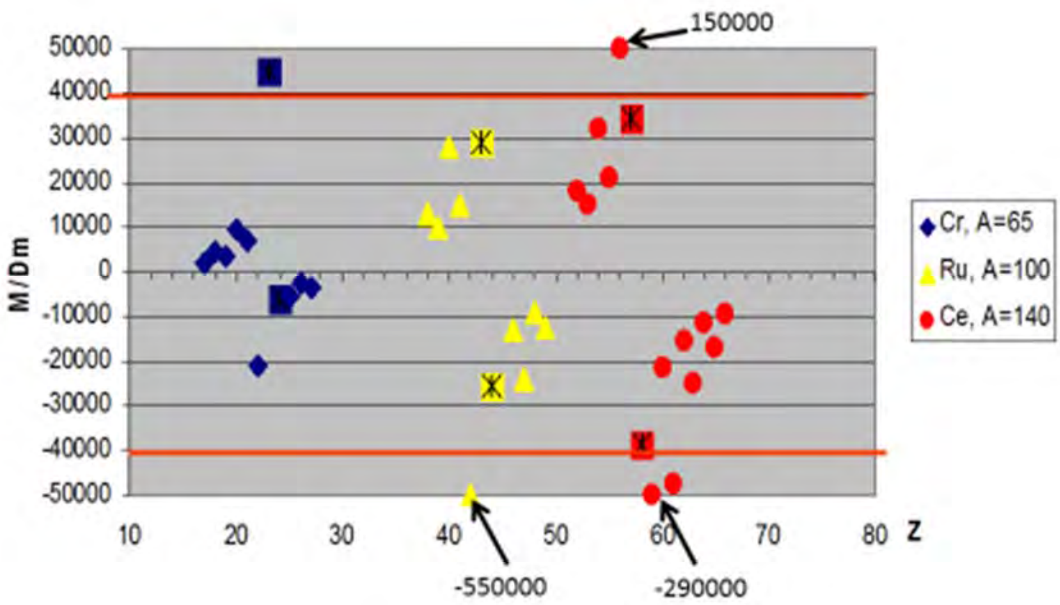
2. Mass Spectrometers:

- ✓ To reduce the contaminants the **High Resolution Mass Spectrometer (ΔM/M~1/20000)** should be used: this may be, for the moment, a second priority.
- ✓ The **HRMS** may introduce a reduction in the final exotic beam current. In some specific cases, depending on the requested purity, this reduction may reach one order of magnitude. It is therefore necessary to verify and evaluate for each experiment the optimal situation: either more intensity but more contamination (needs of experimental tagging), or less intensity but higher purity → to be evaluated on **specific cases**.
- ✓ The **MRMS (ΔM/M~1/2000)** is mainly used to clean from Charge Breeder contaminations, which are generally far away from the desired mass isotope (mainly C, O, N): normally the needed **ΔM/M** for effective RIBs selections are larger than 3000 up to values of 40000 or even more: some examples are shown in Fig. 1.



Despite a mass resolving power of 30.000 seems enough, it is more conservative to achieve higher values to reduce the tails of contaminant with higher yields

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Transport System

- In order to efficiently transport the RIBS, with the present **ALPI** configuration and the **RFQ Injector** design**,** the optimum value in terms of the **A/q** parameter is between 4 and 7:

  - ✓ Some of the listed isotopes cannot reach this optimal A/q value range yet: this may influence the max intensity and/or max energy tabulated for such elements; due to the present RFQ design, which is well matched with the present configuration of the magnets in ALPI. This limit is especially true for values **A/q > 7.5** (● ******** *Feasible with possible lowering in intensity*);
  - ✓ In case of **A/q<4 (**▲ ***** *Feasible but possible reduction of Max Energy*) the accelerator parameters are more easily adjusted (for example lowering the RFQ power and/or diminishing the ALPI magnetic field values). Possible losses in beam intensities and/or maximum energy values should be **taken into account** and **specifically evaluated** in this case, due to non-optimum matching with the Charge Breeder.
  - ✓ **Experimental values (**)** in the ***q+ 2014*** columns in the TABLES means **q+ values** obtained with test on **stable** isotopes.
  - ✓ The **A/q value** indicated in the **Tables** (& consequently the **Maximum Beam Energy** available for that isotope) **is an estimate** of the **most probable q+ value** within the obtainable **charge distribution**. It will be generally possible, therefore, to select a **larger q+** but with a **smaller probability** charge state: as a consequence a following reduction of the final intensity value is expected. This topic can be evaluated together with the **SPES accelerator people** according to specific needs of **USERS**.
- Evaluation on the production yields are in progress concerning some of the lighter targets (SiC or B_4C). At present the yields reported on the Table have been obtained from ORNL-HRIBF available currents.
- Only ~**10**4 p/s** (green cell color in the Table) have to be considered to be **available** as **re-accelerated beams**, at least for the **first SPES phases**. Some years of training are needed to be able to transport more feeble beams along ALPI.

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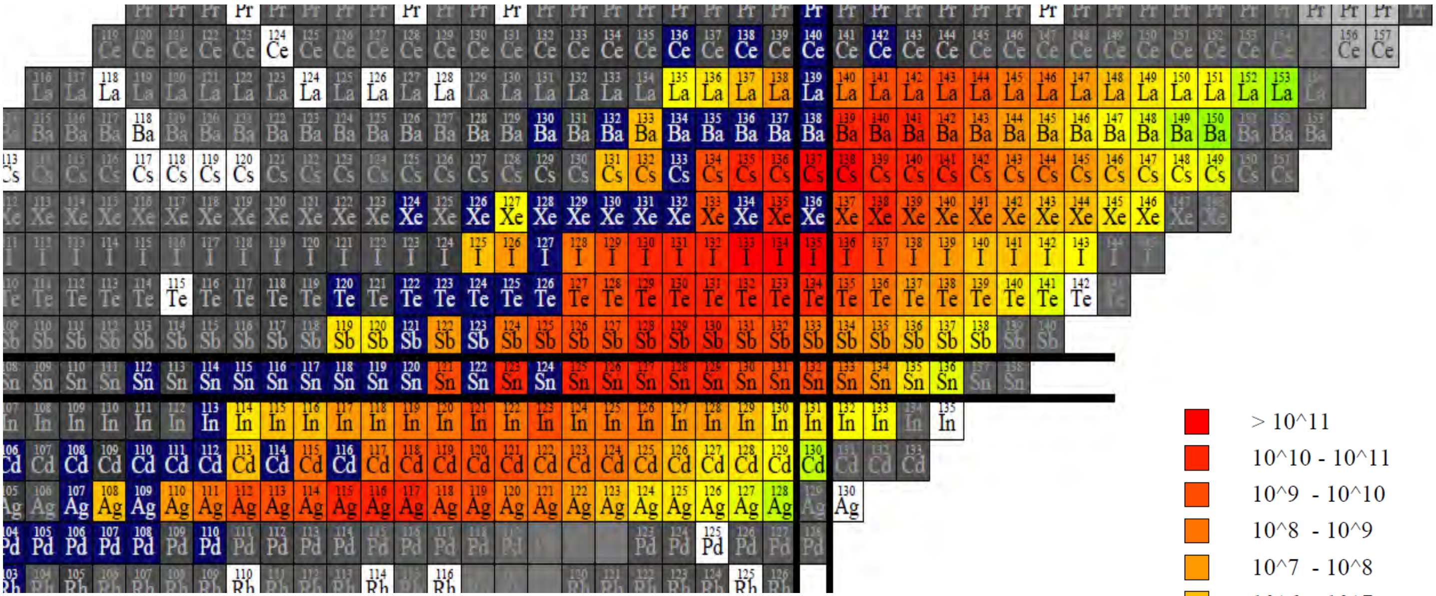
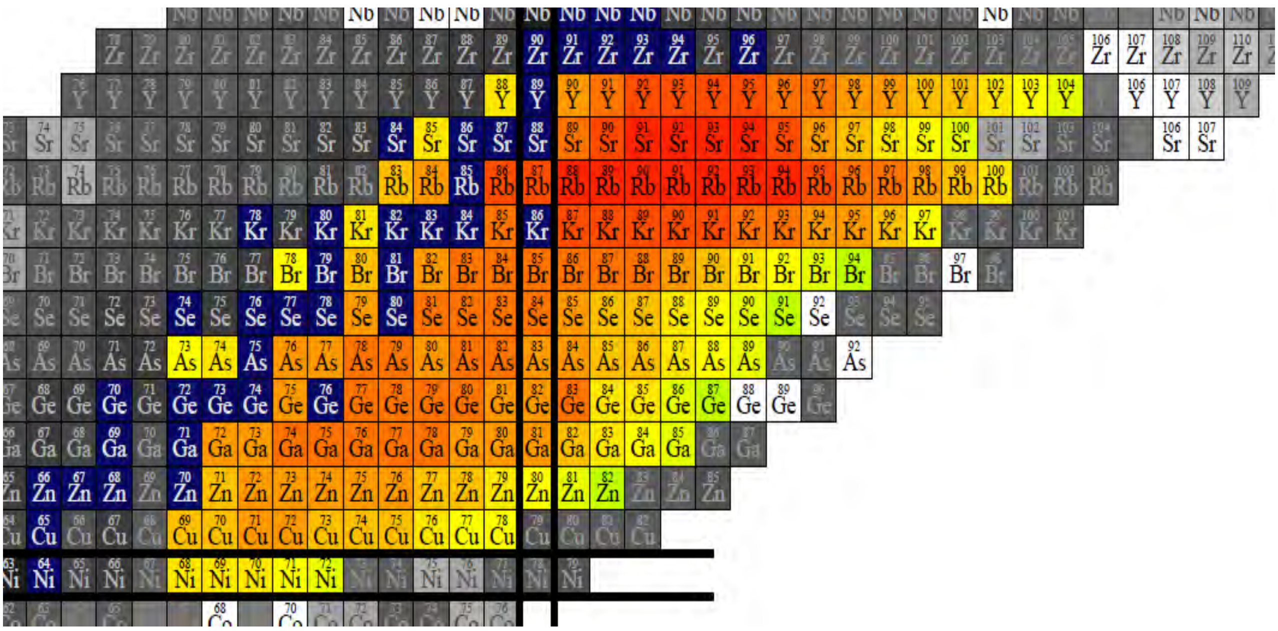
SPES beam intensities (*fission on UCx*) after the Ion-Source (1^+)



- > 10^11
- 10^10 - 10^11
- 10^9 - 10^10
- 10^8 - 10^9
- 10^7 - 10^8
- 10^6 - 10^7
- 10^5 - 10^6
- 10^4 - 10^5
- 10^3 - 10^4
- 10^2 - 10^3
- 10 - 10^2
- < 10

Courtesy of T. Marchi



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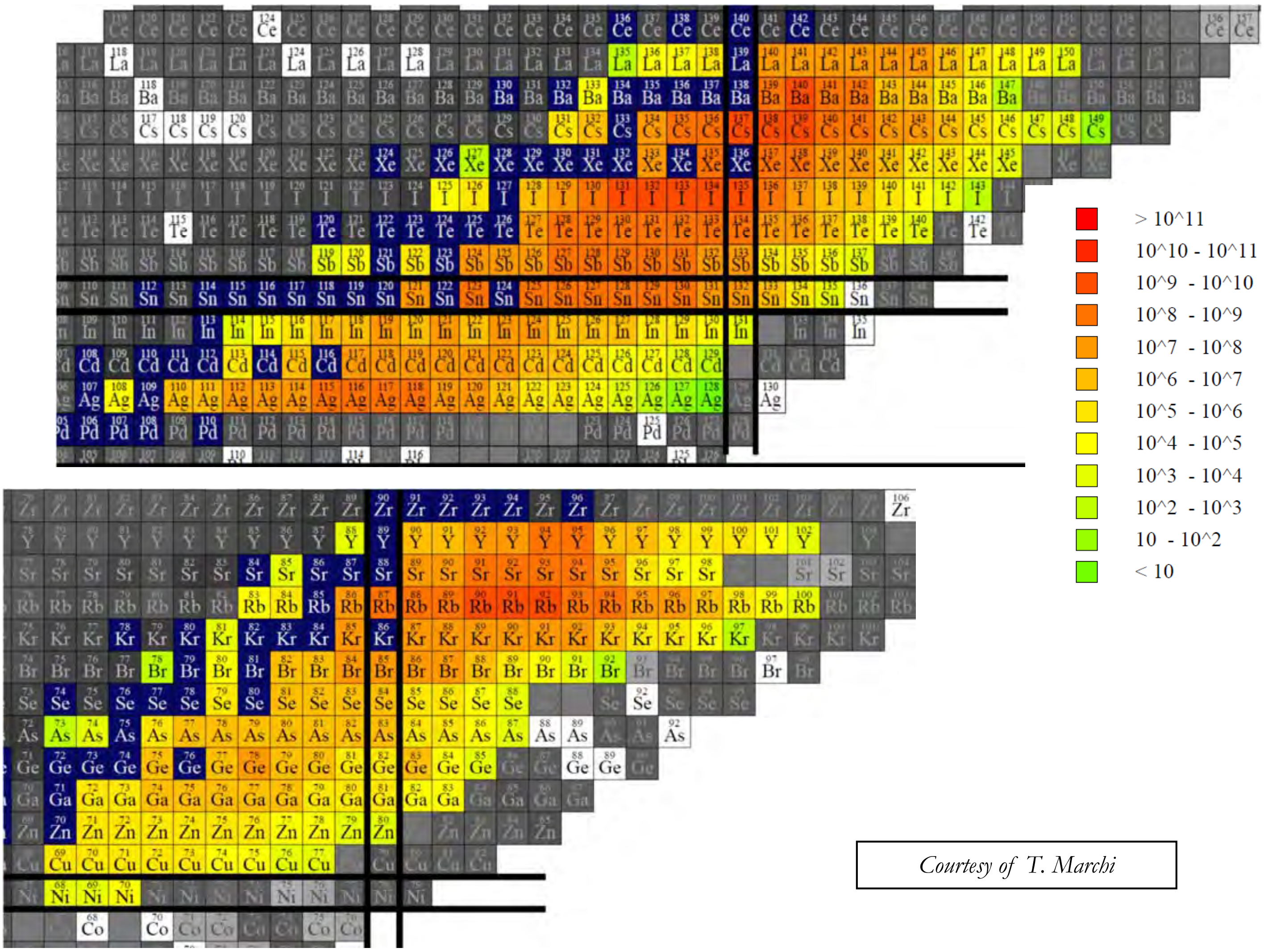
SPES beam intensities (*fission on UCx*) after re-acceleration (q+)



Courtesy of T. Marchi

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