

Towards High Intensity and Energy ISOLDE

Extrapolation of intensities for accelerated isotopes
at REX-ISOLDE

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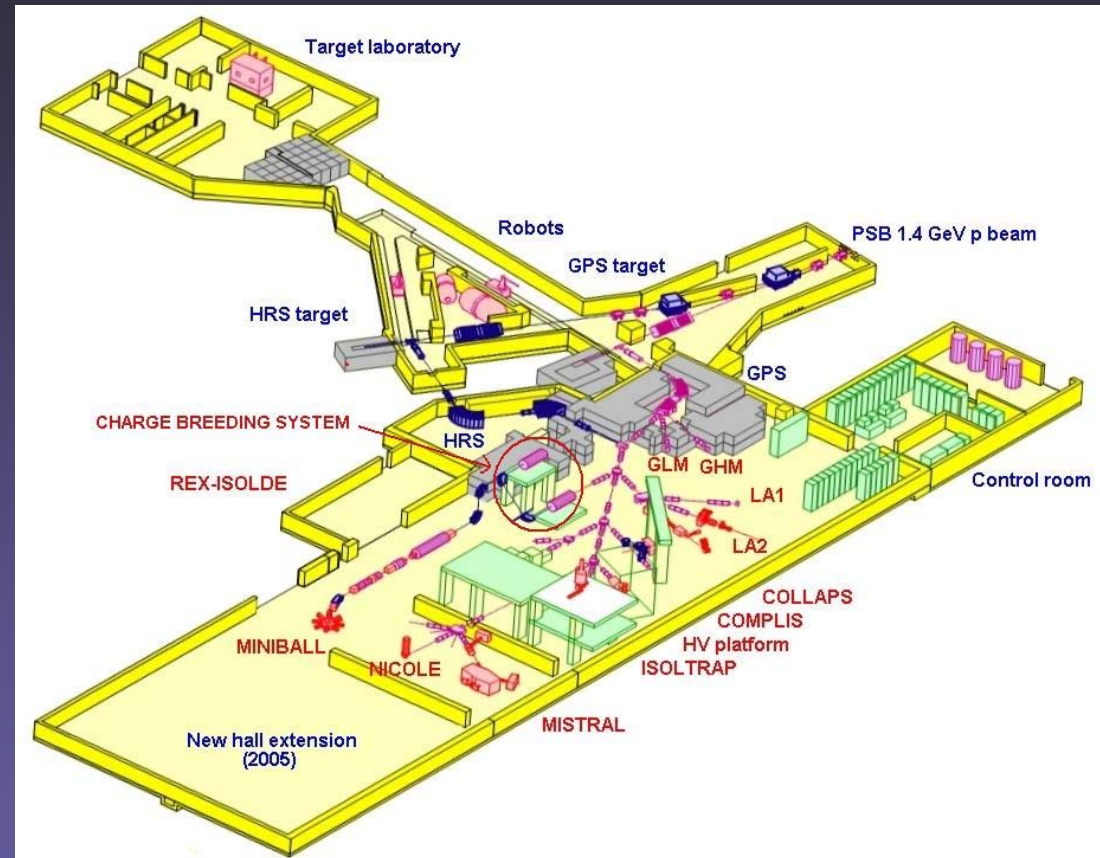
presented by

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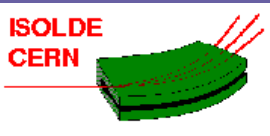
Content

- Starting point:
REX-ISOLDE database
- HIE-ISOLDE project
 - Project overview
 - Assumptions for the calculations
 - Interpolated data and results



Motivation

Since the first year of operation, REX-ISOLDE has been delivering numerous post-accelerated radioactive beams. An additional database to the ISOLDE database is being done, including **REX efficiencies** for more than 50 isotopes corresponding to **17 elements**. Based on this data the intensities of post-accelerated beams were extrapolated for the upgrade of the ISOLDE facility, the so-called **High Intensity and Energy ISOLDE project**.



- J. Cederkall et al., nucl. Phys. A746 (2004) 17c-21c
- D. Voulot et. al. Nucl. Instrum. and Meth. A, proceeding of the EMIS 2007 conference, to be published
- ISOLDE Yield Database: <http://isolde.web.cern.ch/ISOLDE/>

Compilation of data into a REX-ISOLDE database

- data compiled from minutes and logbooks of about **50 runs in 2003 to 2006**
- data from **17 elements** produced at REX-ISOLDE up to 2006
- **web application** to access the data is ready
- **open information:** A/q, Energy, ISOLDE yield, total efficiency, REX-ISOLDE intensities, separator, target
- **user restricted information:** breeding times, efficiencies for REXEBIS, REXTRAP and the transfer line, contaminants

Access to the Yield information at REX

Find the produced isotope from an element

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	1A	2A	3B	4B	5B	6B	7B		8B		1B	2B	3A	4A	5A	6A	7A	8A
Period																		
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac**	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 110	111 111	112 112						
6	Lanthanides*		58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu		
7	Actinides**		90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr		



ISOLDE
CERN



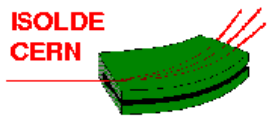
EURISOL
Design Study

The REX-ISOLDE smörgåsbord

Access to the Yield information at REX

Find the produced isotope from an element

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Compilation of data into a REX-ISOLDE database

Access to Rex Yield information

Element	A	Half life	A/Q	Energy	Isolde	Efficiency	Rex-Isolde	Separator	Comments	Target	Date
	<i>number</i>				<i>yield (ions/μC)</i>	<i>Total(%)</i>	<i>yield (ions/μC)</i>				
Cu	67	61.83 h 12	3.53	2.99	5.5E+07	9.4	4.9E+05	GPS		UC2	Aug-2006
Cu	68	31.1 s 15	3.58	2.83		5.1	1.5E+05	HRS		UC2	Jul-2005
Cu	69	2.85 m 15	3.45	2.83	1.8E+08	1.8	1.6E+06	HRS		UC2	Jul-2005
Cu	69	2.85 m 15	3.45	2.97	3.7E+07	9.6	1.8E+06	GPS		UC2	Aug-2006
Cu	70	4.5 s 10	3.68	2.83		4.8	2.5E+04	HRS		UC2	Jul-2005
Cu	71	19.5 s 16	3.55	2.95	1.8E+07	6.3	1.1E+06	GPS		UC2	Aug-2006
Cu	73	3.9 s 3	3.84	2.88	1.6E+07	3.3	1.4E+05	GPS		UC2	Aug-2006

Red means stimated value

[Back](#)

red numbers:

ISOLDE yields from database

Estimated efficiencies

REX-ISOLDE intensities calculated with estimated efficiencies



HIE-ISOLDE objectives

- increase both the **beam energy and intensity**
- **beam quality improvement** (smaller emittance, higher charge state, better mass resolution)

The physicist planning an experiment will need

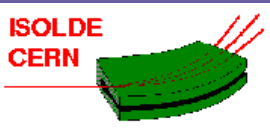
- Information about **beam intensities**
- **purity** of the specific beam of interest



- HIE-ISOLDE: The technical options, November 2006
- HIE-ISOLDE physics report, October 2007

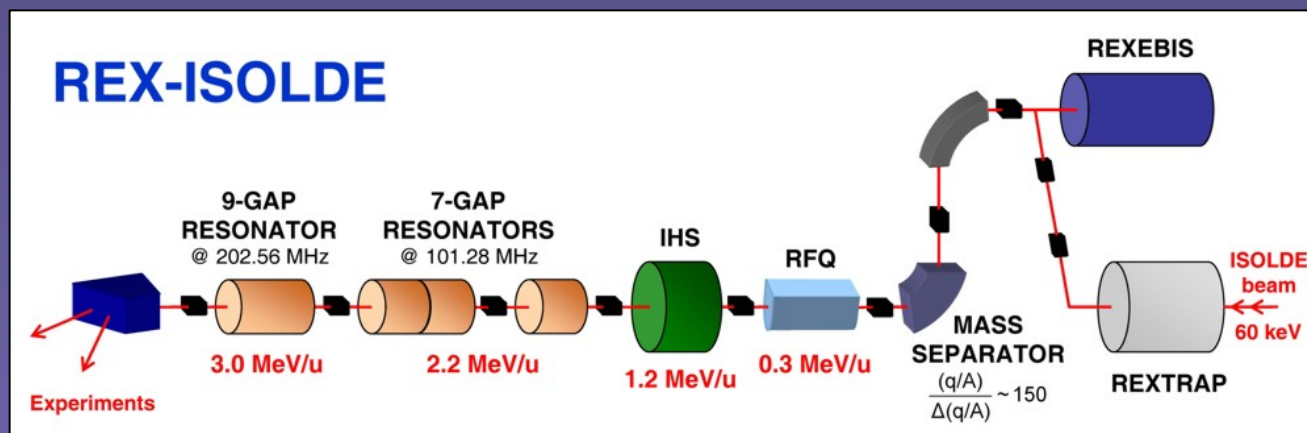
HIE-ISOLDE schedule

	2006	2007	2010	
Scenario	1.2s cycle, Linac 2	0.9s cycle, Linac 2	0.9s cycle, Linac 2	0.9s cycle, Linac 4
Protons/Pulse [$\times 10^{13}$]	3.2	3.2	3.2	6.4
Av. current [μA]	1.9	3.0	3.1	6.4
Gain factor	0.97	1.55	1.61	3.28



HIE-ISOLDE schedule

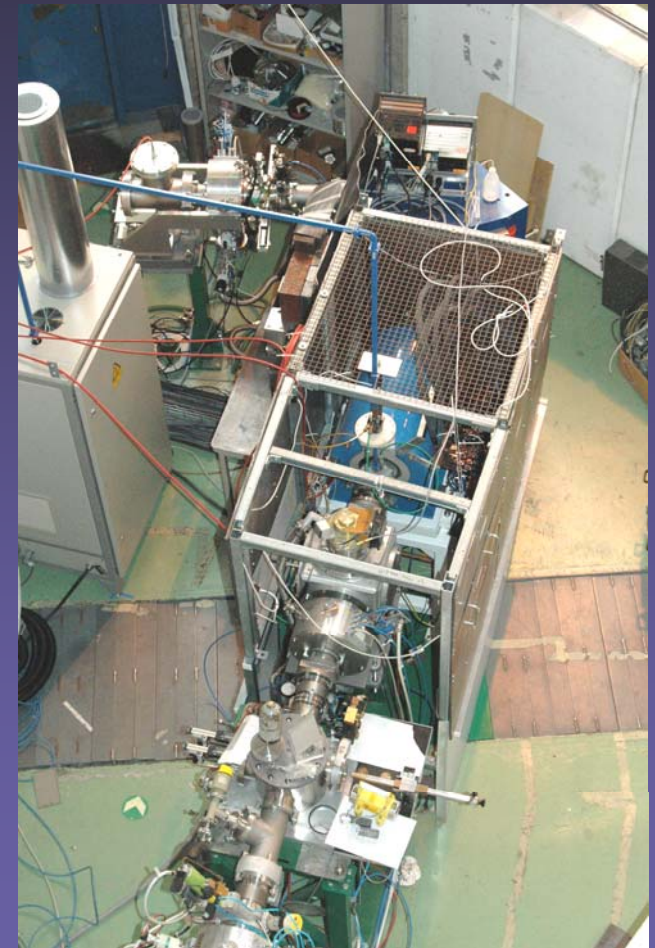
task	scheduled
Fast cycling PSB	May 2009
Targetry for Linac 4	April 2009-2010
REX LINAC upgrade	April 2013
REX trap and charge breeder	April 2011



HIE-ISOLDE option

- Linac4
- Decreased cycling time from 1.2s to 0.9s
- Average current of $6.4\mu\text{A}$ instead of $1.9\mu\text{A}$
- Space charge limit of REXTRAP at 10^8 ions/bunch → using PHOENIX ECRIS charge breeder in parallel to REXEBIS for high intensity radioactive beams
- Upgrade of the LINAC to a superconducting machine → final energy of 10MeV/u

PHOENIX ECRIS



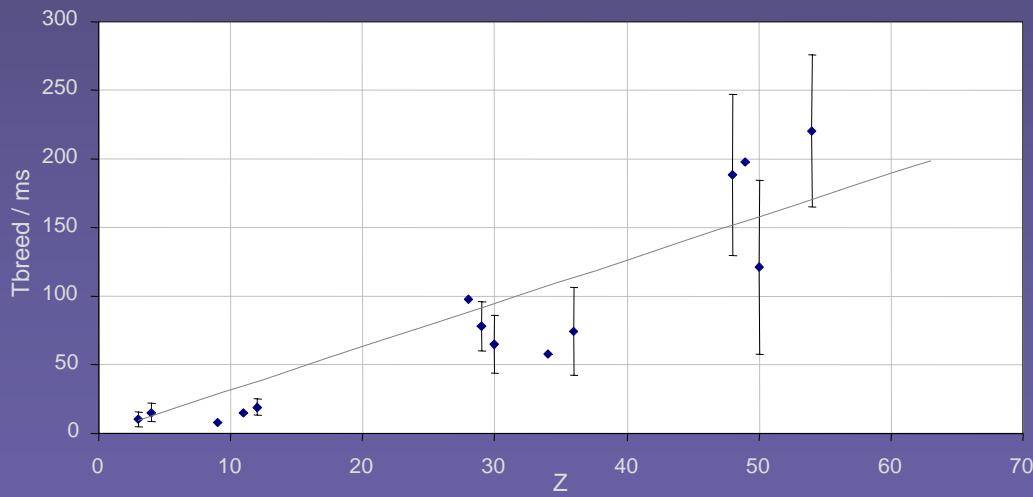
Assumptions for the calculations

Beam availability in 2010	3 x present beam
Upgraded EBIS PHOENIX ECRIS	T_{breed} decreased by factor 4 $T_{\text{breed}} = 200\text{ms}$
Decay losses due to short half lives were taken into account	
REX-LINAC	typical efficiency 80%
Interpolated breeding times and efficiencies from measured data	

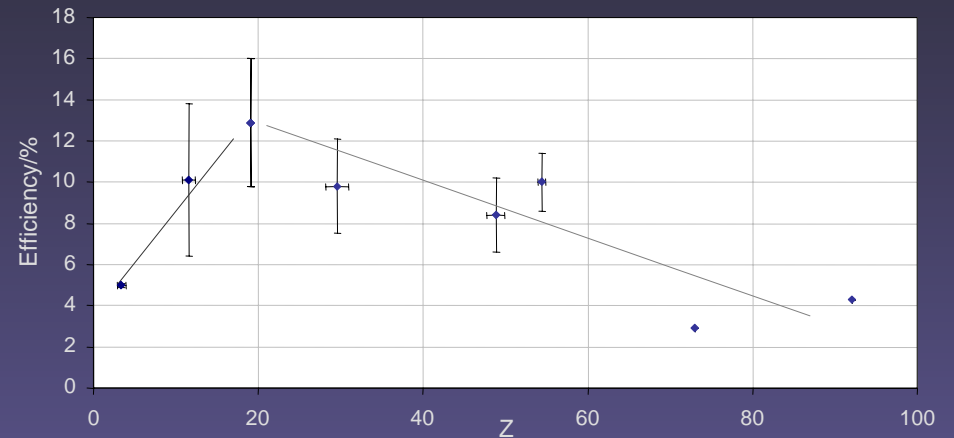
Interpolated data from REX-ISOLDE

- Data taken from REX-ISOLDE database
- Efficiencies measured on radioactive beams

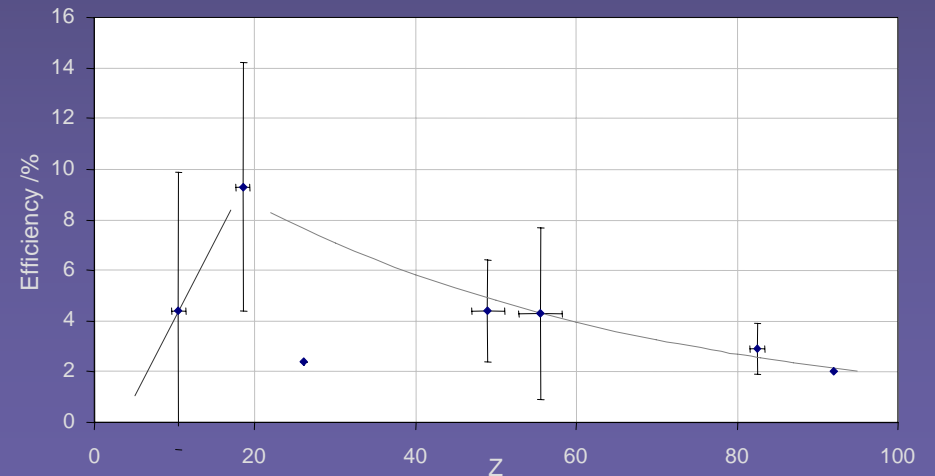
Breeding times for REXEBIS



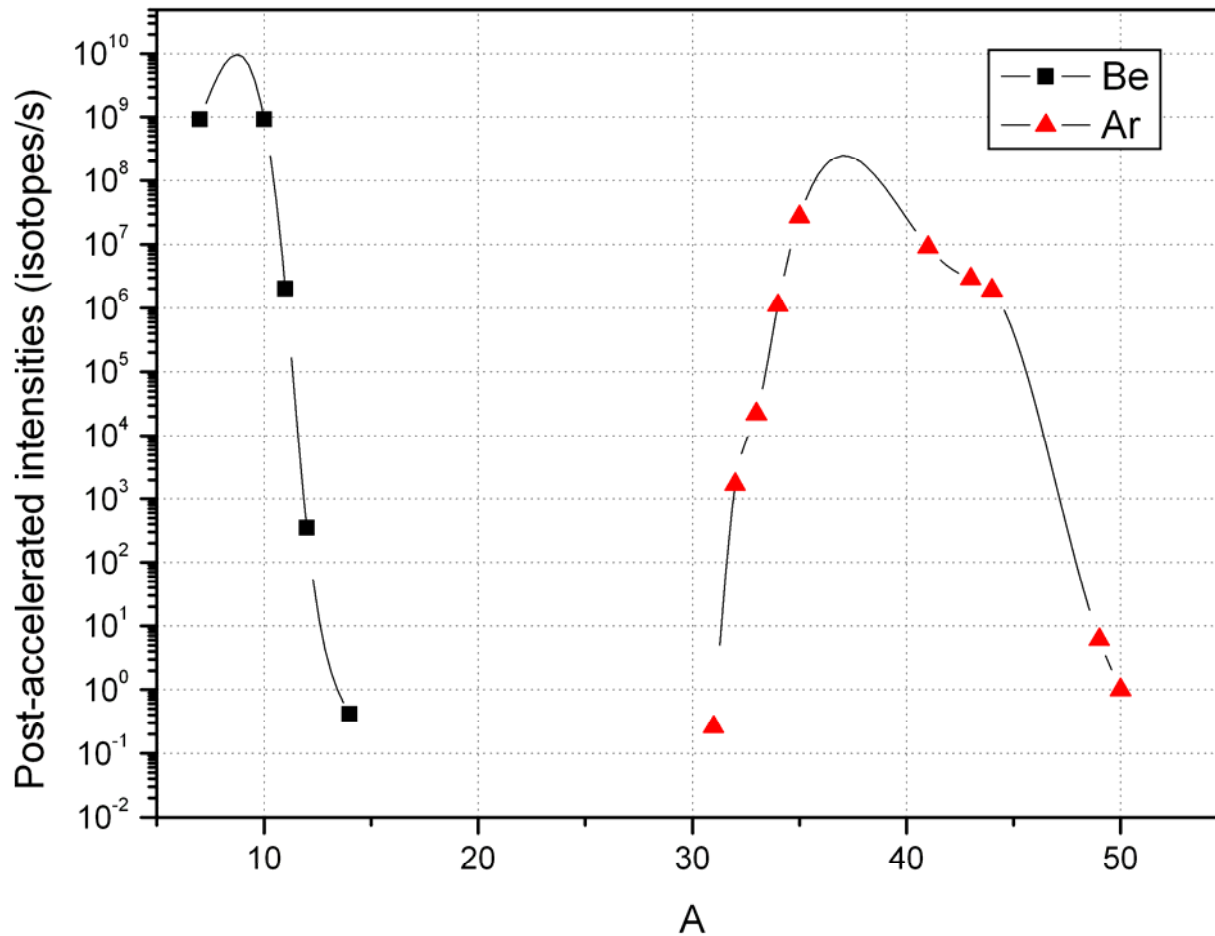
Efficiency REXEBIS+REXTRAP



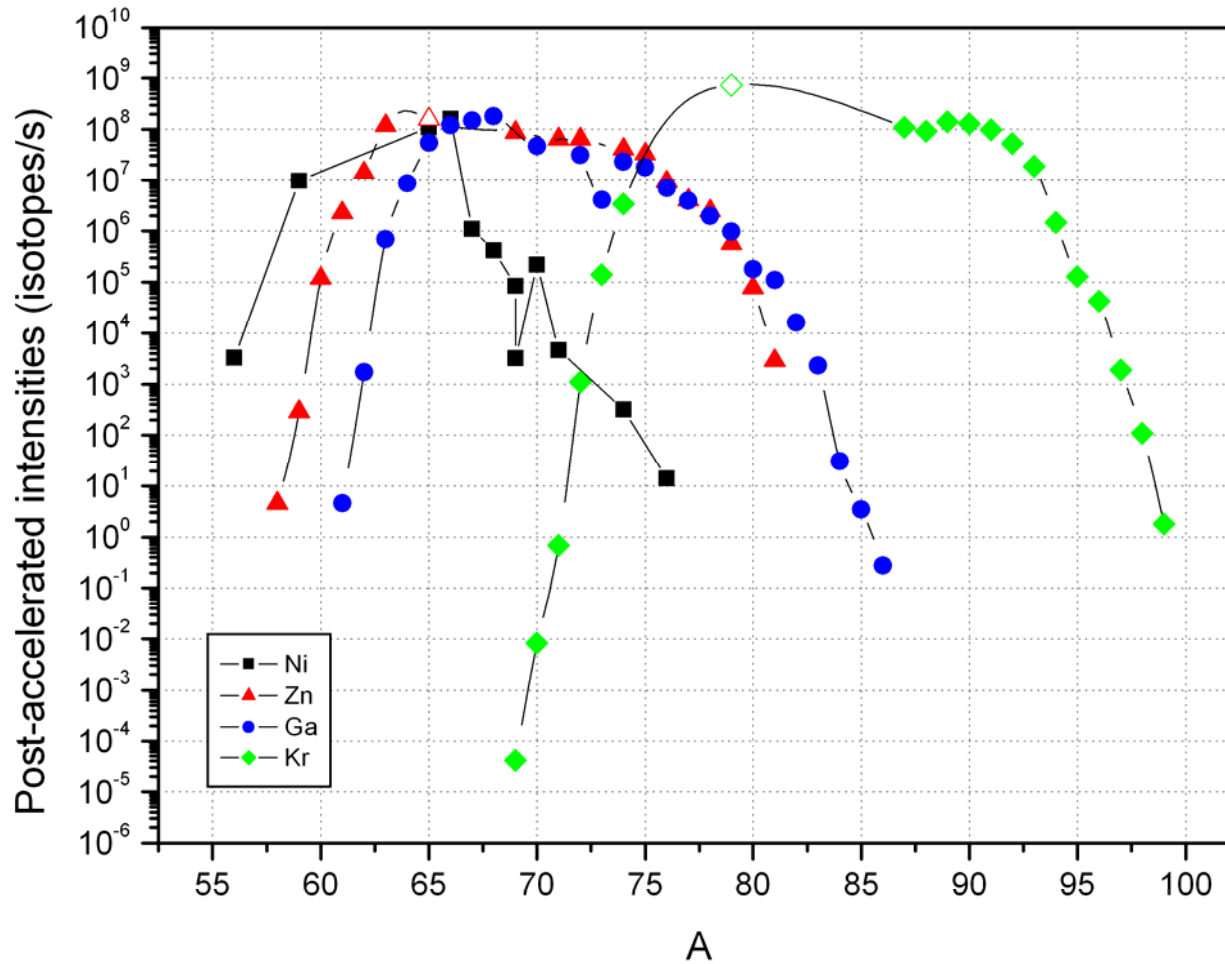
Efficiency for PHOENIX



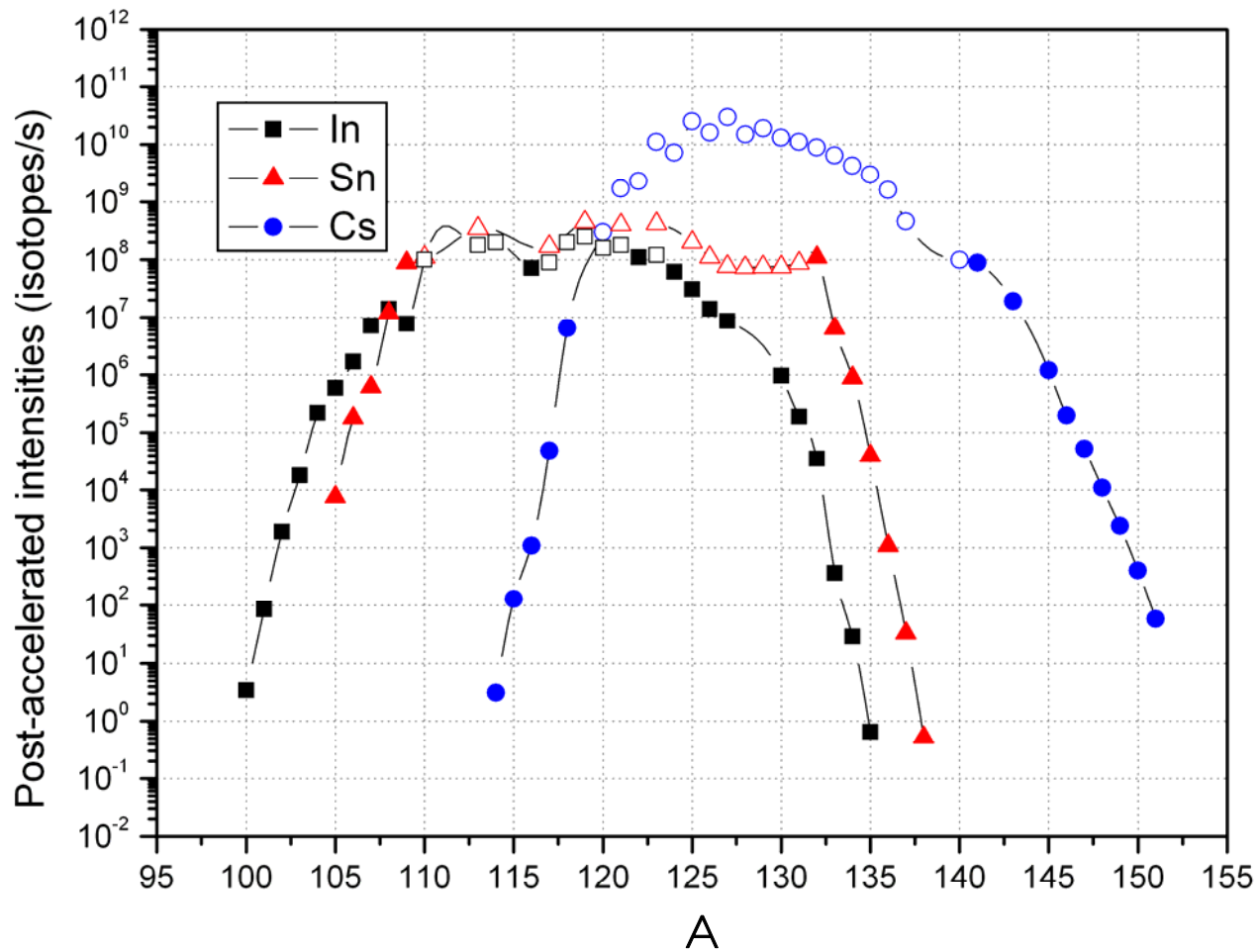
Already estimated RIB intensities



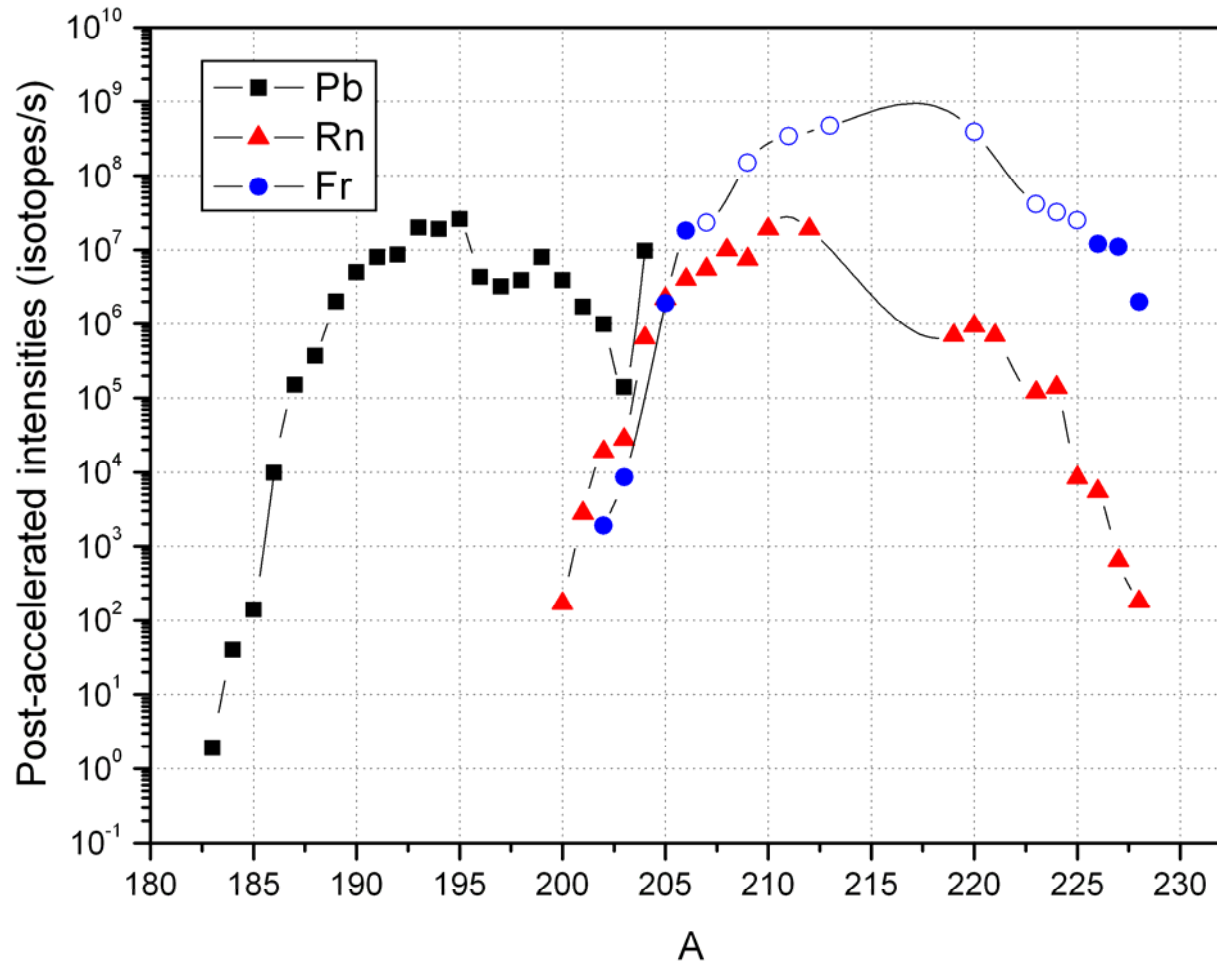
Already estimated RIB intensities



Already estimated RIB intensities



Already estimated RIB intensities



Conclusion

- REX-ISOLDE post-accelerated intensities soon **available from outside**
- HIE-ISOLDE post-accelerated intensities have been estimated for a number of key isotopes assuming an upgraded EBIS in parallel with a Phoenix ECRIS
- Could be extended to other cases if interest is shown
- In average 3 times more intense beams, with higher energy capabilities
- Rather **conservative estimates**, relying on measured data. **Progresses in targetry may result in higher intensities.**



Thank you for your attention!

thanks to

P. Butler, P. Delahaye, L.M. Fraile, M. Lindroos,
K. Riisager, M. Turrión, D. Voulot, F. Wenander
and the ISOLDE Group

