CERN-INTC-2008-002+INTC-SR-008
15 January 2008

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

STATUS REPORT 2007

for experiment IS413 to the ISOLDE and Neutron Time-of-Flight Committee

HIGH-PRECISION MASS MEASUREMENTS OF EXOTIC NUCLEI WITH THE TRIPLE-TRAP MASS SPECTROMETER ISOLTRAP

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The present report gives a summary of the physics runs and developments within the IS413 experiment placed at ISOLTRAP, which have taken place since the last status report in September 2006 [1].

Beam times 2007:

For the online period 2007 the experiment IS413 was allocated 22 shifts out of the remaining 41.5 shifts. Four runs were requested as summarized in Table 1 with two alternatives in order to facilitate and optimize ISOLDE beam coordination.

Table 1: Beam times requested for 2007.

Requested shifts	Isotopes	Target-ion source
8	$^{115\text{-}124}$Ag	UCx/n-converter, RILIS
8	$^{125\text{-}131}$Cd	UCx/quartz transfer line
5	$^{67\text{-}71}$Ni	UCx
3	^{14}O	SiC/ plasma cooled transfer
alternatives		
6	$^{17\text{-}19}$N	Mg/plasma cooled transfer
4	$^{213\text{-}217}$Pb	UCx/RILIS

Based on the request, 4 beam times were scheduled. Since ISOLTRAP was the only requestor for Ni, O, and N beams, these runs were not scheduled. Originally, the run on neutron-deficient Cd was not requested, but other users could not come to their beam time, therefore IS413 was scheduled instead. A summary for the runs which took place since the last status report [1] is presented below. It includes the run from October 2006, which was scheduled after submission of the status report 2006.

Table 2: IS413 beam times scheduled in 2007 and at the end of 2006.

Beam time	Requested isotopes	Remark	Sepa-rator	Target/Ion source
October 2006	$^{17\text{-}19}$N	contamination; H_2O in the trap	HRS	MgO/ cold plasma
May 2007	$^{115\text{-}124}$Ag	In, Cs contamination; wrong proton focus	HRS	UCx with n-converter/ RILIS
June 2007	$^{213\text{-}217}$Pb	Fr, Ra contamination; low Pb yield	GPS	UCx/RILIS
June/July 2007	$^{100\text{-}110}$Cd	not requested; no major problems	GPS	Sn/hot plasma
August 2007	$^{125\text{-}131}$Cd	no Cd visible; wrong proton settings	HRS	UCx with n-converter, quartz transfer line/ RILIS

Table 3: List of nuclides measured since the last status report in September 2006. The uncertainties of the masses taken from literature δm_{lit} are compared with those obtained by ISOLTRAP. The latter ones are preliminary. In cases where the mass was not measured before, the symbol # indicates the uncertainty as extrapolated from systematic trends.

Nuclide	Half-life $T_{1/2}$	δm_{lit} / keV	δm_{exp} / keV	$\delta m_{exp}/m$
^{99}Cd	16 s	210#	2.5	$3\cdot10^{-8}$
^{100}Cd	49 s	100	2.5	$3\cdot10^{-8}$
^{101}Cd	1.4 m	150	2.0	$2\cdot10^{-8}$
^{102}Cd	5.5 m	29	2.0	$2\cdot10^{-8}$
^{103}Cd	7.3 m	15	2.0	$2\cdot10^{-8}$
^{104}Cd	58 m	9	2.0	$2\cdot10^{-8}$
^{105}Cd	56 m	12	2.0	$2\cdot10^{-8}$
^{106}Cd	Stable	6	2.5	$2.5\cdot10^{-8}$
^{107}Cd	6.5 h	6	2.5	$2.5\cdot10^{-8}$
^{108}Cd	Stable	6	2.5	$2.5\cdot10^{-8}$
^{109}Cd	461 d	4	2.0	$2\cdot10^{-8}$
^{117}Ag gs/m	73 s/ 5.3 s	50/50	*	
^{119}Ag gs/m	2.1 s/ 6 s	90/90#	*	
^{120}Ag gs/m	1.2 s/ 0.3 s	70/70	*	
^{121}Ag gs	0.8 s	150	*	
^{211}Ra	13 s	26	*	
^{211}Fr	3.1 m	21	*	
^{212}Fr	20 m	26	*	
^{213}Fr	35 s	8	*	

* under analysis

$^{17-19}$N:

No N isotopes were measured during this beam time. The ISOLDE beam was contaminated with molecules in quantities which could not be anymore cleaned in the purification trap of ISOLTRAP. In addition, the ISOLTRAP cryo-pump broke down and bad vacuum caused fast charge exchange with water molecules.

$^{115-124}$Ag:

The target used was UC_x coupled to the neutron converter and RILIS in order to suppress surface-ionized contaminants. The run was successful only for $^{117,119-121}$Ag and for ^{117,119,120}Ag we could not resolve the ground state and the low-lying isomer. More exotic isotopes could not be addressed due to a large contamination in the ISOLDE beam by In and, possibly, by Cs. . A further handicap was that the focus of the proton beam was set to the standard values and not to the settings for the converter, which was realized only on the last day of the run.

$^{213-217}$Pb:

This run used a UC_x target with RILIS, but it suffered from surface-ionized francium and radium contamination. Additionally, lead yields were about 10 times lower than expected, thus no measurements on radioactive Pb isotopes were possible. We measured masses of $^{211-213}$Fr, ^{211}Ra, with ^{235,238}U as reference. The yield information on Fr and Ra isotopes will be useful for decay studies on neutron-rich Hg and Tl within the planned experiment IS463 [2].

$^{99-109}$Cd:

This beam time was originally not requested, but we were asked to take the beam since the original users could not come. The target was tin with hot plasma ionization. The run was with 11 masses measured very successful and the mass of ^{99}Cd could be determined for the first time.

$^{114-130}$Cd:

A UC_x target with a neutron-converter was used for this experiment., It was coupled by a quartz transfer line to the laser ion source in order to suppress surface-ionized indium and cesium contaminations. Unfortunately, no cadmium ions were observed during the experiment, neither by ISOLTRAP nor by the ISOLDE tape station. Later on it was found that the proton beam was hitting the target and not the neutron converter and that a layer on the quartz window, used to inject the laser beam into the ion source, prevented that efficient laser ionization.

In the absence of cadmium we looked at Ramsey resonances of indium with several species, i.e. ground state and isomer, in the trap. We also checked the yields of thallium and francium which are relevant for the recently approved trap-assisted spectroscopy experiment IS463 [2]: We could observe cooling resonances of ^{208,209}Tl in the purification trap with no visible francium admixtures. . We also observed a time-of-flight resonance of ^{207}Tl. This test shows that it should be possible to perform the IS463 experiment with thallium by using the quartz transfer line..

Summary and planning for the 2007/2008 shutdown

Table 4 gives a summary of nuclides measured and investigated during the period 2003-2007. All nuclides shown in the table were included in the P160 proposal. The green boxes indicate nuclides for which data have been recorded and mass values have been obtained.

In some cases, like ^{134}Sn, more data could have been taken, but time constraints prevented more statistics and the resulting mass uncertainty is not as small as possible with the ISOLTRAP setup.

Nuclides marked with a blue box were requested but not scheduled (usually since ISOLTRAP would have been the only user). Orange boxes indicate unsuccessful beam times, where either contaminants or power cuts led to a failure of the respective runs.

During the off-line period 2007/2008 we plan to finalize the construction and to test two new reference ion sources: one for surface-ionized species, and the other for gases. We also plan to perform tests with H_2 cooling in the buncher which is relevant for mass measurements of very light nuclides.

Table 4: Radionuclides requested in the original P160 proposal.

Element	Ref.	Mass number											
He		6	8										
Li		9	11										
Be		11	12										
N		17	18	19									
O		14											
Ne	3,4	**17**	**18**	**19**				**23**	**24**	25	26		
Mg	5	**22**											
Al	6	**26**											
K	7	**35**											
Mn	8	**58**	**59**	**60**	**61**	**62**	**63**	64	65	66			
Ni	9	**67**	**68**	**69**	70	71							
Cu	9,10	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	75	**76**	77	78
Zn	11	62					**74**	**75**	**76**	**77**	**78**	**79**	
Ga	9	62		**74**	**75**	**76**	**77**	**78**	79	80	81	82	83
Rb	12	**74**											
Ag		115	**116**	**117**	**118**	**119**	**120**	**121**	122	123	124		
Cd		125	**126**	127	128	129	130	131					
Sn	13	**131**	**132**	**133**	**134**								
Tl		211	212	213	214	215	216						
Pb		213	214	215	216	217							
Bi	14	**215**	**216**	217	218								

mass measured
measurement unsuccessful (contaminants, broken target, power cut)
requested but not scheduled

Beam time request:

Table 5 lists the nuclides from P160 whose masses we would like to measure in 2008 and 2009. We have divided the list in two parts: Those nuclides which we would like to investigate with highest priority (**) and those which we would like to measure with lower priority (*). The list is based on the importance of the physics case and also on other facts such as required preparatory studies with our setup, the availability of efficient target/ion source systems or competition at other facilities.

Table 5: Isotopes requested for 2008-2009.

Nuclides	Field of interest	No. of shifts	Priority	Target
^{6,8}He	halos	5	**	ThC / UC
^{11,12}Be	halos	4	**	Thin Ta foil
^{14}O	CVC, CKM	3	**	SiC
$^{125\text{-}131}$Cd	mid masses, δV_{pn}	5	**	UC/ RILIS quartz
^{9,11}Li	halos	5	*	Thin Ta foil
$^{115,122\text{-}124}$Ag	mid masses	5	*	UC/ RILIS
$^{213\text{-}217}$Pb	heavy masses	4	*	ThU/UC / RILIS
$^{211\text{-}216}$Tl	heavy masses	4	*	ThU/UC

INTC documents and publications by the ISOLTRAP Collaboration

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