

Study of high purity NaI scintillator for Dark Matter search

I.S.C.Lab. Co.Ltd.
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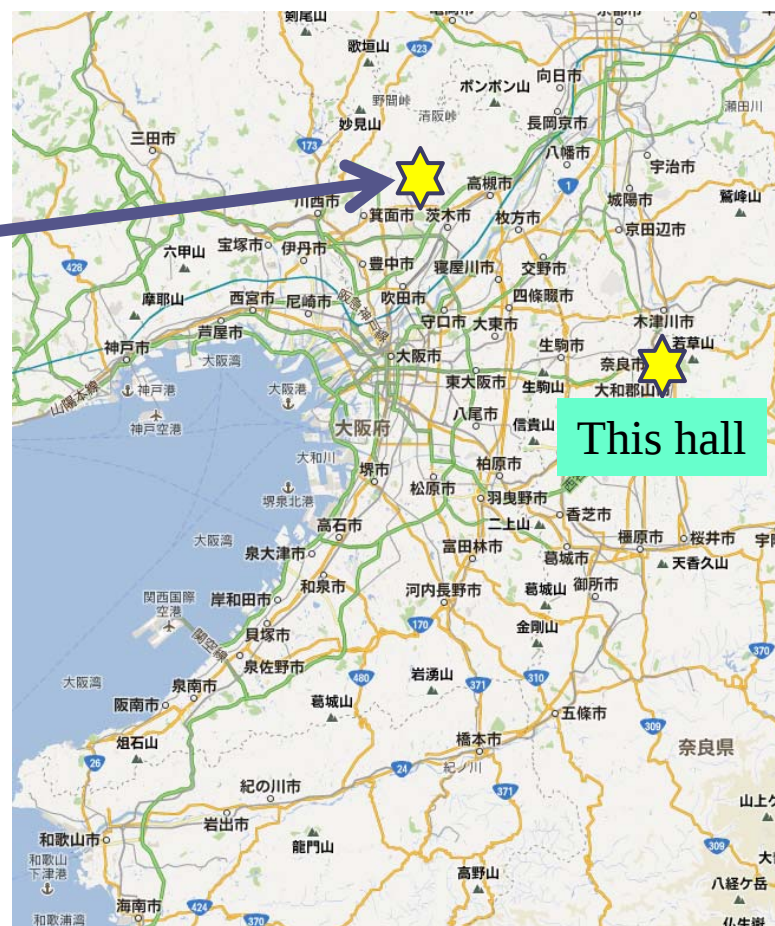
I.S.C.Lab. Co.Ltd

What is I.S.C.Lab.?

Inorganic Scintillation Crystal Laboratory

Location

Saito bio innovation center 204
7-7-20, Saito-asagi, Ibaraki, Osaka
567-0085 Japan
Tel/Fax 072-657-9503



Approach of I.S.C.Lab.

Academic side

Develop the high quality crystal

High purity NaI(Tl)
scintillator

For Dark Matter search



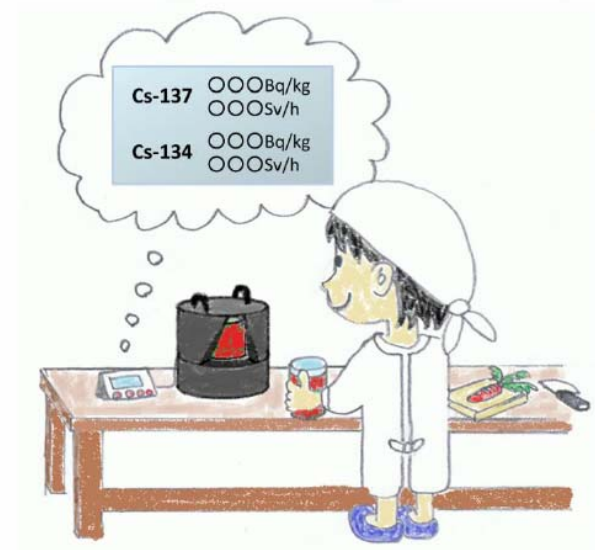
http://spaceinfo.jaxa.jp/ja/andromeda_galaxy.html

General market

CsI(Tl) scintillator

For γ spectrometer

➤ Food , Soil etc.

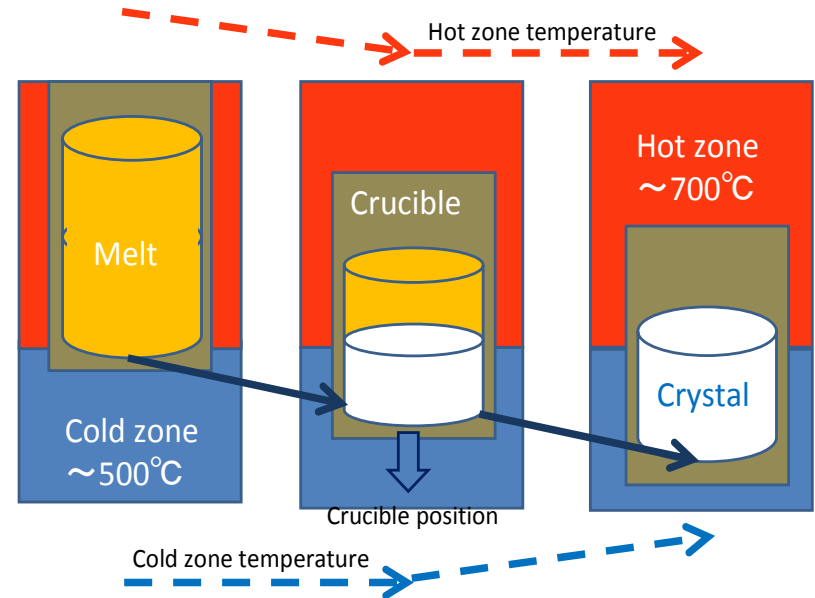


Crystal growth method



Non-vacuum hybrid bridgman method

Hybrid Bridgeman Method



Target

Common contamination of NaI

MASS SPECTROGRAPHIC ANALYSIS UPPER LIMIT - PPM				
Li 0.1	Mn 0.1	Rh *	Gd *	Tl *
Be *	Fe 0.2	Pd *	Tb *	Pb 1.0
B 0.1	Co 0.1	Ag *	Ny *	Bi *
F 0.2	Ni 0.1	Cd *	Ho *	Th *
Na --	Cu 0.1	In *	Er *	U *
Mg 1.0	Zn 0.1	Sn *	Tm *	
Al 1.0	Ga *	Sb *	Yb *	
Si 1.5	Ge *	Te *	Lu *	
P 0.1	As *	I --	Hf *	
S 1.0	Se *	Cs 0.1	Ta *	
Cl 3.0	Br *	Ba 0.5	W *	
K 1.0	Rb *	La *	Re *	
Ca 1.0	Sr *	Ce *	Os *	
Sc *	Y *	Pr *	Ir *	
Ti 0.1	Nb *	Nd *	Pt *	
V 0.1	Mo *	Sm *	Au *	
Cr 0.1	Ru *	Eu *	Hg *	
* Less than 0.01 PPM				

Goal

U-chain < 1 PPT

Th-chain < 5 PPT

^{210}Pb < 0.1mBq/kg

Status

NaI(Tl) scintillator of I.C.S.Lab. Co.Ltd
1.5inch Φ $\times$ 1.5inch
1.0inch Φ $\times$ 1.0inch



Current status of NaI(Tl) scintillator

U-chain	2.5 PPT	} Higher than goal
Th-chain	≤ 700 PPT	
^{210}Pb	$1.4 \pm 0.4 \text{ mBq/kg}$	

Analysis collaborator : Dr.Fushimi(Tokushima)

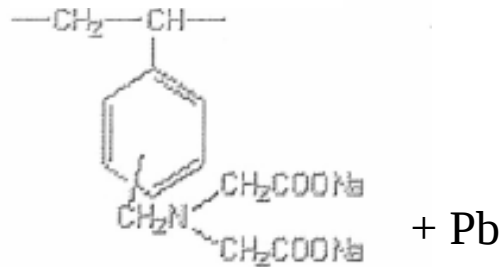
Reason of these contamination

- Raw material
- Environment of preparation
- Other materials(crucible etc.)

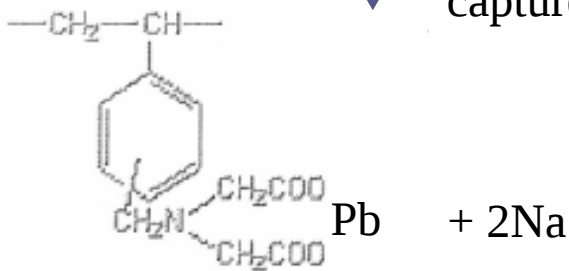
Purification of raw material

Test for ion exchange resin

example



Ion exchange resin
capture Pb



By ion exchange resin to reduce
Pb contamination

Effect of the purification

ICP Stability Report (lines, concentrations)

<u>Sample Name</u>	<u>DateTime Measured</u>	<u>Cc</u>		<u>RSD(%)</u>	<u>Method Name</u>
sample11	09.08.2011 15:15	-0.02	mg/l	7.16	Yamanuki_Pb
sample2	09.08.2011 15:25	-0.01	mg/l	15.43	Yamanuki_Pb
sample4	09.08.2011 15:33	-0.01	mg/l	24.64	Yamanuki_Pb
sample7	09.08.2011 15:39	-0.01	mg/l	33.35	Yamanuki_Pb
sample9	09.08.2011 15:46	-0.01	mg/l	63.10	Yamanuki_Pb
sample1	09.08.2011 15:52	-0.01	mg/l	37.11	Yamanuki_Pb
sample3	09.08.2011 16:09	-0.04	mg/l	0.80	Yamanuki_Pb
sample5	09.08.2011 16:16	-0.04	mg/l	6.19	Yamanuki_Pb
sample6	09.08.2011 16:22	-0.04	mg/l	0.20	Yamanuki_Pb
sample8	09.08.2011 16:28	-0.04	mg/l	2.52	Yamanuki_Pb
sample10	09.08.2011 16:35	-0.04	mg/l	1.38	Yamanuki_Pb
		<u>Mean</u>	-0.02	17.44	%
		<u>SD</u>	0.02		
		<u>RSD</u>	%		

Analysis collaborators : HORIBA,Ltd.

Result of ICP-MS

all sample – less than 0.02ppm for Pb

Environmental management

Clean booth update

HEPA Filter

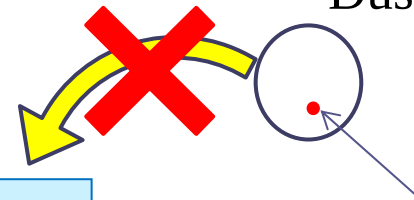
Air dryer

Flow dry air



Prevent mixing of dust etc.

Dust , moisture



NaI raw material

Fouling such as Pb



Other materials

Selection of other materials

Measurement(ICP-MS) results of several sample

	U(ng/g)	Th(ng/g)	K(ng/g)
Sample 1	37	30	21000
 Sample 2	<20	<20	<200
Sample 3	290	30	74000
Sample 4	430	350	<100

Analysis collaborator : Dr.Alex Kozlov(Tohoku)

Previous material : sample 3

For the next : sample 2

U-chain – one order improvement can be expected

Future Prospect

- Create a new crystal for based on the results
- Search for Optimum purification method
 - Selection for ion exchange resin
 - To establish for purification method
- Impurity measurement
 - Check that the goal is reach