Flerov Laboratory of Nuclear Reactions
Joint Institute for Nuclear Research
Dubna

Université catholique de Louvain
Centre de Recherches du Cyclotron
Louvain-la-Neuve

Collection device : status report

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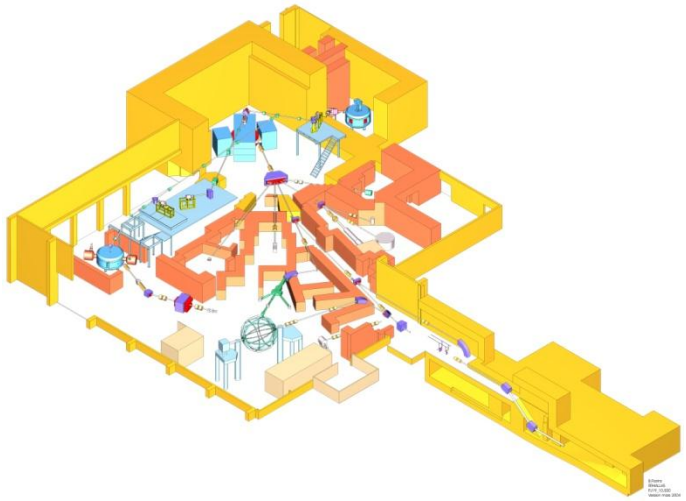
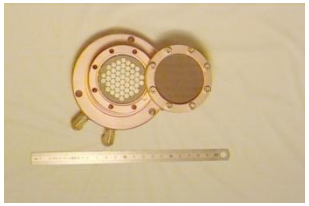




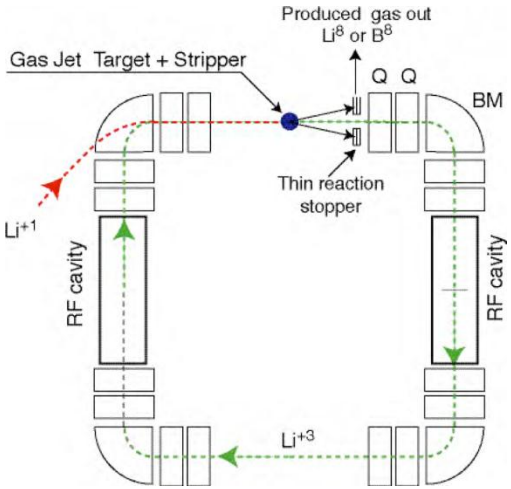
LLN RIB typical intensities **after** post-acceleration **and** isobaric separation on experimenter's target.

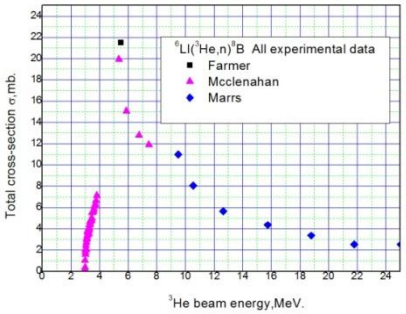
Noble gases or extraction as molecules

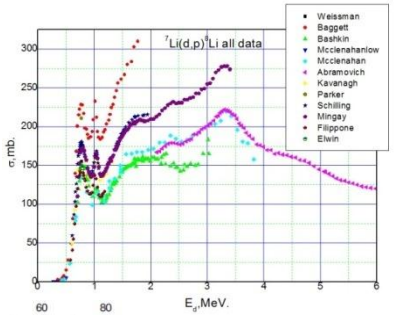
Element	*$T_{1/2}$*	*q*	*Energy Range [MeV]*	*Intensity [pps]**
^{6}Helium	0.8 s	1+	5.3 – 18	$1{\cdot}10^{7}$
		2+	30 – 73	$3{\cdot}10^{5}$
^{7}Beryllium	53 days	**1+**	5.3 – 12.9	$2{\cdot}10^{7}$
		2+	25 – 62	$4{\cdot}10^{6}$
^{10}Carbon	19.3 s	**1+**	5.6 - 11	$2{\cdot}10^{5}$
		2+	24 - 44	$1\,10^{4}$
^{11}Carbon	20 min	1+	6.2 – 10	$1{\cdot}10^{7}$
^{13}Nitrogen	10 min	1+	7.3 – 8.5	$4{\cdot}10^{8}$
		2+	11 – 34	$3{\cdot}10^{8}$
		3+	45 – 70	$1{\cdot}10^{8}$
^{15}Oxygen	2 min	2+	10 – 29	$6{\cdot}10^{7}$
^{18}Fluorine	110 min	2+	11 – 24	$5{\cdot}10^{6}$
^{18}Neon	1.7 s	2+	11 – 24	$1{\cdot}10^{7}$
		3+	24 – 33, 45 – 55	$4{\cdot}10^{6}$
^{19}Neon	17 s	2+	11 – 23	$2{\cdot}10^{9}$
		2+	7.5 – 9.5	$5{\cdot}10^{9}$ (CYC44)
		3+	23 – 35, 45 – 50	$1.5{\cdot}10^{9}$
		4+	60 – 93	$8{\cdot}10^{8}$
^{35}Argon	1.8 s	3+	20 – 28	$2{\cdot}10^{6}$
		5+	50 – 79	$1{\cdot}10^{5}$

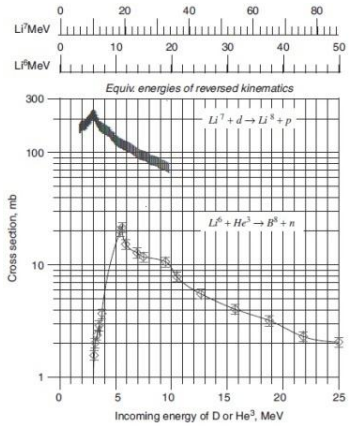
Main idea – "Beam cooling with ionisation losses" – C. Rubbia, A Ferrari, Y. Kadi and V. Vlachoudis in NIM A 568 (2006) 475-487

$^{7}Li(d,p)\,^{8}Li$ and $^{6}Li(^{3}He,n)\,^{8}B$









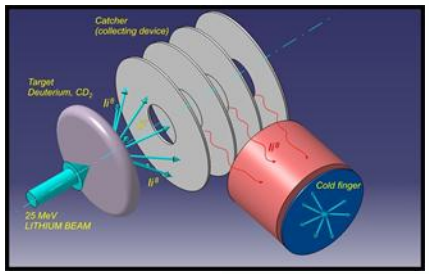
* From Rubbia.

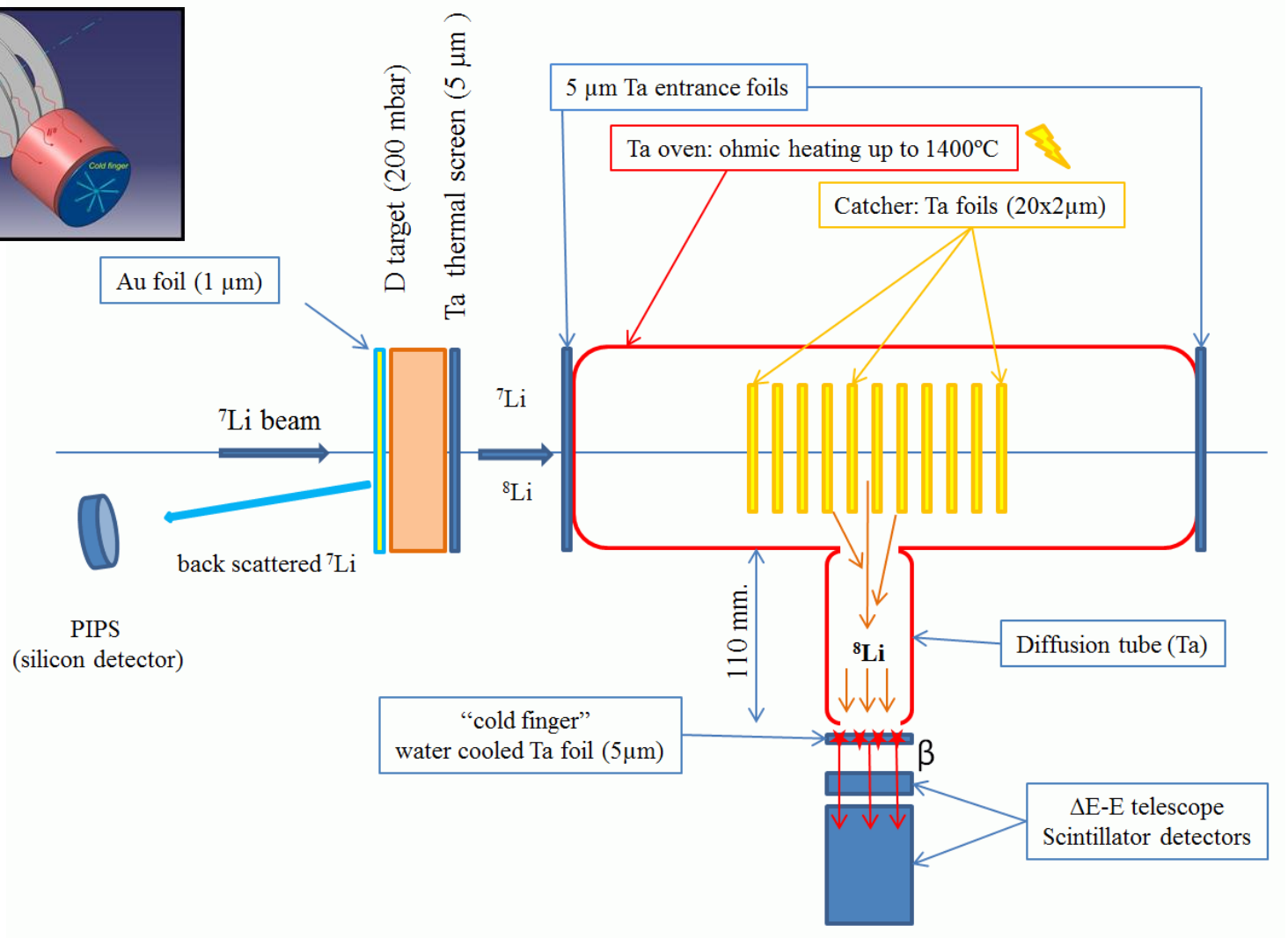
Collection device task:

- ✓ To build the prototype of the collection device and test it on-line.
- ✓ To measure the extraction efficiency for Li-8.
- ✓ To study extraction technique of B-8.

Collection device – what is it

Scheme: beam->target->catcher->diffusion + effusion-> ^{8}Li detection





What we should do to realize it

R&D stages:

- produce ^{8}Li in deuterium target
- stop and catch ^{8}Li in stopper
- extract ^{8}Li from the catcher
- detect and count β – decay of ^{8}Li

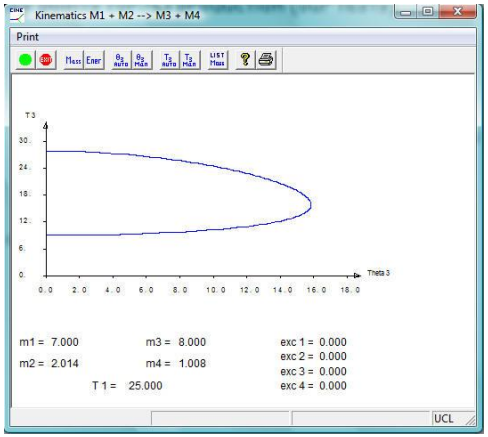
Main goal now is:

We should start from ^{8}Li to make all tests and probe the whole system

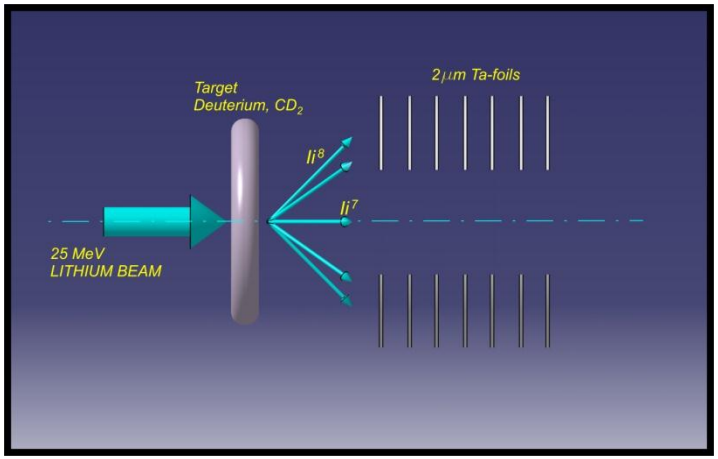
R&D stages:

1. The key points for ^{8}Li production (our tests)

- ^{7}Li beam energy 29 MeV (energy losses in the target)
- intensity starting point - 1 pnA
- deuterium or CD_2 targets
- kinematics => narrow output angular cone for the ^{8}Li



material	thickness	E_{loss}, MeV	E_{remain}, MeV
Au (gold)	1.85 mg/cm^2 (0.96 μm)	0.54	28.46
Cu (copper)	8.92 mg/cm^2 (10 μm)	4.4	24.1
D (deuterium)	0.25 mg/cm^2 (15000 μm)	0.29	23.8
Ta (tantalum)	16.6 mg/cm^2 (10 μm)	6.1	17.7



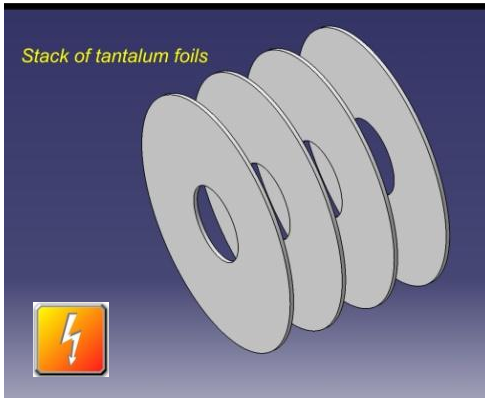
2. Stop and Catch

- tantalum foils with 20x2μm thickness
- toroidal geometry (future)

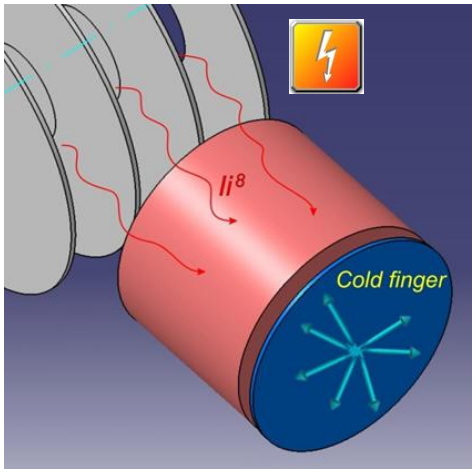
R&D stages:

3. ^{8}Li extraction and effusing

- ohmic heating up to 1400°

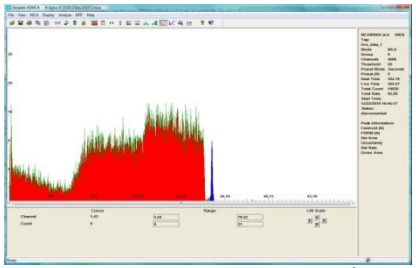


Up to
1000 A



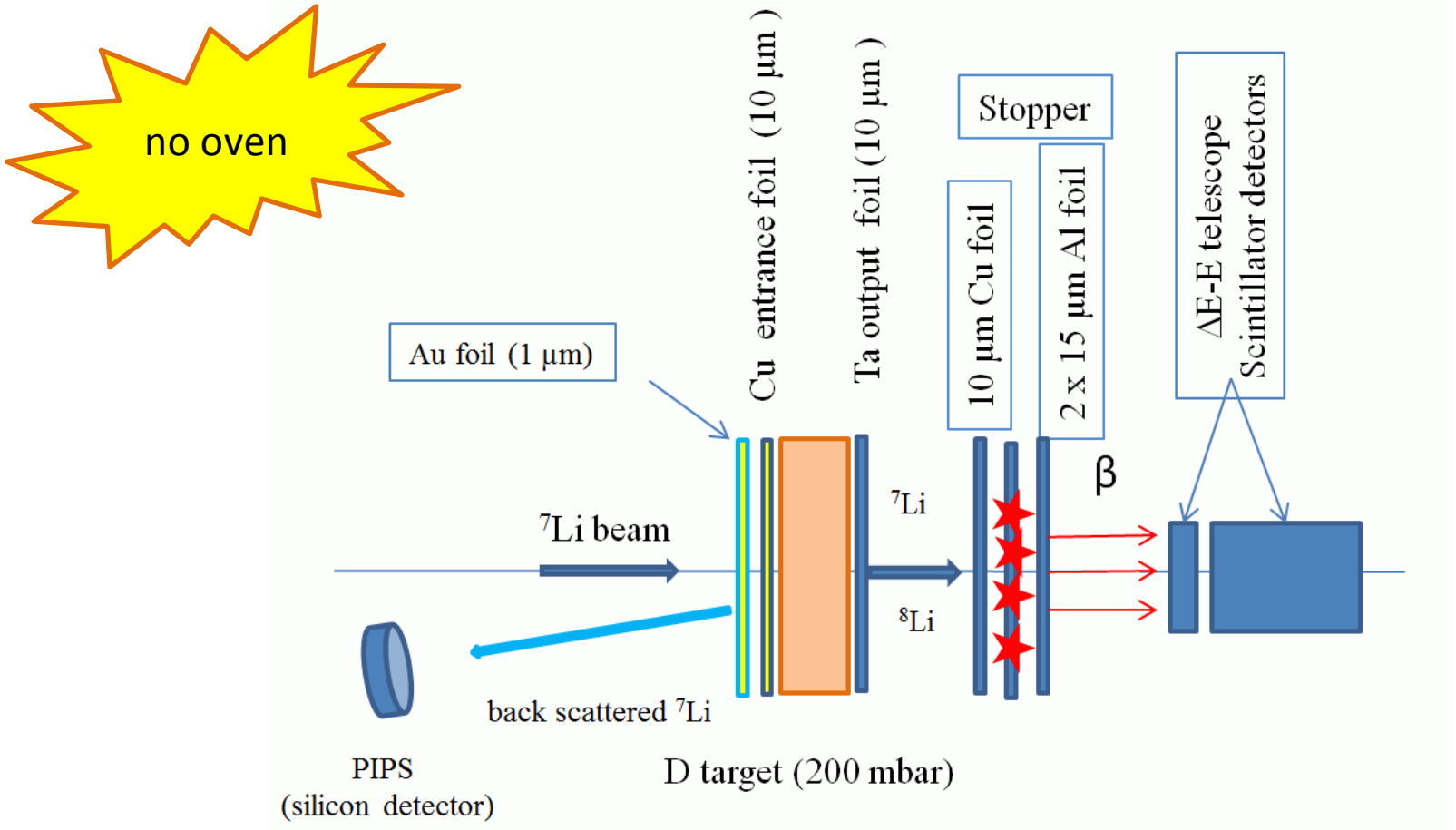
4. Detection
   - catch the ^{8}Li on "cold finger"
   - detect the β decay of ^{8}Li using scintillators
   - measuring ΔE, E, time structure, counting

   - ^{7}Li beam intensity measurement (PIPS detector)



Collection device – efficiency measurement

Scheme: beam->target->stopper->diffusion + effusion-> ^{8}Li detection



- All details are the same (in comparison with "Oven" setup)

What was done

Point by point…

Point #1 Beam and target preparation

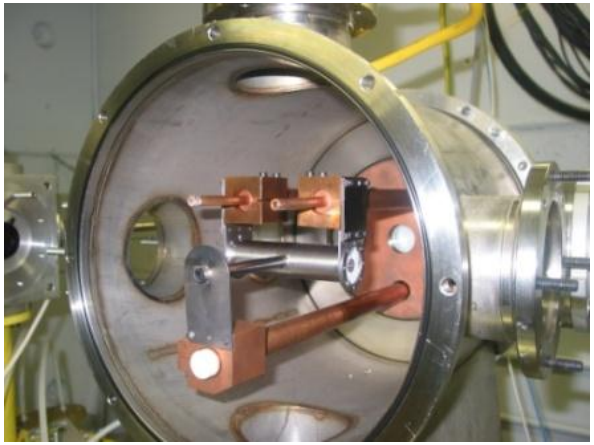
- Modification of the ECR-source for the production of Li ions.
- Update of the beam line.
- Update of the experimental area.
- On-line tests with the primary beam (intensity up to 10nA)
- Target R&D, tests

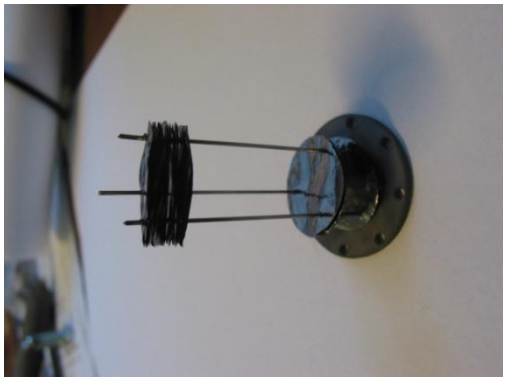
What was done

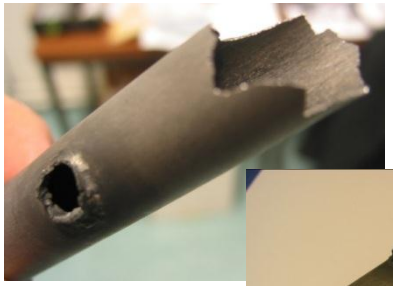
Point by point…

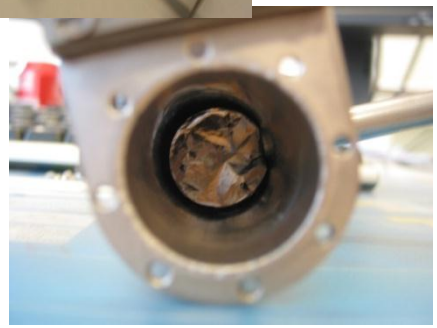
Point #2. Catcher-oven research and design

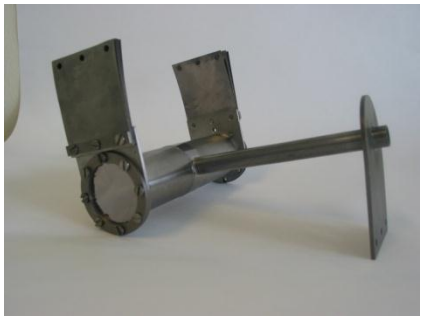
- Development of temperature tests and design
- Technical drawings
- Material (Ta) shopping
- Manufacturing of the oven-catcher unit
- Offline tests









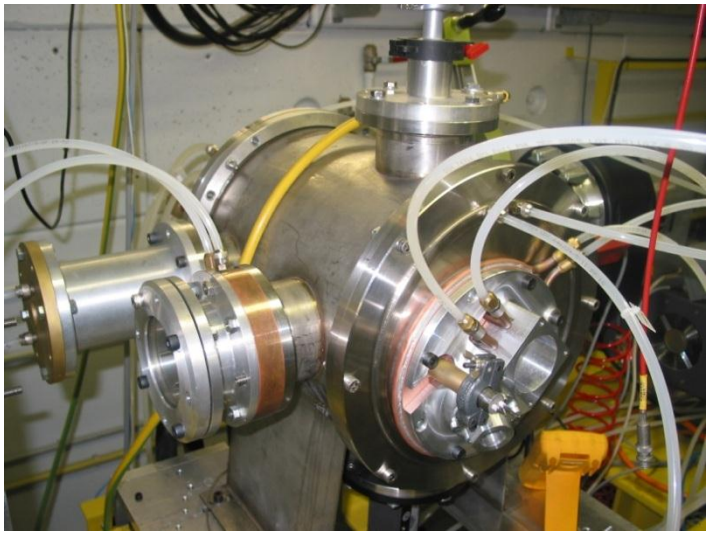


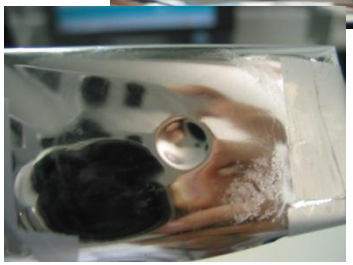
What was done

Point #3 Assembling of the experimental setup, tests.

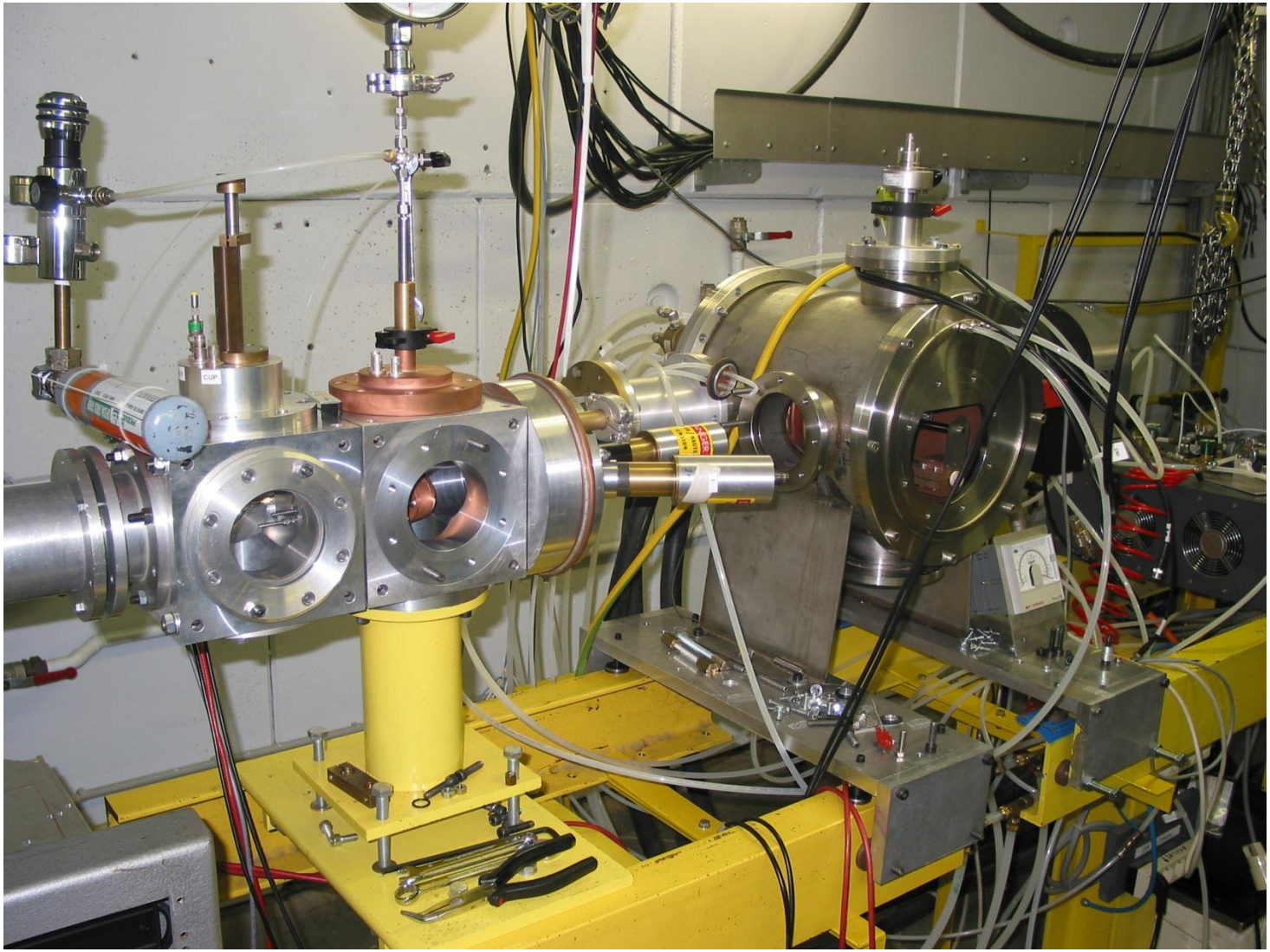
Point by point…

- Assembling of the oven-catcher unit in the laboratory and Igloo R tests.
- Off-line (laboratory) temperature and vacuum tests of the experimental setup.
- On line (Igloo R) tests with the primary beam(intensity up to 0.7 nA).



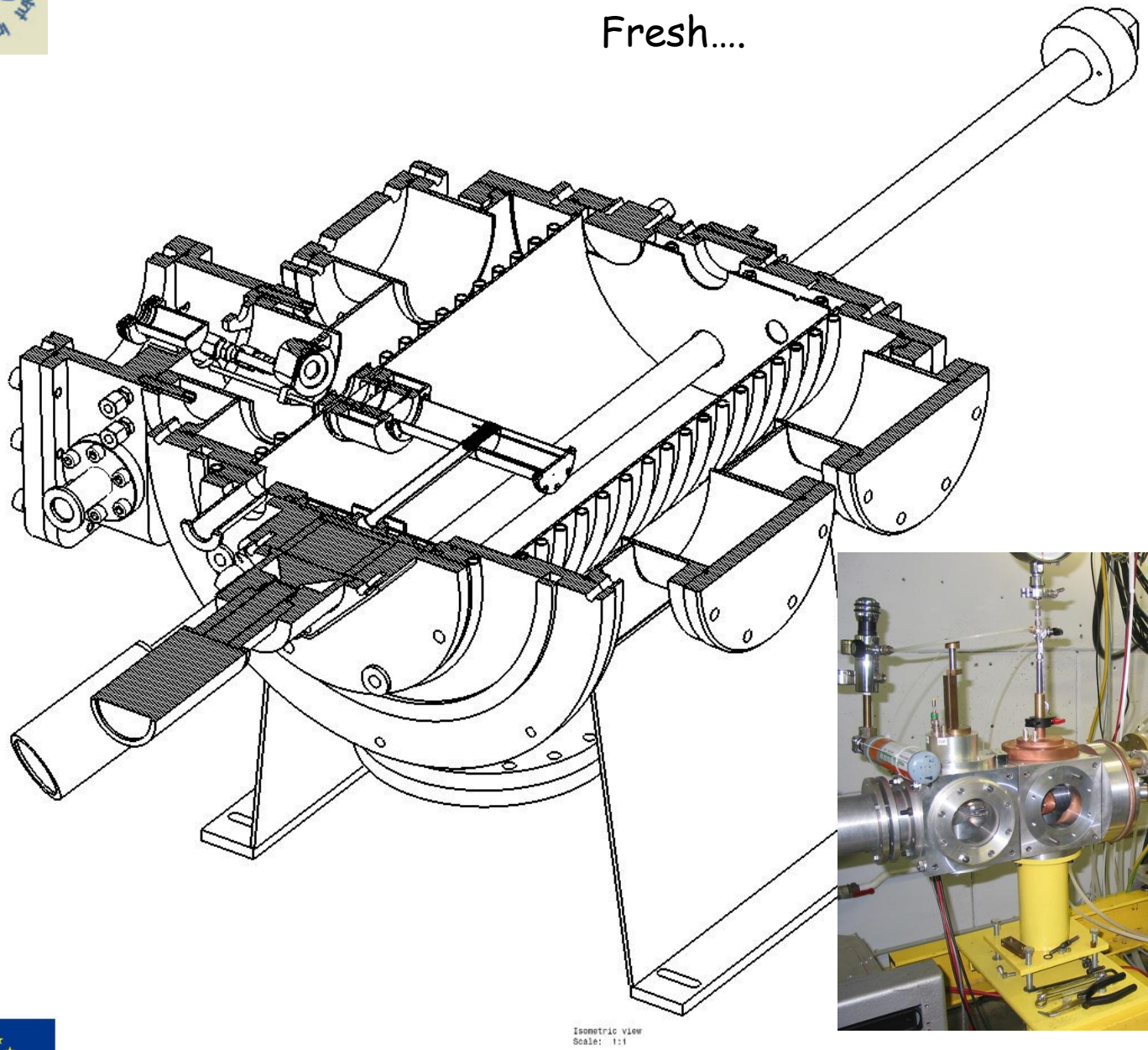


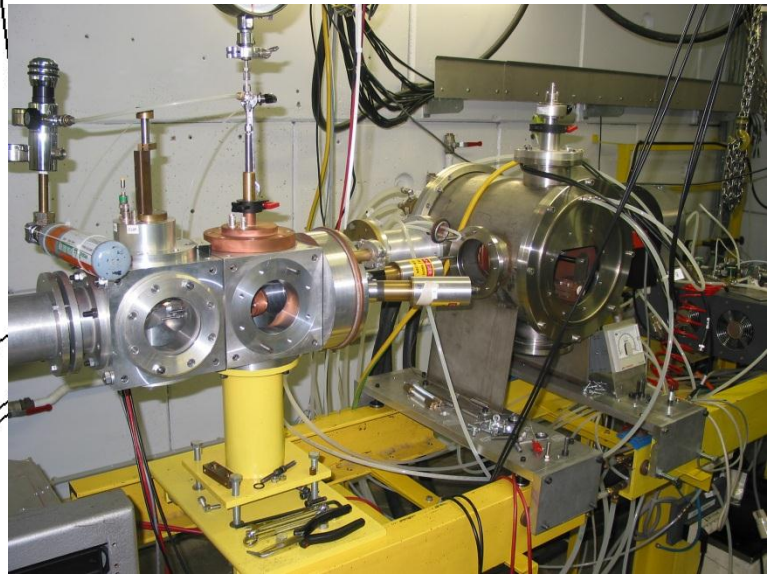
Fresh….



Fresh….

Fresh….





Only mechanics ? No…but….

Point #4 Detection of ^{8}Li and full beam runs (starting September'10)

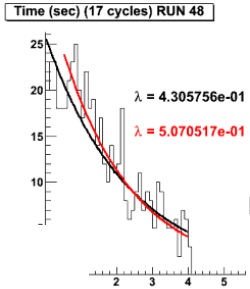
- Development of the data acquisition system and electronics.
- Off-line (generator & source) tests development.
- Off-line (generator & source) tests running.
- Online testing

$$N(t) = N_0 e^{-t/\tau} \qquad \tau = \frac{1}{\lambda}$$

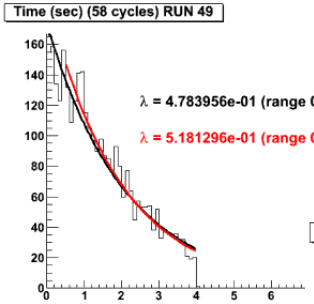
$$t_{1/2} = \frac{\ln 2}{\lambda} = \tau \ln 2$$

$t_{1/2}$ = 0.835 sec; $\lambda = \ln 2 / t_{1/2}$ => λ=0.83

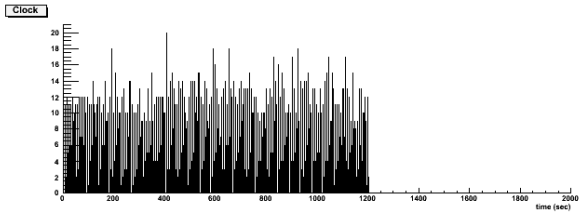
On-line beam tests
November'10

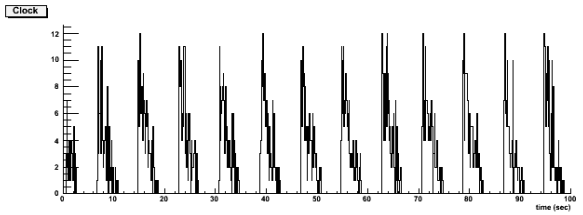


T(oven) = 1200°C, T(diff.pipe)=1247°C



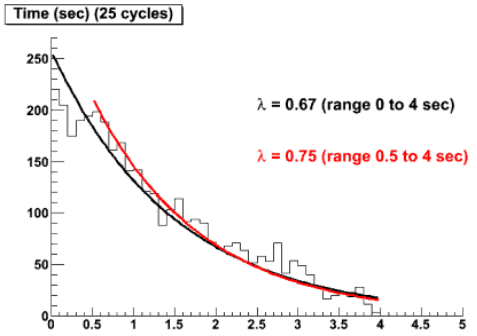
T(oven) = 1300°C, T(diff.pipe)=1300°C





Beam pulsing

T(oven) = 1400°C, T(diff.pipe)=1550°C



- Go further with ohmic heating

Time schedule after meeting

- we hoped to finished with Li-8: ~~June'11~~ *update* September'11
  (September – 3 beam runs, October – 1 run)
- Prototype design study/Prototype technical drawings for the B-8: June'11-September'11
- Workshop (pcs machining) September-October'11
- Off-line + on-line tests for B-8: fall'11
- B-8, the goal is to be fully prepared in December'11

Few words about Boron…

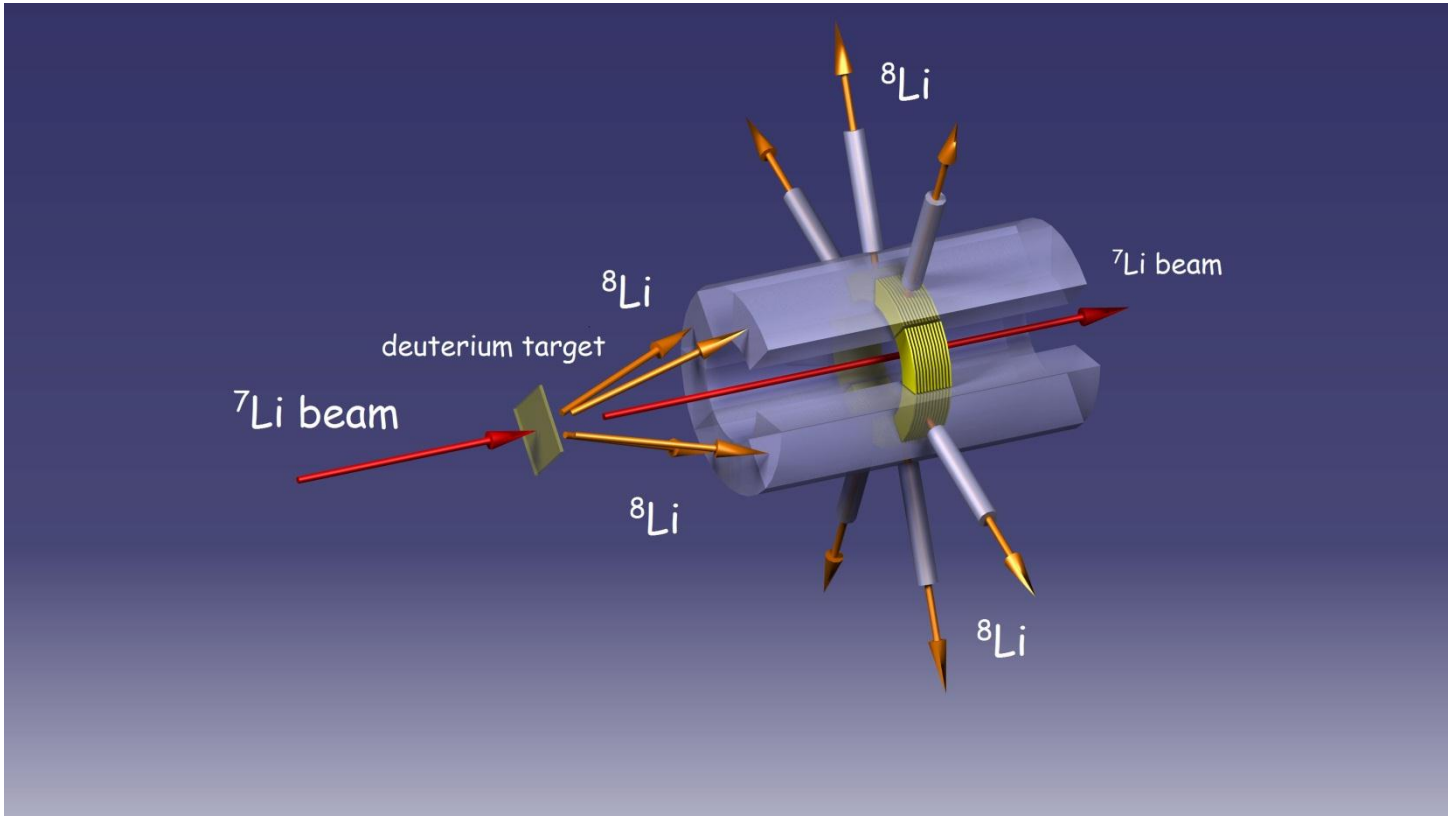
- it will be $^{8}BF_3$ molecule production: $^{8}B+AlF_3 \Rightarrow ^{8}BF_3$
- we will test pure boron diffusion
- Detect the decay of B

Now the B setup is under construction and drawing

- The runs are scheduled for the November'11 and December'11
- Spring'12 – full time measurements for Boron.

Few words about future… who knows…

Sketch of the future …. Far in the future in a galaxy far, far away…..



Price & cost – up to 10 M€

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Thank You for Your attention

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