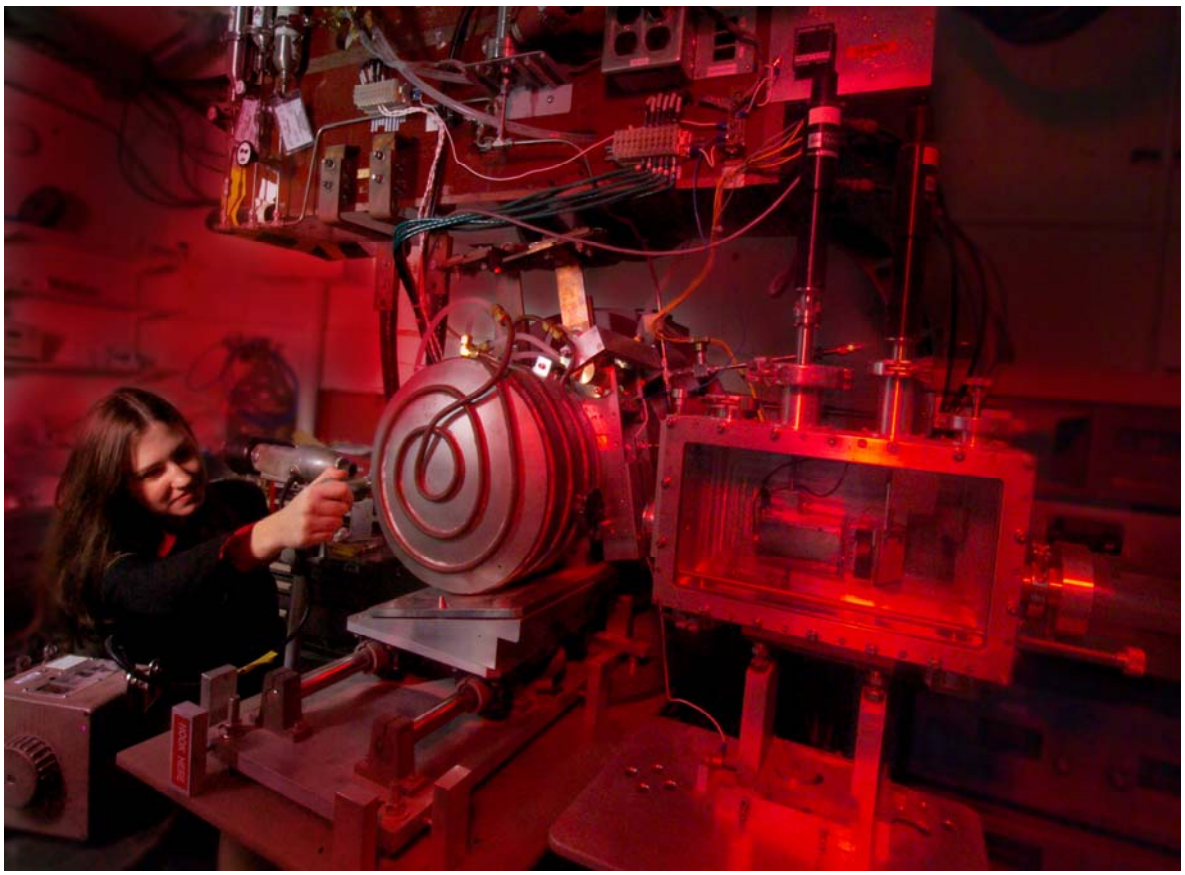
INTDS NEWSLETTER

International Nuclear Target Development Society



July 2005
Volume 32
Number 2

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Cover

Photo coutesy of Dr. Andreas Kronenberg, ORAU (see accompanying article)

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NEWS OF THE INTDS

INTDS-23 World Conference *in TSUKUBA, Japan*

October 16-20, 2006




Dear INTDS colleague!

First Announcement: July 5, 2005

Conference Information;

We (KEK) are very pleased to host INTDS-23 World Conference cooperated with RIKEN, RCNP of Osaka University and National Institute of Radiological Sciences in Japan.
The Conference will be held at Tsukuba International Congress Center from 16 to 20, October 2006.
Tsukuba is one of the "Science and Technology" town in Japan.
The Congress Center is just located 60 km from Tokyo and 40 km from Narita International Airport.

Accommodation: Three types of reasonably priced hotels will be provided.
We will prepare original and friendly atmosphere program during the conference.
So, please join our Tsukuba INTDS-23 Conference.

Correspondence, questions concerning the conference can be addressed to Isao Sugai;

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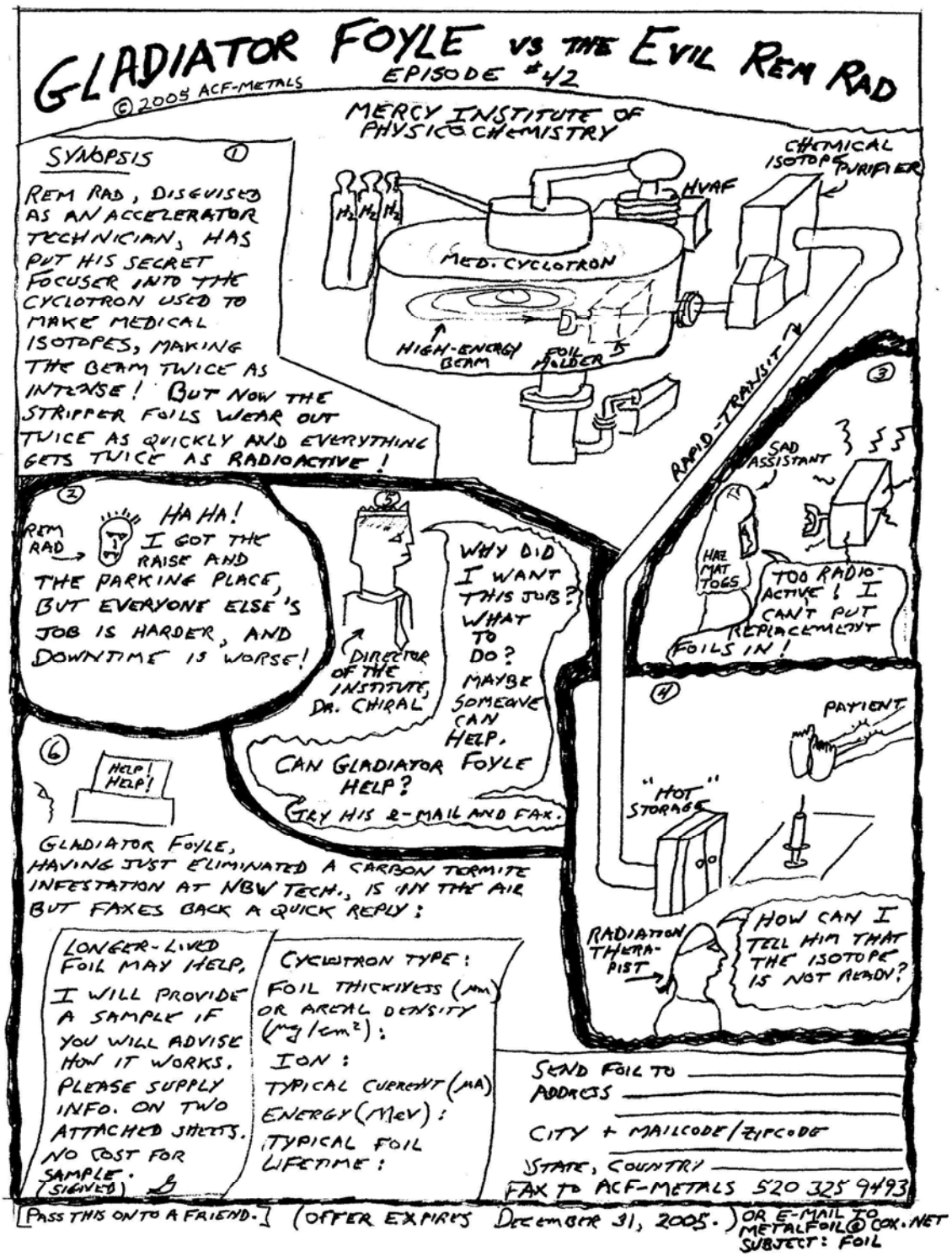

TECHNICAL CONTRIBUTIONS

Summer School and Workshop on Radioactive Ion Beams Brings Young Scientists to Oak Ridge

Andreas Kronenberg, Oak Ridge Associated Universities, Oak Ridge, TN 37831-6374

What exactly is a radioactive ion beam and how do you make one? Young researchers and university students from a wide variety of scientific disciplines had a chance to learn the answer to those questions and many more at the first U.S. "Radioactive Ion Beam–Targets and Ion Sources" summer school and workshop which took place in Oak Ridge, Tenn., May 23-27.

The summer school portion of the program brought 23 young researchers from a variety of scientific disciplines to gain hands-on experience with radioactive ion beams at Oak Ridge National Laboratory's Holifield Radioactive Ion Beam Facility (HRIBF). Following the school, students joined more than 40 other scientists with an interest in radioactive ion beam research for a two-day workshop to discuss emerging trends and techniques in the field.

The purpose of the school was to introduce young researchers—ranging from advanced undergraduates to post doctoral students—to a field of study that was entirely new to many of them. Ken Carter, head of the University Radioactive Ion Beam group for Oak Ridge Associated Universities and co-director of the summer school, said that typically the research and development of radioactive ion beams has been the exclusive realm of nuclear physicists who needed a particular beam for their research.

"By bringing in a broad cross section of disciplines from chemists to material scientists to students in many other scientific disciplines we have a chance to both introduce a new discipline to future scientists and gain from their outside perspectives," Carter said. "This was a unique opportunity to get younger students excited to learn about the research opportunities and challenges available in the growing field of radioactive ion beams."

The idea for the school rose from the fact that that the field of nuclear physics has a fast growing need for radioactive ion beams, Carter explained. A number of facilities in the U.S. and around the world are beginning to use radioactive ion beams now. In addition, construction of a new Rare Isotope Accelerator (RIA) facility is one of the top three priorities for the Department of Energy. Simply equipping that facility will require a major infusion of both new personnel and new ideas.

The summer school's morning sessions were dedicated to lectures from experts from all over the world covering topics from motivations for making radioactive ion beams to diffusion/effusion in the target-ion source system and ion beam optics. In the afternoon, participants divided into five groups where docents and ORNL staff members guided students through hands-on experiments in the laboratory.

The afternoon experiments included the release of arsenic out of proton-irradiated germanium target material that was heated to different temperatures at different times. The students measured the time-profile of the release of stable arsenic implanted in a catcher in the target position of a target-ion source. Another experiment took place at the ion source test facility monitoring a stable beam. Additionally, students were given an introduction to different

computer programs for thermochemistry and nuclear physics. Students also had a chance to dissemble ion source parts and view different kinds of target materials.

One of the students, Suzy Lapi, who is a graduate student in chemistry at Simon Fraser University in British Columbia, Canada, said the program was an eye-opening experience for her because it allowed her to see radioactive ion beam research up close.

“The morning talks gave an overview and these were really beneficial to me. But during the experiments we got to see what we had been discussing actually taking place which really drives the concepts home,” Lapi said. “I like how the field is very multi-disciplinary. It seems like there is more use for chemistry coming into radioactive ion beam research.”

School participants worked hard each day, but also had the opportunity to get a taste of the local culture with a visit to the Museum of Appalachia. Other social activities in the evenings as well as breaks throughout the day provided opportunities for conversations between the participants and the mentors.

The workshop following the school changed the focus and level of the science at the event as experienced scientists joined the school participants at a conference center in downtown Oak Ridge. The workshop, which was organized by John D’Auria, professor emeritus of chemistry and physics at Simon Fraser University, focused on the production of new radioactive ion beams that are presently not available, as well as improving existing beams in intensity and purity. The two-day workshop consisted of presentations followed by discussions designed to take advantage of the various viewpoints of the cross-discipline audience.

Seven topics were selected in the general area of Isotope Separator On-Line (ISOL) targets and ion sources, and these were discussed by key experts from various laboratories around the world. Topics ranging from how to develop radioactive beams now considered very difficult to produce, to various alternate methods of producing such beams, to listening to comments from specialists in related non-nuclear disciplines such as material science on the properties of materials were covered in short, two-hour sessions.

One of the major topics covered was the use of gas cells for the production of very clean beams, possibly without using thick target ISOL type systems. Questions were assigned prior to the workshop and answers were provided if possible during discussions.

According to D’Auria, the format and topic of the Workshop were quite timely. “Two days is about the right time to attempt to get some of the very busy scientists to meet, and this was the first time a serious workshop was held on ISOL targetry in North America in a non-conference situation,” he said. “This workshop should be repeated and could be very helpful in the path to RIA.”

Preparation of self-supporting targets with thickness of less than 100ug/cm^2 by focused heavy-ion beam sputtering

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Low energy nuclear reaction studies require thin, preferably self-supporting targets in order to get optimum resolution. Standar techniques for producing them include resistance heating, electron-beam bombardment and focused heavy-ion beam sputtering. High vacuum sputter deposition is a very good method of preparing high melting point targets and isotopic expensive metal targets. Focused heavy-ion beam sputtering was used to produce self-supporting, thin targets justifiable. Copper foils with thickness of 10~20um worked as substrates, and target frames' square is 0.9cm^2.And when etchant, HNO_3 or $CCl_3CO_2NH_4$ was used, we found it resulted in strong, little stress foils. Parameters of sputtering are compiled in table 1, and a list of tested targets is complied in table 2.

Table 1. Parameters of sputtering

Ion type	Acceleration voltage//kv	Focused voltage/kv	Ion-source pressure/pa	Sputtering chamber pressure/pa	Beam current/mA
Ar^+	5~12	0.8~1.5	4.5~6.5	2×10^{-3}	0.2~0.4

Table 2. Self-supporting targets<100ug/cm^2

Element	Etchant	Etchant(ug/cm^2)	Element	Etchant	Etchant(ug/cm^2)
Ir	HNO_3	50	Fe	$CCl_3CO_2NH_4$	48
Zr	HNO_3	44	Dy	$CCl_3CO_2NH_4$	44
Ta	HNO_3	60	Lu	$CCl_3CO_2NH_4$	50
Rh	HNO_3	40	Er	$CCl_3CO_2NH_4$	40
Hf	HNO_3	70	Sm	$CCl_3CO_2NH_4$	60
Nb	HNO_3	20	Y	$CCl_3CO_2NH_4$	73
Ru	HNO_3	20	Sb	$CCl_3CO_2NH_4$	55
Cr	HNO_3	30	Co	$CCl_3CO_2NH_4$	40
Si	HNO_3	12	Mg	$CCl_3CO_2NH_4$	45
C	HNO_3	16	Pb	$CCl_3CO_2NH_4$	50
Re	$CCl_3CO_2NH_4$	65	Os	$CCl_3CO_2NH_4$	50
Ni	$CCl_3CO_2NH_4$	37	Mo	$CCl_3CO_2NH_4$	55
Ti	$CCl_3CO_2NH_4$	44	V	$CCl_3CO_2NH_4$	40
Pd	$CCl_3CO_2NH_4$	40	Yb	$CCl_3CO_2NH_4$	60
Pt	$CCl_3CO_2NH_4$	64			

References:

[1] J.C.Gursky,Proc.5th World Conf of the INTDS,LA-6850-C,1976,P.198~199.
[2] J.C.Gursky,Proc.10th World Conf of the INTDS,Rehovot,Israel,1981,P.83~91.
[3]H.J.Maier, Proc.15th World Conf of the INTDS,Volume A303.No.1,1991,P172~181.

Conductance Measurements of Permeable Samples

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1. Definition of the method:

A method for measuring the conductance of permeable samples was developed in the target laboratory of the Physics Division, Argonne National Laboratory. This technique allows measuring the conductance of permeable samples being traversed by any gas. The size of the samples can vary from some millimeters to a maximum of 3 cm diameter. This limitation is presently given by the size of the vacuum chambers used in the set-up, but it can easily be changed. The value of the conductance is obtained by comparing the difference of pressure between the two sides of the sample with the one obtained with a calibrated orifice.

The set-up is shown in Fig. 1:

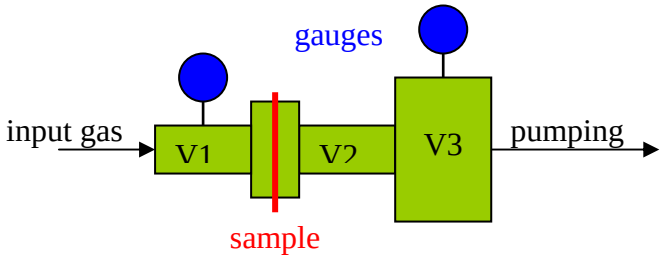

Fig. 1: set-up for measuring the conductance of permeable samples

When a vacuum steady–state is established in the system, the quantity of gas circulating in the volumes V1, V2 and V3 are the same and equal to Q. Therefore, one can write the following relationship between the conductance C_S of the sample or orifice, the conductance C_2 of the pipe V2 and the pressures in V1, V2 and V3:

$$Q = (P_1-P_2)C_S = (P_2-P_3)C_2 = (P_1-P_3)C_{2S} \quad (1)$$

where P_1, P_2 and P_3 are the pressures in volumes V1, V2 and V3 and

$$C_{2S} = (1/C_S + 1/C_2)^{-1} \quad (2)$$

Moreover, the pumping speed (S_3) in the volume V3 is constant, therefore, one can write:

$$Q = S_3.P_3 \quad (3)$$

Substituting (3) in (1), one obtains the following relation between the pressures P_1 and P_3:

$$P_1 = (S_3/C_{2S}+1)P_3 \quad (4)$$

Knowing the conductance of the pipe in V2 (by construction) and measuring the pressures P_1 and P_3 for a calibrated orifice allows one to obtain the pumping speed S_3, which in turn, can be used for calculating the conductance of the sample given the pressures P_1 and P_3 measured with the sample. The procedure adopted for obtaining the conductance of a sample is:

1. Deduce the value of S_3 using a calibrated orifice via the measurement of pressures P_1 and P_3.
2. Measure the pressures P_1 and P_3 with the sample, deduce the value of $(S_3/C_{2S}+1)$ from equation (4) and extract the conductance from the relationship (2).

Fig. 2 shows a picture of the experimental set-up.

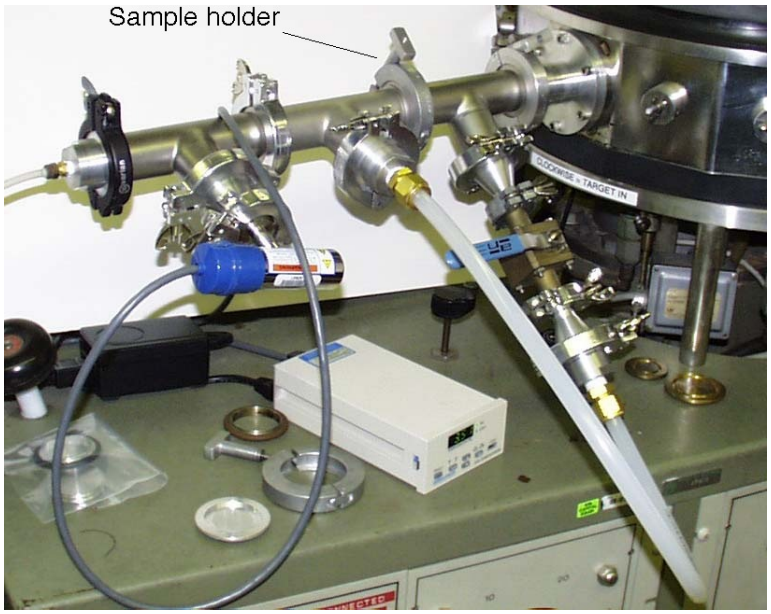

Figure 2: Picture of the experimental set-up. The blue valve is a by-pass between volumes V1 and V2.

2. Calibration of the pumping speed.

The calibration of the pumping speed of the system was made using an orifice of 1 cm^2. Air was injected in the system and the following values of pressures were measured (Table 1).

	P_1 (torr)	P_3 (torr)
1	$3\ 10^{-3}$	$2\ 10^{-5}$
2	$6.2\ 10^{-3}$	$4\ 10^{-5}$
3	$9.3\ 10^{-3}$	$6\ 10^{-5}$

Table 1: Pressure P_1 and P_3 measured with a calibrated orifice of 1 cm^2 area.

From this data, and using the plot given in Fig. 3, one could deduce the value of $(S_3/C_{2S}+1)$ for the calibration orifice as being equal to 157.5. Given that the conductance of an orifice of 1 cm^2 area for air at 20°C is 11.6 l/s and the conductance of the pipe V2 is 30 l/s, the pumping speed at V3 is equal to: $S_3 = 1321.4$ l/s. This value is compatible with the speed of the diffusion pump (v = 2400 l/s) used in the test bench, if one considers that the pump is not placed directly on the volume V3.

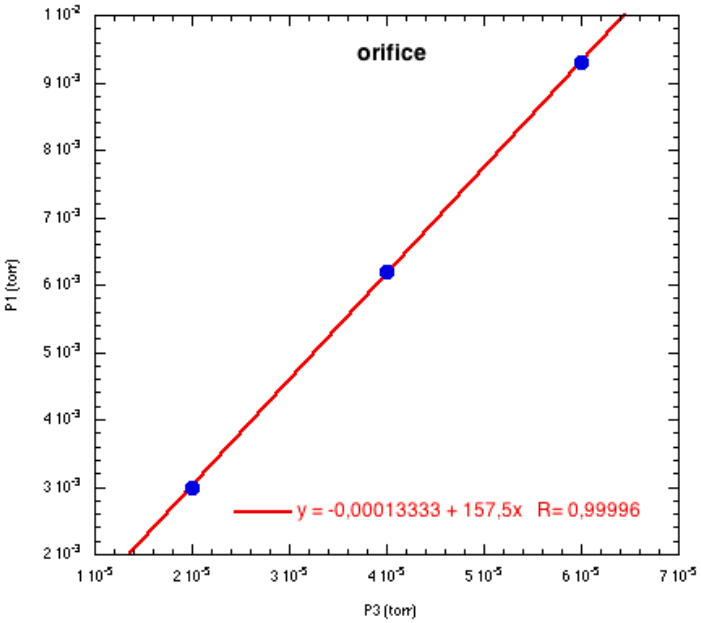

Figure 3: Pressures in the volumes V1 and V3 using a calibrated orifice of 1 cm^2 area.

3. Measurement of carbon aerogel conductance

The Southern Institute provided the carbon aerogel used in the measurement. Samples were cut from this material with dimensions corresponding to approximately 2 cm x 2 cm with thickness of 2 mm. No treatment was performed after the cut process. The sample was glued onto a circular orifice of 1 cm^2 area between volumes V1 and V2 (see Fig. 4). The data obtained (P_1 and P_3) is shown in Table 2 and Fig. 5.

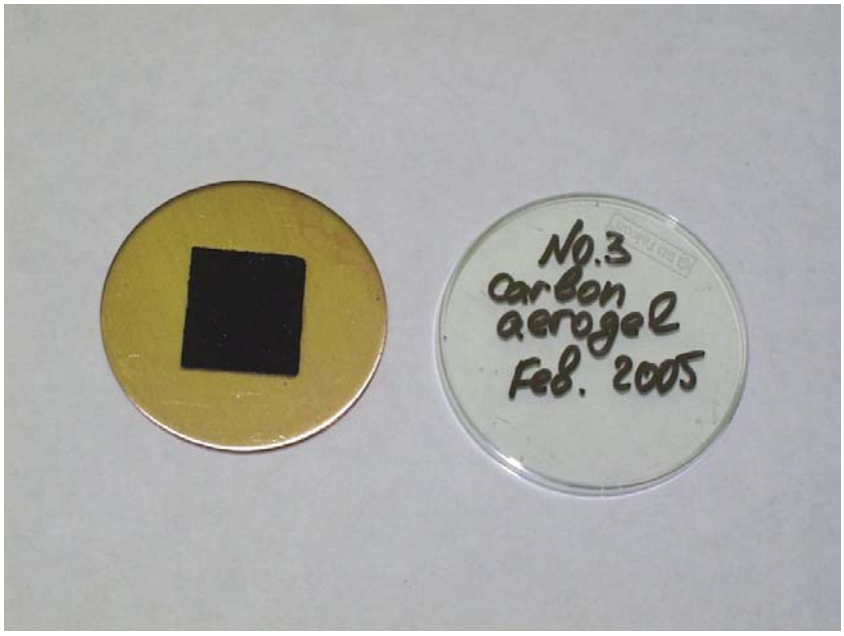

Figure 4: Carbon aerogel glued onto a copper disk.

	P_1 (torr)	P_2 (torr)
1	$252\ 10^{-3}$	$3\ 10^{-6}$
2	$400\ 10^{-3}$	$5\ 10^{-6}$
3	$556\ 10^{-3}$	$7\ 10^{-6}$
4	$1250\ 10^{-3}$	$1.7\ 10^{-6}$
5	$2530\ 10^{-3}$	$3.3\ 10^{-6}$
6	$3700\ 10^{-3}$	$5.8\ 10^{-5}$

Table 2: Pressures in volumes V1 and V3 with carbon aerogel sample.

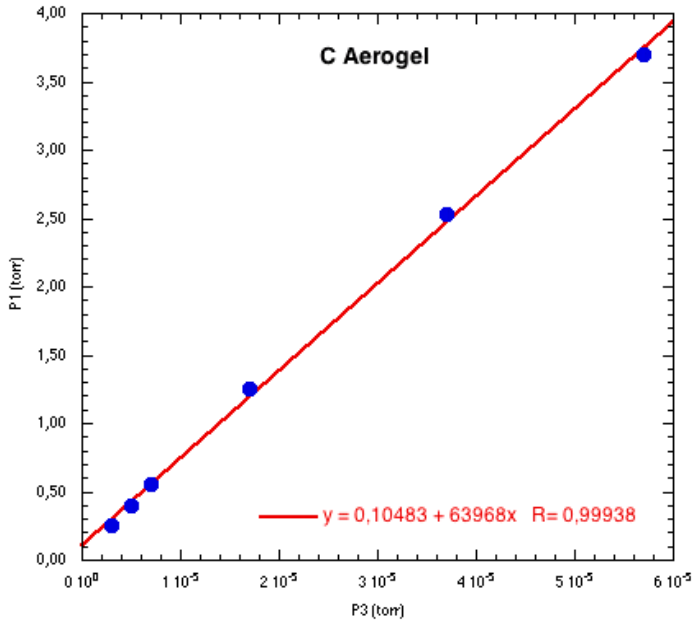

Figure 5: Pressures in volumes V1 and V3 with carbon aerogel sample.

Using equation (4), one can obtain from the fit in Fig. 5: $S_3/C_{2S} + 1 = 63968$. Using the value of S_3 deduced in the preceding section and using equation (2), one can deduce that for the carbon aerogel sample of 2 mm thickness and 1 cm^2 diameter:

$C_S = 0.0206$ l/s

The conductance can be expressed for any diameter size as a conductance density (for 2 mm thickness) as: $c = 0.0206$ l cm^{-2} s^{-1}. For this particular aerogel sample, this corresponds to a reduction in conductance of approximately a factor of 563, when compared with an open orifice of the same area. The equivalent orifice would have a diameter of 0.42 mm.

The error of the measured conductance can originate from the relative calibration of the vacuum gauges, small leaks or degassing of the system, and parasitic conductance between V1, V3 and the vacuum gauges. In Fig. 3 and Fig. 5 we observed that the two straight lines do not cross “zero” as they should, probably due to calibration offset. Each of these errors contributes approximately 10% of error to the final value. Therefore, a crude estimate would give an overall error of 20% for the measured conductance.