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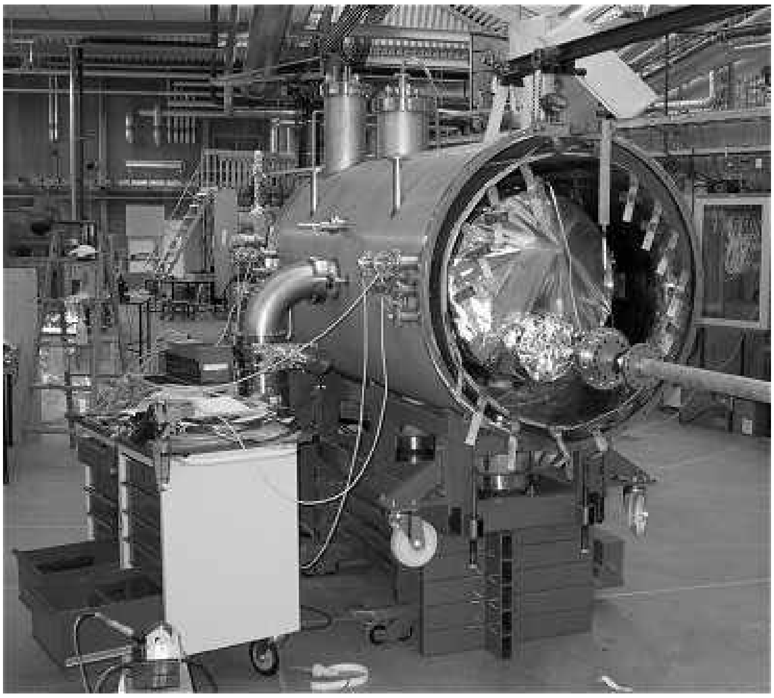
Svenska Vakuumsällskapets Tidskrift
nr 70 Maj 2001



Max-labs nya supraledande wiggler

TEMA: KRYOTEKNIK

KALLELSE TILL SVENSKA VAKUUMSÄLLSKAPETS ÅRSMÖTE

ANNONSIDA Advanced Vacuum 1

INNEHÅLL:

OMSLAGSBILD:

MAX-labs nya supraledande wiggler

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ANNONSSIDA PFEIFFER 1

KALLELSE
ÅRSMÖTE I SVENSKA VAKUUMSÄLLSKAPET

Tid: måndag 2001-06-18 kl 10.00.
Plats: rum C368, Fysicum, Professorsgatan 1, Lund, (Nanometerkonsortiets sammanträdesrum)

Verksamhetsberättelse, ekonomisk redogörelse och budget för nästa år utdelas på sedvanligt sätt vid årsmötet.

Dagordning för årsmötet:

1. Mötets stadgeenliga utlysande
2. Val av två rösträknare och två justeringsmän
   Val av ordförande och sekreterare för mötet
3. Styrelsens verksamhetsberättelse
4. Revisorns berättelse
5. Fråga om ansvarsfrihet för styrelsen
6. Fastställande av budget för nästa verksamhetsår samt årsavgiftens storlek
7. Val av ny styrelse
8. Val av revisorer och revisorssuppleanter
9. Val av valnämnd
10. Övriga frågor

Välkomna till årsmötet!

Annonssida Löwener

Vakuum Nytt nr. 70, Maj 2001

The Benefits of Modern Refrigerator-Cooled Cryopumps in Industrial Processes and Research and Development

D. Mueller and G. Voss, LEYBOLD Vakuum GmbH

Summary

The function of modern refrigerator-cooled cryopumps as well as the pumping and regeneration processes are explained. The potential user receives a guideline where he can proove if the specific properties of cryopumps are of profitable use in his vacuum process.

1. Introduction

Ever smaller, denser and finer structures; that is the trend in the area of microelectronics today. This trend, however, has its risks: finer structures increase the effects of contamination during the production process.

The most detrimental kind of contamination in the processes employed in the production of semiconductors is due to hydrocarbon molecules. This also applies to many vacuum coating processes in the optical industry.

Modern industrial series production of high-tech products increasingly demands a vacuum *which is free of hydrocarbons*. A wide range of commercially available turbomolecular pumps and cryopumps are in line with this trend. The turbomolecular pump is dominant for small vacuum chambers (volumes of less than 300 l) with small high vacuum flange diameters (below 250 mm). For large vacuum chambers (volumes over 700 l) and large high vacuum flange diameters (over 400 ISO-K) there is only one reliable solution for a vacuum free of hydrocarbons: the cryopump.

2. The Principle of the Cryopump

2.1 Pumping

The cryopump is a *gas-bonding vacuum pump* which is preferably employed in the *pressure range from* 10^{-2} *to* 10^{-10} *mbar*. The pumping effect of the cryo-pump is based on the fact that the gases which need to be pumped condense inside the pump on sufficiently cold surfaces. In short one may say: *production of vacuum by cold.*

That warm gases condense on colder surfaces is known to everyone with spectacles. When they enter a warm room from the cold the lenses get clouded. This indicates that water vapour (at a temperature of 27 °C = 300 Kelvin) condenses at the surface of the cold lenses (at a temperature of, for example -10 °C = 263 Kelvin). Operation of the cryopump is based on the same principle, except that here the condensation surfaces are cooled to temperatures of down to *minus* 263 °C = 10 K (K = Kelvin). All gases, except hydrogen, helium and neon, can be bonded inside the cryopump by *cryocondensation* (see box 1 and box 2). In order to be able to bond the other three gases, surfaces have to be covered with an adsorbent cooled to 10 K as well. In this way hydrogen, helium and neon are bonded inside the cryopump by means of cryo-sorption (see box 1 and 2).

Being a gas-bonding pump, the cryopump has only a limited capacity. This means that, for each type of gas, only a certain amount may be bonded inside the cryopump. If this capacity limit is exceeded, the pumping effect for that type of gas is markedly reduced. Thus full usability of the cryopump to the process is reduced.

For this reason, operation of the cryopump needs to be arranged in such a manner that

Cryocondensation	Physical, reversible bonding of gas on to a cold surface which may be already covered by gas particles of the same kind.
Cryosorption	Physical, reversible bonding of gas on to a cold surface which is covered by some adsorptive material but not yet covered by gas particles. The gas particles that are later cryosorbed can form a layer up to one atom/molecule thick (monolayer) but they do not condense on particles of the same kind. Possible cold surfaces are, for example: a polished metal surface the surface of an adsorbent (activated charcoal or Zeolite, for example) the surface of a gas which condenses easily (like argon or carbon dioxide, for example)

Box 1: Gas-bonding processes

the pumping mode is terminated before reaching the capacity limit and that the pump is subsequently *regenerated*.

2.2 Regeneration

During *regeneration* gases collected in the cryopump are released again (reversible bonding of gas !) and removed from the pump. The pump is thereby returned to its initial state and is once more ready to enter the *pumping* mode.

Bonding of the gas particles is reversed by warming the cold surfaces inside the cryopump as well as the baffle and the thermal radiation shield. The released gases are discharged either through a valve or pumped out using a suitable backing pump.

The three most important methods of regeneration may be outlined as follows:

R1: *Regeneration through natural warming*

Switch the refrigerator off; if required, purge the cryopump with inert gas; wait until the cryopump has warmed up to room temperature naturally by means of thermal conduction and thermal radiation; discharge the released gases either through the safety valve of the cryopump or pump them away using a suitable backing pump.

R2: *Regeneration through pre-warmed inert gas*

Switch the refrigerator off; continuously vent and purge the cryopump with pre-warmed inert gas (the temperature of the inert gas will be typically 50 to 60 °C); the inside of the cryopump will warm up to the temperature of the inert gas (significant gain in time over R1); at a slight over-pressure the released gases together with the inert gas are continuously discharged through the safety valve of the cryopump.

R3: *Sequential regeneration using electric heaters*

Switch the refrigerator off; the cold surfaces, the thermal radiation shield and the baffle are not warmed simultaneously but sequentially (!) to 50 to 60 °C using electric heaters; the inside of the cryopump is thus — in contrast to R1 and R2 — warmed locally and under time control by maintaining the following sequence (see also box 2):

- Gases with a very low melting
- Gases with a low melting
- Gases with a relatively high melting point

Subsequently, and regardless of the regeneration method, the inside of the cryopump must be evacuated down to a pressure of 2 x 10^{-2} mbar. The pump may then be cooled down once more.

	are preferably bound	through	at temperatures of
Very low melting point gases These are hydrogen, helium and neon.	On the areas of the cold surface covered by an adsorbent (activated charcoal, for example)	Cryosorption	< 20 K The cold is usually generated by the second stage of the cold head.
Low melting point gases These are, for example, argon, nitrogen and oxygen.	On the areas of the cold surface facing the baffle	Cryocondensation	< 30 K The cold is usually generated by the second stage of the cold head.
Relatively high melting point gases These are, for example, water vapour, ammonia and carbon dioxide.	At the baffle and the thermal radiation shield	Cryocondensation	< 100 K The cold is usually generated by the first stage of the cold head.

Box 2: Information as to the operation of the cryopump

3. Characteristics of the Refrigerator-Cooled Cryopump

3.1 Hydrocarbon-Free High Vacuum Pump

The cryopump is by design a high vacuum pump which is free of hydrocarbons. Operation of the pump does not require oil or any other lubricants, in contrast to the oil needed to operate a diffusion pump.

Compared to turbomolecular pumps having mechanical bearings, cryopumps do not require any moving or even lubricated parts on the high vacuum side.

3.2 Gas-Bonding High Vacuum Pump

In the *pumping* mode, the valve between the forevacuum port and the backing pump is closed. The backing pump may be switched off. The backing pump is only required during starting and while regenerating the cryopump.

3.3 Extremely High Pumping Speed for Water Vapour - High Pumping Speed for all Gases

For a given diameter for the high vacuum flange, the cryopump offers the highest pumping speed of all high vacuum pumps. This is especially apparent when comparing the pumping speeds for water vapour and hydrogen. For example, the pumping speed for water vapour of the cryopump is three to five time greater than that provided by a corresponding turbomolecular pump or a diffusion pump. In the case of hydrogen the cryopump is typically better by a factor of 2.

3.4 Crossover Value

The crossover value is a characteristic quantity of a refrigerator pump ready for operation. Ready for operation means here that all cold surfaces inside the pump have been cooled to the temperatures necessary for operation (see box 2).

The crossover value is of importance when the cryopump is connected via a high vacuum valve to the vacuum chamber. It indicates the maximum quantity of gas (with the reference being $T_n = 293$ K) that may be present in the vacuum chamber so that on opening the valve, the cryopump continues to operate normally.

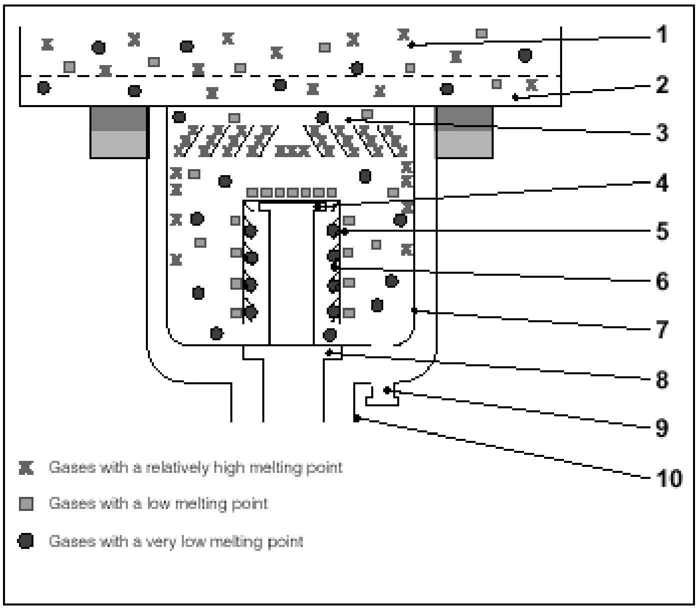


Fig. 1 Refrigerator-cooled cryopump in the pumping mode

1 Vacuum chamber
2 High vacuum valve (open)
3 Baffle (80 to 100 K); in mechanical and thermal contact with 7; is a conden-sation surface for gases having a relatively high boiling point.
4 Cold head, 2nd stage
5 Cold surface (10 to 20 K); in mechanical and thermal contact with 4; the side facing the baffle is the condensation surface for gases having a low boiling point.
6 Cold surface (10 to 20 K); in mechanical and thermal contact with 4; the side covered with adsorbent and facing away from the baffle is the adsorption surfacefor gases having a very low boiling point.
7 Thermal radiation shield (60 to 80 K); in mechanical and thermal contact with 8; behaves like 3 as the condensation surface for gases having a relatively high
boiling point.
8 Cold head, 1st stage
9 Forevacuum port; in the pumping mode the valve between forevacuum port and backing pump is closed.
10 Vacuum jacket (at room temperature)

3.5 Cooling using a High-Power Refrigerator

Today, almost all commercially available cryopumps are cooled by *Gifford/McMahon refrigerators.* Such a refrigerator uses a closed helium-gas circuit. A fully-functional unit consists of a two-stage cold head, a compressor unit and pressure lines connecting the cold head to the compressor unit.

If a high pumping speed is demanded of the cryopump (for example in connection with sputtering processes used in semiconductor production lines) the refrigerating capacity of the second stage for the cold head must be high. If the cryopump is to be highly stable when exposed to large thermal loads (for example when degassing optical components before they are coated) the first stage of the cold head needs to be particularly powerful.

4. The Benefits of the Cryopump in Research and Development

In the area of research and development, the requirements for the quality of the vacuum are often more stringent than in case of industrial processes run later on.

Reproducible measurement results demand low base pressures and „cleanliness“ (defined by the composition of the residual gas). Further, in many research applications, the vacuum pump is exposed to strong magnetic fields or radiation. This factor, together with low investment costs, must also be considered.

In Table 1 we have compared the special characteristics of the cryopump to the potential benefits to the user in the area of research and development.

5. Benefits of the Cryopump in Industrial Series Production based on the Example of Precision Optics Coatings

Optical components used in high-performance optical systems are invariably finished by the application of coatings to their surfaces in a vacuum. The evenness and purity of the coating becomes ever more significant if the optical component is to be used at short wavelengths. Clusters of hydrocarbon molecules on the surface of a lens or a prism will impair imaging

Table 1: Benefits to the user

	Benefits to the user concerning		
Characteristics of the cryopump	**Process capability**	**Ease of operation**	**Low investment costs and cost of ownership**
Hydrocarbon-free	Uncontaminated high and ultrahigh vacuum	No contamination in case of misoperation of power failure	In many cases an (U)HV gate valve will not be required.
Maximum pumping speed for condensable gases	Low pressures are attainable, clean starting conditions	Fast pumpdown	
Multiple operation with one compressor			Cost reductions at an installed pumping speed of 3000 l/s or more
High refrigerating capacity of the refrigerator	High gas throughput	High crossover pressure	Cost-effective forevacuum system
Capable of operation in magnetic fields up to about 600 Gauss	Applications in connection with particle accelerators		
Radiation resistant up to 10^6 rad	Applications in connection with particle accelerators	Low failure probability	Low repair costs
On-location maintenance	Application in contaminated environments		
Maintenance without having to disassemble the chamber		No venting of the UHV chamber, thus no need to degas once more	
Operation independent of orientation		Flexibility as to the design of the system	

quality more in the ultra-violet range than at longer wavelengths.

Here the cryopump, being by design a high vacuum pump free of hydrocarbons, can guarantee the utmost regarding reliability during the production process. For example, the possibility of oil backstreaming into the vacuum chamber can be entirely excluded. When using an oil diffusion pump, suitable precautions must always be taken to suppress the backstreaming of oil. In many coating systems, an oil vapour trap cooled with liquid nitrogen (LN_2) is usually installed between the diffusion pump and the vacuum chamber. On the one hand this provides the required degree of safety but it is costly. For example, an oil trap having a nominal width of DN 500 cooled with liquid nitrogen consumes about 5 litres of LN_2 per hour. At 6,000 operating hours per year and a cost of 1 DM per litre LN_2 , this results in operating costs amounting to 30,000 DM per year. Under these circumstances the investment in a modern cryopumping system would already pay off after 2 years.

Table 2 demonstrates which benefits the user can expect in view of the process and productivity from the *high pumping speeds* and *high crossover values* of modern cryopumps. The following example is typical of the everyday practice in running a precision optics coating system:

Vacuum chamber: equipped with a thermal radiation protection baffle and a 90plate valve (DN 500), volume: about 800 l.

Cryopump: LEYBOLD COOLVAC 10.010, pumping speed at the high vacuum flange (DN 500) for water vapour: 30,000 l/s; for air: 10,000 l/s; crossover value: 700 mbar x l.

Under these conditions the cryopump evacuates the vacuum chamber from 2 x 10^{-1} mbar — at this pressure the plate valve is opened — down to 1.4 x 10^{-5} mbar in only 5 minutes, and after further 10 minutes already a pressure of 3 x 10^{-6} mbar is attained. It should be said that in principle the high vacuum valve could

Table 2: Features/benefits matrix of a 10,000 l/s cryopump (LEYBOLD COOLVAC 10.010) with automatic controller (LEYBOLD FIRST) operating in connection with a precision optics coating system.

	Benefits to the user concerning			
Characteristics of the cryopump	**Process**	**High productivity**	**Ease of operation**	**Low operating costs**
Vacuum pump free of hydrocarbons, no mechanically moving parts on the vacuum side	Very clean vacuum No back-streaming of oil		Oil traps cooled with liquid nitrogen are not required. No handling of liquid nitrogen. Topping up of oil or other lubricants is not required.	No costs for operating the liquid nitrogen supply. No waste disposal costs for oil.
Gas-bonding high vacuum pump				The backing pump runs only on initial start-up and during regeneration of the cryopump.
Extremely high pumping speed for water vapour High pumping speed for all gases, hydrocarbons in particular	Extremely low partial pressure for water vapour Low total pressure Very clean vacuum	Extremely short pump-down time The crossover pressure for the process is attained very quickly.		
High crossover value		During the pump-down phase the high vacuum valve may be opened early. Significantly reduced pumpdown time		
Cryopump equipped with electric heaters (at the 1st and 2nd stages of the cold head)	The gases bonded in the cryopump may be released and pumped out one after the other.	Hydrogen is regenerated at low pressures (< 10 mbar). Hazardous mixtures of hydrogen and oxygen cannot form.		
Automatic control with temperature and pressure sensors in the cryopump	The cryopump may be integrated easily in complex high vacuum systems. The pumping surfaces are regenerated with high efficiency. Water vapour is sublimed during regeneration; no liquid water forms in the pump.	The pressure and the temperatures in the pump are monitored continuously. The regeneration cycle is fast and inherently safe.	The desired operating mode is selected through a push-button or through the interface. The regeneration cycle is fully automatic.	No costs for compiling and maintaining the programs used to control the cryopump
Cooling by a powerful refrigerator	The cryopump is very stable with respect to thermal loading.	The cryopump may be cooled down quickly to the required operating temperatures.		

already have been opened at a pressure of 8.8×10^{-1} mbar (= 700 mbar x l/800 l).

One factor against the introduction of cryopumps into industrial production was initially the need to regenerate the pumps from time to time. Regeneration not only reduces production time but also requires careful planning to incorporate the regeneration cycle in the control of the system. For this reason, at the beginning of the Nineties, leading manufacturers introduced cryopumps which were operated under automatic control. This has very much simplified the operation of cryopumps. Such *intelligent* cryopumps can be integrated without problems into complex high vacuum systems.

Operation of such pumps is simplified because the desired operating modes — e.g. pumping or regeneration — may be selected through a key-press or via the pump's interface.

The regeneration process has been optimised with respect to speed, safety and efficiency. The regeneration cycle is fully automatic. For example, the 10,000 l/s cryopump (LEYBOLD COOLVAC 10.010) shown in Fig. 2 is regenerated automatically within 4 to 4.5 hours. Here the method of *sequential regeneration with electric heaters* is employed (see section 2.2).

This method guarantees that any hydrogen and oxygen that has been pumped will never be able to mix in the cryopump because the hydrogen has already been discharged from the pump before the oxygen is released from the cold surfaces. A further advantage is that the water vapour is only released towards the end of the warming-up phase in the cryopump so that it may be removed from the pump at a low pressure [$p(H_2O) < p_{\text{triple point}}(H_2O) = 6$ mbar]. The water vapour is thus sublimed during regeneration. No liquid water forms in the pump.

As soon as the cold surfaces have been freed of all gases to a sufficient degree, the controller will automatically start the cool down process in the cryopump.

In Table 2 we have again tried to link the most important features of the cryopump to the user benefits. Comparison with Table 1 shows that the features/benefits matrix naturally depends in each case on the kind of application.

10,000 l/s cryopump, high-vacuum flange: DN 500 ISO-K (LEYBOLD COOLVAC 10.010)

6. Outlook

In high vacuum processes requiring pumping speeds of 3000 l/s or more, the cryopump has an established role and has displaced the previously employed oil diffusion pumps or large turbomolecular pumps. At low pumping speeds it is used in all applications where a turbomolecular pump cannot be used because of special ambient conditions. Modern controllers in which the special characteristics of the cryopumping process are taken into account automatically, simplify operation in practice. Future developments are targeted at even higher gas throughputs and further simplifications in the area of system integration.

NYTT STRÅLRÖR FÖR MATERIALVETENSKAPLIG FORSKNING VID MAX-LAB.

DEL 1: MAX-WIGGLERN

Vid det nationella synkrotronljuslaboratoriet MAX-lab i Lund byggs nu ett strålrör för materialvetenskaplig forskning. Strålröret ska leverera hård monokromatiserad röntgenstrålning till tre olika experimentstationer: en för röntgendiffraktion, en för EXAFS och en ultrahögvakuumstation för bland annat yt-EXAFS. Röntgenkällan är en supraledande wiggler i den moderna MAX-II-lagringsringen. VakuumNytt ska i några reportage beskriva strålröret, med namnet I811, och vi börjar i detta nummer med att berätta om den supraledande wigglern.

Synkrotronljus är den elektromagnetiska strålning som uppstår när en elektronstråle med relativistisk hastighet accelereras i böjmagneter i en lagringsring. Ett kontinuerligt strålningsspektrum med hög intensitet från infrarött till röntgenstrålning emitteras tangentiellt till elektronbanan. Synkrotronljusest stora fördelar ligger i det kontinuerliga spektrat och dess mycket höga intensitet och kvalitet (s. k. briljans). Intensiteten och briljansen ökas ytterligare med så kallade insättningselement; undulatorer och wigglers. Dessa är periodiska magnetstrukturer i raka sektioner i ringen som tvingar elektronstrålen att gå i en ”slalombana”, varvid ljus emitteras med intensitet som kan vara flera storleksordningar högre än ljuset från böjmagneterna. MAX-II-ringens böjmagneter och nuvarande insättningselement ger användbar strålning upp till cirka 5 keV. Denna övre gräns beror på ringens energi (dvs. elektronernas kinetiska energi) som är 1,5 GeV.

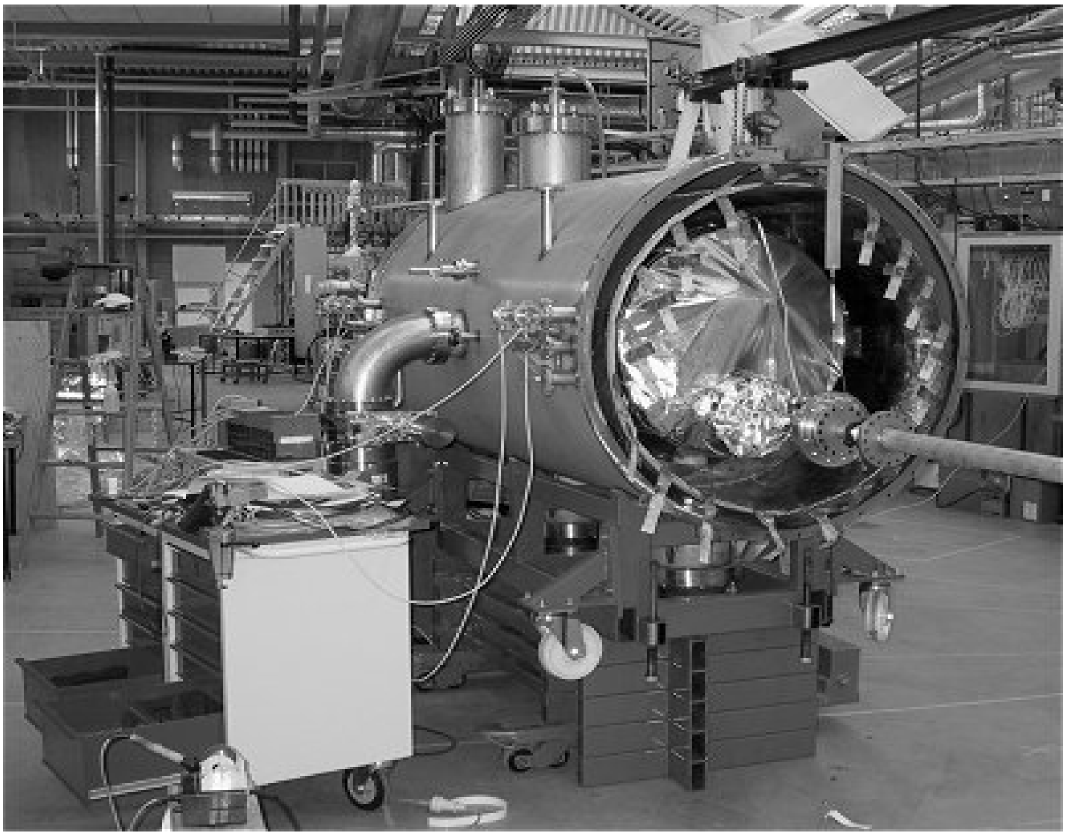
Vid MAX-lab finns ett ökande behov av högintensivt röntgenljus för bland annat kristallografi och annan materialvetenskaplig forskning. För att möta detta behov byggs nu två nya strålrör, ett för materialvetenskaplig forskning (I811) och ett för proteinkristallografi (I911), där ljuskällan, en s.k. supraledande wiggler, ska leverera högintensiv röntgenstrålning upp till 20 keV. För emission av så hård röntgenstrålning i MAX-II krävs en wiggler med extremt höga magnetfält, vilket uppnås med supraledande magnetspolar som kyls med flytande helium. MAX-lab beslutade att utveckla och bygga en egen supraledande wiggler, ett projekt av betydande komplexitet och svårighetsgrad. Efter cirka två års utvecklingsarbete är MAX-wigglern nu redo för att monteras in i MAX-II-ringen. Utvecklingsarbetet har bland annat innefattat bygget av en prototyp för tester av bland annat den termiska lasten och kylkapaciteten vid drift i MAX-II. De närmast inblandade personerna i projektet är Erik Wallén, Greg LeBlanc och Leif Thånell.

Figur 1. Wigglerns vakuumrör med magnetpoler monterade

MAX-wigglern är 1,5 m lång och består av 47 magnetpoler med en maximal fältstyrka på 3,5 Tesla, vilket uppnås med en spolström på 280 A. Polerna med de supraledande spolarna monteras direkt på vakuumröret, vilket innebär att såväl poler som vakuumrör kyls med flytande helium, ned till 4 K (en s.k. cold-bore design). I figur 1 visas vakuumröret med polerna monterade. Wigglern förväntas ge ett flöde på $2{,}3\times10^{14}$ fotoner/sekund/mrad/0,1% bandbredd vid den s.k. kritiska energin 5,2 keV, med en typisk ringström på 200 mA. Den totala utstrålade effekten är 5,0 kW, ett högt värde som ställer höga krav på det efterföljande optiska systemet (speglar, monokromator).

I figur 2 visas wigglern monterad i He-kryostaten. Kryostaten är updelad i fyra olika temperaturzoner från 4,2 K till cirka 40 K, var och en med en specifik värmelast. Wigglerstrukturen kyls i ett LHe-bad och det förångade heliumet används till att kyla den termiska avskärmningen. Värmelasten på 4,2 K-nivån beräknades vara under 1 W, men tester med prototypen gav ett betydligt högre värde. Vid full ringenergi och ringström på 180 mA var värmelasten 3,2 W och avkokningen av He 4,4 liter/h. En kritisk fråga för denna cold-bore-design var den ökade värmelasten på grund av inducerade strömmar i det kalla vakuumröret. Dessa s.k. image currents uppstår när elektronstrålens pulser – bunches – passerar genom röret och ökar med högre ström och kortare pulser. MAX-II ringens karakteristik är dock fördelaktig i detta avseende – strömmen består av många små och uttänjda pulser. Testerna visade att värmelasten från elektronstrålen var 1,0 W vid 180 mA, vilket inte anses vara ett högt värde.

MAX-wigglern kommer att installeras i MAX-II under sommaruppehållet 2001 och tester av dess strålningskarakteristik börjar till hösten. Då installeras också övriga delar av strålröret – monokromator och experimentstationer. Parallellt med bygget av den första MAX-wigglern tillverkas en kopia, som senare ska användas vid strålrör I911, avsett för bl.a. proteinkristallografi.



Figur 2. Wigglern monterad i kryostaten

ANNONSSIDA PIAB

AVANCERADE KURSER I VAKUUMTEKNIK, TUNNFILMSBELÄGGNING, ETC

Är du intresserad av avancerade kurser i vakuumteknik, tunnfilmsbeläggning etc? Vi har hittills i samarbete med American Vacuum Society (AVS) och/eller International Union of Vacuum Science Technique and Applications (IUVSTA) anordnat följande kurser:

Operation and maintenance of vacuum pumping systems.
Controlling contaminations in vacuum.
UHV design and practices .
Föreläsare: Ron Outlaw (Uppsala i juni 1994)

Sputtering
Föreläsare: Bill Westwood, Canada, samarbete med AVS, (Linköping aug. 1997)

Thin film deposition
Föreläsare Angus Rockett, USA. (Göteborg i aug 2000)

Vilka kurser skulle Du vilja att Svenska Vakuumsällskapet anordnar här i Sverige?

Se även under kurser på följande AVS (www.vacuum.org) och IUVSTAs hemsidor: http://www.vacuum.org/ (Se: short courses), resp. http://iuvsta.vacuum.org/iuvsta/materials.html

Svara per e-mail till vår kurssamordnare Lars Bagge. E-postadress: bagge@msi.se.

ANNONSSIDA RIETSCHLE

KOMMANDE KONFERENSER OCH MÖTEN

2001

July

- **July 10-14**. 31st IUVSTA Workshop: "Nanoparticles", Stratford-on-Avon, England, www.nprl.bham.ac.uk
- **July 16-19.** ASEVA Summer School “Thin Films of Magnetic Materials" Hotel Reina Isabel, Avila, Spain, Chair: Prof. J.L. Martinez martinez@icmm.csic.es
- **July 19-27.** 2nd International Summer School on Quantum Devices, Erice, Italy. Contact:M.Sancrotti, www.aiv.it/erice2001.htm
- **July 22-26:** Nanotube 01: International Workshop on the Science and Applications of Nanotubes, Potsdam, Germany. www.nanotube.org/
- **July 23-26.** ASEVA Summer School “Growth and Behaviour of Metal-Oxide Interfaces” Hotel Reina Isabel, Avila, Spain, Chair: Prof. G. Thornton (g.thornton@man.ac.uk)
- **July 23-27,** The Thirteenth International Conference on Vacuum Ultraviolet Radiation Physics (VUV-XIII), "Stazione Marittima", Trieste, Italy. vuv13.elettra.trieste.it/vuv13/
- **July 29-August 3.** 19th International Conference on Atomic Collisions in Solids, Paris, France. Contact: icacs19@veof1.lcam.u-psud.fr

August

- **August 5-10**. 33rd IUVSTA Workshop: "Diamond and Diamond-like Carbon: Science and Applications", Aguas de Lindoia, Sao Paulo State, Brazil. r.jackman@eleceng.ucl.ac.uk

September

- **September 3-7.** ECOSS-20, Krakow, Poland, http://www.confer.uj.edu.pl/ECOSS20/
- **September 3-14.** NATO-ASI on "Chemical Physics of Thin Film Deposition Processes", Kaunas, Lithuania, contact: Prof. Yves Pauleau, http://www.polycnrs-gre.fr
- **September 17-20.** 7th European Vacuum Conference(EVC-7) & 3rd European Topical Conference on Hard Coatings (ETCHC-3), Madrid, Spain. contact: Instituto de Ciencia de Materiales de Madrid. CSIC , http://www.icmm.csic.es/aseva/evc7.html

October

- **October 26-November 2**. 15th International Vacuum Congress (IVC-15)/ 11th International Conference on Solid Surfaces (ICSS-11), in conjunction with the American Vacuum Society Symposium Moscone Center, San Francisco, USA

November

- **November 12-16.** 33rd IUVSTA Workshop: “Diamond and Diamond-like Carbon: Science and Applications”, Aguas de Lindoia, Sao Paulo State, Brazil, contact: r.jackman@eleceng.ucl.ac.uk , http://www.ee.ucl.ac.uk/deg

2002

March/April

- ***Date to be Announced*: Applied Surface Science Division,** 34th Workshop: “XPS: From Spectra to Results-Towards an Expert System”, Saint-Malo, France, Contact: Cedric Powell, NIST, Gaithersburg, MD.

June

- **June 16-20.** 9th Joint Vacuum Conference, Seggau Castle Conference Centre, Graz, Austria, contact: M. Leisch, Technische Universitaet Graz; m.leisch@tugraz.at

July

- **2nd week of July**. Nano-7 and TATF ´01, Malmö, Sweden, Chair: Lars Samuelson, Lund University
- **July 22-26,** 7th International conference on the structure of surfaces, Newcastle, NSW, Australia. Contact: John.OConnor@Newcastle.edu.au

September

- **September 1-6. Thin Film Division:** 12th International Conference on Thin Films (ICTF-12), Bratislava, Slovakia. contacts: ictf12@savba.sk; http://www.savba.sk/sav/inst/fyzi/ictf12

2003

Summer

- ***Date to be Announced*: XAFS-12,** Lund, Sweden, www.xafs12.maxlab.lu.se

2004

June/July

- **June 28-July 2**, 16th International Vacuum Congress (IVC-16)/ 12th International Conference on Solid Surfaces (ICSS-12), Venice, Italy

ANNONSSIDA ROWACO

FRÅN REDAKTIONEN.

Presstopp för *Vakuum Nytt nr. 71* den 15 september 2001!!

Skicka bidragen på diskett eller med e-post. För att försäkra Er mot ev. misstag, sänd även en en papperskopia av bidraget till redaktionen.

Lars

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