# The Rôle of Large-Scale Facilities

## EPS ASSOCIATE MEMBERS ANNUAL MEETING

**Grenoble, France, 10 November 1992**

*Inside the ESRF's new central services building.*

Many scientists will be visiting the new central services building at the European Synchrotron Radiation Facility (ESRF) in Grenoble when the high-brilliance x-ray source becomes operational next year. EPS had the honour to baptise in a certain sense the building, as it was the site for this year's Annual Meeting of the EPS Associate Members. The meeting was hosted by Professor R. Haensel, ESRF Director-General, and by Dr. J. Charvolin, Director of the adjacent Institut Laue-Langevin that now shares some services with the ESRF.

Invited guests and delegates from some 40 Associates participated in a round-table discussion on the rôle of large-scale facilities, starting with presentations by Directors of centres. Each talk led to a fair amount of interesting comment so there was little time left for an extensive general discussion before visiting nearby laboratories.

**Physical Societies**

The President, Maurice Jacob, reviewed the Society's activities, and the progress in restructuring EPS to a full member society (see page 219), before turning to the Associates' special rôle. The Society is fortunate in being able to count upon substantial support from companies, laboratories, organizations, institutes, and universities. He felt the confidence shown in EPS is justified as the Society among other things works to minimise duplication and overlap in activities, and to catalyze and channel initiatives by individuals. Nonetheless, the Associates have specific needs which EPS tries to meet by organizing special workshops, seminars and study panels, by providing advice and information, and by promoting contacts between the various physics communities, whether they be public or private, east or west, national or international. There are also issues such as physics teaching, university curricula, and professional qualifications directly affecting the Associates' personnel which call for effective and efficient action at the European level. As EPS cannot act in isolation, the President said the Society was always seeking comments, advice and ideas from the Associates.

Regarding the rôle of facilities, Maurice Jacob reminded us that physics relies increasingly on large instruments requiring greater international collaboration to satisfy user communities and cost constraints. Physical societies have an important part to play in the gestation and planning of facilities ranging from world-scale super-projects to regional centres that are large with respect to what their users traditionally expect. The joint statement on large facilities issued recently by the Presidents of EPS and The American Physical Society outlined how collaboration should move forward. The President felt one important merit of the trend was that it allows an increasing number of young scientists to spent part of their training at the frontiers of science and technology in a stimulating and competitive environment. Facilities also provide great opportunities for motivating teachers and young people by opening windows onto science.

Mindful of the situation in east and central Europe (E&CE), there remains of course the problem of ensuring access to facilities by less-fortunate communities. The EPS strategy is to promote the "bottom up" approach by stimulating communication through directories, journal subscriptions, missing issues, electronic networks, management of science workshops, *etc.*

**Neutron Sources**

In starting the discussion of the rôle of specific types of facilities, Dr. Charvolin, the ILL Director, described the impact of the discovery in 1991 of cracks in a baffle inside the core of the Institute's High Flux Reactor (HFR). A joint statement issued by the Chairman of the ILL Steering Committee in May 1992 gave the principles of an agreement between the three partners (UK, Germany and France) for the future of the Institute. It was decided that a European neutron source is still needed and the negotiating teams recommended five experimental cycles each year using 25 instruments (down from 30 in 1990) with an operating budget of 240 MFF involving different contributions from the three partners (the UK, temporarily at least, contributes less). As the budget is insufficient for 25 instruments, the ILL seeks other partners, especially from among ESRF members. It is also considering allowing Collaborating Research Groups (CRG's) to propose experiments along the same lines as for the ESRF; an announcement is expected shortly.

*From the left, Professor P. Wyder, Professor R. Haensel, Dr. J. Charvolin, and Dr. P. Schofield, the ILL's UK Director.*

Scientific activities begin again once the 323 MFF reactor refurbishment is completed in mid-1994. As the annual budget will decrease from 313 MFF in 1991 to 240+ MFF in 1994, staff will have to be reduced progressively from about 480 while at the same time assuring some rejuvenation. The refurbished HFR will have the capability to operate for at least 20 years, so Europe will possess in 1994 two modern, complimentary and adjacent facilities offering a broad range of opportunities.

In response to questions, Dr. Charvolin indicated that the instrument modernisation programme that had been planned by the ILL is "asleep", and that other sources had been very helpful in providing ILL users with beam time. He stressed that the HFR was being rebuilt according to the original design to avoid an entirely new and time-consuming safety assessment. So the HFR will not have a direct rôle to play in the development of a next-generation neutron source. He reminded the Associates that a Commission of the European Communities (CEC) study panel recommended in 1991 one or two international neutron sources supported by a network of national facilities [see *EN* **22** (1992) 62]. A study group based in Germany is examining one alternative, namely the European Spallation Source (ESS), but the reactor option has yet to be taken up.

**CEC Urged to be Top-Down**

Professor U. Finzi's presentation on the CEC's rôle (see box) led to a lively exchange of views. Participants remarked that the only non-US example of the US approach for constructing scientific facilities was not too encouraging. This involved the Tristan accelerator in Japan that turned out to be unnecessarily expensive. Second, keeping inside science the capacity to help build facilities means one is able to improve the technology needed to serve science, an activity which is often not an industrial priority. Professor Finzi felt that the example cited (see below) in high-energy physics may not be representative of possibilities for other fields. In any event, Europe urgently needs efficient transfer of knowledge to industry at the very early stages of scientific progress.

Professor W. Hoogland, CERN's Research Director, argued that particle physics is not the only scientific field characterised by its goals. He emphasized that while the aims are scientific its means require extensive technology transfer.

Professor F. Mezei, the Hahn-Meitner Institute's Research Director, asked whether the CEC can help in establishing a basic level of support for science. Professor Finzi replied that this problem lay at the delicate "interface between science and politics" where there are "limitations and very tight and slowly moving boundary conditions". Dr. H. van Vuren representing FOM in The Netherlands argued that this view reflected a weak policy for science at the Community level, where discussion was dominated by larger countries. The Commission should take more initiative by adopting a top-down approach. Professor Finzi stressed that the Commission views matters in terms of cohesion between Member States; it works hard to keep smaller countries involved on the same terms as large countries. Indeed, the former participated more heavily in the 1988-92 Large-Scale Facilities Programme. Any initiatives acknowledging special factors are tempered by the fact that, seen from Brussels, there is little difference between large and small countries since both contribute at the same level to EC programmes.

### Synchrotron Sources

Professor Haensel, in outlining the ESRF's plans, noted that the ESRF has 12 member countries and a budget for the 11 years following a two-year foundation phase ending in 1988. The 6 1/2-year construction phase is due to end in 1994 with the operation of 7-8 beam lines. Further lines (bringing the total to 30) will be installed progressively up until 1998. The ESRF is perhaps unique in that it has a long-term budget and a measure of the support is that the members (also called Associates) have even advanced funds. The machine itself is ready for beam line operation six months ahead of schedule at the planned 6 GeV and brilliance level. The level of beam stability that is demanded at the high-brightness source has called for strenuous efforts. The machine layout is fortunately fairly conservative and the ESRF profited greatly from a close collaboration with CERN. The approach adopted was in effect a spin-off from high-energy physics, even though the goal is very different.

Professor Haensel summarised how users gain access. Basic research published in the open literature can be carried out on "public" beam lines made available free of charge, on the basis of scientific merit, to users (both industrial and academic) from contracting countries; CRG's hoping to build additional instruments with independent funding submit separate proposals.

The ESRF's outlook was somewhat overshadowed by the status of the floor of the experimental area [see *EN* **23** (1992) 140]. The floor has been grouted to eliminate vibration and now appears to be performing correctly. The situation is being careful monitored but to avoid spotlighting a difficult phase, the official inauguration planned for the week preceding the Associates Meeting had been cancelled. Litigation against the contractor is also being considered.

## CEC Facilities Options Limited

**Professor Umberto Finzi, Scientific Advisor to the Director-General for science of the Commission of the EC, speaking at the EPS Associate Members Annual Meeting, clarified the CEC's rôle.**

The Commission's task is not to define actions and strategy from the top. The key phrase is instead a bottom-up approach, with the CEC promoting discussion in a world where competition for resources is forever increasing. Given that the EC's annual budget for science of about 2000 MECU represents only 2-3% of the total spent on research by EC Member States, funds must be distributed in well-chosen areas. The selection strategy, that must incorporate the "subsiduarity" principle of only doing at the Community level those things that cannot be done at a national level, is therefore important. Professor Finzi cited prenormative research where basic work to support eventual standards is done early on by the EC to avoid hold ups in harmonising products.

Over and above promoting the discussion of requirements, the Commission does not generally need to interfere in the creation and running of facilities serving specific communities. There are, however, projects such as the JET fusion reactor which are simply too large for a single country to take on alone. So fusion research is not simply an exception stemming from the creation of the Euratom community in the 1960's. JET's technical aims have largely been met and Europe is now clearly at a world level. A new experiment ITER is being designed on a global scale by a common team, symbolising that even the largest countries now have neither the resources nor the manpower to build certain next-generation facilities.

Another CEC initiative was the 30 MECU Large-Scale Facilities (LSF) programme in the 1988-92 Science Plan to help scientists access 17 facilities covering a very broad range of fields. The programme offered a way to exploit facilities as the Commission felt many were underused; it continues within the current mobility programme *via* fellowships. The LSF programme has been evaluated and a study panel chaired by Professor R. Dutray of the CEA, France, has recently assessed ways to improve technology spin-off from large facilities [*]. The US and Japanese practice of assigning more responsibility to industry by appointing a main constructor has good and bad points. The most significant negative feature is that a project often costs more since management costs are included. The European approach of having the scientific community manage a project makes spin-off more difficult as industry is less involved.

Another useful mechanism for promoting collaboration at a world level involved two OECD workshops (the last in October 1991) attended by the EC Commissioner for science and the Chief Scientific Advisor to the US President. The conclusion was that discussion and mutual criticism at the highest level helps tremendously in defining options for large-scale facilities.

[*] *Report of the Study Group on Large Scientific Installations in the Community and the Development of Advanced Technologies* (CEC, DG XII-H) August 1992. The report recommends long-term initiatives to promote industrial participation in the construction of large facilities, especially support for the qualification of small- and medium-sized companies. In the short term, technology transfer teams should be set up to "effect" technology transfer in specific areas, starting with synchrotron radiation laboratories.

### Particle Physics

Professor W. Hoogland noted that CERN operates Europe's first truly large-scale facility. The organization now has 18 members states and it has recently moved eastwards with the admission of Poland, Czechoslovakia and Hungary. Cooperation agreements have been set up with Albania, Romania and Bulgaria (essentially countries that will never become full members) and China had signed an agreement in early-November. CERN has evolved into being the first global facility as half the world's experimental particle physicists take part in experiments. Success can be traced to the machine building programme and to the broad spectrum of physics on offer.

LHC, the next proposed collider, will be built in the typical CERN fashion on the shoulders of previous machines. Another distinguishing feature is the scale: CERN's machine are usually very large, involving 10 years from conception to operation. In the case of LHC, this means one is essentially taking decisions on physics needs for a period starting roughly 15 years after the name LHC was coined by CERN Council in 1984. LHC's cost (estimated at 1500-2000 MSFR) is commensurate with the machine's size and much advanced technology is needed, notably for detectors.

### Big *versus* Small

Professor Hoogland argued that big *versus* small science was not a real issue as the proper question is good science *versus* bad science. Given that there is a general trend in most fields to larger facilities, and that some fields necessarily need large facilities, he felt it useful to understand the conditions for success. Apart from the obvious need for a high-quality scientific programme, adequate resources and good management, a facility requires motivated and coordinated scientists, technical expertise, and transparent contacts with academia. The benefits to be expected are improved scientific competitiveness, cost efficiency, international collaboration, educational opportunities, and a marked impact on industrial competitiveness. He criticised the EC for being unaware of the successes of European collaboration in science in making its R. & D. programmes more synergetic.

Some participants suggested that CERN is the exception as it serves a large, homogeneous group of users whereas more representative facilities such as the ILL and ESRF cater for multidisciplinary teams. Professor P. Söding, DESY's Scientific Director, argued this was overstating the case because high-energy facilities also serve diversified communities coming from a variety of institutions. Nevertheless, the fact that particle physicists set their sights on a restricted number of goals, while the average synchrotron user comes to the facility with a sample in his or her pocket, perhaps suggests that there is a fundamental distinction. Dr. Charvolin reinforced this view by adding that particle physicists needing an answer go to CERN, but a condensed matter scientist only gets part of the answer by going to the ILL.

Professor T. Springer, Director of the Institute for Solid-State Physics at KFA Jülich, felt that the importance of setting common goals to establish facilities had been appreciated early on by particle and nuclear physicists. It was now the turn of others to catch up so there is no fundamental difference between big and small science. Dr. H. Godfrin, Scientific Director of a facility that might be termed small, namely the CNRS's CNBT low-temperature laboratory in Grenoble, was nevertheless convinced there remain some intrinsic differences between facilities and small science because the former tend to draw away from their communities as they grow in size. Professor Hoogland summarised the lively debate on the distinction between large and small by concluding that some differences clearly exist, but they are not as serious as some think.

*Some of the participants: from the right are Dr. H. Godfrin, Professor U. Finzi, P.H. Melville (Deputy Chairman, EPS ACAPPI committee), C.M. Rønnevig (Special Advisor to Norway's CERN Committee), Professor D. Sette (CNR, Rome), D. Theis (Siemens, Munich).*

### A Major National Facility

Professor P. Söding described later in the day how DESY, Hamburg evolved in a national context to become a large international facility (1400 staff). DESY was set up in 1959 to apply particle accelerators to synchrotron radiation research and to offer universities basic research opportunities complementary to CERN in elementary particle physics. It now has four major machines (the 7.5 GeV electron synchrotron; the 2 x 5 and 2 x 23 GeV ep storage rings DORIS and PETRA; the 30 + 820 GeV ep collider HERA). The HASYLAB synchrotron radiation laboratory which exploits DORIS has eight insertion devices and 30 beams from bending magnets. Over 1000 regular users are served and there is no fee for basic research. Participants were particularly interested in the question of access by industry. Professor Söding indicated that DESY's philosophy is to minimise red tape and to only ask a fee if results are withheld. Thus, as many as 10% of HASYLAB's users come from industry.

The now-famous HERA model of using international partnerships (Italy, France, Holland, Canada, and Israel together contributed 15-20%) to construct and exploit a major (≈ 1000 MDM) facility grew out of the high-energy physics tradition. Essential elements are a common scientific interest, the existence of partners without home facilities, agreements within counties and not between them, contributions in kind, and technical responsibility with the host lab.

DESY is now entering an R. & D. programme for a future $e^+e^-$ linear collider to complement pp colliders (SSC and LHC). A first step aims to develop technology for a 300-500 GeV machine by 1996-98. The main options are the S-band approach pioneered at SLAC in the USA (3 GHz with conventional accelerating cavities) and the 1.3 GHz superconducting TESLA design where it needs to be shown that a relatively high (25 MV/m) field gradient can be sustained. The next linear collider for particle physics will inevitably be a built in an international context: the hope is that there will soon be agreement on a four-year international R. & D. programme [see *EN* **21** (1991) 184].

Germany's science council had asked DESY two years ago to incorporate the relatively small (210 staff in 1991) High-Energy Physics Institute in Zeuthen in eastern Germany following the evaluation of former GDR institutes. When asked about progress, Professor Söding said the the experience so far was very encouraging and there had been few problems.

### Central European Networks

The round-table continued after lunch with a short presentation by Professor N. Kroo, Director of the KFKI Institute for Solid State Research in Budapest, on the Hexagonale cooperation that has been renamed the Central European Initiative. This initiative has adopted a network approach to coordinate short- and long-term regional actions to mobilise and exploit existing human and technical resources. Growth of the educational system and reversing the brain drain are foremost considerations. Four areas have been selected, namely synchrotron radiation, neutron scattering, lasers, and special products such as catalysts. Six activities are being developed within the European Network of Science and Technology (NEST). Each deals with a large facility in the sense that its is large for the region.

Professor Kroo reported that two additional beam lines (bringing the total number to eight) will be made available to scientists from E&CE at the Elettra synchrotron source under construction near Trieste. The machine starts operation in mid-1993 and the first users' meeting was held at the end of last month. Elettra essentially comprises a 260 m in diameter electron storage ring operating at 2 GeV with a maximum current in the multibunch mode of 200-400 mA. There are 13 bending magnet sources and 11 insertion device sources. The facility is set up as a not-for-profit company managed by a Board of Directors chaired by Professor C. Rubbia, the CERN Director-General, and is funded from a variety of sources [see *EN* **23** (1992) 140].

NEST's second component is the recently upgraded 10 MW Budapest research reactor at the KFKI [see *EN* **23** (1992) 60]. The start-up process following an environmental enquiry is now underway and the aim is to offer neutron beam time to outside users to help cover Europe's shortfall. It now seems likely that Italy, Austria and Poland will collaborate with Hungary in building beam-line instrumentation.

The third NEST item is the proposed AUSTRON neutron spallation source [see *EN* **23** (1992) 60]. This source, which even in the first phase would be slightly more powerful (>100 kW on target, 63 mA) than ISIS at the UK's Rutherford-Appleton Laboratory, is based on a classical 25 Hz, 1.6 GeV design. Originally put forward by Austria to fill the gap between a future next-generation neutron source (*e.g.*, ESS) and existing sources, the project has recently been adopted by NEST.

*Dr. V. Kadesheveski, Director of JINR, Dubna (on the left), and Dr. S. Krupicka, Director of the Czechoslovak Academy's Institute of Physics, Prague.*

Professor Kroo felt that while support for the Eurocryst project to establish a crystal growing facility in central Europe [see *EN* **21** (1990) 180] was weak, this item had been include in NEST for discussion. Efforts are also underway to coordinate the activities of several materials science labs, and to set up a 256 kb/s computer network fanning out from Trieste that will do much to improve the region's communications.

**Medium-Scale Facilities: What to Do?**

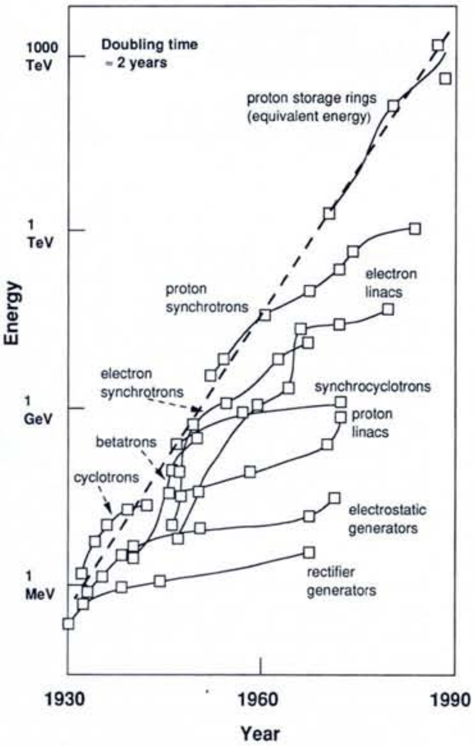
Participation by Czech and Slovak physicists in large-scale activities was outlined by Dr. S. Krupicka, who had been called back in 1990 from retirement by the Federal Government's new Science Board to become Director of the Czechoslovak Academy of Sciences' Institute of Physics in Prague. He said that everything had focussed until recently on JINR Dubna in Russia (Czechoslovakia was one of the founders). Emancipation started in 1986 with an agreement with DESY to participate in the H1 detector for the new HERA collider. The big change came in 1992 with CERN membership. Some 100 graduate students in both physics and engineering are now participating in DESY- and CERN-based R. & D. programmes for LHC and LEP-II detectors, on data collection and analysis, and in developing electronic hardware for H1.

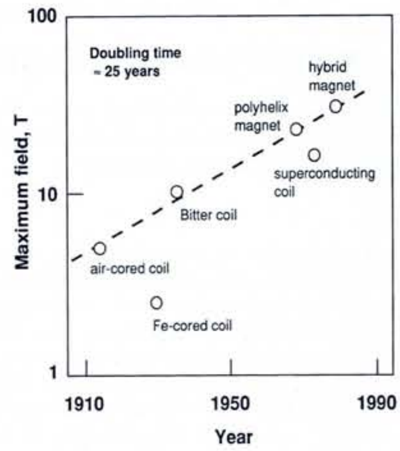
Participation by Czechoslovakia's solid-state community in synchrotron sources is not so well developed and Dr. Krupicka was looking forward to possible involvement in the ESRF.

Czechoslovakia has a problem in knowing what to do with its own medium-sized facilities as priorities have changed. The Institute of Physics in Prague is the largest of the Academy's institutes (10% of total budget). Following an international evaluation, it was consolidated in 1991 from 35 sites with a staff of 1000 onto six sites with a staff of 700 operating as four divisions (particle physics, condensed matter, solid-state physics, and optics). The Institute recently completed building a large 50 J/pulse iodine photodissociation laser, a project that was started in collaboration with the former Soviet Union some years ago. Dr. Krupicka indicated that there was now a possibility that the facility would be used for beam-target interaction studies. Prospects for the Institute's T3 type 40 x 10 $cm^2$ tokamak appeared not to be very promising.

The Czechoslovak Academy's Nuclear Physics Institute in Řež with a staff of 200 operates a U-120M 40 MeV isochronous cyclotron, a Van de Graff accelerator, and a neutron reactor source that historically concentrated on isotope production. Here too the situation is unclear.

A federal commission set up in April 1992 now channels government support for science. The change means that participation in international collaborations such as the JINR is no longer centrally planned and that smaller facilities must fend for themselves. The fact that the Academy budget for 1992 is the same as three years ago (in spite of 100% inflation) and is only 80% covered makes everything more difficult. The best way to handle the situation is to set up networks of centres.




*The growth of facilities: graphs showing that the performances of accelerators (left) and high-field magnet installations (right) double every 2 and 25 years, respectively. [Courtesy of P. Wyder]*

The various sections of the reorganized Institute of Physics could benefit from increased cooperation but this is not a trivial matter to arrange. Financial aspects are clearly important as particle physics is expensive. Dr. Krupicka said a balance has been achieved by having the Foreign Ministry cover membership fees for particle physics. The main concern is how to ensure an efficient transfer of technology.

**High Magnetic Fields**

Addressing relatively small facilities, Professor P. Wyder, Director of the joint CNRS/Max-Planck Hochfeld-Magnetlabor in Grenoble, described the interest in high magnetic fields for condensed matter research and how needs are met. One has to keep things in perspective, for while high magnetic fields influence quite significantly the state of a system, the 300 T short duration pulse fields that can be achieved do not approach the $10^8$ T found in pulsars. For example, placing a Bohr magnetron in a 1 T field is equivalent to raising the temperature by 0.67 K. The CNRS/MPI laboratory, which recently doubled its installed power capacity to 20 MW [see *EN* **22** (1991) 158], has eight resistive magnets with fields up to 25 T, a variety of superconducting units covering 0.6 to 12 T, and a 31 T hybrid magnet. With a staff of about 20 and annual budget of some 10 MSFR, the facility aims to offer magnets and a sophisticated experimental infrastructure essentially free of charge to qualified users, to develop advanced magnet technology, and to carry out independent basic research tasks. These naturally lead to a corresponding set of basic requirements. Resources are somewhat greater than those found in an average condensed matter group, but remain about an order of magnitude less than for a large, solid-state oriented facility such as the ILL.

As for the future, the US is presently building a new 300 MSFR high-field magnet facility in Florida [see *EN* **22** (1991) 158] and Europe is discussing a similar option. There remain many interesting possibilities to discover new physics: while quasi-stationary fields are needed for most experiments, pulsed fields lead the way so options range from 30 T DC-restive to 300 T microsecond pulse systems, not forgetting 24 T/1 GHz magnets for NMR.

**EPS Priorities**

The presentation and discussion of the various types of facilities finished with some reflection on the Society's rôle. In response to a comment that EPS should catalogue access to unused capacity, E.W.A. Lingeman, whose committee coordinates EPS east-west initiatives, noted that it is not sensible to promote opportunities for which there may be little demand. EPS instead aims to provide information of what is available and whom to contact. The first step is a 250-page directory called *Physics Institutes in Central Europe* [available from the EPS Secretariat; price: SFR 120.-] to be followed by a similar directory for the former Soviet Union. The EPS also has the overall task of helping ensure that all competent physicists have reasonable access to facilities, especially in these difficult times.

The day ended with most participants choosing to visit the ESRF experimental hall as this forms part of a truly next-generation facility in the making. Some braved atrocious weather to visit the ILL which now has an assured future with many opportunities. The hope is that all came away with a better understanding of how large installations interact with the scientific community, and indeed with the world at large.

**P. G. Boswell**

NATO ASI:

**Modern Aspects of Small-Angle Scattering**

12-22 May 1993 Villa Olmo, Como, Italy

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