1 Introduction

SAP delivers on its promises:

- SNO produced its first exciting results on Solar Neutrino oscillations. " Neutrino oscillates on their way from the Sun."
- ISAC delivers its first radioactive accelerated beams.
- GSC19 reimburses its debt on schedule and as predicted in 1997.
- ATLAS Canada is on track to deliver the hadronic calorimeters to CERN as per its MOU.

These achievements are the results of careful planning for the discipline, good support from NSERC and NRC, and good monitoring of performance. Since 1995 NSERC has instituted a Five year planning exercise which has resulted in a very focused program matched to the resources available. Similarly TRIUMF, the only remaining infrastructure facility for the discipline in CANADA, is operated under a contribution agreement from the Federal Government on a Five year cycle with effective monitoring from NRC. It is managed by a consortium of 10 Canadian Universities for the benefit of the whole country.

The reallocation exercise is linked to these. Because NSERC is the funding agency for the experimental program and the research activities which are dependant upon the availability of international facilities either in Canada or abroad, GSC19 must cope with the high degree of internationalization of the discipline, the long term gestation period required to develop new facilities and exploit them, and the globalisation of the effort. On one hand it guarantees that the Canadian effort is peer-reviewed at the international level, on the other it must respond on time-scales which are often dictated by others.

The fact that Canadian physicists have built an international reputation of effectiveness within severe constraints is a testimony to the management of the discipline's resources and to the quality of its personnel.

Summarize "Importance to Canada" issues here?

2 Vision Statement

GREAT OPENING PARAGRAPH GOES HERE **How about the introduction from the Five Year Plan Report?**

Should contain:

1. the vision for subatomic physics at a global level
2. identify the vision for Canadian subatomic physics community
3. Focus has to be on answering the "big questions"

2.1 Ideas on the Table at McGill

Most of this appeared to the McGill group to be either strategies or specific proposals, and not appropriate in a vision statement.

Vision statement for the discipline:

1. Complete the approved SNO programme
   - Determine the contribution of neutral current reactions
   - Establish unambiguously neutrino oscillations and their parameters(mixing angles and mass differences)
2. Exploit aggressively ISACI and its radioactive accelerated beams:
   - Determine some key reaction cross sections in the CNO/ NeNa cycles
   - Precision studies of weak decays to search for physics beyond the STD model.
   - Nuclear structure of very far from the stability line isotopes
3. Get ready to capitalize on the investment made at the LHC and ATLAS:
   - Delivery of the Canadian contributions on schedule
   - Participation in the CDF physics programme
   - Development of the analysis capabilities for the Canadian community

In parallel, Complete the search for CP violation in the quark sector in the BABAR and Rare K+ decay program (E949)

Complete the programme of studies of the nucleon's quark and gluon structure, of its spin structure, of its electromagnetic and weak form factors: ZEUS, HERMES,HIGS,G0 programs

Complete searches for Physics beyond the standard model in dedicated experiments at the precision frontier at TRIUMF: (TRINAT,TWIST)

Continue involvement in Hadronic physics at TJNAF.

Develop the ideas and the technology for the future:

.Define a Canadian participation in the international accelerator based neutrino program.

. Participate in the definition of the future HE program based on lepton colliders and in its instrumentation R/D.

. Build the infrastructure to start a Nuclear Physics program at ISACII.

. Participate in the second generation experiments at The TJNAF

. Establish a Non accelerator based particle astrophysics program in Canada, exploiting the opportunities at the SNO site for neutrino astronomy and dark matter searches, at the STACEE observatory for Ultra High energy gamma ray astronomy and possibly others.

Beyond 2005' towards 2010

ATLAS takes data ISACII takes data Neutrino programme is in the building and initial data taking phase Non-Accelerator based programme is producing physics results at SNO, STACEE,PICASSO. Some selective experiments at Hall-D, BNL continue. R/D phase and contruction for a NLC programme starts

Other opportunities the community may get involved in :

RHIC RHIC spin B- physics beyond BabAR Hadronic physics at JHF,TJNAF

3 Strategy

At the McGill meeting, the following strategies were suggested:

1. Use community-based long range plan to identify the high priority scientific projects. Goals of Fenton plan were achieved with the increased funds available to GSC 19.

2. Continue to insist that Canadian projects be held to the highest standards of international peer review, with specific funding decisions being made by GSC 19, which has a tradition of approximately 50international membership.

3. The field will only thrive if there is a healthy balance in the programme of i) a significant experimental effort collaborating with an colleagues from other countries on projects at international facilities (including SNO and ISAC), ii) a strong theoretical community focussed on developing the mathematical framework that incorporates the observed phenomena and identifies the most significant experimental questions to address, and iii) a strong effort in developing those advanced technologies needed to perform the next generation of experiments. These technologies include new forms of instrumentation and high performance computer hardware and software systems needed to analyze the large datasets and extract physics results.

3.1 Smorgasbord of Text

The subatomic program is dependent upon a few international facilities. Two of them are in Canada (TRIUMF-ISAC and SNO), the rest in the USA, Europe and Japan. The main mode of operation for all experimentalists is that of suitcase physicists and this has enormous implication on the operating budgets of groups.

As the community moves to the operating phase of SNO and ISAC and into the assembly and commissioning phase for ATLAS, the pressure on the operating part of the Subatomic physics envelope will become such that the current envelope will limit the ability of Canadian groups to meet their commitments. As most of the program is based on international commitments, there is little flexibility in deciding upon the timing and the schedule of field trips. For example, during the upcoming commissioning phase of the ATLAS detector, presence at the CERN site will be mandatory for the professionals who have contributed sections of the detector; a large team will have to ensure that the Canadian contributions perform as planned. Physicists will have to contribute to the operation of the detector and will be responsible for providing the the operating software, calibrations, and analysis tools for the collaboration as a whole.

- The first priority is to ensure that sufficient operating funds become available for exploiting the investments made in the last few years. Even after the reallocation of the current capital funding to operation funding, the GSC will be faced with an untenable situation to support the minimum travel budget required by our international commitments. The weakness of the Canadian dollar on the US and European markets is creating a difficulty for a GSC which is expected to operate on a constant envelope without any provision for inflation and exchange fluctuations. The recent announcement of the first results from SNO has triggered a massive request for presentations of the experimental details world wide and it is only fair to give enough support to the SNO collaboration to reap the benefit of their 15 years investment. In doing so it is the whole canadian scientific community as well as NSERC which get a higher profile.

- The second priority is to establish in Canada a computing infrastructure which will meet the requirements of the new generations of experiments. Several applications have been submitted to the Canadian Foundation for Innovation in that context. If we assume that we would be successful in getting the capital investments required, the long term operation and staffing of these centers will require more funding from the granting councils. This is not a situation unique to the subatomic community but our demands are simply not compatible with the current funding situation at NSERC nor in the Universities and the process of getting CFI funding doesn't allow for long term planning as required by our international involvement in Science . Consequently we must also allow for the scenario of not receiving CFI support in which case the pressure on NSERC equipment funding will add to the plea of the GSC .

- The third priority is to continue rebuilding a Research and development component in the programme by developing local R/D infrastructures in the universities. This was recognized as important by the previous reallocation committee and a small step has been initiated in that direction which must now be strengthen. Although CANADA has secured a substantial detector construction infrastructure at TRIUMF, a key component of being a player in subatomic physics research at the international level is the capability of developing innovative and state of the art technologies for our detectors. This research is best done at the University level with modest but sophisticated equipment, in collaboration with other departments (Interdisciplinary aspect) and is important to nurture future generation of physicists. This is the place where young faculty members can best show their potential and get the recognition which will lead to entering an international effort. Because of the nature of the research sociology in subatomic physics where large team are involved, this component is very important to maintain a strong presence at the departmental level and in getting students involved at the early stages, .This is also the a spect which may naturally lead to transfer of technologies to the private sector in the future.

- The success of SNO, the opportunity to develop a unique deep underground laboratory at the Creighton Mine in SUDBURY and the successfull development of a detector technology capable of detection of massive particles in a low background environment present a superb opportunity to expand Canada's impact in particle astrophysics, a field rapidly developping at the interface of particle physics and astronomy and which is gaining attention world wide. The subatomic physics community is prepared to invest heavily in this new field of research and proposes to mount a very sensitive search for dark matter candidates, nicknamed PICASSO. Other experiments like the STACEE program studying ultra high energy gamma sources , or new supernovae detectors would be included in this support which could also be shared with other GSC's.

- Finally any operation of an international experiment involves costs associated with the operation of common equipment for the benefit of the collaboration as a whole. This mandatory financial responsibility is established by each collaboration based on the number of scientists participating. CANADA has never been in a position to contribute its share of such common funds and is regarded as "free-loading" on other nations by having to make downward adjustments to its contributions. We are then seen as other underdeveloped countries who have to beg reductions of their contributions due to their poor economic situation (Russia..). CANADA should be a fair partner in any international collaboration. The NSERC envelope should be adjusted to include a fair common fund contribution to each of the international effort we decide to join. This is in line with the discussions which are taking place at the Global Science Forum on this subject.?? (to be confirmed)

4 Specific Proposals

4.1 Proposals from McGill

1. Provide the support for the status quo scenario, which will allow Canada to capitalize on the initial science success of SNO and ISAC, complete the Canadian contribution to ATLAS and prepare for physics at the LHC. We should argue pursuasively to have the $1.6M we put in the reallocation pot. If we don't receive these funds, the section of "consequences of no reallocation funds" would identify the costs.

2. Operating support for the highest priority projects in the "status quo" scenario is not sufficient for Canadian scientists to maintain their scientific leadership roles. The SNO scientists are at a significant disadvantage relative to their own collaborators in the U.S. and U.K., reducing the impact of the Canadian team. The ATLAS team does not have the necessary resources to maintain the growing team at CERN required to install the Canadian instrumentation over the 2003-2005 timeframe, and to take leadership roles in the physics analysis efforts that are now under development. The ISAC researchers are funding-limited in the number and rate of experiments Canadian scientists are able to perform, leaving signficant measurements to other national groups. Canadian leadership at ISAC is at stake.

3. Support University-based advanced technology capability.

   All of the major projects in subatomic physics are carried out at large facilities serving the international subatomic physics community. However, much of the advanced technology required for future experiments is developed in Canadian University groups that require adequate technical and engineering resources. This requires maintaining technical staff with high level design and engineering skills. Such efforts are already in place at a few institutions such as the University of Albert and the University of Toronto, and they facilitate the R & D associated with new and existing projects and effectively leverage contributions from the home institutions. The presence of this infrastructure is essential for the health of the graduate programmes, as training in the development of new technologies is an essential element .

4. Support for a National Computing Initiative:

   The ATLAS/Canada effort will require significant computational facilities and technical infrastructure leading up to the start of LHC data taking in 2005-6. In addition, several other projects (TWIST and BaBar) require increased computational capability at home institutions. The subatomic physics community has identified the need to increase in a coordinated way the number of software professionals and physicist programmers supporting these computing systems and developing the software systems used to enable Canadian physicists timely access to the data produced by these experiments. A National Computing Initiative is been proposed to provide these resources.

5. Funding for astro-particle physics

   Many exciting scientific opportunities arise at the interface between astrophysics and particle physics. The activities at SNO and newer projects like PICASSO promise exciting results in this field and should be strengthened. Specifically, we request funds to properly support the scale-up of the dark matter search experiment PICASSO to be competitive with other international experiments. We also request funds to support VERITAS. (Do we mention SNO' here?)

6. The strengthening of SAP theory

   The development of the science associated with subatomic physics is critically dependent on the presence of a vibrant and active community of theorists in this field. Initiatives are needed to provide opportunities for the exchange of ideas and to promote collaborations. One such suggestion has been the establishment of an Institute for SAP theory.

7. A Research and Development fund for future projects

   Funds are needed for the R & D required to ensure the success of future projects. For example: equipment needed for the ISAC-I and II at TRIUMF and the readout for the TPC at the future Linear Collider.

5 Consequences of Failure

- There will have to be a further reduction in operating support. This will have the following impacts:

  - Inadequate operating support for SNO will leave the Canadian team unable to fully participate in the physics analysis of this experiment as they fulfil their responsibilities to operate the facility itself. The neutral current measurement from SNO will be delayed, leading to this Canadian experiment being "scooped" by competing off-shore experiments. Although SNO is unique, a number of neutrino experiments have the ability to compete. The SNO collaboration itself will be unable to desseminate the impact of its research most effectively.
  - The ISAC I science programme, especially the more difficult and low rate astrophysics measurements, will be delayed. Although ISAC is the most intense source in the world, there are many competing

initiatives worldwide. TRIUMF's competitiveness in the high profile area of nuclear astrophysics will be damaged. Progress on the design and construction of ISAC II will also be affected, leading to Canada losing ground in the high-energy beam programme.

  - The ATLAS/Canada collaboration will not be able to meet its schedule to test the remaining calorimeter modules, while at the same time completing construction of the hadronic endcap and forward calorimeter. This would lead to a schedule slippage in installation of these calorimeters at CERN, threatening the overall LHC schedule.

- The community's ability to perform the essential R&D for the next generation experiments will be impaired through less University-based infrastructure support and the needed funding to develop next-generation experiments such as PICASSO+, TIGRESS and KOPIO. **split this?**

- The resources to provide the data processing and scientific computation to analyze the current large data sets being gathered by Canadian scientists will not be available. This would effect experiments such as E949, TWIST, CDF II, ZEUS and SNO, which depend increasingly on Canadian data-processing capability.

- There would be a further erosion in support for Canadian students and postdocs working on experiments at the major international laboratories, reducing our effectiveness in the international context and having an adverse effect on training of our students.

6 Implementation of the Last Exercise

Two of the proposals in the last submission were supported by the Reallocations Committee. Fully funded was the proposal for support of the Five Year Plan, in the amount of \$1.2M. The request for \$0.6M in support of research and development and smaller new initiatives was partially funded at \$225k. In addition, there was a general increase to the NSERC grants budget with our share being \$294k. This total of \$1,719,452 less the \$1.176M put into the reallocations pot meant a net gain ultimately of \$543k, phased in over a period of four years.

With respect to the reallocations funding in support of the subatomic physics community's Five Year Plan, with top priorities being the ISAC, ATLAS, and SNO projects:

- Funds were allocated to support the capital needs of our top priority projects, in accordance with the detailed planning document of the community. These capital needs peaked during the period of implementing this exercise, with the corresponding pressure on operating budgets for the entire community. Total spending on SNO, ISAC, and ATLAS peaked at \$9.58M in 2000, of which ?? was capital.

- The period coincides with the milestones of first delivery of unaccelerated radioactive beam at ISAC (Nov 98) followed by delivery of the high energy beam (Dec 00). Continuing strong and timely support of the ISAC experimental program is particularly necessary in order to fully exploit this unique facility. This recognition has been reinforced by the award of reallocations funds aimed at initiatives for new detector systems.

- The scope of the ATLAS project was expanded (to include construction of a second wheel of the hadronic end cap calorimeter)

- Significantly increased operating funds for ATLAS will allow successful delivery of the detector components under construction as well as the opportunity to engage in development of physics analysis tools.

- Support of the now fully operational SNO project has generated the first exciting and definitive investigations of the solar neutrino problem. The collaboration measures a total solar neutrino flux in excellent agreement with the prediction of the standard solar model, while also finding a deficit in the charged current rate. The implication is that neutrinos do oscillate between species and some discrimination between models has already been accomplished with these first results. The unique neutral current measurement with salt in the water is underway.

With respect to the reallocations funding in support of R & D and smaller new initiatives:

- Pent up need for support directed at potential future projects is reflected in the pronounced rise in awards of this nature - rising from less than $100k in 1999 to over $800k in 2001.

- A few small initiatives were funded.

- A limited number of R& D projects with the potential for tremendous future impact in the international context:

  - KOPIO as an initiative growing out of the exisiting rare kaon decay program

  - PICASSO exploiting a novel detection system for dark matter and, perhaps, also the unique characteristics of the SNO site

  - two projects aimed at a future international Linear Collider facility; such a facility may become the highest priority for particle physics beyond the LHC so early participation is critical for Canada*s future role (precisely characterize discoveries at the LHC); here the possibility also exists for accelerator development with TRIUMF expertise

  - Research and development funds for the proposed search for exotics at the TJNAF Hall D.

- Some of the hardware for ISAC also falls into this category as noted above.

With respect to the general increase:

- Operating funds remain extremely lean across the program.