PS/AR/Note 91-13
PS/AR/PL/tk

19.11.1991

POSSIBLE FUTURE PS ANTIPROTON PROGRAMME

(A Status Report after the October 91 Zürich Workshop on the Physics at SuperLear)

Pierre Lefèvre

Note for P. Darriulat, K. Hübner, G. Plass and H. Wenninger.
Copy to G. Brianti, D. Möhl, S. Maury and D.J. Simon

Executive Summary

1. No major problem to prepare a feasibility study for the Cogne 92 SPSLC meeting on a future antiproton programme.
2. For the superconducting elements of SuperLear we conclude that it is necessary to set up external collaborations with the aim to start now the construction of prototypes and to get them at low cost and manpower for CERN.
   They have to start now to fulfil the requested time table for physics.
3. We received proposals for collaborations :
   - 3.1. What is the reaction of the CERN management on the TAC proposal? Shall we go on and prepare the framework of a collaboration to build a prototype at TAC?
   - 3.2. Can we study the possibilities to build prototypes of quadrupoles and/or multipoles at INP Novosibirsk?
   - 3.3. Can we prepare with Ansaldo and HERA specialists the cost estimate of a prototype using HERA tools?
   - 3.4. Shall we consider the Dubna proposal to provide manpower for SuperLear? Who pays?

1. One mandate of the working group for the future PS antiproton programme is to prepare for the SPSLC Cogne Meeting (September 1992) the feasibility study of a facility to fulfil the physics demands recommended by the PSCC Cogne Meeting (September 1990) and further workshops organized by the potential users.

   These "prime" physics domains are :

   a) ANTIHYDROGEN SPECTROSCOPY
      facility : $\bar{p} \leq 100$ MeV/c to be degraded, stored and cooled in Penning Traps.
      e^+ production and storage
      $\bar{H}$ recombination and storage

   b) Direct CP violation studies ($p\bar{p} \Rightarrow \Lambda\bar{\Lambda}$)
      facility : $\bar{p}$ around 1.65 GeV/c
      jet target

   c) Spectroscopy of charmed mesons (charmonium, hybrids and 4q states)
      facility : $\bar{p}$ at 3 to 12 GeV/c
      jet target and/or external beams

   d) Study of strange hybrid mesons and strange hyperon pair production.
      facility : $\bar{p}$ at 2 to 3 GeV/c
      external beams and/or jet target

   Our proposal is to perform a) & b) with LEAR modified after the completion of the present physics programme and c) & d) with SuperLear.

   The report to be presented at Cogne 92 will include cost and manpower estimates taking into account external collaborations for the construction and the commissioning.

   Studies with potential users continue, in particular on the Penning Trap facility, $\Lambda\bar{\Lambda}$ and SuperLear experimental set up.

   Informal collaborations with external specialists on the feasibility of the superconducting magnets have led to clarifying contributions at the Zürich workshop; **more formal collaborations have to be set up to continue the studies and to start an R&D programme.**

2. Lear Modifications (under study - no problem)

   2.1. Low energies.

   Multibatch filling of Penning Traps at 60 or 100 MeV/c.
   - Continuation of Electron Cooling developments,
   - New electrostatic fast kicker (not expensive).

   2.2. $\Lambda\bar{\Lambda}$ physics.

   Topping up or multibatch injection at higher energy (~ 1.2 GeV/c) to store higher intensities.

Modifications (reasonable) of :
- PS extraction,
- PS-Lear transfer line,
- Lear injection scheme.

2.3. Possible time scale.

Some developments are done in the frame of the current exploitation programme of Lear, as they are already useful for the present programme (low energy and JetSet experiments).

They can be completed at the end of the present programme in a normal January shutdown (94 or 95).

3. SuperLear general layout and standard technology (this part is under study without major problems).

The proposed machine is a fixed but adjustable energy storage and stretcher ring installed in the East Hall. The particles from AA are accelerated in the PS to the SuperLear operating energy and transferred in the East Hall via a new PS fast extraction and transfer line.

Several layouts of the machine exist with a circumference ranging from L = PS/5 ~125m to L = PS/4 ~150m, with minor or major consequences on the existing test beams. They differ in the number of facilities which can be accommodated (2 jet targets, 1 jet target +1 extraction, 2 jet targets + 1 extraction).

The lattices are designed to favour very strong stochastic cooling; half of the machine is isochrone to have no mixing of samples between pickup and kicker, the other half has relatively large η (0.1) to have good mixing from kicker to pickup independent of the working energy (variable transition - many different quadrupole families).

The lattices also permit two working conditions :

- Jet target (D=0, low β) or extraction (1/3 integer resonant extraction Lear type with separatrix alignment);
- Work to optimize the lattice continues; injection, ejection, external damping and beam cleaning schemes are under study.

4. Superconducting elements for SuperLear.

4.1. The key problem is the study of the feasibility of curved bending magnets and of quadrupoles belonging to several different families so that only few are powered in series.

The help of CERN specialists was obviously impossible but we have benefitted from informal collaborations with experts of DESY, Novosibirsk and Texas Accelerator Center. At the Zürich workshop the experts pointed to the feasibility of building the SuperLear magnets with at least two alternative technologies, either as superferric or as curved cosθ magnets.

We had a priori chosen B = 6T and $\phi_{i\ coil}$ = 75 mm (same aperture as HERA magnets) for the dipoles, typically 30° and 3.5m length and about G = 85T/m for the 0.4m long straight quadrupoles.

- H. Kaiser (DESY) presented the adaptation of the HERA design.
- P. Vobly (INP, Novosibirsk) presented the possibility of using 3 x 1m long straight dipoles and "many turns" quadrupoles.
- P. McIntyre presented the superferric techniques well adapted to 30° (or more) arc magnets.

4.2. We believe that it is necessary to set up more formal collaborations in order :

- To build now a prototype of a superferric dipole and a quadrupole to verify their behaviour in the whole SuperLear energy range;
- To prepare a prototype of a many turns quadrupole (Novosibirsk technique);
- If possible to assemble a full scale basic unit with 1 bending (3,5m) and a quadrupole doublet, including the correcting elements (separated dipoles and sextupoles).
- To estimate with Industry the cost of a HERA type curved dipole using the existing HERA tools, and possibly build such a prototype.

We note that this R&D programme has to start now to permit the choice in 1993. The cheaper part (for CERN) of the programme (TAC and Novosibirsk) started now will let enough time to commute to the industrial part if necessary at a second stage.

Such a programme is of general interest as laboratories and industries are concerned with curved superconducting magnets for industrial synchrotron light facilities. The time is favourable for launching such an R&D.

4.3. We have received some more or less formal proposals of collaborations. We ask for the authorisation of the CERN management to look into these proposals and prepare with the colleagues concerned several proposals for agreements.

- TAC proposes to build prototypes of B and Q and, if successful, the construction of dipoles or all magnets.
- NOVOSIBIRSK informal proposal to build a prototype of a many turn quadrupole.
- HERA informal proposal to use HERA tool and know-how.
- ANSALDO informal contacts to explore the possibility of the adaptation of HERA techniques to SuperLear magnets.
- DUBNA proposes to send technical engineers to CERN to work on SL.

The first question is :

Do we have a red or green light to prepare proposals for collaborations? Which ones and with whom to prepare the agreements? May we persue the contacts with Ansaldo ?

4.4. What is the feeling of Working Group?

- The collaborations and R&D programmes we would like to set up now concern **only** the studies and the realisation of prototypes, including their magnetic measurements.

- The proposal for setting up collaborations for the construction and the commissioning of SuperLear itself will come later, after the Cogne meeting and the CERN management decision (end 92?). The result of the prototype measurements will be included in the design report which then can be prepared.

- The scenario we regard as the most favourable at the present time is :

TAC	prototype of B : 6T - 3,5m - 30° or prototype of cryostat ensemble including B and Q (1 or 2).
Novosibirsk	prototype of Q (many turns) (1 or 2) or/and prototype of correcting dipoles and multipoles.
ANSALDO (+ subcontractors) + HERA specialists	cost estimation of adaptation of HERA tooling to SuperLear bending magnets. Possibly construction of a prototype at a second stage.

Open questions :

- What support and contributions can we expect from AT? Can we benefit from an AT expert as linkmen and advisor?

- Shall we consider the Dubna proposal?
  Is it better to wait for the evolution of the situation with Novosibirsk?

- Shall we start a HERA type prototype in parallel with a TAC magnet or, as we propose, accept the risk and wait for the first results of the TAC prototype and of the willingness of industry to make a cosθ prototype free of charge for SuperLear.

4.5. Possible time table