Minutes of the sixty-fourth meeting of the
Proton Synchrotron and Synchro-cyclotron Committee
held at Cogne from 12 to 15 September and at CERN on 17 September 1990

The PSCC met in Cogne from 12 to 15 September 1990 to review the current LEAR programme and to formulate guidelines for the future. A copy of the transparencies presented in the various sessions will be available in the CERN Library. A report on the main conclusions of the Cogne Meeting was given by A. Donnachie in an Open Session of the PSCC on 17 September, 1990. A copy of his transparencies is attached. A summary of these conclusions and recommendations will be discussed at the November meeting of PSCC and included in the minutes. Current PSCC matters were discussed at a Closed Session on 14 September.

CLOSED SESSION (14.9.90)

Apologies were received from M. Albrow, B. Allardyce, R. Billinge, H. Haas, B. Jonson, N. Stone and C. Rubbia

1. DISCUSSION ON PS 185, PS 199 and PS 202
   The Committee took note that PS185 cannot take the allocated 12 days of running time this year. The request to use the 12 days of running time in 1991 to complete their programme will be considered at the next PSCC meeting after hearing the referee's report.
   The remaining 12 days of beam time in 1990 will be shared between PS199 (5 days) to complete their experiment, and PS202 (7 days).

2. ANY OTHER BUSINESS
   The next meeting of the PSCC will take place on 13-14 November 1990, together with the SPSC meeting.

The PSCC received the following papers:

- Darmstadt-Missouri Collaboration
  Measurement of differential cross sections for single and double ionization of He in collisions with antiprotons (PSCC/90-15/I 78).
• Cagliari-Geneva-Saclay-Trieste-Turin

Extension of experiment PS199: Further study of the spin structure of $\bar{p}N$ scattering at LEAR (PSCC/90-16/P93 Add. 2).

• C. Amsler and the Crystal Barrel Collaboration

Meson formation in proton-antiproton annihilation at LEAR (PSCC/90-17/I 79).

• C. Amsler and the Crystal Barrel Collaboration

Meson production with a $\bar{p}p$ minicollider (PSCC/90-18/I 80).

• The Crystal Barrel Collaboration

Meson spectroscopy with the Crystal Barrel (PSCC/90-19/M311).

• Carnegie Mellon Univ.-CERN-Erlangen Nürnberg Univ.-Freiburg Univ.-Univ. of Illinois at Urbana Champaign-Jülich IKP KFA-Uppsala Univ.-Vienna IMEP ÖAW

Search for strangeness -2 baryonic and dibaryonic states at LEAR (PSCC/90-20/M312)

• Darmstadt-Heidelberg-Houston-Madison-Mainz-Marburg-München-Piscataway

Status report of P92 - FILTEX Collaboration (PSCC/90-21/M313).

• PS194 Collaboration (E. Uggerhøj)

On future activities of the PS194 Collaboration (PSCC/90-22/M314).

• PS185 Collaboration (K. Kilian)

Addendum to proposal PS185 to measure the charged channels $\bar{p}p \rightarrow \Sigma \Sigma$ (PSCC/90-23/P49 Add. 1).

• R. Gotta

Answer to the questions raised by the PSCC on 25.6.90 concerning proposal P124 (PSCC/90-24/P124 Add. 1).

• F. Bradamante

Request of 8 days of running time for PS199 (PSCC/90-25/M315).
Report on the Cogne V PSCC Meeting

A. Donnachie

PSCC Open Session
17 September 1990
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• There is a need to maintain a diversified scientific programme at CERN.

• The LEAR programme is part of that diversification and for the immediate future (i.e. the next 3 years) much of that programme is sensible.

• The medium (3 + 5 years) and long term (25 years) position is less clear (for LEAR and/or Super-LEAR) and it will be 1-2 years before the position is fully resolved.

• Experiments have been accepted on to the LEAR programme with insufficient thought as to the availability of adequate beam time. This impinges on the present programme, and priorities will have to be established.

• The LEAR image in the wider community could be improved, and the LEAR community should take this in hand.
Immediate Future (≈ 1 – 3 years)

Prime physics is: Spectroscopy
- C.P. violation
- Essential now

Spectroscopy (Crystal Barrel, Obelisk, Jetset)

- Main issue: exotic (glueballs, hybrids, etc.)
- Look for states not fitting into SU(3) models
- Establish their properties — P.W.A. essential
  → high statistics
- Comparison of different production mechanisms:
  - peripheral, including C.E.K, C.E.K. violating
    (LASS, BNL, KEK, NA12 (GAMS))
  - radiative J/ψ decay (gluon rich.)
    (Mk III, Beijing)
  - sγ interactions; s + γ, C+ (mod. gluon rich.)
    (PETRA, PEP)
* - central (gluon rich.)
  (NA12, WA91 (Omega))
* - pp annihilation (gluon rich; good hybrid possibilities)
* - need such a complementary programme.

- LEAR experiments complement each other
  (different channels, same mechanism e.g. AX(1565))
  and the SPS experiments (same channels, different mechanism)
- Waup in which one can experimentally separate
  glueballs/hybrids/q̅q̅ q̅q̅ molecules? Nuclear target?
• Programme will evolve — too early to say if it is appropriate and.
• Clear scheduling problems (addition of multi-light
  annihilation, neutron + nuclear targets, in-coming
  specific triggers ——). Parallel trigger possibilities?
• LEAR spectroscopy programme must be viewed
  as integral part of global effort and accorded
  priorities accordingly.

**CP Violation (CPLEAR)**

• CPLEAR: uses tagged K±/K0 from Bb —— K± π± πn-
• Marginal for (S/E) — require enormous statistics
  — even so S(E/E) = 1.0 ± 15 x 10⁻³
  
  BUT systematic errors of different nature than fixed targets.
• Δφ : Δφ = φ⁺ — φ⁻ sensitive to CPT violating amplitude  
  CPLEAR can improve significantly on present values  
  (and incidentally improve some by a factor 10⁻³).
• M3π : important check that it is at a level compatible
  with E.
• lepton asymmetries — check consistency (K±, K0, π±π±, π±πn).
  
  improve ΔS = 0 limits by sensible amount

• CPLEAR is a "universal" experiment: many
  parameters measured in one detector. Worth
  every effort to get precise numbers.
Inertial Mass (PS189, PS196)

- Test of CPT: eminently reasonable to ask whether baryons behave differently from leptons or mesons under CPT.
- Previous CPT tests: $10^{-4}$
  - $\delta \rho_e / \rho_e \leq 10^{-12}$
  - $10\mu_1 / m_e \leq 2 \times 10^6$
- Current baryon CPT: $10\mu_1 / m_p \leq 4 \times 10^{-8}$
- Aim for $\leq 10^{-9}$

[Gravitational mass (PS200): long term project – see later]

p Atoms

- Rather beautiful and elegant experiments, although they have revealed nothing unexpected.
- New technology offers considerable improvement for p atoms (e.g. resolution/statistics of present experiments insufficient to observe spin–spin splitting)
  - increased resolution with crystal spectrometer and CED
  - increased intensity with electron trap for p atoms
- A variety of possible experiments, and should find time for approved ones in the programme.

[Potentially the most interesting atomic physics is with F atoms using 2-photon Doppler-free spectroscopy: a long way off – see later]
Reaction Dynamics ($PP \rightarrow NN, YY$ etc.: unpolarised + polarised)

- Arguments for:
  1. Nice data available on $NN$, $NN$, $KN$, $KN$ so why not $NN$?
  2. Spin dynamics interesting as all theoretical expectations wrong.
  3. New data will help constrain $NN$ potential, in particular annihilation part, and to build a low-energy phenomenology.
  4. $NN$ meson exchange: cancellation in $V_{L5}$ term
     very strong evidence in $V_T$ for $I=0$
     $\Rightarrow$ new ordering of $I=0$ bound states according to $J$ rather than $L$:
     $3P_0 (0^{++}) < 3S_1, 3P_1 (1^-) < 3P_2, 3F_2 (2^{++})$
     So if $AX (1542)$ is an $NN$ bound state, then $J^{0^{++}}, I^{-}$ at lower mass.
     $\Rightarrow$ important to have good description of $NN$ to allow reliable calculation of these bound states.
     [Note for atomic physicists: $AX \equiv NN$ bound state
     $\Rightarrow$ anomalous shift of $3P_2$ state in protonium]

- Arguments against
  1. $NN$ studied for 40 years — despite detailed amplitude analysis understanding limited to hybrid models: $LR \equiv$ meson exchange $\big\{ \text{matching?} \}
     SR \equiv$ quark interactions
  2. $NN$ much more complex because of annihilation channels: $LR \equiv$ meson exchange $\checkmark$
     $SR \equiv$ phenomenological/quarks/composites etc. $?$
     Results sensitive to matching between L.R. and S.R.
     — a basic ambiguity.
(ii) The L.R. interaction has strong isospin dependence:
\[ t_1 < f_0 \Rightarrow \sigma(\bar{p}p \rightarrow \pi^0 n) \approx \sigma(\bar{p}p \rightarrow \bar{p}p) \]
\[ 1 \approx \frac{f_0}{2f_1^2} \]
Experimentally \( \sigma(\bar{p}p \rightarrow \pi^0 n) \ll \sigma(\bar{p}p \rightarrow \bar{p}p) \)
\Rightarrow dominance of S.R. interaction, which must be isospin blind

(iv) Polarisation measurements sensitive to small amplitudes (inevitable with any precision) so model failures in such measurements not necessarily significant

- So considerable scepticism, and any future programme should have clearly focussed and well defined aims.

Some questions:
- Can the L.R. component be filtered by spin transfer and/or spin correlation measurements to focus on \( V_1 \)?
- Can the \( \bar{N}N \) potential be extracted with adequate accuracy to sufficiently small \( R \) to make bound state calculations useful?
- Can reaction dynamics be used meaningfully in conjunction with spectroscopy to help clarify the nature of states?

Don't forget:
(i) \( \bar{p}p \rightarrow \pi^0 n \ldots \) (radial excitation of secton mass)
(ii) \( \bar{p}p \rightarrow \pi^0 n \ldots (J \neq 1, C = +1) \)
\( \beta \)-Nucleus and \( \beta \)-induced Fission

- As an aid to spectroscopic studies, \( \beta \)-nucleus OK (well within present Crystal Barrel and Cherie programme).
- Hunt the \( H \) (nucleus): fashionable, but still seems about as exciting as the detection.
- Unsteady: strangeness enhancement } amazing, but ...... Pottascom reactions

- Nuclear studies per se: no enthusiasm: global (inclusive) features well understood at low energies by the Intra Nuclear Cascade (INC) model.
- \( \beta \)-induced fission – mostly well reproduced by INC calculations – no real evidence of anything new.
- Don’t buy quark-gluon plasma formation

- Spectroscopy has high priority, and nuclear studies are seen primarily as an adjunct to this. Any other aspect, including \( \beta \)-induced fission, will have low priority in the immediate (and future) programme.
Medium - term Future (~ 3 ÷ 5 years)

- Unclear at present how far it is sensible to extend the current programme, which is driven primarily by the needs of the spectroscopy. It will be ~ 2 years before a clear picture begins to emerge whether LEAR should be continued in its present form for any significant period beyond 3+ years. [See below for S-LEAR and other possibilities]

- Does this mean one does nothing?

Direct CP violation in $\Lambda \Lambda$, $\Xi \bar{\Xi}$ decay

- Interesting parameters: rate $T$
  - decay asymmetry $\alpha$
  - decay polarisation $\beta$

- CP asymmetries: $A = \frac{\alpha + \beta}{\alpha - \beta}$, $B = \frac{\beta^2 + \alpha^2}{\beta^2 - \alpha^2}$

S.M. order of magnitude:
$$ A_\Lambda \approx -0.5 \times 10^{-4}, \quad B_\Lambda \approx 3 \times 10^{-3} \quad \text{current limit}$$
$$ A_\Xi \approx -0.7 \times 10^{-4}, \quad B_\Xi \approx 5 \times 10^{-4} \quad \text{uncertainty}$$
- assumes NA31 2$/\mu$E
- usual problem of light quark hadronic matrix elements

- It appears to be possible to come (experimentally) into the range of predictions. It is an independent measurement, worthwhile if it can be achieved, and merits further study both experimental and theoretical.
• Recommend working party for detailed study of experiment with $7 \times 10^{32}$ integrated luminosity.
  Need not be coupled explicitly to S-LEAR — other possibilities should be explored.

• Would like to see this getting underway as soon as possible and reporting in ~6 months.

Ultra low energy $\bar{p}$ facility.

• Aspects of this already in the LEAR programme.

• Very interesting physics potential for an ultra low energy $\bar{p}$ facility (particularly if $\bar{p}$ can be produced — very far future):
  - $\bar{p}$ atom studies e.g. $\bar{p}H_2 + FD_2$
  - $\bar{p}$He x-rays from different ionized "few" electron systems
  - $\bar{p}$ polarizability of $\bar{p}$
  - gravitational mass of $\bar{p}$ and $\bar{p}$
  - $\bar{p}$ gravity tests
  - precision spectroscopy of $\bar{p}(e^+)$ and $p(e^-)$
  - hyperfine transitions in $\bar{H}$ and $H$

• Can be achieved in context of LEAR or S-LEAR but could be completely disconnected from either:
  possible to produce an inexpensive dedicated facility.

• This option should be actively pursued.
S-LEAR: to be or not to be?

Physics case, as seen at present, rests firmly on
spectroscopy (having disconnected $\Sigma$'s and ultra
low energy $\pi$'s, and giving most everything
else low priority).

(i) charm sector ($\bar{\phi}$ accessible states inaccessible to $\phi, c$ factors)
above charm threshold (FNAL. will have dealt with
most/all of charmonium sector).

- S-LEAR gives luminosity $\times 10$ need this for
charm exotics (hybrids, "charmed" b-quark states).

- if not found, they probably don't exist (much
easier to analyse and interpret than the light
quark sector).

- programme would involve detailed energy scan, so
needs high luminosity

- on nuclei
  - pentaquark ($\bar{\phi}$, $\bar{\phi}q$, $q\bar{q}$ eg $\bar{\phi}c\bar{c}$?
$\bar{\phi}q\bar{q}$
  - annihilation produces $\bar{c}c+5$ plus
rearrangement on another nucleon
  $\rightarrow [\bar{c}c] + \text{charm} + \text{strangeness}

- nuclear bound charmonium $\rightarrow \eta_c\Lambda$
  $\eta_c^\Lambda$, B.E. $\approx 19$ MeV

- colour transparency $\bar{\phi} \rightarrow \Lambda(1405)$
  (just accessible to FNAL.?)

- charmed hypernuclei $\bar{\phi}p \rightarrow D^{+}\pi^-$
  $\rightarrow D^+ n [\eta^+ n^+ \rightarrow \Lambda e^+\nu^0]$
(ii) light quark hybrid, gluonium spectroscopy > 20 GeV
- case depends on developments of current spectroscopy programme (SPS and LEAR)

(iii) CP may come back in, of course.
- Physics case should mature in ~ 1-2 years
  (further detailed theoretical and experimental studies required)

- If there is a S-LEAR it has to be a high energy version (10-15 GeV)

- Best option is with jet target

- Enabling R&D should be done in this 2 year period to avoid further delay if programme goes forward and is approved.
• LEAR has an interesting programme for the next 3+ years, but it will need to be more focussed than hitherto, and priorities set.

• Spectroscopy and CPLEAR have the highest priority. Reaction dynamics and nuclear studies have lower priority, except in so far as they aid the spectroscopy.

• The continuation of LEAR beyond this period is an open question: it will depend to a large extent on the output of the current programme. The position should be considered in ~2 years.

• CP-violation in $\bar{p}p \rightarrow \Lambda \bar{\Lambda}$ merits immediate further detailed study.

• A dedicated ultra low energy $\bar{p}$ source is a possible option and should be considered.

• The outline of a case exists for S-LEAR, but further detailed study is required. Energies should be well above the charm threshold.