CERN/AC/22
23 September, 1959

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

ADVISORY COMMITTEE ON VISITING TEAMS

Fifth Meeting

6 October, 1959

DESCRIPTION OF EXPERIMENTS REQUESTED BY VISITING TEAMS

Attached is a description of the experiments which the following Universities and Institutions have requested to perform with the synchro-cyclotron :

Institut für Technische Kern-physik der Technische Hochschule, Darmstadt	Exp. 31
Istituto di Fisica, Via Marzolo 8, Padova	Exp. 32
Istituto di Fisica, Università di Roma	Exp. 27
Istituto di Fisica, Università di Roma	Exp. 33
Fysisch Laboratorium, Utrecht	Exp. 2
Harwell & University College London	Exp. 4 b
A.E.R.E. Harwell Group	Exp. 4 a.
Liverpool University	Exp. 3

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

QUESTIONNAIRE CONCERNING PROPOSED EXPERIMENT WITH THE CERN CYCLOTRON

by : Prof. Dr. P. Brix

date : 14 August, 1959.

Complete address : Institut für Technische Kern-physik
der Technischen Hoch-schule, Darmstadt,
Hochschulstrasse 1.
Phone: Darmstadt 852116
Bundesrepublik Deutschland.

Short title of experiment : μ -Mesonic Atoms:

a) Radii of heavy nuclei
b) Helicity of the μ^--meson

Nature and purpose of the experiment (Please describe briefly the background of the proposed experiment, how it is intended to carry it out, and what is its purpose. An additional sheet of paper may be attached if necessary): μ -Mesonic Atoms.

a) Radii of heavy nuclei

After the classical paper of Fitch and Rainwater (Phys. Rev. 92, 789-800 (1953)) little work has been done to use the bound μ-meson as a probe of nuclear electromagnetic properties. In the region of heavy elements ($Z > 50$) mesonic X-rays have been measured by Fitch and Rainwater (Sb, Hg, Pb, Bi), Butement (Pb) and Backenstoss and Sutton (Ta, W, Hg, Pb, Bi, U, unpublished). For lead, e.g., the

Nature and purpose of the experiment (continued)

experimental values for the 2P-1S transition are 6.02, 5.89 and 5.73 MeV, respectively. They are to be compared with 5.93 MeV as calculated (Sens: Phys. Rev. 113, 679, (1959)) from the charge distribution measured by the Hofstadter group. Remembering that for lead an energy change of 0.05 MeV corresponds to a 1% change of radius, the often quoted agreement is still not too well established, and it should be tried to gain a more accurate experimental value.

Differences of nuclear radii of isotopes can be deduced from the optical isotope shift of heavy elements. It would be desirable to combine these data with a few absolute nuclear radii determined from mesonic X rays, especially for the rare earth region. With some increase in accuracy an investigation of a series like Cs, La, Pr might yield additional information on nuclear shell effects and nuclear compressibilities.

The experiments planned are conventional, using the traditional set up with a NaJ scintillation spectrometer. Emphasis is on better accuracy for a few selected K-lines and for energy differences of neighbouring elements.

It is hoped that more refined measurements, e.g. on deformed nuclei and on μ-capture γ-rays, may follow in later stages of this research programme.

b) Helicity of the μ^- - meson

A measurement of the circular polarization of the μ-mesonic K-lines would be of interest mainly as a means of determining the helicity of the μ^- -meson (cf. A.Z. Dolginov, Nuclear Physics 7, 569, (1958)).

The set up required for, and the experience gained in experiments mentioned above form a basis and natural starting point for this more refined investigation. It is proposed to detect the circular polarization of the K - X-rays in the usual way by measuring the transmission through magnetized iron. Estimates have shown that this experiment should be successful, at least after the expected gain in meson beam intensity has been obtained.

Experimenters' names :	Institutions :
Dr. G. Backenstoss	now at CERN
Dipl. Phys. U. Hegel)	Institut für Technische
Dipl. Phys. D. Quitmann)	Kernphysik, Darmstadt
N. N.	---
Theory:	
Prof. Dr. H. Marschall	Physikalisches Institut der Universität Freiburg

Are you supported by any national organization dealing with CERN matters? Yes If so, which? Bundesministerium für Atomkernenergie und Wasserwirtschaft, Bad Godesberg.

Please show on a floorplan the proposed arrangement of the experiment:

Floorplan on attached sheet.

1. Which beam is used?

   Monoenergetic pure μ^- -beam of high intensity; energy not significant (low).

2. What target, material and dimensions?

   Exp. a) Heavy elements, about 5 g/cm^2, 5 cm diam.
   Exp. b) Probably lead, about 5 g/cm^2, 5 cm diam.

3. Show position of bending magnets and lenses:

   a) for bending magnets give identifying letters * or poleface dimensions and gap,

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x For available magnets and lenses and normal beam intensities, see CERN/SC/5372 B.

b) for lenses give identifying letters [x] or aperture and focal distance.

cf. floorplan. Standard arrangement for $\pi^- - \mu^-$ beam. To stop more μ's per gram of target material and to reduce the background, slight variations may be desirable.

4. Show shielding with principal dimensions. Is a roof required?

cf. floorplan. No roof.

5. Describe detection equipment.

Standard scintillation counter telescope and NaJ (Tl) - spectrometer.

Required Cyclotron Operating Conditions

Proton energy ~ 600 MeV Experimental beam energy MeV

Average intensity particles/sec over cm^2

Special operating conditions: None. Standard $\pi^- - \mu^-$ -beam of low energy and maximum intensity. A few hundreds of stopped μ^-/sec are desirable. If the expected increase in intensity by a factor of 8 or 10 should be realized, this would be especially important for experiment b.

Cyclotron Time Request :

	Earliest date Month, year	No. of shifts (8 hours/shift; 3 shifts/day) Exper. a)	Exper. b)
Preliminary test	Feb. 1960	about 7	additional 5
Main run	April 1960	about 15	5*
Check run	---	5	2*

*This number is based on an μ^--beam intensity increased to about $4 \cdot 10^3$ stopped particles/sec.

[x] For available magnets and lenses and normal beam intensities, see, CERN/SC/5372 B.

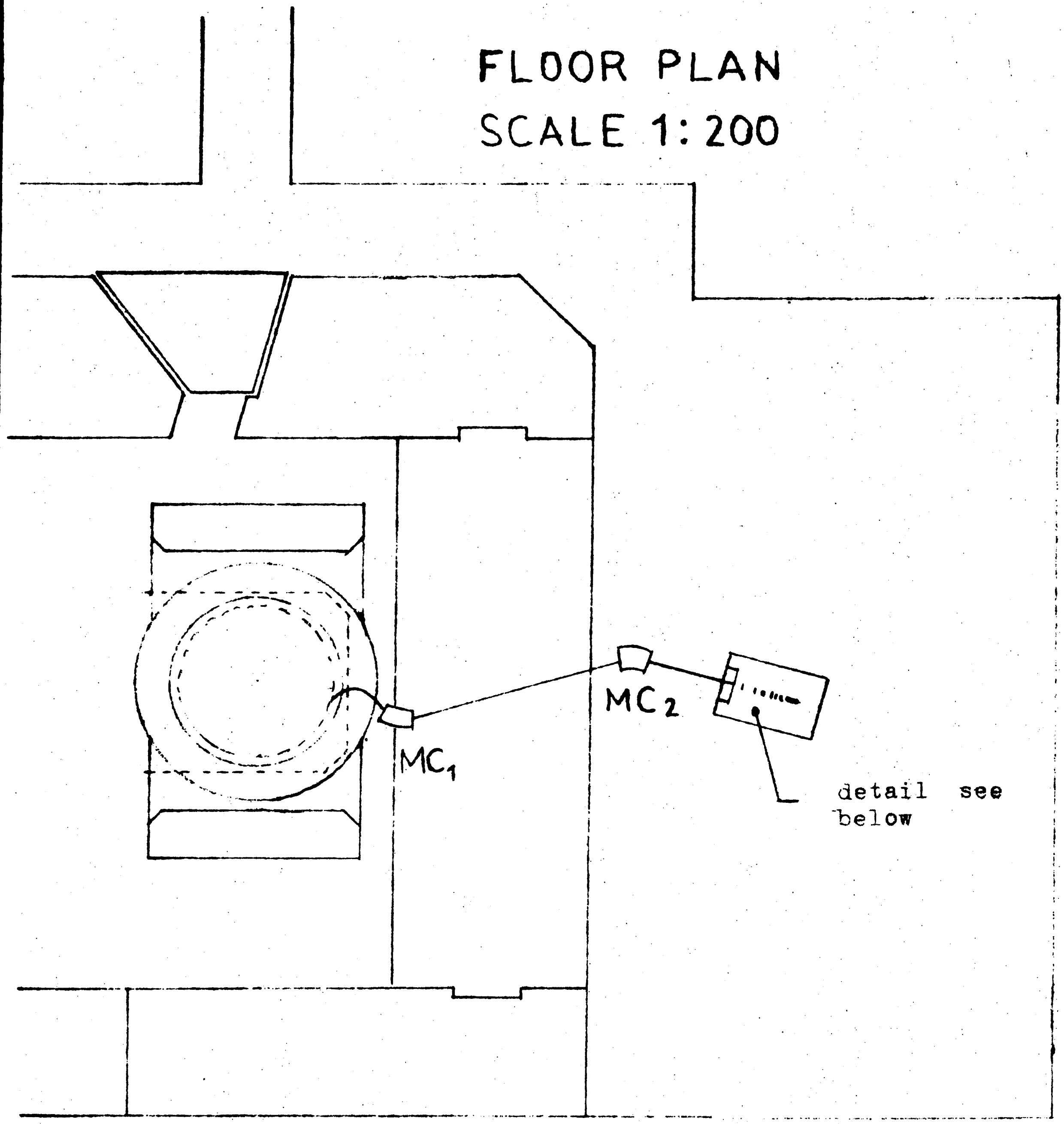
<u>Laboratory space request</u> : 30 m^2

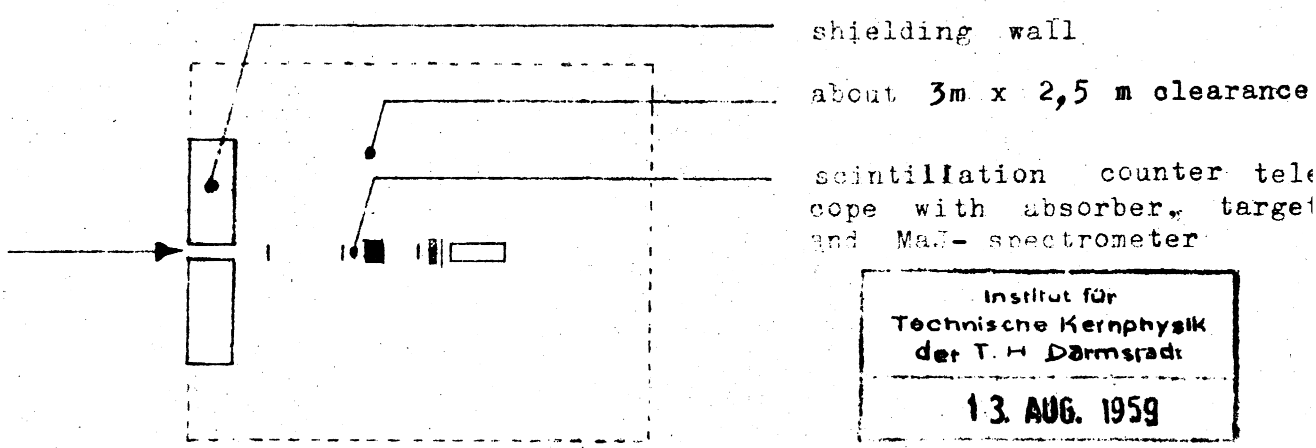
<u>Office space request</u> : 15 m^2

<u>Remarks</u> :

The proposed experiments require a multichannel pulse-height-analyzer. The question arises whether such an instrument could be borrowed from CERN. A discussion of this point at an early date would be appreciated.

FLOOR PLAN
SCALE 1:200





EXPERIMENTAL SETUP
SCALE 1:50

CERN/SC 5372A
Exp. 32

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

QUESTIONNAIRE CONCERNING PROPOSED EXPERIMENT WITH THE CERN CYCLOTRON

by : A. LORIA

date : 9th September 1959

Complete address : Istituto di Fisica - Via Marzolo 8, Padova, (Italy.)

Title of experiment : π^+ -p scattering at 90 and 150 Mev K.E.

Nature and purpose of the experiment: It appears not far from being established that the α_3 phase shift deviates from linearity as a function of the momentum of the incident pion. These measurements should contribute to determining the analytical dependence of α_3 on the momentum.

Experimenters' names :	Institutions :
A. Loria	Istituto di Fisica della Università, Padova (Italy) Via Marzolo 8
R. Santangelo	ditto
G. Zago	Sezione dell'Istituto Nazionale di Fisica Nucleare Via Marzolo 8, Padova (Italy)

Are you supported by any national organization dealing with CERN matters? Yes If so, which? Comitato Nazionale per le Richerche Nucleari

Please show on a floorplan the proposed arrangement of the experiment:

See enclosure.

95

Required Cyclotron Operating Conditions

Proton energy 600 MeV Experimental beam energy 120 and 180 MeV

Average intensity 600 particles/sec. over 25 cm^2

Special operating conditions : None

Cyclotron Time Request

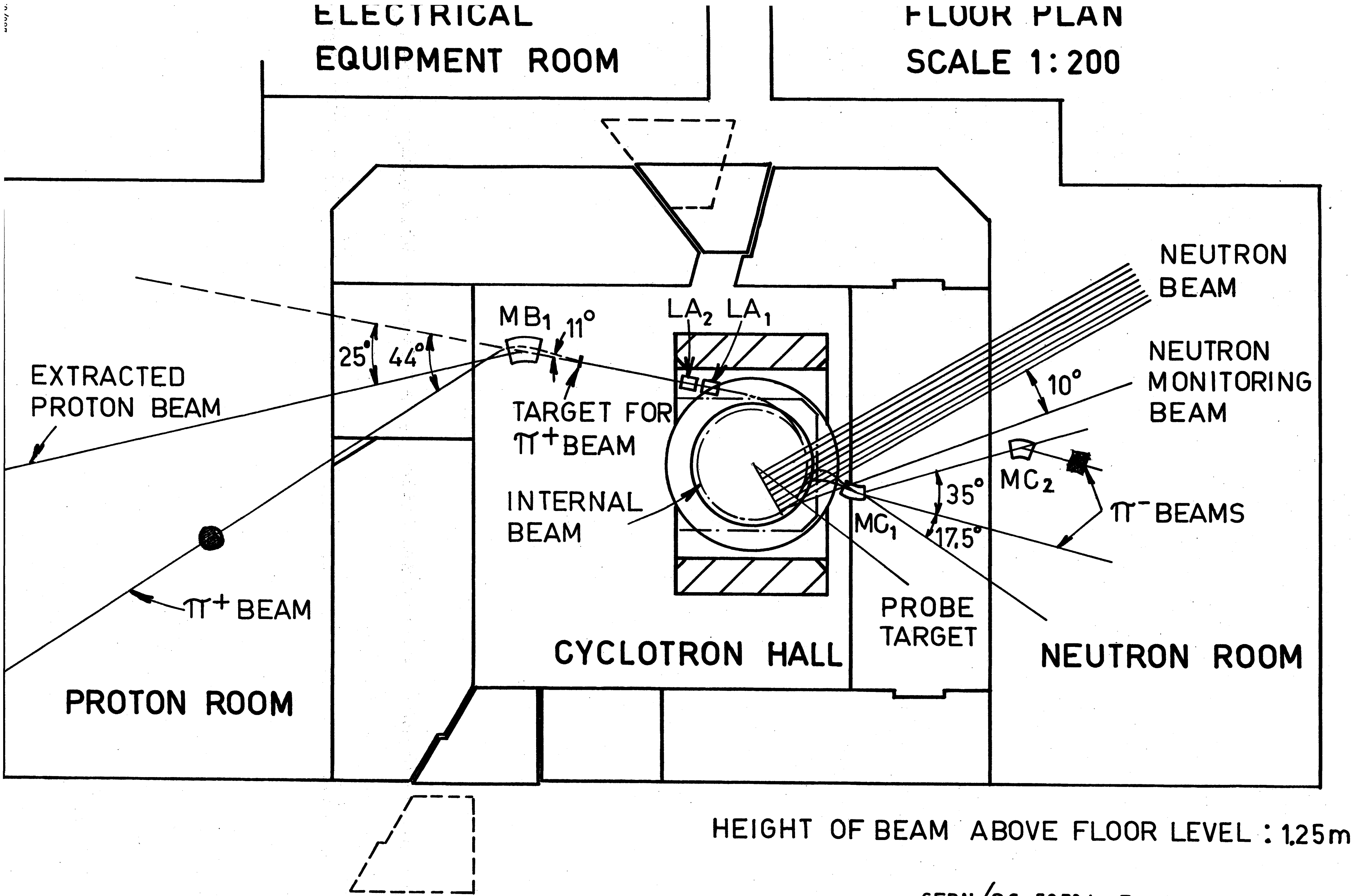
	Earliest date Month, year	No. of shifts (8 hours/shift; 3 shifts/day)
Preliminary test		6
Main run	As soon as possible	12 for 90+3 for 150 Mev = 15 Possibly divided into 3 runs at least
Check run		Not required.

Laboratory space request : 40 m^2

Office space request : none

Remarks : The time request is sufficient only if the beams are already available.
The runs should be preceeded by two days of setting-up time in the experimental rooms.

Encl.



CERN/SC 5372 b Feb.1959

ENCLOSURE

According to our previous experience with the CERN S.C. a suitable 120π^+ beam can be obtained, instead of the π^- beam, in the Neutron Room by bombarding internal beryllium target: it also appeared that at 150 Mev the intensity was rather high so that it is probable that even a 180 Mev π^+ beam could be profitably used by us in the same place, shown by a red square in the enclosed floor plan.

Both the 180 Mev π^+ and 120 Mev π^+ beams should be obtainable in the Proton Room, at the point shown by a red circle, by bombarding Hydrocarbon target with external proton beam. Another possibility should be offered by a radial 200 Mev pion beam in the Neutron Room.

Two magnets of C Type are necessary in the first case, most probably magnetic deflections are needed also in the other two cases in order to reduce sufficiently the spread in energy, but more details could hardly be given now.

Apart from a few heavy concrete cubes, no shielding is required: certainly no roof.

The detection equipment is the propane bubble chamber 7·14·21 cm of Padua University, already used recently at CERN.

CERN/SC/5372 A
Exp. 27

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

QUESTIONNAIRE CONCERNING PROPOSED EXPERIMENT WITH THE CERN CYCLOTRON

by : M. Conversi
date : 16th September, 1959

Complete address : Istituto di Fisica
University of Rome
(Italy)

Short title of experiment : Polarization of neutrons from muon capture.

Nature and purpose of the experiment : Polarization of neutrons from μ^-+ meson capture.

Preliminary information was given in previous requests for time allocation at the CERN synchro-cyclotron (1). The proposed experiment can be regarded as a contribution to the understanding of the weak process $\mu^- + p = n + \nu$ (1) which has not yet been extensively investigated. More precisely, in the spirit of universality for the weak interactions (2) and in accordance with recent results on the hyperfine splitting of the lifetime of bound muons (3), one can assume that process (1) is governed by a V-A interaction. If so, the capture should occur in a singlet S-state and the neutron be longitudinally polarised. A measurement of the sign of this polarization yields a test for the conservation of the leptonic charge.

A direct investigation of the elementary process (1) is made hard (and perhaps out of the present possibilities) essentially by the very low rate at which muon capture occurs in hydrogen. It has been pointed out, however, that if the muons are stopped in a light material (but of Z still large enough to make the capture process compete favourably with spontaneous decay) then the more energetic neutrons (which are formed in reaction (1) with a continuous spectrum owing to the momentum distribution of the capturing protons) have a relatively low chance of losing their polarization before escaping out of the nucleus. It seems, furthermore, that this conclusion does not depend critically either on the model assumed for the absorbing nucleus or on the state of polarization of the absorbed muon (4).

In our experiment we plan to use a Mg target (5) (Z = 12) to stop the muons.* Some of the neutrons arising from muon capture are made to travel in a magnetic field sufficient to transform their original longitudinal polarization into a transversal one. They are subsequently scattered in a He 100 atmosphere gas scintillation proportional counter (6). The asymmetry with respect to the plane identified by the direction of motion and the neutron spin is measured by means of coincidences between the pulses of the He counter and those of two large liquid scintillators capable of recording the scattered neutrons (7).

Because of the general neutron background, the main difficulty of the experiment seems connected to the possibility that chance coincidences of this type mask the expected asymmetry. Due to the large capture time in Mg ($\sim 1\ \mu$sec) this difficulty cannot be overcome by use of fast coincidences between pulses produced by the incoming muons and the scattered neutrons.

Preliminary measurements at the CERN machine (8) suggest, however, that with proper shielding the neutron background can be reduced enough to see clearly in 10 shifts a $\sim 50\%$ polarization, if a beam of 2000 $\bar{\mu}$/sec. 100 cm^2 (energy $\sim$70 MeV) is available.

A suitable electronics discriminates against neutrons arising from interactions and/or captures of negative pions mixed in the muon beam. Use of a dual-trace oscilloscope makes it possible to record photographically a considerable amount of information, including the pulse height of the He counter (which is related to the energy of the scattered neutron) and the delay of the scattered neutron with respect to the incoming muon.

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*A view of the apparatus is given in the last attached sheet.

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1) Letter of December 15, 1958, to Professor Bernardini (copy to Prof. Puppi, Member of the Advisory Committee) and request of March 21, 1959 (copies to Prof. Bernardini, CERN; Dr. Hedin, CERN; Prof. Puppi, University of Bologna; Dr. Baroni, CNRN, Roma)

2) Feynman and Gell-Mann, P.R. 109, 193 (1958); Sudarshan and Marshak, P.R. 109, 1860 (1958)

3) Telegdi, P.R.L., 3, 59, (1959); Kiev International Conference, July 1959.

4) Cini and Gatto (N. Cim. 11, 253, (1959) use a Fermi model and for unpolarised muons captured in C^{12} find a 20% depolarisation for neutrons emitted with energy $>$ 6 MeV; Blokhintsev (1959) uses a shell model and for polarised muons captured in O^{16} and Ca^{40} finds a 50% depolarisation for neutrons emitted with energy $> \sim 3$ MeV.

5) This choice is suggested by measurements recently carried out at the Nevis Cyclotron (private communication by C. Rubbia).

6) C. Rubbia and M. Toller, Nuovo Cim. 10, 410, (1958).

7) This method has been first employed by Pasma (Nucl. Phys. 6, 141, (1958).

8) Information kindly given to us by Dr. Zavattini,

Experimenters' names :	Institutions :
Marcello Conversi	University of Rome and I.N.F.N.
Luigi Di Lella	University of Pisa
Alberto Egidi	University of Rome and I.N.F.N.
Carlo Rubbia	University of Rome and I.N.F.N.
Marco Toller	University of Rome and I.N.F.N.

Are you supported by any national organization dealing with CERN matters? Yes. If so, which? I.N.F.N. (C.N.R.N., Rome)

Please show on a floorplan the proposed arrangement of the experiment:

See drawings in the last attached sheet.

1. Which beam is used? See remark 1)
2. What target, material and dimensions? Magnesium: 2.12.22 cm^3

Required Cyclotron Operating Conditions

Proton energy 600 MeV, or what is best for maximum mu-beam intensity.

Experimental beam energy See remark 1)

Average intensity See remark 1)

Special operating conditions : NONE.

Cyclotron Time Request :

	Earliest date Month, year	No. of shifts (8 hours/shift: 3 shifts/day)
Preliminary test:	End of November	4 - (distributed over a period of about 3 months)
Main run	February 1960	10
Check run	April 1960	1 (see remark 2).

<u>Laboratory space request</u> : About 20 m^2

<u>Office space request</u> : "

REMARKS

1. Beam to be used

To keep the expected asymmetry out of the estimated background in about 10 shifts, at least 1000 mu-mesons per sec. per 100 cm sq. are needed. Accordingly, either one of the following alternatives would be satisfactory:-

a) Contaminated mu-beam (from pion-beam) with 4 to 5.000 muons/ sec. 100 cm sq. of energy 75 MeV (probably available before the end of November 1959)* or,

b) Muon beam of momentum 140 MeV/c presently being developed by Dr. Citron and his collaborators (probably available within this year)**

2. Check run

Were the searched asymmetry not found however, more time would be required to check the energy distribution of neutrons emitted in muon capture theoretically predicted (Reference (4) quoted under "Nature and purpose of experiment").

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*Thanks are due to Professor Bernardini and Dr. Fidecaro for the information kindly given to us on May 12th, 1959, concerning this alternative.

**Thanks are due to Dr. Citron for information kindly given to us on May 13th, 1959 concerning this beam.

EXPERIMENT ON THE POLARIZATION OF NEUTRONS FROM MUON CAPTURE
(M. Conversi, L. Di Lella, A. Egidi, C. Rubbia, M. Toller)

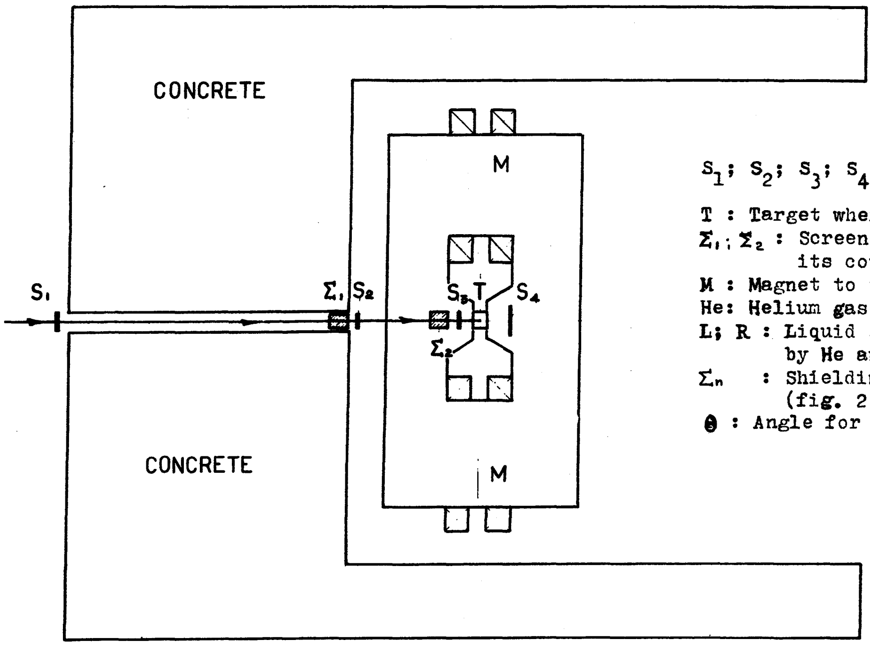
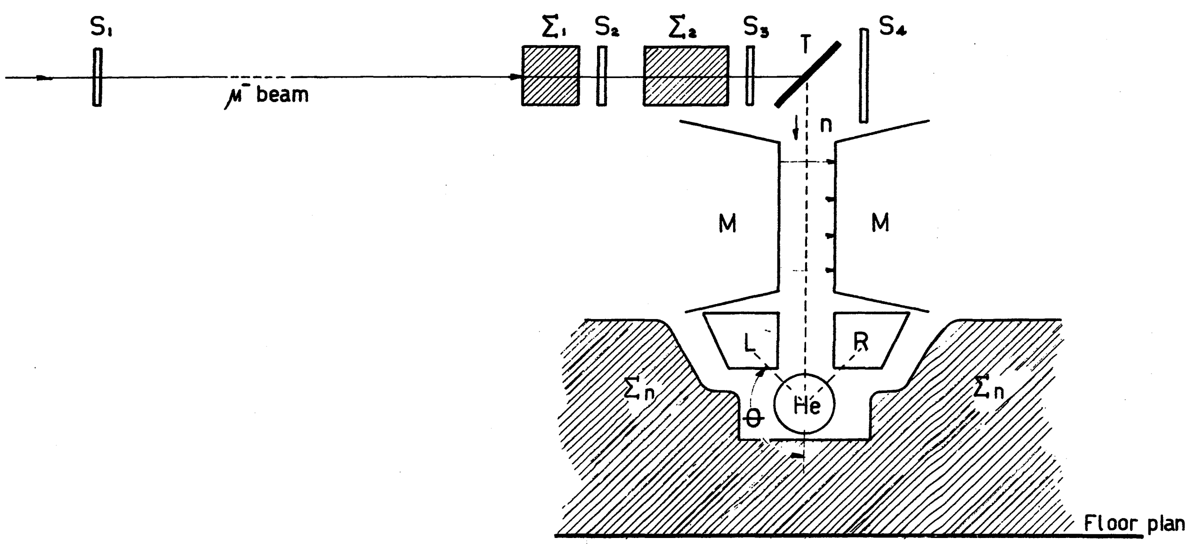


Fig.1: EXPERIMENTAL ARRANGMENT ON A FLOORPLAN

Explanations (both figures)

S_1; S_2; S_3; S_4: Plastic scintillators to record particles stopped in T (anticoincidences $S_1 S_2 S_3 \bar{S}_4$)
T : Target where muons are stopped
Σ_1; Σ_2 : Screens to moderate muon beam energy and reduce its contamination
M : Magnet to turn of 90° neutron spin
He: Helium gas proportional scintillation counter (fig.2)
L; R : Liquid scintillators to record neutrons scattered by He and measure left-right asymmetry (fig. 2)
Σ_n : Shielding to reduce neutron background in L and R (fig. 2)
θ : Angle for which the asymmetry is maximum (fig. 2)

Fig.2: LATERAL VIEW (SCHEMATIC BUT TO SCALE) OF THE APPARATUS



CERN/SC/5372 A
Exp. 33

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

QUESTIONNAIRE CONCERNING PROPOSED EXPERIMENT WITH THE CERN CYCLOTRON

by : M. Conversi

from : 16th September, 1959

Complete address: Istituto di Fisica, University of Rome (Italy)

Short title of experiment: A search of the process $N + \mu^- = N + e^-$

Nature and purpose of the experiment: A search of the process $N + \mu^- = N + e^-$

The importance of establishing small upper limits to the occurence of "unwanted processes" in the decay ($\mu \rightarrow e + \gamma$: $\mu \rightarrow 3$ e) and capture ($N + \mu^- \rightarrow N + e^-$) of the mu-meson, has been recently stressed by several theorists [1] in connection to the problem of the structure of the weak interactions.

We propose an experiment to search for the process

$$N + \mu^- \rightarrow N + e^- \qquad (1)$$

which should make it possible to place an upper limit of $\sim 2.10^{-5}$ for the relative rate of this process to that of the usual nuclear absorption: $p + \mu^- = n + \nu$ (2)
It will be recalled that the best upper limit thus far obtained is 5.10^{-4}.[2] The information derivable from the proposed experiment is essentially complementary to that obtained by the search for the decay $\mu = e + \gamma$ recently carried out in CERN. [3]

Apparatus

Negative mu-meson stopped in a target, T, are detected by a standard telescope of scintillation counters. Electrons emitted in process 1) with energy greater than 55 MeV could be recorded by a channel consisting of six plastic scintillators, with interposed thicknesses of low Z material, and an integral absorption Cerenkov counter, C_{ia}. The latter gives the residual energy of the electrons entering it with an accuracy of $\sim 20\%$.

The material between T and C_{ia} is sufficient to prevent most of the electrons arising from process 2) (energy < 55 MeV) from reaching C_{ia}. If, however, one of these electrons reaches counter C_{ia}, it can be recognized unambiguously from the information displayed on the sweeps of a dual trace oscilloscope. This information includes the position in time and the pulse height from counter C_{ia}, as well as the presence and relative position in time of the pulses from each of the six plastic scintillators. The origins of the time scales are fixed by the arrival of the μ^- which is responsible for the recorded event.

The ability of the apparatus in discriminating against decay electrons can be tested experimentally, of course, using a beam of positive muons.

Participants

The experiment would be carried out by the following physicists of the University of Rome:

M. Conversi, L. Di Lella, A. Egidi, C. Rubbia, M. Toller.

The participation of a member of the CERN staff would be welcome.

Request for time allocation

With the increased intensity of the SC and the new $\pi - \mu$ beams it should soon be possible to stop in the target 3 or 4.000 μ^--mesons per sec. If this is true the experiment can be carried out in 10 shifts so distributed: 5 shifts for preliminary tests (including the measurements with the beam of μ^+ mesons).
4 shifts for the main run,
1 shift for a check run.

The preliminary measurements could presumably be started in June 1960, since a large part of the necessary equipment is already available to the group. (The group has, in fact, prepared an experiment to test the conservation of the leptonic charge in muon capture, to be carried out in CERN in the near future.[4])

N.B. Copies of this request have been forwarded to:

Professor C.J. Bakker, Director-General, CERN
Professor G. Bernardini, SC Division, CERN
Dr. B. Hedin, SC Division, CERN
Professor G. Puppi, CERN Advisory Committee, University of Bologna
Dr. A. Baroni, Cultural Exchange, C.N.R.N. Rome

Bibliography

1) See for example R. Gatto: Fortschritte der Physik. 7, 147, (1959)

2) J. Steinberger, H.B. Wolfe: Phys. Rev., 100, 1490 (1959), also for previous references.

3) F. Ashkin, T. Fazzini, G. Fidecaro, N.H. Lipman, A.W. Merrison, H. Paul: CERN preprint 7337/SC/Kw.

4) Request of 21st March, 1959 (to Professor Bernardini and Dr. Hedin, CERN, etc. questionnaire CERN/SC/5372 A to Professor Bakker, Director-General, CERN, sent 16th September, 1959.

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

QUESTIONNAIRE CONCERNING PROPOSED EXPERIMENT WITH THE CERN CYCLOTRON

by : F.P.G. Valckx
date : 1.9.1959.

Complete address : Fysisch Laboratorium
Bylhouwerstraat 6,
Utrecht.

Short title of experiment : Scattering of positive mesons by complex nuclei.

Nature and purpose of the experiment.

The main purpose of the experiment is to measure with high accuracy elastic and pseudoelastic scattering of positive pions on various nuclei. Quite a lot of theoretical work has been done on elastic scattering (mainly by Watson, Francis, Gammel, Kisslinger and Wada) but so far only some angular distributions are measured with greater accuracy (W.F. Baker and J. Rainwater, Phys.Rev. 112, 1763 (1958)) and even here the separation between elastically and inelastically scattered pions can be questioned.

The differential cross-section of the elastic scattering can be compared with optical model calculations, which also gives information about the mass distribution in the nuclei. Also one can try to explain the angular distributions with the known single nucleon-pion interactions. It would be very useful to measure π^+ and π^- scattering on mirror nuclei, to observe the interference between meson forces and electromagnetic interactions. So far, apart from chamber and emulsion experiments with almost unavoidable great statistical errors in the results, all measurements on pion scattering have been done with a differential range method or with similar methods. The energy resolution which can be obtained is then limited by the range straggling, which makes a good separation of elastic and inelastic scattered pions practically impossible for higher pion energies (above 70 MeV). Therefore we have decided to measure the pion energy by total absorption in a big plastic scintillator. The scintillator is split up into two pieces - the first is 20 cm long and the second 10 cm. Close between the two crystals is a thin smaller counter, and in front of the whole system another defining counter. For coincidences of the two defining counters together with the beam monitor counters, the pulses of the two big crystals are added and recorded. The coincidence requirement of the two defining counters gives two advantages. Firstly we eliminate the main part of the background, caused by interactions of the pions in the 20 cm counter. Secondly we only measure pions for which the angular deflection in the crystals is not so great that the pions leave the crystals. This system has been tried with two big counteres for which we know that the light collection was far from uniform over the crystals. Even with these counters the pion-energy resolution obtained is comparable with the best range measurements. Now the system is being improved, with the greatest attention to uniformity in light collection.

With this counter-system we want to measure elastic and pseudoelastic scattering of 120 MeV pions on carbon and oxygen in the first place. For the latter we will use H_2O targets, to get in the meantime a calibration of the counters with the known cross-sections of the reaction $\pi^+ + p \rightarrow \pi^+ + p$.

To be able to make the measurements with the required energy resolution, it is of course necessary that the energy spread of the pion beam is sufficiently small. We need a π^+-beam of 120 MeV and with an energy spread of 3 MeV or lower. The intensity must also be sufficient to be able to measure the angular distributions with a reasonable statistical accuracy. At the moment no such beam is available, so some time has to be spent on the preparation of the beam.

We think it would also be possible to measure single pion-nucleon interactions in the nuclei with our equipment. So, in case we can get enough machine-time, we would like to extend our programme to this point.

Experimenters' Names: Institution :

Prof. Dr. P.M. Endt
Dr. F.P.G. Valckx
Dr. A. Dymanus
M. Kruiskamp
B.A. Strasters

Fysisch Laboratorium der Rÿksuniversiteït, Utrecht - Netherlands.

Are you supported by any national organization dealing with CERN matters? Yes.

If so, which? Stichting FOM (Fundamental Research of Matter). Lucas Bolwerk 4 - Utrecht.

Please show on a floorplan the proposed arrangement of the experiment:

1. Which beam is used ?

   The beam which we are thinking of using is a 120 MeV π^+ beam, produced with the external proton beam.

2. What target, material and dimensions ?

   For scattering targets will be used C, H_2O, Bl, eventually Al and Cu. Target dimensions 10 x 10 cm^2, thickness 2 - 4 g/cm^2.

3. Show position of bending magnets and lenses:

   see floor plan.

4. Show shielding with principal dimensions. Is a roof required ?

   No special shielding, no roof.

5. Describe detection equipment.

   Please see "Nature and purpose of the experiment".

<u>Required Cyclotron Operating Conditions</u>

Proton energy 600 MeV   Experimental π^+ beam energy 120 MeV

Average intensity 10^4 π^+ particles/sec. over 10 cm^2.

Special operating conditions: Beam energy spread $\leq$ 3 MeV.

Cyclotron Time Request:

	Earliest date Month, year	No. of shifts (8 hours/shift; 3 shifts/day)
Preliminary test	Sept. 1959	15 shifts
Main run	Dec. 1959	45 shifts
Check run	Jan. 1960	15 shifts

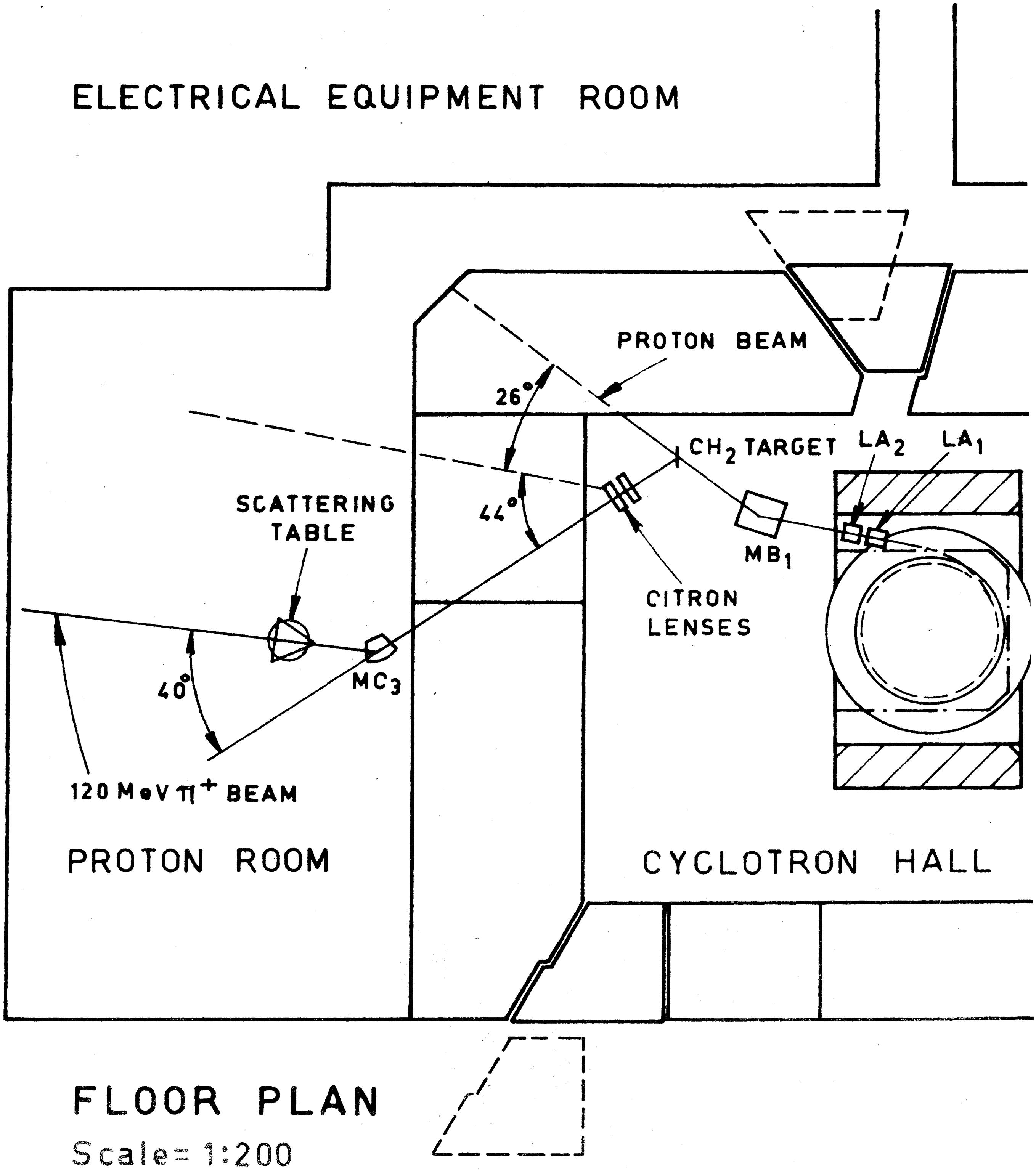
Laboratory space request: 40 m^2

Office space request : 15 m^2

Remarks:

1. The beam to be used, indicated on the floorplan, is the beam we think at the moment to be the best. In fact so far no set-up is known which gives a beam of the right intensity and energy spread, but certainly it must be possible to make such a beam. We expect that a sufficient number of shifts will be available for the preparation of the beam.

2. The Dutch governmental authorities have consented to a permanent stay of the Utrecht team at CERN for 9 months, starting in July 1959. We hope that the requested number of shifts will be given during this period, to enable us to finish this experiment in the given time.



FLOOR PLAN

Scale= 1:200

CERN/SC/5372 A
Exp. 4 b

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

QUESTIONNAIRE CONCERNING PROPOSED EXPERIMENT WITH THE CERN CYCLOTRON

by : Joint visiting team from Harwell & University College, London.

date : 2nd September, 1959.

Complete address : R.C. Hanna, A.E.R.E., Harwell, Berkshire, England

F.F. Heymann, Physics Dept., University College, Gower Street, London.

Short title of experiment : Polarisation of recoil protons from $\pi^+ + p$ elastic collisions.

Nature and purpose of the experiment : Polarisation of recoil protons from $\pi^+ + p$ elastic collisions.

The purpose of this experiment is to determine the polarisation of the protons resulting, at various recoil angles, from the interaction $\pi^+ + p \rightarrow \pi^+ + p$ at a meson energy of about 270 MeV.

The experiment is being performed in order to throw light on the behaviour of the small phase shifts. In particular, a study of the polarisation of the recoil protons is of importance in determining the value of α_{31}, which is difficult to obtain from angular distribution data alone. The polarisation is also sensitive to small values of D wave phase shifts, so that the results of the experiment should give information on the existence of D-wave scattering.

The π^+ beam is produced in an 8 cm polythene target placed in the external proton beam. It is separated from the proton beam and transported as shown in the attached floor plan. Mesons produced in the forward direction from the reaction $p + p \rightarrow \pi^+ + d$ are utilized.

The $\pi^+ + p$ interaction takes place in a liquid hydrogen target.

The proton polarimeter consists of a carbon scatterer and a set of scintillation counters arranged to be sensitive only to protons scattered through a defined range of angles by the carbon. The polarimeter has been calibrated empirically by exposing it to a proton beam of known polarisation at Harwell.

Experimenters' names :	Institutions :
D.G. Davis	U.C. London
A. Ghani	U.C. London
R.C. Hanna	A.E.R.E. Harwell
F.F. Heymann	U.C. London
G. Heymann	U.C. London
A.L. Read	U.C. London

Are you supported by any national organization dealing with CERN matters ? Yes If so, which ? A.E.R.E. and D.S.I.R.

Please show on a floorplan the proposed arrangement of the experiment :

Floorplan on attached sheet.

1. Which beam is used ? 270 MeV π^+
2. What target, material and dimensions ? Liquid hydrogen

Required Cyclotron Operating Conditions

Proton energy 600 MeV Experimental beam energy 270 MeV

Average intensity 2×10^5 particles/sec over 5 cm^2

Special operating conditions : None

Cyclotron Time Request

	Earliest date Month, year	No. of shifts (8 hours/shift; 3 shifts/day)
Preliminary test	Sept. 1959	ten (10)
Main run	Oct. 1959	twenty (20)
Check run	Dec. 1959	ten (10)

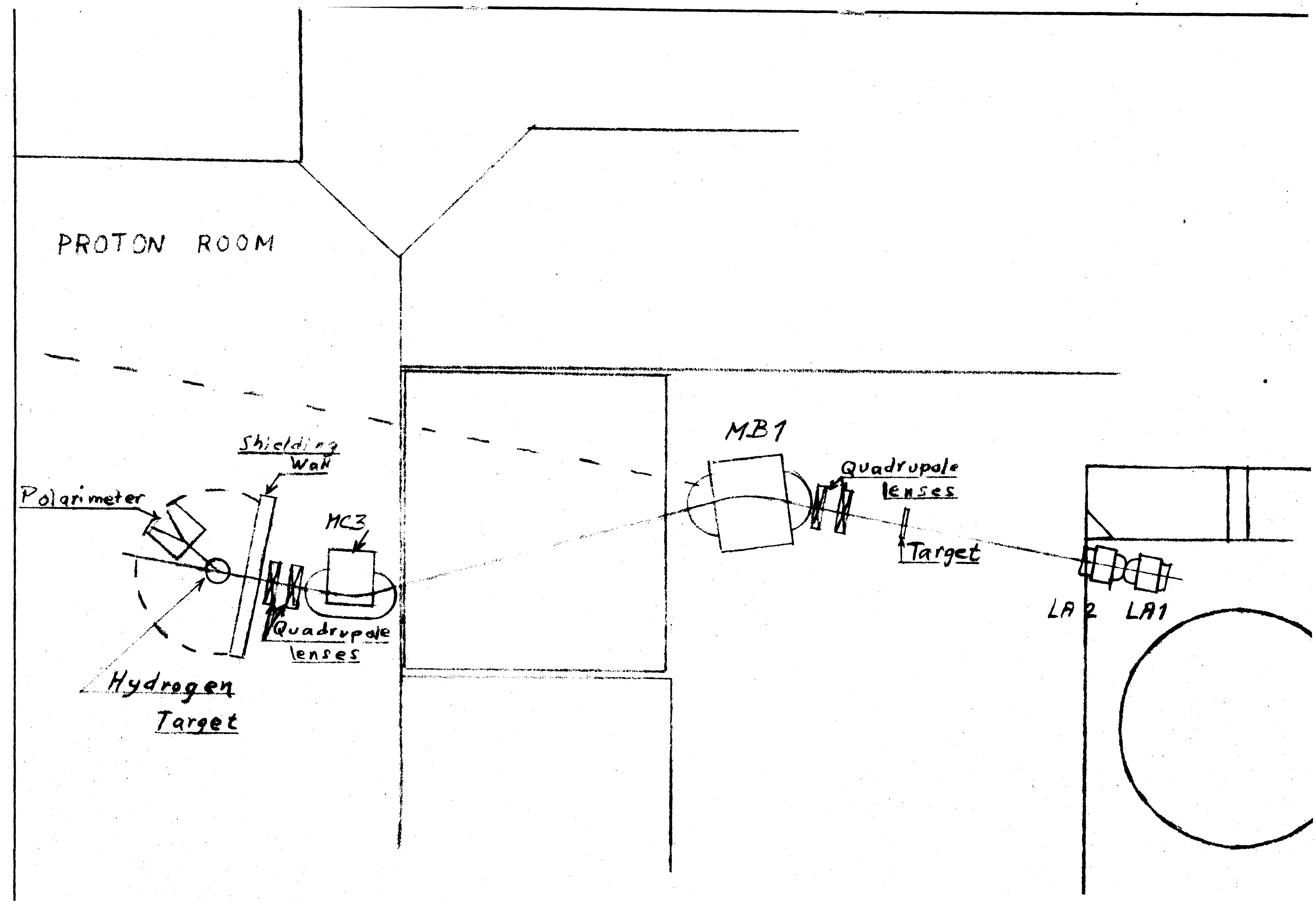
We would require in addition as many shifts as might be needed in order to help establish the externally produced π^+ beam.

Laboratory space request : 100 m^2

Office space request : 30 m^2

This space is already occupied by us, being shared with the Whitehead visiting team.

7433/p



PROTON ROOM
Shielding Wall
Polarimeter
MC3
Quadrupole lenses
Hydrogen Target
MB1
Quadrupole lenses
Target
LA 2
LA1

CERN/SC/5372 A
Exp. 4 a

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

QUESTIONNAIRE CONCERNING PROPOSED EXPERIMENT

WITH THE CERN CYCLOTRON

by : A.E.R.E. Harwell Group

date : 2nd September, 1959

Complete address : United Kingdom Atomic Energy Authority Research Establishment, Harwell, Berks.

Short title of experiment : Polarisation in neutron - proton scattering at 150 MeV.

Nature and purpose of the experiment : See Annex

Experimenters' names :	Institutions :
Dr. G. H. Stafford	National Institute for Research in Nuclear Science, Harwell, England.
Dr. C. Whitehead) Mr. F. Uridge)	U.K. Atomic Energy Authority Harwell, Didcot, England.

Are you supported by any national organization dealing with CERN matters? Yes If so, which? U.K. Atomic Energy Authority.

Please show on a floorplan the proposed arrangement of the experiment:

Floorplan attached.

Required Cyclotron Operating Conditions

Proton energy $\sim$300 MeV Experimental beam energy $\sim$150 MeV neutrons. Full beam on an internal target.

Special operating conditions: NONE

Cyclotron Time Request :

	Earliest date Month, year	No. of shifts (8 hours/shift; 3 shifts/day)
Preliminary test	Completed	
Main run	October 1959	36
Check run	March 1960	12

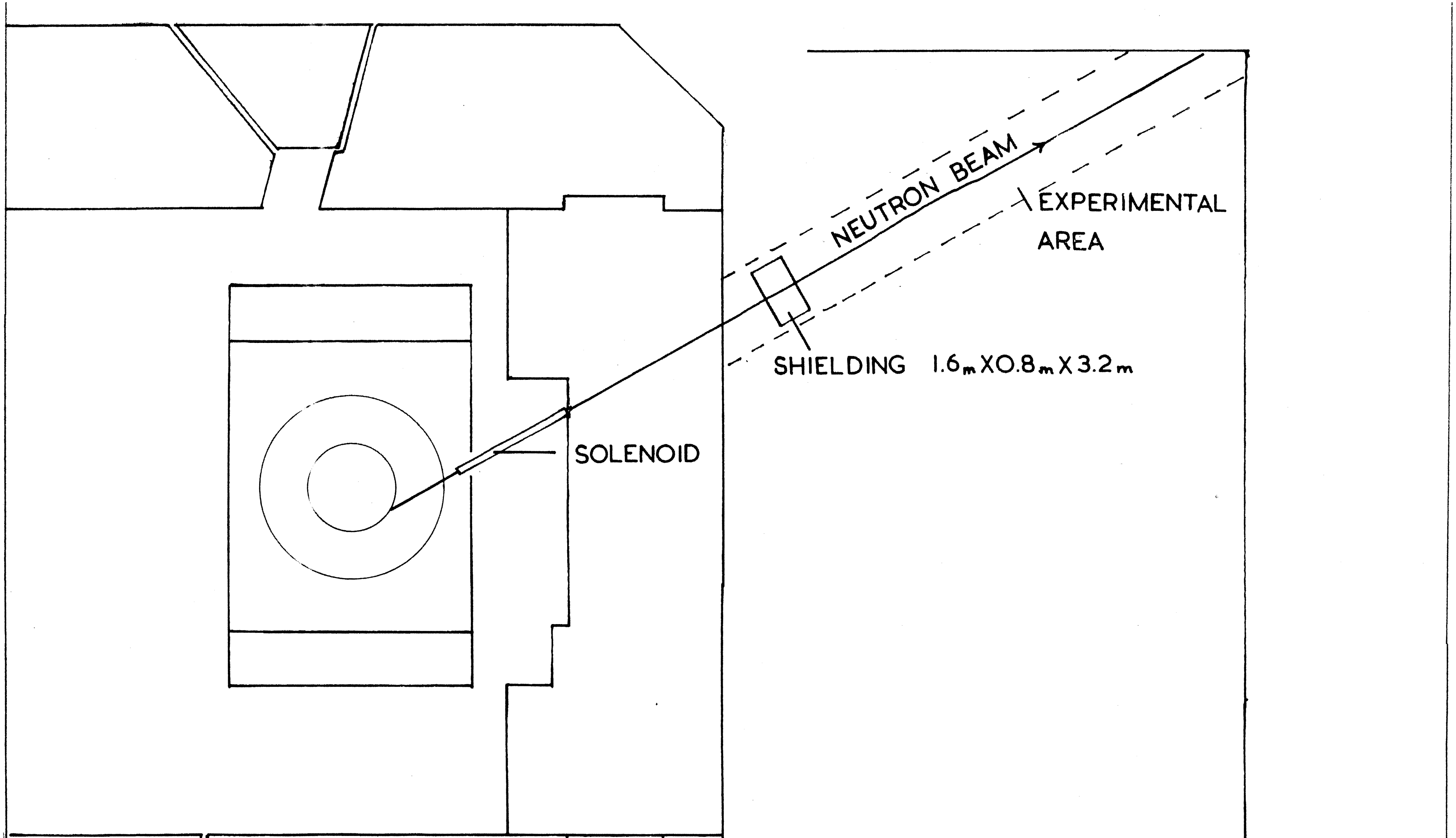
Laboratory space request : 100 m^2

Office space request : 30 m^2

Remarks :

Laboratory and office space already allocated and is being shared with the University College, London, truck team.

Enc.



Item Pos.	No. req. Nb. de p.	Descriptions	Material Matière	Pattern Modèle	Observations
1 11					
2 12					
3 13	III II I	HARWELL GROUP EXPERIMENT		Scale Echelle	CERN-GENÈVE
4 14					
5 15					
6 16					
7 17		Modifications	Signatures		

Proposed experiment to be carried out at CERN by a team from The United Kingdom Atomic Energy Authority Research Establishment, Harwell.

POLARISATION IN NEUTRON - PROTON SCATTERING AT 150 MeV

The experiment to be carried out is to measure the polarisation in neutron-proton scattering at an effective energy of approximately 150 MeV. This measurement is intended to complement work on nucleon-nucleon scattering in the energy interval from 40 MeV to 150 MeV which has already been done principally at Harvard University and at Harwell. The overall aim of this nucleon-nucleon scattering programme is to measure all possible experimental parameters in neutron-proton and proton-proton scattering, i.e. unpolarised differential cross-sections, polarised differential cross-sections and polarisation rotation parameters, such that the phase shifts describing the interactions may be specified uniquely. These phase shifts may then be compared with theoretical predictions derived from models describing the nucleon-nucleon interaction.

Some work has already been completed at CERN and this has indicated that the originally planned beam geometry did not afford a beam with sufficient intensity. The attached floor plan shows the new arrangement to be used in which the beam intensity is effectively increased by factors up to 10 compared to the geometry originally planned.

The experiment is best envisaged in three parts:

(1) Production of a beam of polarised neutrons with an effective energy of $\sim$ 150 MeV.

In order that the experiment may be completed in the minimum time a highly polarised neutron beam is desirable. Experiments at Harwell and Harvard have shown that neutron beams with up to 30% polarisation can be produced by irradiating beryllium targets with high energy protons and using the neutrons produced at large angles to the incident proton beam direction. It is proposed to use at CERN a production angle of $\sim 45^{\circ}$ and protons of ~ 300 MeV. Initial experiments have shown that this beam is polarised but the enhanced beam intensity is required to complete the measurement.

The beam polarisation is determined by measuring the asymmetry in scattering from uranium at an angle of $\sim \frac{1}{2}^{\circ}$. A long solenoid is used to precess the polarisation vector of the neutron beam and this makes it possible to measure asymmetries without moving the detectors.

The solenoid has a power dissipation of approximately 50 KW i.e. 1250 amps. at 40 volts. The power supplies for this are available and have been used.

The neutron detectors consist of large volumes of liquid scintillator viewed by a number of photomultipliers.

(2) Measurement of asymmetries in the production of recoil protons.

The polarised neutron beam after passing through the solenoid irradiates a liquid hydrogen target and the recoil protons are detected by 10 separate proton telescopes covering at 10° intervals the scattering region from 70° to 160° in the centre of mass system. Measurements of asymmetry are made simultaneously with all the telescopes.

A further telescope is used to measure the neutron energy spectrum.

(3) Measurement of asymmetries of scattered neutrons.

A second liquid hydrogen target is used in this part and in conjunction with 4 large liquid scintillator detectors the asymmetries in the scattering of neutrons by liquid hydrogen **is** measured at 4 angles simultaneously in the region 20° to 90° in the centre of mass system. The equipment is then adjusted to allow the measurement at 4 interlaced angles in this range.

In total the asymmetries will be measured at 18 angles between 20° and 160° in the centre of mass system.

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CERN/SC/5372 A
Exp. 3

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

QUESTIONNAIRE CONCERNING PROPOSED EXPERIMENT WITH THE CERN CYCLOTRON

by : R. Voss

date : 22 September, 1959.

Complete address : Liverpool University (now PS Division, CERN)

Short title of experiment : A study of the total cross section and angular distribution of the reaction $\pi^+ + D \rightarrow P + P$ at an energy of about 300 MeV.

Nature and purpose of the experiment : The reaction $\pi^+ + D \rightarrow P + P$ has been extensively studied. It appears to show a resonance at a meson C.M. momentum of about 1.7, but to date there is very little data at higher energies. It is proposed to explore this region, to confirm the resonance due to the (3/2, 3/2) state.

Experimenters' names :	Institutions :
R.G.P. Voss	CERN (formerly Liverpool)
A. Astbury	Liverpool University

Are you supported by any national organization dealing with CERN matters ? Yes If so, which ? Department of Scientific and Industrial Research, CERN Committee.

7561

1. Which beam is used ? External π^+ beam

2. What target, material and dimensions ? Polythene, about 5 GM/cm^2

4. Show shielding with principal dimensions. Is a roof required ? No

5. Describe detection equipment. 6 scintillation counters plus associated electronics.

Required Cyclotron Operating Conditions

Proton energy 600 MeV Experimental beam energy ~300 MeV

Average intensity *

*As yet uncertain, how much can be obtained ?

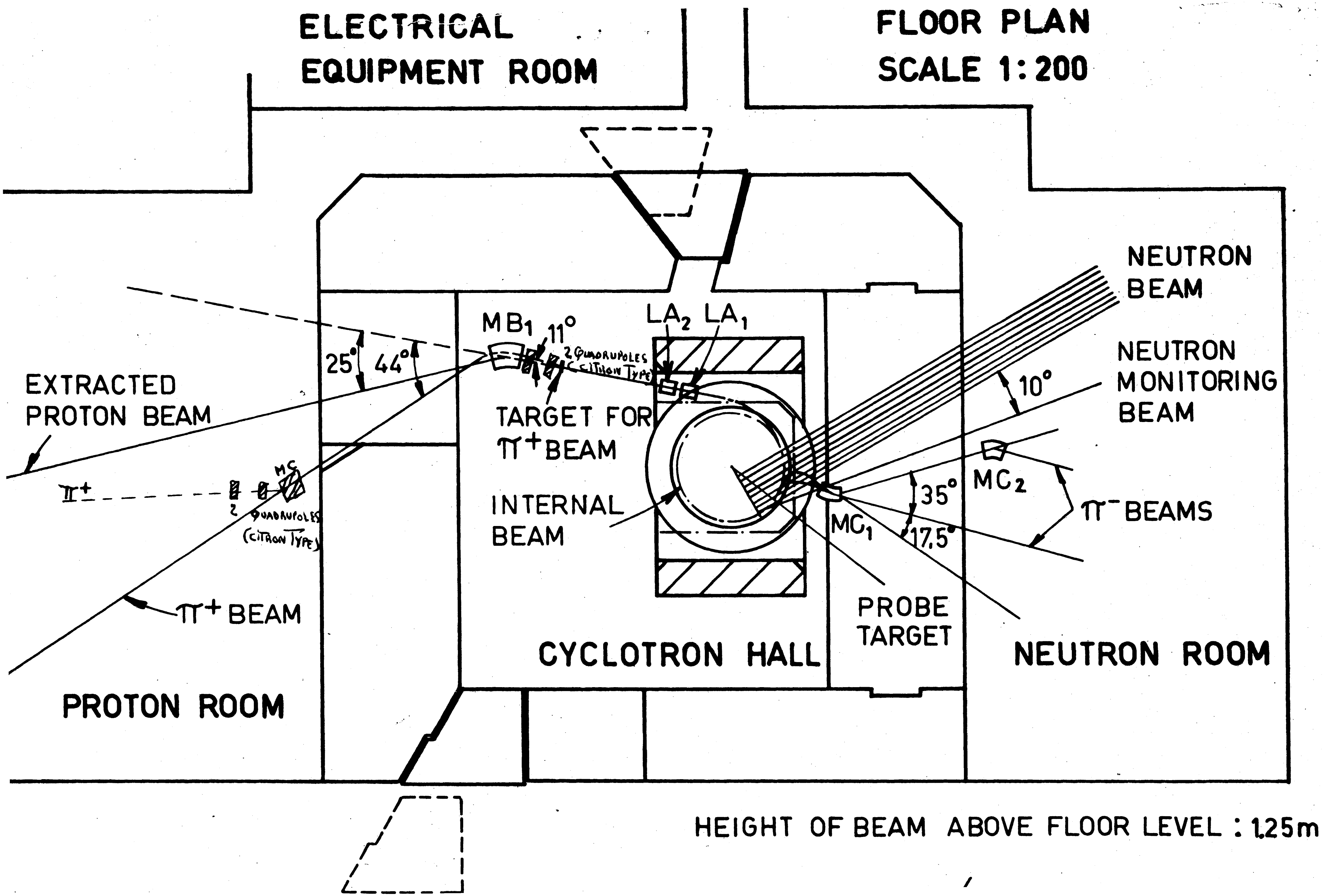
Special operating conditions : none

Cyclotron Time Request :

	Earliest date Month, year	No. of shifts (8 hours/shift 3 shifts/day)
Preliminary test	February, 1960	10 shifts
Main run	March, 1960	50 shifts

Laboratory space request : As at present in use in SC

Office space request : Nil


ELECTRICAL
EQUIPMENT ROOM
FLOOR PLAN
SCALE 1:200
NEUTRON
BEAM
NEUTRON
MONITORING
BEAM
10°
MB1
11°
2 QUADRUPOLES
(CITRON TYPE)
LA2 LA1
25°
44°
EXTRACTED
PROTON BEAM
TARGET FOR
π+ BEAM
π+
MC
2
QUADRUPOLES
(CITRON TYPE)
INTERNAL
BEAM
35°
MC2
π− BEAMS
MC1
17,5°
π+ BEAM
PROBE
TARGET
CYCLOTRON HALL
NEUTRON ROOM
PROTON ROOM
HEIGHT OF BEAM ABOVE FLOOR LEVEL: 1,25m