CERN/PSCC/79-42
Add to PSCC/78-8/P1
Date: 1979-11-21

M E M O R A N D U M

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To/A : The PSC Committee

From/De : The CERN-Copenhagen-Grenoble-Lund Collaboration

Subject/Objet: Addendum to proposal CERN/PSCC/78-8/P1
Measurments of π^+ production cross-sections.

This note is a request to the PSC Committee for an extension of the experiment SC-83 described in proposal PSCC/78-8/P1 and in the memo PSCC/79-2/M17. The extension consists of the determination of π^+ production cross-sections and requires no increase in beamtime nor any change in the beam layout as it is known to us at present.

The experiment is motivated by an ever increasing interest in studies of subthreshold pion production in heavy ion interactions. Such experiments could give information on the degree of collectivity in the production mechanism, on deviations from the standard Fermi internal momentum distribution in nuclei and on Coulomb focusing effects near the beam velocity. One experiment has been performed already, where pions with $E > 30$ MeV were registered in Ne induced reactions at energies 100 - 400 MeV/nucleon [1].

We propose here to use a $\Delta E - E$ solid state telescope (Fig 1) placed on the fixed exit side of our scattering chamber ($\Theta_{lab} = 60, 90, 120, 150^\circ$; without disturbing any data taking by the other telescopes of our exp) or on the 20 - 160° window (when no measurments are performed with our light particle telescope). The pion energies which give both ΔE and E signal ranges from 8 to 80 MeV. This upper limit is slightly larger than the maximum pion energy obtained in the collision between a nucleon in a Fermi momentum sphere moving with 0.4c ($\sim$ 86 MeV/nucleon) and a nucleon in a Fermi sphere at rest.
The delayed e^+ signal from π^+ stopped in the scintillator and thus undergoing $\pi^+\mu^+e^+$ decay ($<\tau> = 2.2\ \mu s$) will be taken in coincidence with the $\Delta E - E$ signal. The delayed signal comes either from the large scintillator or from the additional Čerenkov telescope also seen in Fig 1.

The energy integrated cross section from Fig 2 gives $d\sigma/d\Omega \approx 15\ \mu b/sr$ for Ne - NaF reactions at 100 MeV/nucleon. From this data we could estimate cross sections for 86 MeV/nucleon $^{12}C + {}^{12}C$ at 20-90° lab angle to be 1 - 10 $\mu b/sr$. The counting rates in our telescope given in Table 1 are calculated under assumptions of such $d\sigma/d\Omega$ values and beam intensities of $10^{10} - 5 \cdot 10^{10}$ ions/s . The chance coincidence rate of a proton entering into the corresponding ΔE-E window for pions with another proton triggering the system within 3 μs has been calculated with the help of $d^2\sigma/d\Omega dE$ spectra from a preinvestigation of 86 MeV/nucleon ^{12}C reactions in emulsion [2].
As one can see from Table 1 it may prove to be valuable to work at large

angels, if the degree of isotropy is much higher for pions than for protons as is indicated in [1] .

If the number of chance coincidences is found to be too high we have a second possibility to look for the delayed e^+ signal from the Čerekov counter i.e. a $S_2 - S_3 - \check{C} - S_4$ signal. The average path of the e^+ in the large scintillator will be ~6 cm which stops ~10 % of the positrons which have an energy spectrum ranging from 0 to 53 MeV.

The data aquisition will be made either on the existing PDP 11/40 computor or in the first test period only on a multi-channel analyzer in order to look only for e^+ counting rates etc.

A list of electronics to be borrowed from CERN is enclosed. In addition a few more standard electronic devices may have to be borrowed.

CERN 1979-11-21

Hans-Åke Gustafsson Bo Jakobsson

References: [1] W.Benenson et al P.R.L. 43 (1979) 683
J.Sullivan Private communication.

[2] CERN-Copenhagen-Grenoble-Lund preinvestigation of 50-100 MeV/n ^{12}C induced reactions in emulsions Unpublished.

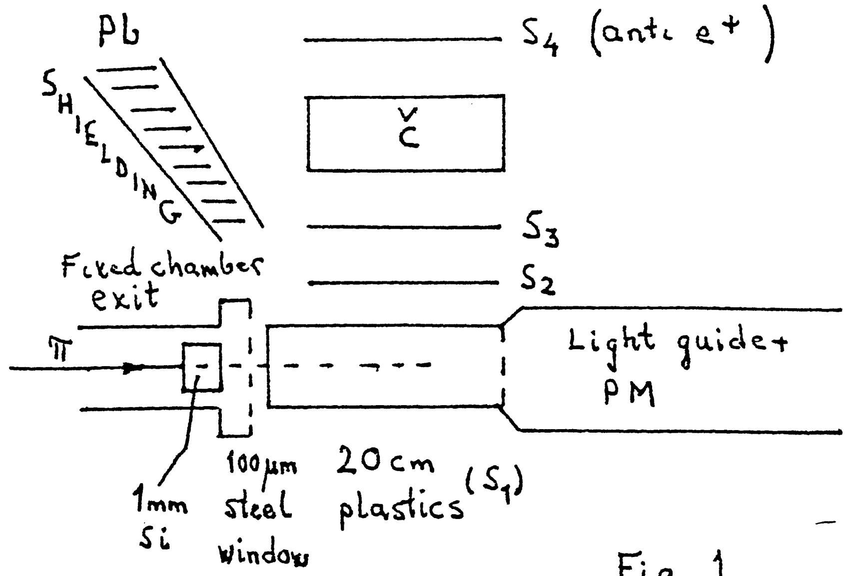
Table 1

Counting rates for π^+ in $^{12}C + ^{12}C$ at 86 MeV/nucl

	$I_{0\,min}; \frac{d\sigma}{d\Omega}_{min}$	$I_{0\,max}; \frac{d\sigma}{d\Omega}_{min}$	$I_{0\,min}; \frac{d\sigma}{d\Omega}_{max}$	$I_{0\,max}; \frac{d\sigma}{d\Omega}_{max}$
Nr of counts/h	150	760	1500	7600
Nr. of chance coinc / Nr of counts	$\Theta = 30^\circ$ ~2 $\Theta = 90^\circ$ ~0.2	~2 ~0.2	~0.2 ~0.02	~0.2 ~0.02

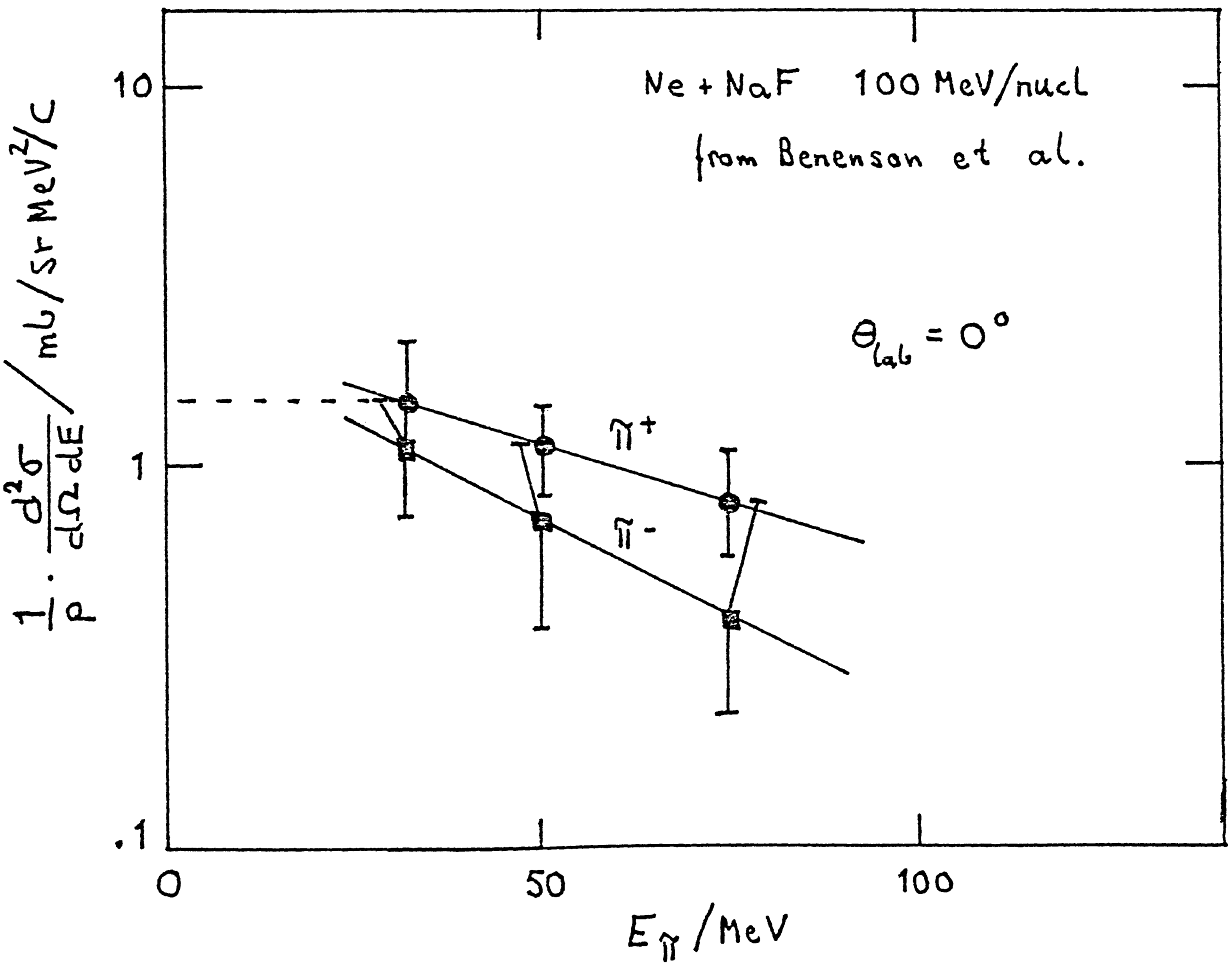
$\Omega_{acc} = 2.8$ msr $I_{0\,min} = 1 \cdot 10^{10}\ s^{-1}$ $I_{0\,max} = 5 \cdot 10^{10}\ s^{-1}$

$d_{target} = 30\ mg/cm^2$ $\frac{d\sigma}{d\Omega}_{min} = 1\ \mu b/sr$ $\frac{d\sigma}{d\Omega}_{max} = 10\ \mu b/sr$



Pb
SHIELDING
S4 (anti e+)
C
S3
S2
Fixed chamber exit
π
Light guide + PM
1mm Si
100μm steel window
20cm plastics (S1)

Fig 1



Ne + NaF 100 MeV/nucl
from Benenson et al.
θlab = 0°
π+
π-
10
1
.1
0
50
100
$\frac{1}{p} \cdot \frac{d^2\sigma}{d\Omega dE}$ / mb/sr MeV²/c
Eπ / MeV

Fig 2

List of electronics

1. 1 Fluke high voltage supply
2. 1 Voltage divider
3. 5 N 6009 Discriminator (2 LRS 621CL)
4. 10 N 9053 Delay unit
5. 1 LRS429 Fan In/Fan Out
6. 1 LRS333 Linear Ampl.
7. 2 LRS465 Coinc unit
8. 1 Silena MCA 1024 Ch
9. 2 Nim Crates