

# Establishment of a modern experimental technique of a $\Sigma p$ scattering experiment at J-PARC

Yuya AKAZAWA<sup>1</sup>, J.K. Ahn<sup>9</sup>, T. Aramaki<sup>2</sup>, S. Ashikaga<sup>5</sup>, S. Callier<sup>10</sup>, N. Chiga<sup>2</sup>, S.W. Choi<sup>9</sup>, H. Ekawa<sup>13</sup>, P. Evtoukhovitch<sup>11</sup>, N. Fujioka<sup>2</sup>, M. Fujita<sup>2</sup>, T. Gogami<sup>5</sup>, T. Harada<sup>5</sup>, S. Hasegawa<sup>3</sup>, S. Hayakawa<sup>3</sup>, R. Honda<sup>2</sup>, S. Hoshino<sup>6</sup>, K. Hosomi<sup>3</sup>, M. Ichikawa<sup>5</sup>, Y. Ichikawa<sup>3</sup>, M. Ieiri<sup>1</sup>, M. Ikeda<sup>2</sup>, K. Imai<sup>3</sup>, Y. Ishikawa<sup>2</sup>, S. Ishimoto<sup>1</sup>, W.S. Jung<sup>9</sup>, S. Kajikawa<sup>2</sup>, H. Kanauchi<sup>2</sup>, H. Kanda<sup>7</sup>, B.M. Kang<sup>9</sup>, H. Kawai<sup>4</sup>, S.H. Kim<sup>9</sup>, K. Kobayashi<sup>6</sup>, T. Koike<sup>2</sup>, K. Matsuda<sup>2</sup>, Y. Matsumoto<sup>2</sup>, K. Miwa<sup>2</sup>, S. Nagao<sup>2</sup>, R. Nagatomi<sup>6</sup>, Y. Nakada<sup>6</sup>, M. Nakagawa<sup>13</sup>, I. Nakamura<sup>1</sup>, T. Nanamura<sup>3,5</sup>, M. Naruki<sup>5</sup>, S. Ozawa<sup>2</sup>, L. Raux<sup>10</sup>, T. Rogers<sup>2</sup>, A. Sakaguchi<sup>6</sup>, T. Saka<sup>2</sup>, H. Sako<sup>3</sup>, S. Sato<sup>3</sup>, T. Shiozaki<sup>2</sup>, K. Shirotori<sup>7</sup>, K. N. Suzuki<sup>5</sup>, S. Suzuki<sup>1</sup>, M. Tabata<sup>4</sup>, C.d.L. Taille<sup>10</sup>, H. Takahashi<sup>1</sup>, T. Takahashi<sup>1</sup>, T.N. Takahashi<sup>7</sup>, H. Tamura<sup>2,3</sup>, M. Tanaka<sup>1</sup>, K. Tanida<sup>3</sup>, Z. Tsamalaidze<sup>11,12</sup>, H. Umetsu<sup>2</sup>, M. Ukai<sup>1</sup>, T.O. Yamamoto<sup>3</sup>, J. Yoshida<sup>3</sup> and K. Yoshimura<sup>8</sup>

<sup>1</sup>High Energy Accelerator Research Organization (KEK),

<sup>2</sup>Department of physics, Tohoku University, Japan

<sup>3</sup>Japan Atomic Energy Agency (JAEA), Japan

<sup>4</sup>Department of physics, Chiba University, Japan

<sup>5</sup>Department of physics, Kyoto University, Japan

<sup>6</sup>Department of physics, Osaka University, Japan

<sup>7</sup>Research Center for Nuclear Physics (RCNP), Osaka University, Japan

<sup>8</sup>Department of physics, Okayama University, Japan

<sup>9</sup>Department of physics, Korea University, Korea

<sup>10</sup>OMEGA Ecole Polytechnique-CNRS/IN2P3, France

<sup>11</sup>Joint Institute for Nuclear Research, Russia

<sup>12</sup>Georgian Technical University (GTU), Tbilisi, Georgia

<sup>13</sup>RIKEN, Japan

E-mail: akazawa@post.kek.jp

(Received November 29, 2019)

We are performing a scattering experiment between a  $\Sigma$  hyperon and a proton (J-PARC E40) at the K1.8 beamline in the J-PARC Hadron Hall. The purpose of this experiment is to investigate the  $\Sigma N$  interaction by measuring the differential cross sections of the  $\Sigma^+ p$ ,  $\Sigma^- p$  elastic scatterings and  $\Sigma^- p \rightarrow \Lambda n$  inelastic scattering. The experimental data gives a strong constraint on the theoretical models of the  $\Sigma N$  interaction. The identification of  $\Sigma p$  scattering event with a high statistics is important by overcoming the difficulties in the hyperon proton scattering experiment. We have introduced a new identification method of the  $\Sigma p$  scattering event, which does not need to detect  $\Sigma$  particles directly. We used a new detector system called CATCH and two spectrometer systems installed at the upstream and the downstream of a liquid hydrogen target. A high intensity  $\pi$  beam of 20 M/spill was used to produce  $\Sigma$  particle. The momenta of  $\pi$  beam and scattered  $K^+$  were measured by the spectrometers to reconstruct the momentum of a  $\Sigma$  beam produced via the  $\pi p \rightarrow \Sigma K^+$  reactions. The scattering angle and the kinetic energy of recoil protons from the  $\Sigma p$  scattering were measured by CATCH for the identification of the  $\Sigma p$  scattering events by checking the kinematic consistency.

A part of the experiment was performed in 2018 and 2019 in J-PARC. As a result of analyzing the collected data, the  $\Sigma^-$  production and the  $\Sigma^- p$  scattering reaction have been identified. It means that our new measurement and analysis method are successfully working well. Analysis for deriving the differential cross section of the  $\Sigma p$  scattering is on going.