

INDIANA COOLER (1981 – 2002) – ARCHIVE

The ‘Indiana Cooler’ was a storage ring for light ions consisting of a circular magnet lattice of about 100 m in circumference. It was part of the Indiana University Cyclotron Facility (IUCF). Initially, the IU Cyclotron delivered the ion beam for the ring; eventually a dedicated Injector Cyclotron was added. The Cooler ring was built specifically for the purpose of exploiting the novel technology of electron cooling which made the use of an internal target possible. For more, see: H.O. Meyer, *The Indiana Cooler: a Retrospective*, Annu. Rev. Nucl. Part. Sci. 2007. 57:1-31

During my involvement with the Cooler, many documents concerning the construction and commissioning of the machine and covering much of the conducted research have accumulated in my files. After some culling and ordering, I have submitted these documents to the **Indiana University Archives**. The material is contained in five boxes. Each box comes with a detailed table of content.

Hans-Otto Meyer, April 2018

Box 2: Cooler Experiments

The Cooler experiments were numbered consecutively after they had been accepted by a program advisory committee. Experiments that did not receive beam time are not listed here.

CE01: see Box 1

CE02: Pionic Atoms as Compound States in Nucleon-Nucleus Collisions (Meyer, IUCF)
proposal (1984), update (Dec. 1989), theoretical motivation, detector issues

CE03: Kinematically complete Measurements of $pp \rightarrow pn\pi^+$ near threshold (Daehnick, Pittsburgh)
Proposals 1985 and 1986, layout in the T-region
Data 1992

CE08: Proton-Proton Analyzing Power in the Coulomb-Nuclear Interference Region (Pitts, U of Wisconsin)
proposal (1988), planning details, ann. rep. contribution, A_y calibration in the 64” scattering chamber

CE09: Measurements of Electron Capture Cross-Sections (Ross, IUCF)
proposal (1988), some supporting info

CE11: Measurements of Dielectronic Recombination Using the IUCF Cooler (Tanis, Western Michigan U)
proposal 88-101, supporting info

CE12: Search for Ordering in Cold Ion Beams (Schiffer, Argonne Natl Lab)
proposal 88o-102, supporting info, another proposal on crystallization that got rejected

CE13: A Search for Narrow Dibaryon Resonances with $^1\text{H}(^3\text{He}, pp)X$ Using the IUCF Cooler (Pancella/Meyer, IUCF)

CE14: Spin Dependence of the N-N interaction as seen in $^3\text{He}(p, n)3p$ (Goodman/Sowinski, IUCF)
proposal 88-106, feasibility arguments, Goodman letter, layout of the T-region

CE16: The Spin-Splitter: Study of a Method for In-Site Polarization in Storage Rings (Penzo, INFN and U of Trieste, Italy)
Proposal 88-104, letters by Rosmanith and Penzo

CE17: Exploring the Luminosity Boundaries of the IUCF Cooler (Pollock, IUCF)
Proposal, Pollock’s notes

- CE18: Limits of Energy Resolution for Experiments with the Indiana Cooler (Przewoski/Meyer, IUCF)
Proposal 90-01, PAC response
- CE19: Study of the $^{16}\text{O}(p,n)^{16}\text{F}(0^-)$ Reaction at $T_p=300$ MeV in the IUCF Cooler (Bowyer, Vigdor, IUCF)
Proposal
- CE21: Pion Production in pd-Reactions Near Threshold (Scobel/Meyer, U Hamburg)
Proposal 90-101, PAC defense, analysis by Rohdjess
- CE22: Nonlinear Beam Dynamics Experiments at the IUCF Cooler Ring (Lee, IUCF)
Proposal 90-102
- CE23: see Box 1
- CE25: Investigation of the ^3He Wave Function by Quasi-free Scattering (Sowinski/van den Brand, IUCF/U of Wisconsin)
Proposal 90-111, experimental planning, detector details, run plans, results
- CE26: Tests of Gas Storage Cells in the Cooler (Pitts, U of Wisconsin)
Proposal, this was Karl's storage cell (April 1991), runs Feb to Jun 1991
CE28: update of CE11 (Tanis, Western Michigan U)
proposal 91-02
- CE30: An Immersed-Field Target - An IUCF Cooler Experiment (Pollock, IUCF)
proposal 91-04
- CE31: Cross section and analyzing power for $pp \rightarrow d\pi^+$ (Segel, Northwestern U)
Proposal 91-09, MC simulation (Ackerstaff), experiment description for group meeting 1/13/95, about Coulomb corrections, proposal 92-103 (von Przewoski), discussion of partial wave contributions.
P.C. Heimberg, PhD thesis, 'A study of $pp \rightarrow d\pi^+$ at threshold'
- CE32: Search for Resonant Pion Production by Protons on Carbon using Recoil Detection (Bent/Hardie, IUCF)
Two proposals 91-11, 91-107
- CE34: Modelling the IUCF Cooler Ring (Lee, IUCF)
Proposal 91-103
- CE35: see box 3
- CE36: Measurements of Spin-Dipole State Analyzing Powers from the Reaction $^{12}\text{C}(d, ^2\text{He})^{12}\text{B}$ at 280 MeV (Spraker, IUCF)
Proposal 91-107
- CE38: Analyzing Powers for $pp \rightarrow pn\pi^+$ near Threshold (Daehnick, U of Pittsburgh)
Proposal 92-02, letters between Daehnick, Wilkin and Meyer, results, Daehnick's contribution on pion production to Boulder, CO symposium, 1993
R.W. Flammang, PhD thesis, 'Analyzing Powers and cross sections for $pp \rightarrow pn\pi^+$ close to Threshold'
- CE42: Measurements of pp Spin Correlation Parameters at $\theta_{cm}=90^\circ$ in the Energy Range Between 100 and 500 MeV (Przewoski, IUCF)
Some data: stability of polarization during energy ramping
- CE44: Pion production $\vec{p}\vec{p} \rightarrow pp\pi^0$ with polarized beam and polarized target (Meyer, IUCF)
1 History, general documents
Pollock's 1984 (!) proposal for $\vec{p}\vec{p} \rightarrow pp\pi^0$, first pion with polarized target (9/16/97), *Pion production at IUCF with pol. Beam and pol. Target* (Balewski talk, 1999)

- 2 Hardware
floor plans, scattering chamber, scale drawings, detector positions and dimensions, Target chamber modification (12/97), target cells, E- and H-detector, BGO recoil detector (not realized), beam polarization based on fields in ring magnets
- 3 The running of the experiment
Run plans, meeting minutes, correspondence, run lists: c44b (2-8 May, 97), c44c (19-25 June, 97), c44d (10-17 Sep 97), c44e (14-21 Oct 97), c44g (16-29 Jan 98), c44h (16-29 Jun 98), c44i (8-21 Oct 98), sorting master directory
- 4 Event analysis topics
WC efficiency and angle offset, matching of WC prongs with scintillator elements, Light from scintillators: position and magnetic field dependence, calibration in MeV, dead time
- 5 Background investigation
- 6 Correction for central hole in detector stack
- 7 Event sorting
gate assignments, sorting conditions, complete ce44 sample spectra, Analysis procedure (Pia Thörngren, 12/98), target polarization not quite longitudinal, 'ntuples' with complete sorting code, determination of σ_{tot} , $\Delta\sigma_T$ and $\Delta\sigma_L$, pp scattering (ev 7), luminosity from 45 detectors, single-prong events (ev 6) and observation of $\mu^\pm$ decay
- 8 Observation of a large longitudinal analyzing power
- 9 Partial wave decomposition
Dependence of observables on energy and azimuth, Ps strength from total cross sections, Knutson's contributions (9/99), orthogonal filtering, determining partial wave coefficients (HOM, 6/00), final coefficients
- 10 Final data

CE45: Measurement of the Spin Correlation Coefficient A_{zz} with the Indiana Cooler (Meyer, IUCF)

Proposal 92-109, PAC response, run plan, C45D, first use of C-solenoid

CE46: Skimmer Targets for the Cooler (Pancella, Western Michigan U)

Proposal 92-111, correspondence from Pancella

CE48: Nonlinear Beam Dynamics Experiments at the IUCF Cooler Ring (Lee, IUCF)

Proposal 93-01

CE51: update of CE43

Proposal 93-06

CE54: The Extraction of Spin-Dependent Cross-Sections by Measurement of the Beam Lifetime (Sowinski, IUCF)

Proposal 94-03, PAC response, planning meeting, email about experiment, design of bunched-beam intensity monitor (Ball), emails from Haeberli

CE55: Measurement of beam depolarization by beam-gas interaction (Meyer, IUCF)

Proposal 94-101, PAC response, some notes on planning, evidence for beam depolarization in CE08 and CE35

CE57: Acceleration through Depolarizing Resonances with an RF Dipole (Krisch, U of Michigan)

proposal

CE59 Search for Channel Coupling Between $pp \rightarrow d\pi^+$ and $pp \rightarrow pn\pi^+$ (Segel, Northwestern U)

proposal 94-111, PAC response

CE60: Feasibility Test of an Optical Beam Monitor (Meyer; Horowitz, IUCF)

Proposal (April 1995), PAC presentation, light seen from beam through the target cell, log book from the data run Jan 27, 1995

CE64: Breakup in the p+d Reaction, Beam and Target Polarized (Meyer, IUCF)

Proposal 95-101, PAC response, earlier proposal 93-04
PAC defense
Experiment planning, details and pictures
CE64 correspondence
Analysis of yields
PRL draft of paper on Axial Observables
Phase space code with Pia and Johanna

CE67: Spin-dependent cross sections for $pp \rightarrow pn\pi^+$ (Daehnick, Pittsburgh)

Proposal 96-05, correspondence with Wilkin, Wellinghausen (1996), correspondence 1997, write-up for 1998 DNP at Santa Fe, partial waves and results, what can be learned? (HOM, 1999), results 1/16/01

CE70: The nuclear polarization of molecular hydrogen formed by recombination of polarized atoms in a storage cell (Wise, U of Wisconsin)

- 1 Planning
Early memos from Haeberli, June 4, 1996
Proposal to IUCF, May 7, 1997
Email exchange between Wise and Haeberli with IUCF
Planning and pictures of setup
First run (CE70A) Nov. 1999
- 2 Results
Planning for continuation
Talk by Hauke Kolster at IUCF Sept. 17, 1999
Analysis of production run (CE70D) by Wellinghausen
Talk by Wise at PST2001

CE79: Spin correlation in $pd \rightarrow t\pi^+$ (Przewoski, IUCF)

Data for spin-dependent total cross section, much info on the polarization formalism, results, comments from Falk, Wilkin

CE80: Spin dependence of the three-nucleon force, spin correlation coefficients in pd scattering (Przewoski, IUCF)

- 1 Experiment
Detector and target layout, Energy loss in stack, Silis (detectors, electronics, hydrogen damage)
Slow ADC assignments, Spin bits
Info on individual runs, run summaries, run preparations, Run lists
- 2 Event sorting
K_gains, sili gains (TJ), Ce80 tracking algorithm (HOM 2/12/01), Double bananas, multiplicities (2/12/01), Subtracting background (HOM 2/16/01), Study of sili performance (HOM 2/27/01), F-detector handling (5/3/01), The funny shape of Ayp (HOM 1/28/03)
- 3 From yields to observables
Mathcad code (3/24/03), MSword summary of ϕ -dep cross section, Fourier analysis of combinations of trig fcts (9/2/01), Spin-dep total cross section (7/2/99), Write-up on pd analysis (B. Lorentz, 12/11/96), Early analysis efforts, mathcad work
Ytopo, General, fitting algorithms, YTOPO3v, YTOPO2v, YTOPOlong
- 4 Final data
- 5 Publication (a sad story)
- 6 T.J. Whitaker, PhD thesis, 'Measurement of A_z^p , $C_{zz,z}$ and $C_{y,x} - C_{x,y}$ in $\vec{d}\vec{p}$ breakup at 270 MeV'