# Operation of the Coupled Cyclotron Facility at Michigan State University

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**NSCL / Michigan State University**

**Workshop on Accelerator Operations**

**SLAC National Accelerator Laboratory**

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# National Superconducting Cyclotron Laboratory

- National user facility for rare isotope research and education in nuclear science, astro-nuclear physics, accelerator physics, and societal applications
- Located on the campus of Michigan State University in East Lansing
- One of the three nuclear-science flagship facilities in the US: RHIC at BNL, CEBAF at JLAB, NSCL at MSU [2007 NSAC Long Rane Plan]
- Largest university-based nuclear physics laboratory in the U.S. – 10% of U.S. nuclear science Ph.D.s
- Over 500 employees (NSCL+FRIB), incl. 45 graduate students, and 43 faculty – over 700 users
- Graduate program in nuclear physics ranked 1st [U.S. News and World Report]
- NSCL provides accelerated beams of heavy ions from oxygen to uranium, including rare isotope beams
- Michigan State University has been selected to establish FRIB, the Facility for Rare Isotope Beams

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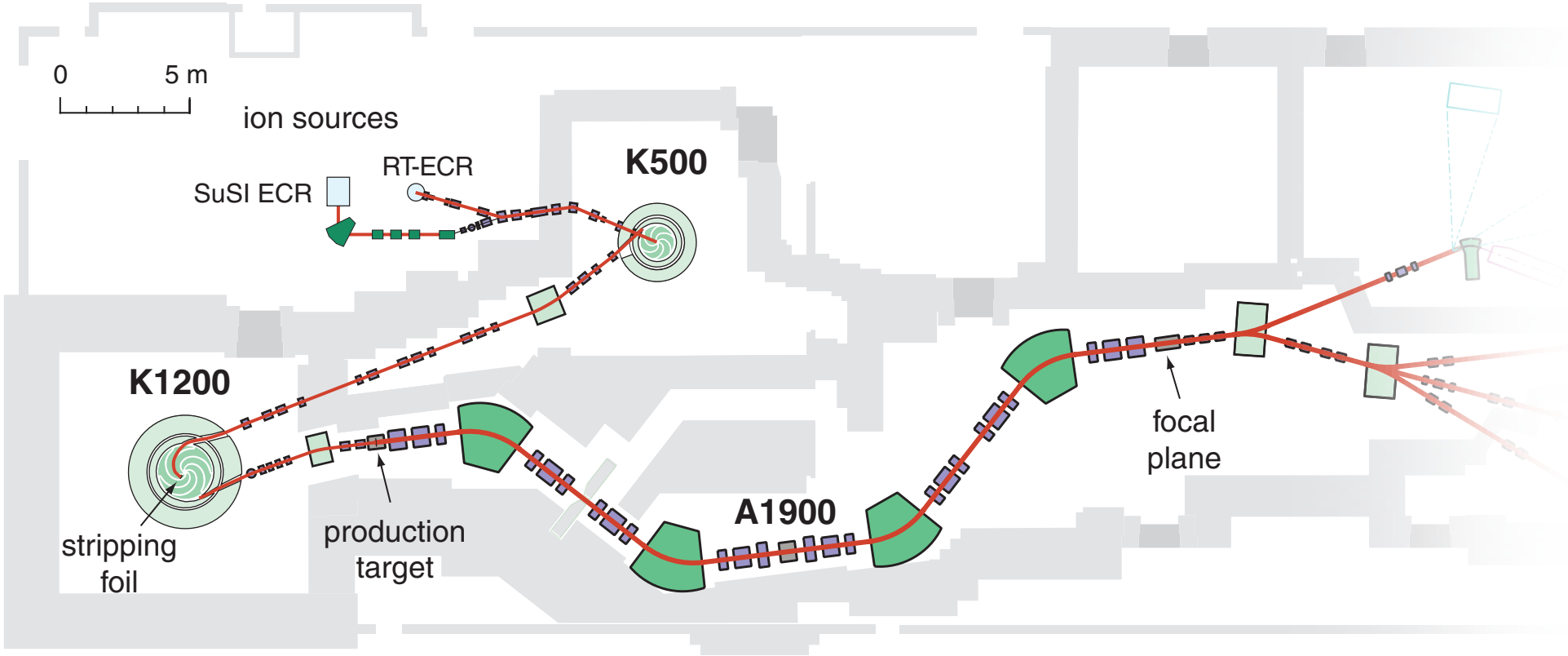
# Coupled Cyclotron Facility




2 coupled cyclotrons
primary beams: oxygen to uranium
K500: 8 - 12 MeV/u, 2-8 eμA
K1200: 100 - 160 MeV/u, up to 2 kW

A1900 fragment separator
to produce rare isotope beams

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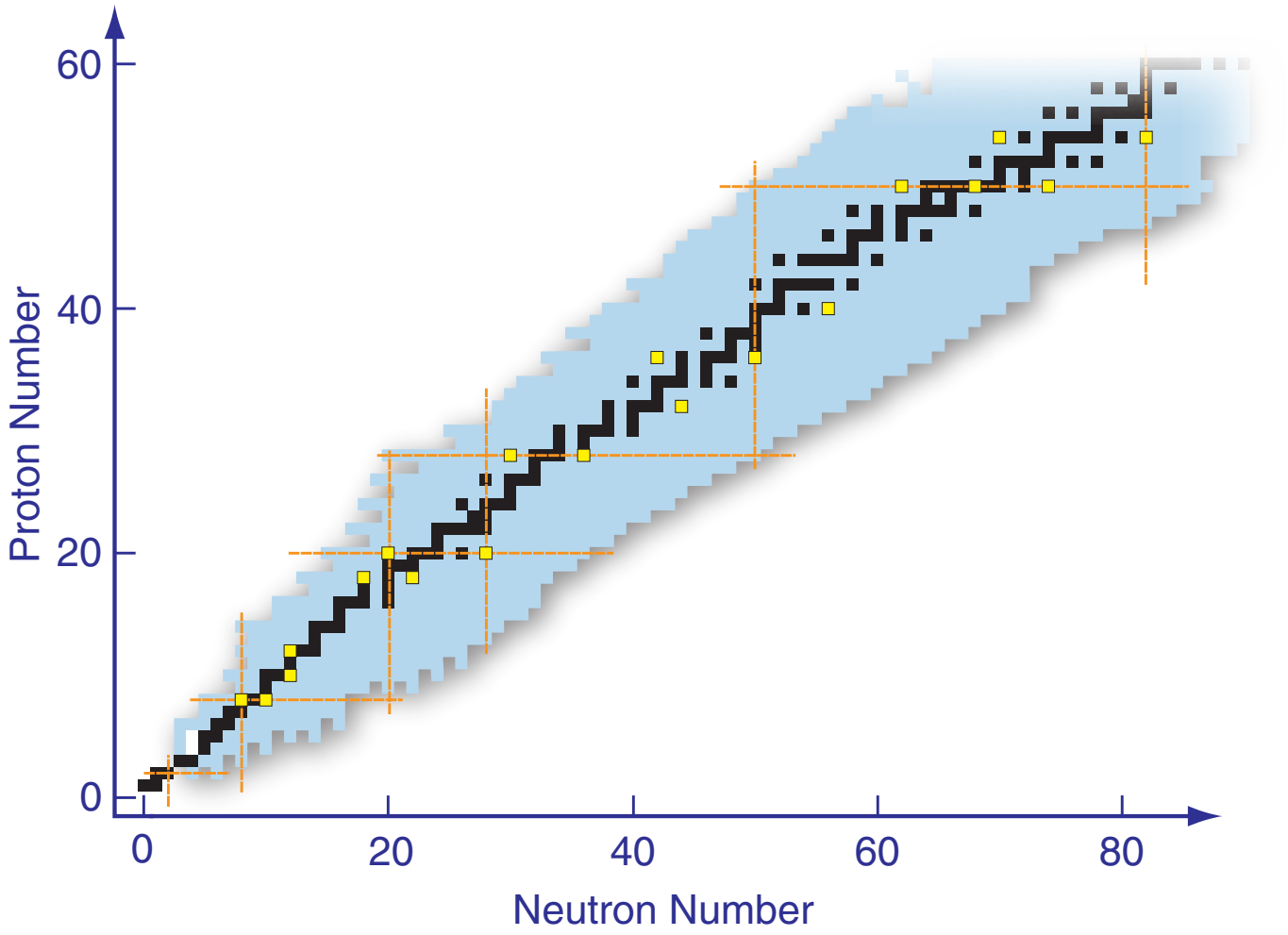
# NSCL Primary Beam List




| Particle | Energy [MeV/u] | Intensity [pnA] |
|---|---|---|
| $^{16}$O | 150 | 175 |
| $^{18}$O | 120 | 150 |
| $^{22}$Ne | 120 | 100 |
| $^{24}$Mg | 170 | 60 |
| $^{36}$Ar | 150 | 75 |
| $^{40}$Ar | 140 | 75 |
| $^{40}$Ca | 140 | 50 |
| $^{48}$Ca | 140 | 80 |
| $^{58}$Ni | 160 | 20 |
| $^{64}$Ni | 140 | 7 |
| $^{76}$Ge | 130 | 25 |
| $^{82}$Se | 140 | 35 |
| $^{78}$Kr | 140 | 25 |
| $^{86}$Kr | 140 | 25 |
| $^{96}$Zr | 120 | 1.5 |
| $^{112}$Sn | 120 | 4 |
| $^{118}$Sn | 120 | 1.5 |
| $^{124}$Sn | 120 | 1.5 |
| $^{124}$Xe | 140 | 10 |
| $^{136}$Xe | 120 | 2 |
| $^{209}$Bi | 80 | 1 |
| $^{238}$U | 85 | 0.2 |

Primary beam list as offered for experiments (July 2012)

(some available beam energies not shown)

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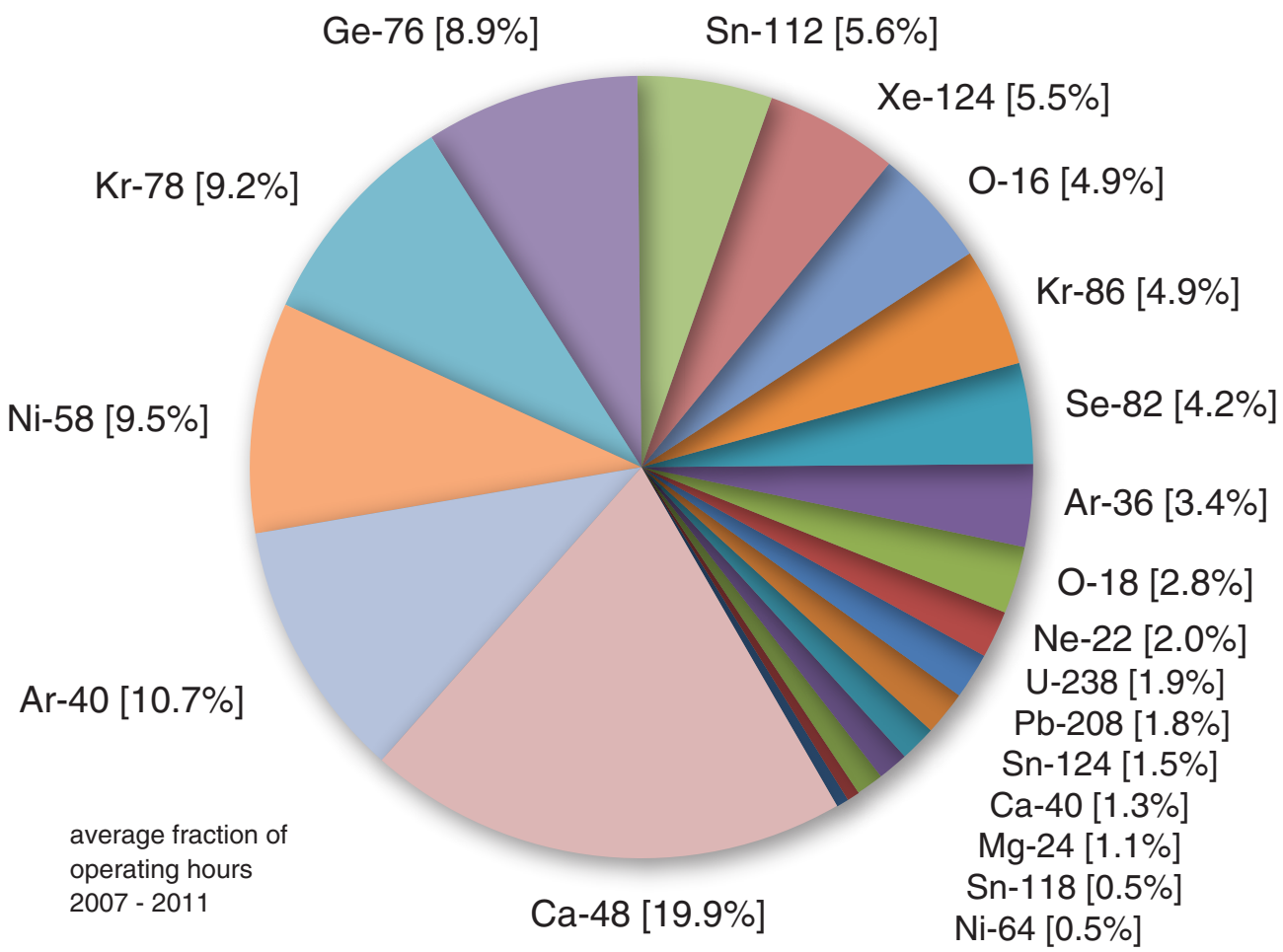
# Primary Beam Statistics

CCF delivers a different primary beam every 5 to 7 days, typically 30 beam changes per year.

The development of new primary beams (isotope and energy) is driven by user demand.

## CCF Primary Beam Isotope Statistics

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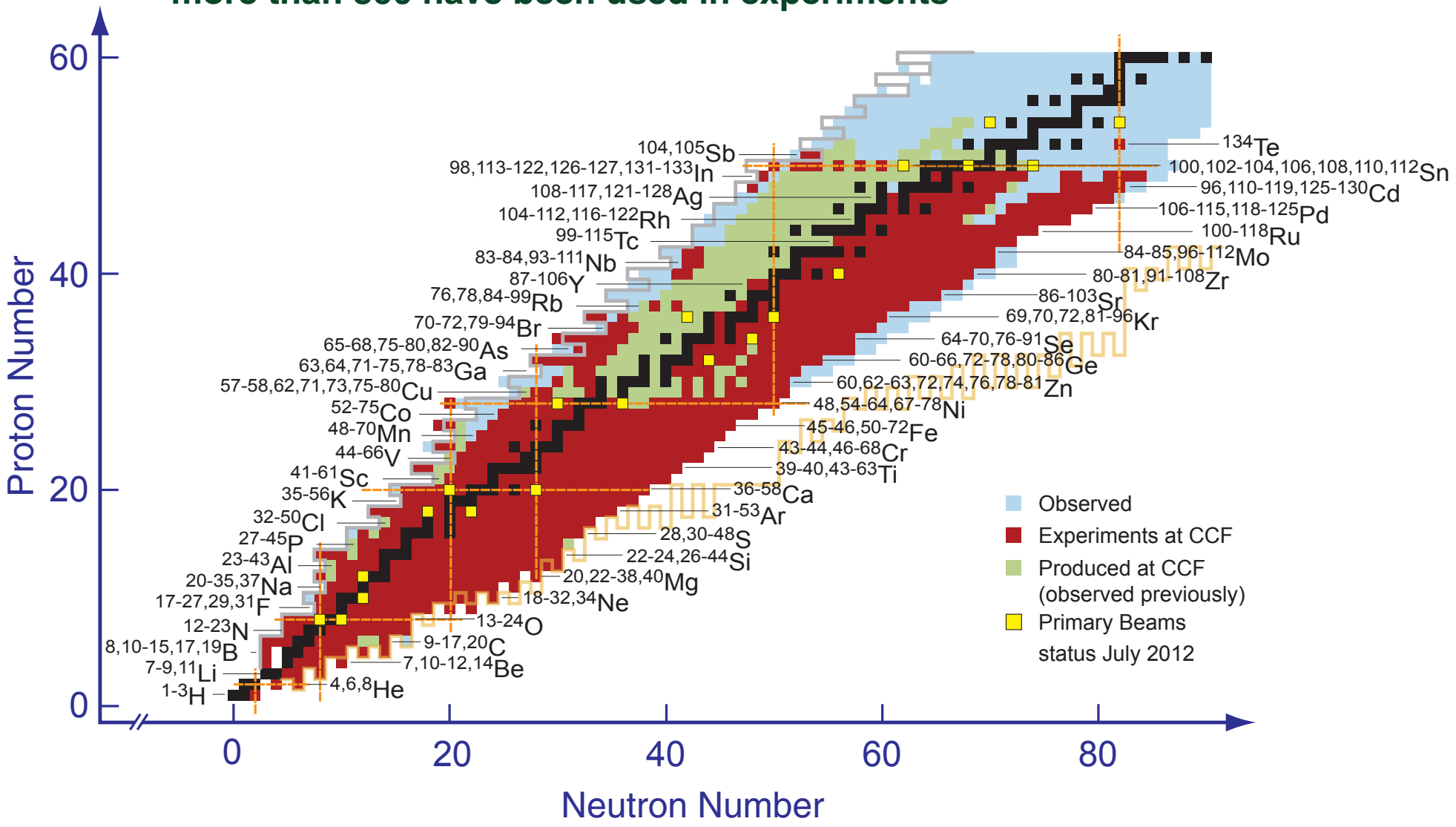
# Rare Isotopes produced at NSCL

**more than 1000 RIBs have been produced (2001-2012)**
**more than 860 have been used in experiments**

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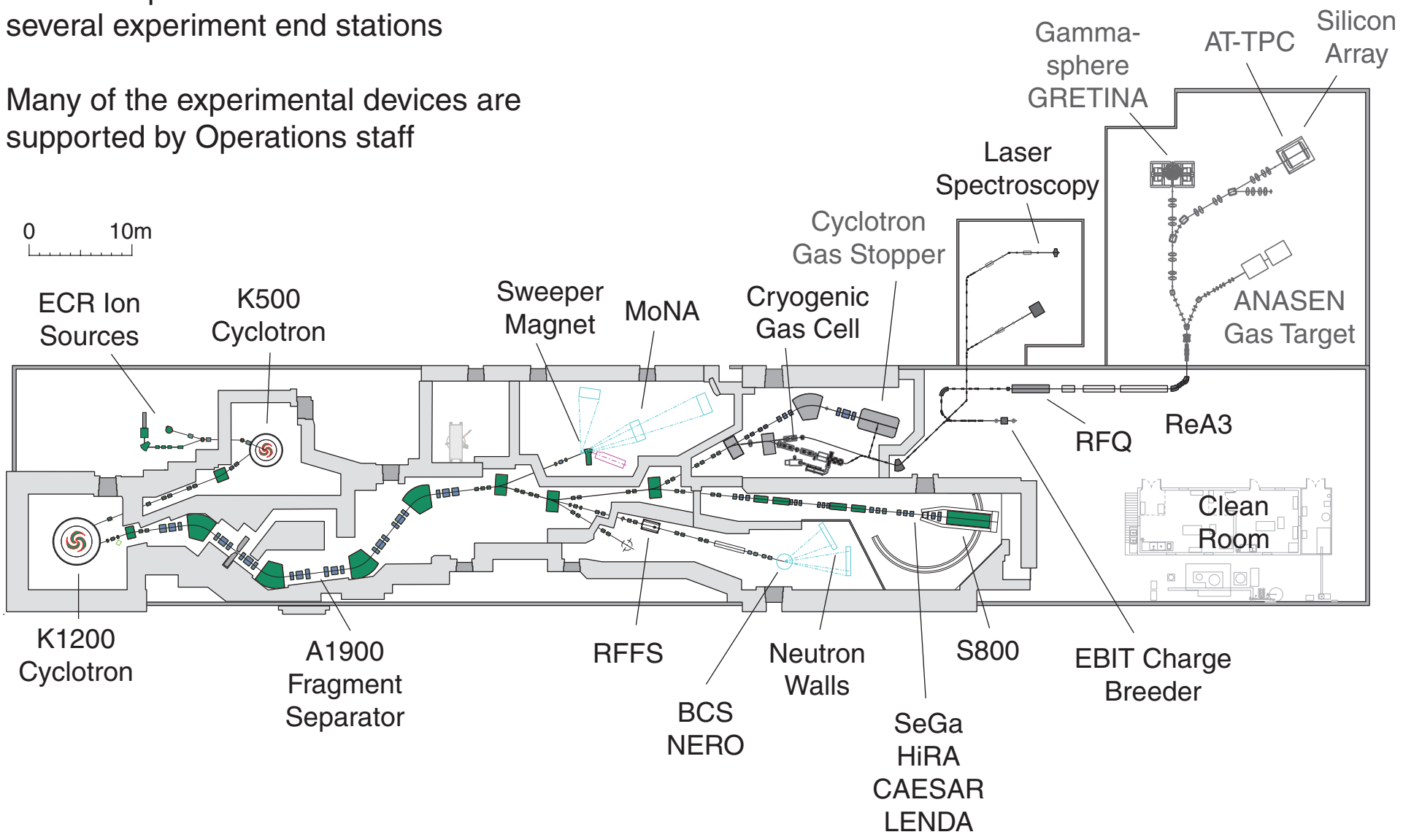
# NSCL's Facility Plan

Rare isotope beams can be delivered to several experiment end stations

Many of the experimental devices are supported by Operations staff

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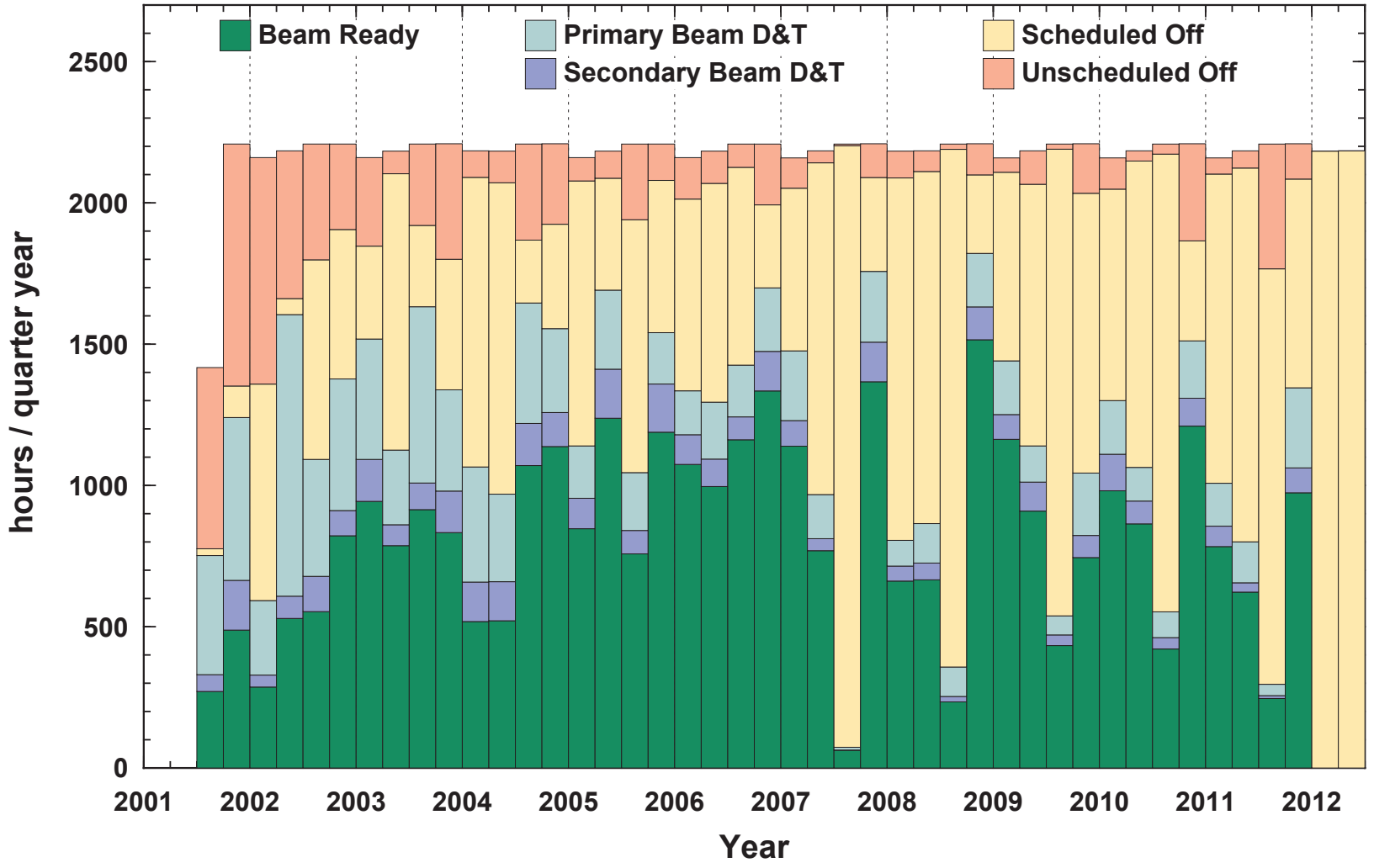
# CCF Operations Statistics




NSCL ist currently funded for 2500 operations hours per year

Coupled Cyclotron Facility (CCF) operates 24/7 during beam delivery periods

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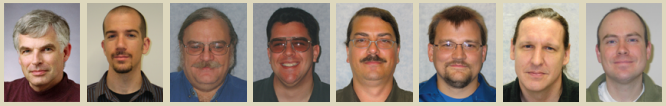
# Organizational Structure

## Operations

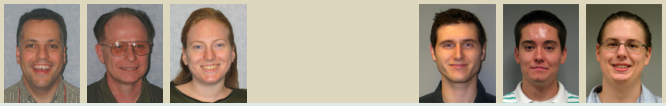
### Ion Source Group

ion source support,
weekdays 08:00-17:00 on-site,
call-in support at other times

### Operations Engineers Group

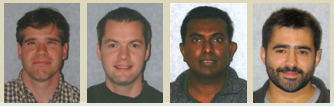


### Maintenance Engineers Group



cyclotron operations
(+ maintaining ion source tune),
24/7 on rotating shift
weekdays 08:00-17:00 during maintenance

### Beam Physicist Group



beam delivery support, weekdays 08:00-17:00 on-site,17:00-24:00 and weekend on-demand, call-in support at other times

### Development Group

weekdays 08:00-17:00 on-site, on-demand and call-in support at other times

**Electronics**
**Facilities**
**Computer**
**Mechanical Design**
**Fabrication&Assembly**

day time on-site technical support,
call-in support at other times
for RF systems, power supplys,
cryogenics, vacuum systems,
control system, computer,
mechanical repair, ...

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# Quality Management System

NSCL introduced Quality Management System to achieve and maintain high availability (third-party certification to ISO 9001 in 2008)

Every system or process failure triggers “Trouble Report”

Root cause analysis, corrective and preventive action

Labwide Preventive Maintenance Database

Scheduled Maintenance with Reminder Emails

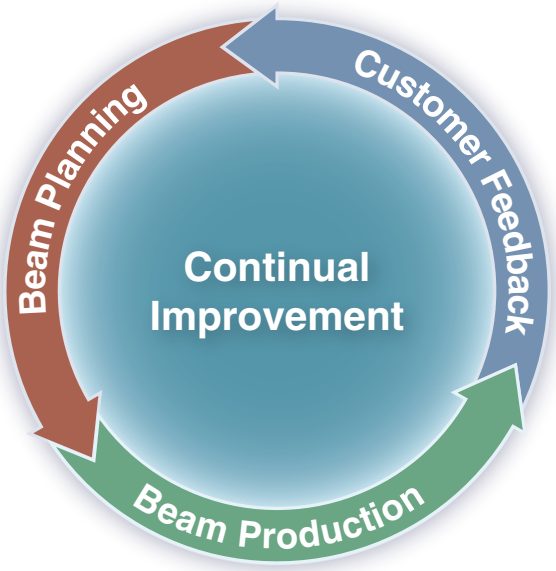
Maintenance Records to document maintenance history

Experimenter Feedback Survey to analyze “Customer Satisfaction”

Experimenter feedback helps to improve beam delivery

Employee Training

Online Training modules can be taken any time,
training database to document successful training




similar management systems for Integrated Safety (OHSAS 18001certification ) and Environmental Management (ISO 14001 certification)

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