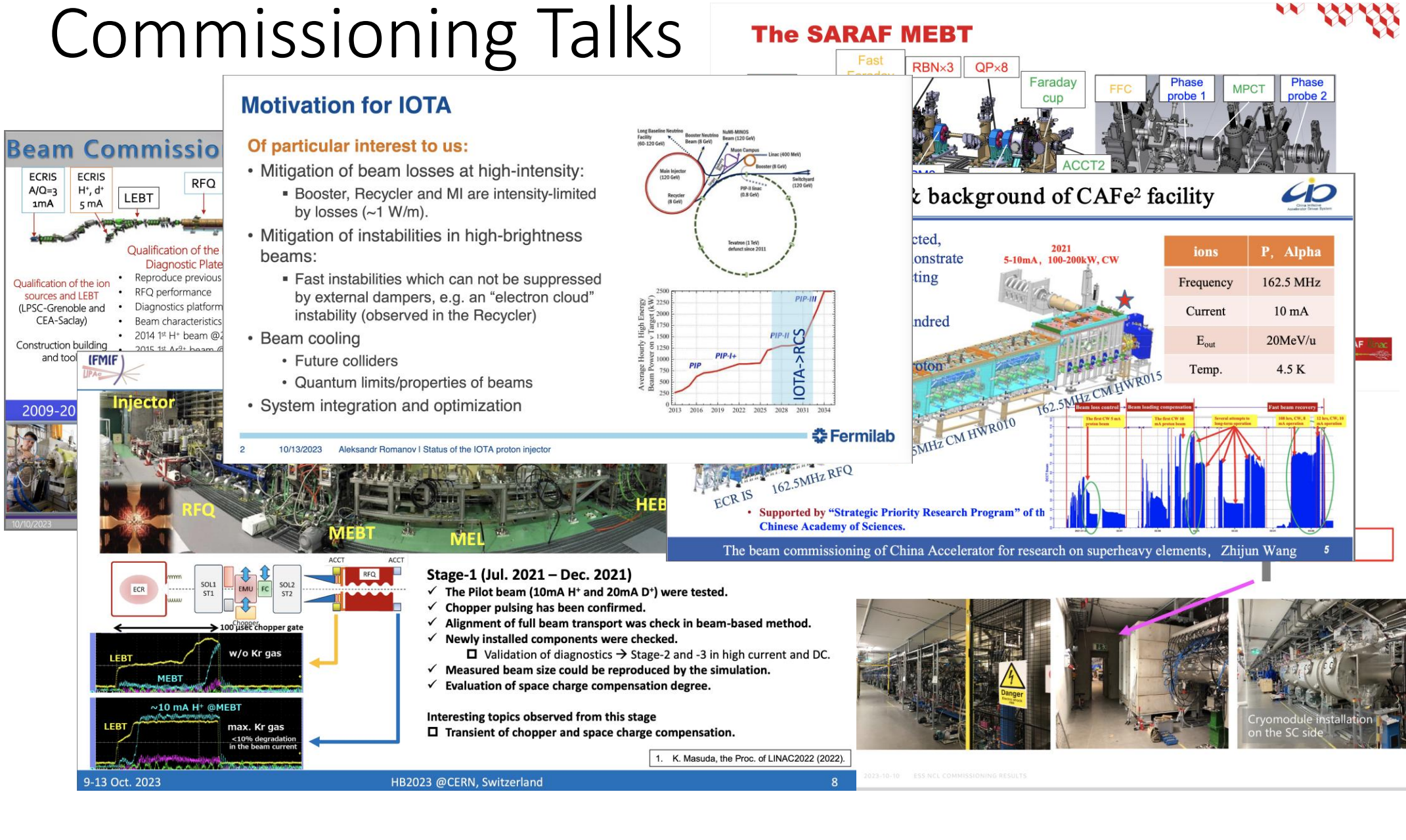
WGD Summary

Natalia Milas, Mei Bai and Sheng Wang

Some numbers to start

- 17 talks
  - 12 invited
  - 5 contributed
- Topics:
  - 7 Facility Commissioning/Status
  - 4 Facility Upgrade plans
  - 6 Operational aspects/Optimization for operations

Commissioning Talks



Commissioning Talks

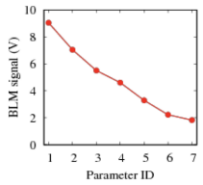
- Many facilities under commissioning or just out of it.
- Characterizing the machine at this early stage is important.
  - Knowledge of the dynamics + Diagnostics
  - How close/good is the machine model with respect to reality?
  - Longitudinal tuning is key (Linacs/low energy machines)
- Unforeseen events:
  - Scattering on beam dump
  - Phase oscillations for different beam currents

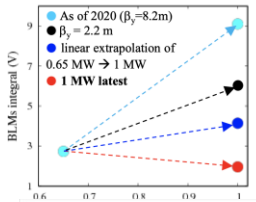
Established Facilities

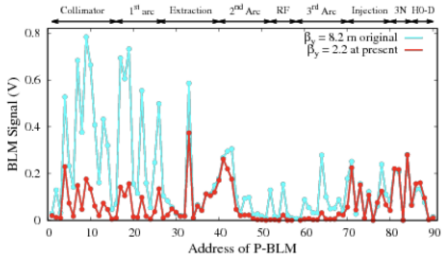
History of the RCS beam power to the MLF

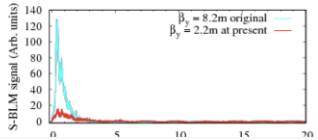
Beam loss mitigation as compared to previous 1 MW operation

ID	Parameters	BLMs integral (V)
1	Original: Tune (6.46, 6.32), β_y = 8.2m	9.04
2	Tune: (6.45, 6.36) LP by Δp/p offset of inj. beam	7.05
3	β_y = 2.2m ; Foil Vert. 20mm → 14mm	5.5
4	SB x0.8 for $3\nu_x$ = 19 partial correction	4.6
5	LP optimization (LI Dp/p + RF freq. offset)	3.28
6	TP modification	2.22
7	Tune optimization	1.82









- The residual beam loss is <
- The SC effect has sufficien
- *A laser stripping can thus g*

Pranab Saha

SNS
pow
The SNS
the hig
SRF lina
Succes
at 1.7M
Capab
SNS do
opens
leverag
potenti
scientif
applic
additio
scatter

SNS science and opportunities beyond neutron sc

At **1.7 MW** the SNS linear accelerator is the **highest power proton accelerator in the world.** The facility will be capable of **2.8 MW** after the execution of the Proton Power Upgrade (PPU)

Discussed at the 2021 Neutron Advisory Board and included in NScD 10-year strategic plan

Opportunity: Advancing the construction of the STS beamline can make the extra power available for use before the STS is completed

A multi-MW **high-power linear accelerator** is the optimal driver for applications such as:

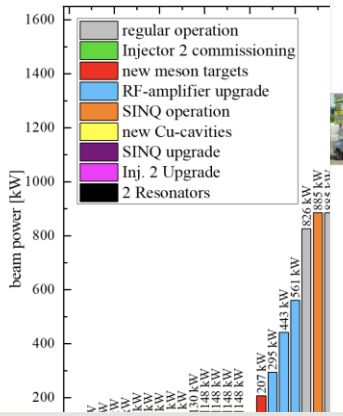
- **Isotope production** (accelerator driven production, ISOL)
- **Irradiation facility** (SEE – *Single Event Effects, High-Power Target Testing Facilities*)
- **Intense muon source** (mSR – *muon spin resonance,* muon beams)
- **Fundamental physics** (neutrinos, neutrons, accelerator R&D for muon collider)
- **Material testing for nuclear fusion** (with extracted SNS beam or target mount)
- **Accelerator driven systems** (transmutation nuclear fuel, energy production)

OAK RIDGE National Laboratory | SPALLATION NEUTRON SOURCE

14

History of the Beam Power

Designed for 60 kW



10 Year Upgrade Plan

- **Electronics and Control System**
  - Replacement of CAMAC-based system
  - New Firmware and Control system integration
  - interlock integration and level adaption

started -2026

- **RF – Renewal and/or Upgrade**
  - new Flattop
  - Renewal / Upgrade of RF-amplifiers (SSD)

Injector 2 -2025
prestudies -2030
strategic decision

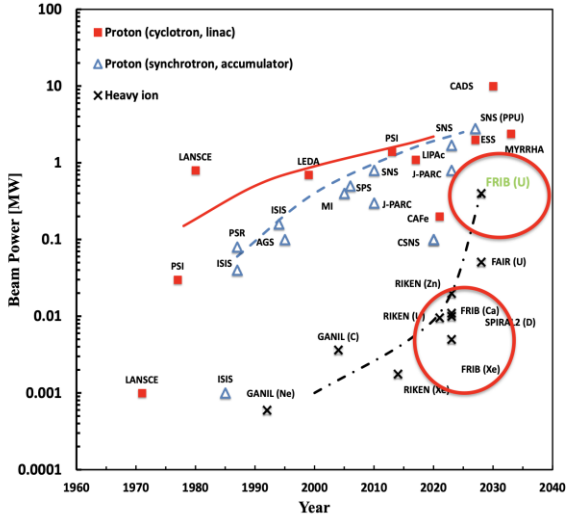
- **Magnet Renewal and Spares**
  - many coils over 50 years old
  - Bending magnets critical stock

inventory
stock keeping

- **Diagnostics**
  - Fast Wire Scanners (beam current 3 mA)
  - BPMs in 590 MeV beamline

started -2026
strategic
started -2030
-2026

Evolution of Proton and Heavy Ion Beam Power



- Compared to proton-based facilities, lower-energy, heavy-ion based facilities face challenges, including high dissipation-power density and high radiation damage
  - FRIB started user operations at 1 kW
  - Progressively increasing the average beam current
  - Currently operating at 10 kW
  - Beam power ramp-up goal: 400 kW in 2028

J. Wei, HB2023 THC1I2, Slide 7

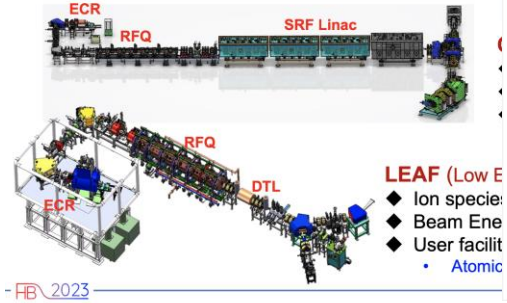
Established Facilities

- There is a lot of drive to push machines beyond their original design power:
  - Upgrades and pushing the envelope: SNS, FRIB, JPARC and PSI
- Reduction of losses is the main concern and a lot of work done towards this goal:
  - Better understanding of transverse dynamics (instabilities and resonances)
  - Space charge and chromaticity tunes shifts
  - Optimization of working points and tuning (symmetry of the lattices and tunes)
  - Better understanding of your model vs real machine
- For user machines Reliability is also key
  - Combination of machine knowledge and experience
  - Fine balance between conservative goals and pushing the machine performance

Operations

Heavy ion acceler

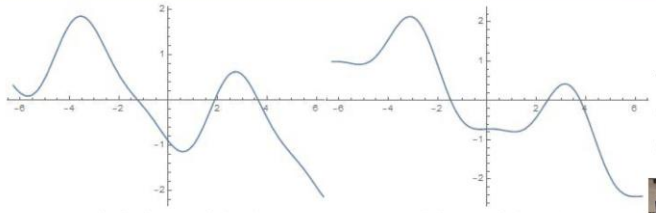
HIRFL (Heavy Ion Research Facility in Lanzhou)
- Ion species: H~U
- Beam Energy: several MeV/u ~ 1 GeV/u
- User facility for:
  Nuclear physics, ion beam applications…



LEAF (Low E
- Ion species
- Beam Ene
- User facilit
  - Atomic

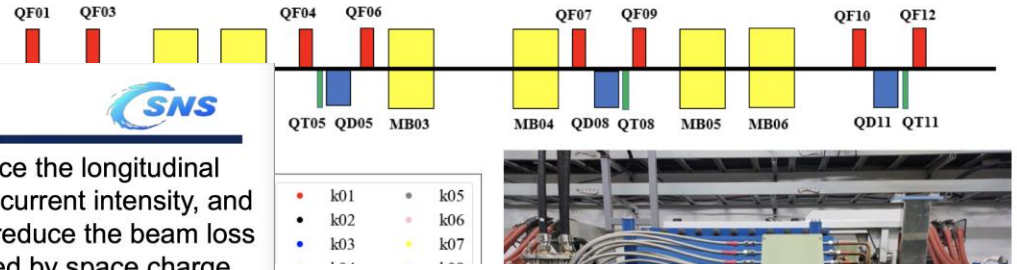
HB 2023

The Dual Harmonic RF System



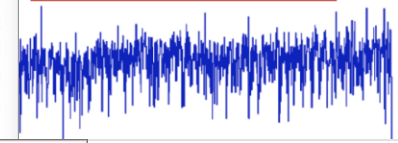
Reduce the longitudinal peak current intensity, and thus reduce the beam loss caused by space charge effect.

140kW has achieved

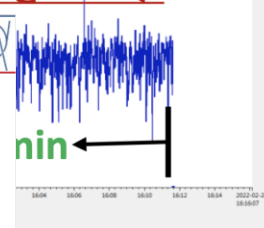


Operating mode @125 kW

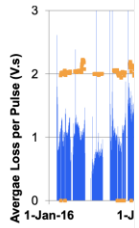
98.1% @ with QT



96.4% @ no QT



A Journey in Los Summary



- Closed Orbit control critical in recovering post LS
  - Control re-established
  - Aim to leverage regular magnet surveys to predict close
- New method of tune control being implemented and tes
  - Chopped beam measurement provides much utility in lat
  - Lattice measurements improving lattice models
- Beam loss critical to operations
  - Existing diagnostics provide robust machine protection
  - Utilising data for more systematic and detailed loss contr
- Long-Term:
  - Continue to support measurement-based machine setup
  - Develop understanding of our RCS by developing more
    based on regular measurements
- General trend
  - Reduction
    in beam int

Science and Technology Facilities Council
ISIS Neutron and Muon Source

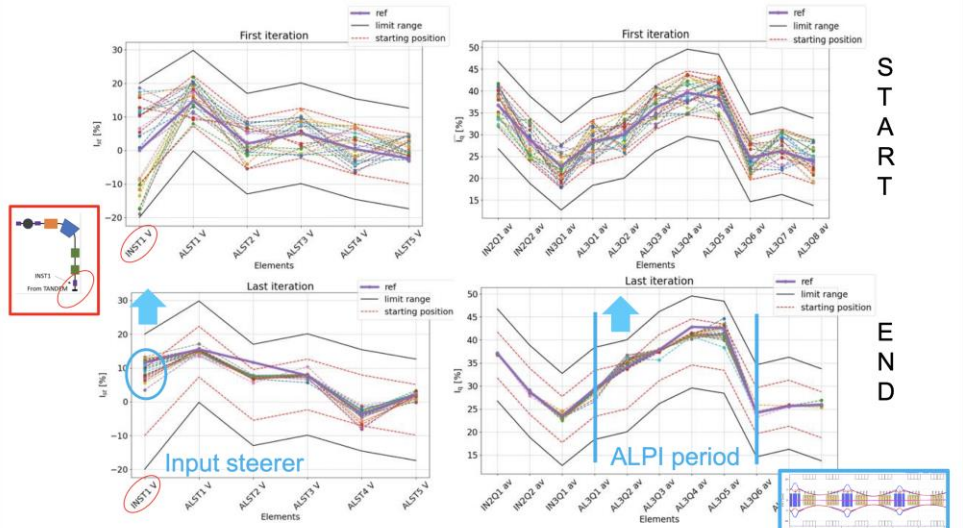
Science and Technology Facilities Council
ISIS Neutron and Muon Source

18

Results

25 swarm components, 1.5 h of time

HB 2023

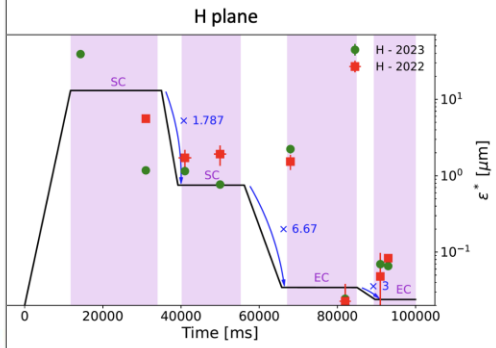


INFN
10
National Laboratories of Legnaro

le of the CERN Antiproton Decelerator

ng the cycle

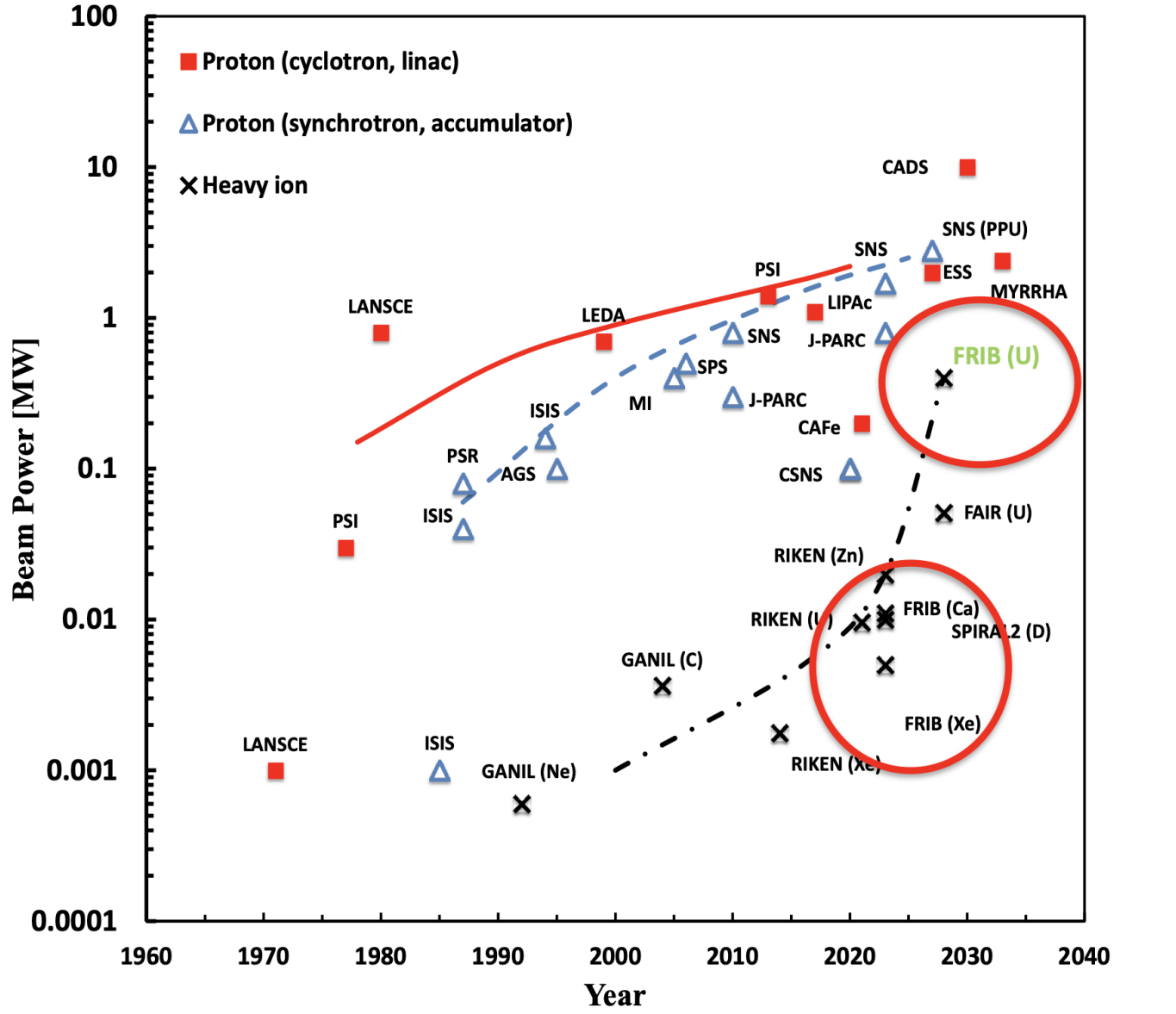
decelerations
plateaus
→ Performance assessment



kshop
8

Operations

- Reliability again is the word.
- Ensure you have the relevant data available (comparison with past performance, evolution on the machine and equipment, etc).
- Ensure you have the right diagnostics to the job, that is key to performance improvement and operations.
- Right people to do the job (training and knowledge transfer is important).


Proton (cyclotron, linac)
Proton (synchrotron, accumulator)
Heavy ion
Beam Power [MW]
Year
100
10
1
0.1
0.01
0.001
0.0001
1960
1970
1980
1990
2000
2010
2020
2030
2040
CADS
SNS (PPU)
SNS
PSI
ESS
MYRRHA
LANSCE
LEDA
LIPAc
SNS
J-PARC
FRIB (U)
SPS
MI
J-PARC
ISIS
CAFe
PSR
AGS
CSNS
ISIS
FAIR (U)
PSI
RIKEN (Zn)
FRIB (Ca)
RIKEN (U)
SPIRAL2 (D)
GANIL (C)
FRIB (Xe)
LANSCE
ISIS
GANIL (Ne)
RIKEN (Xe)

HB 2023

Thank you!