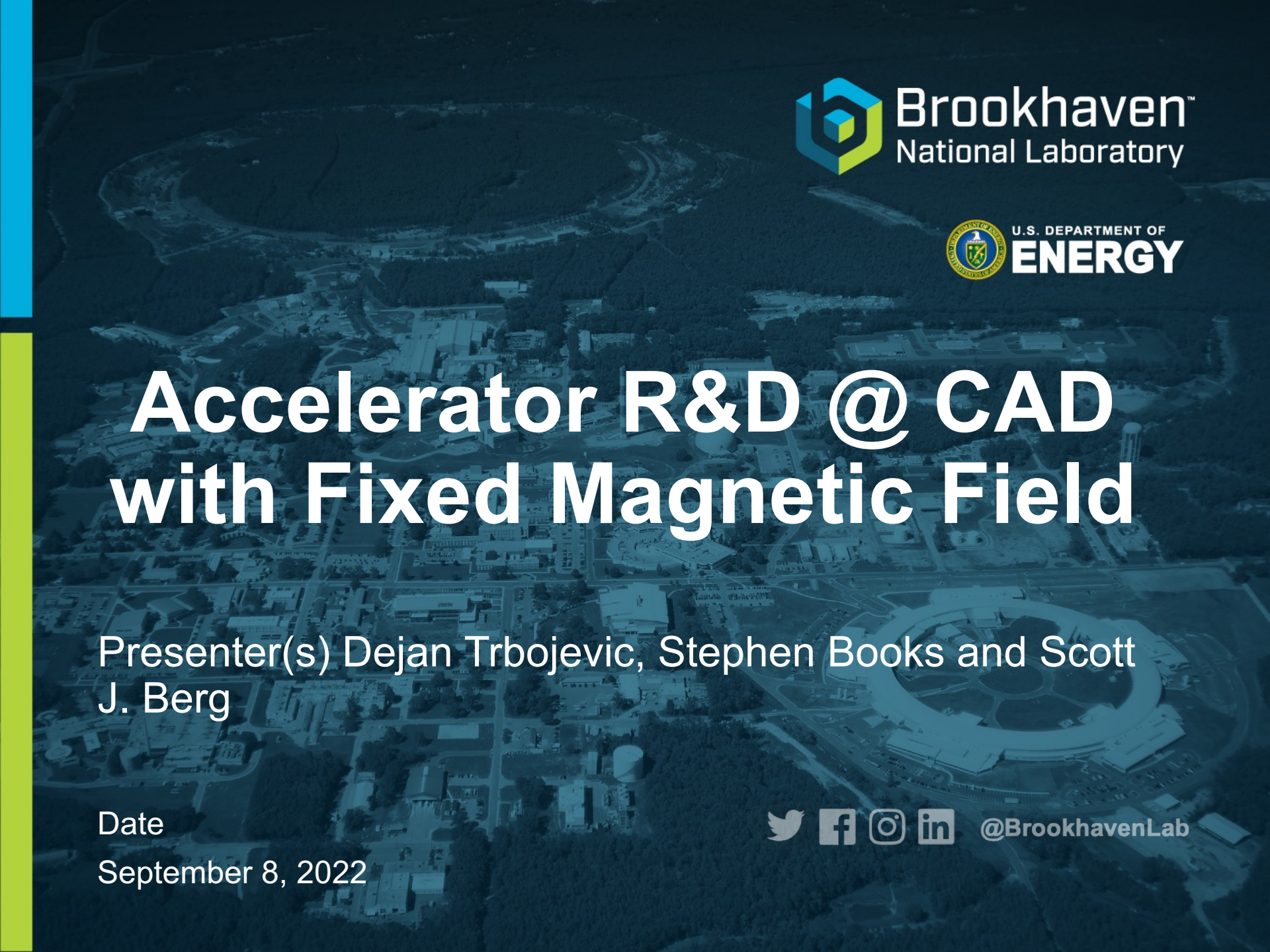


Accelerator R&D @ CAD with Fixed Magnetic Field

Presenter(s) Dejan Trbojevic, Stephen Books and Scott J. Berg

Date

September 8, 2022

@BrookhavenLab

Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

Accelerator R&D @ CAD with Fixed Magnetic Field

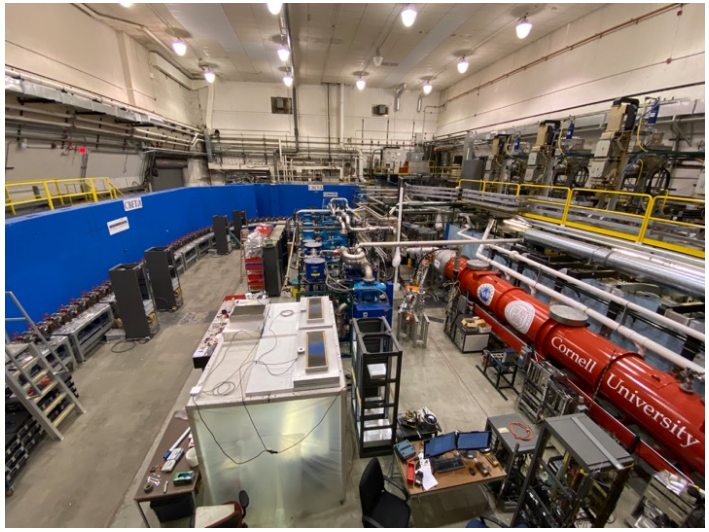
Presenter: Dejan Trbojevic

September 8, 2022

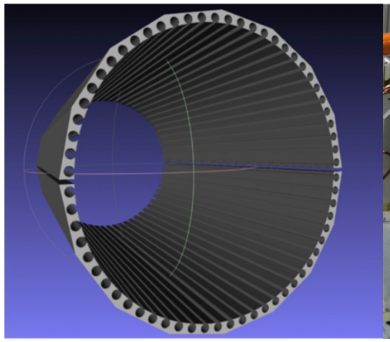
@BrookhavenLab

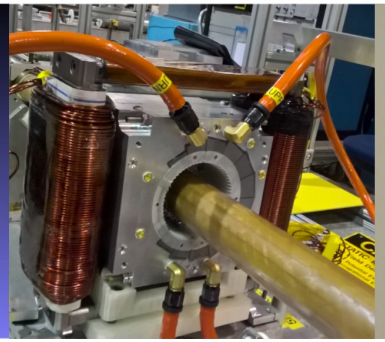
Following the CBETA success the NPP Accelerator R&D continues for the CEBAF energy upgrade from 12-23 GeV with a single FFA beam line

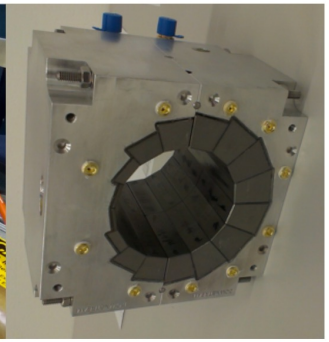
Cornell University **B**rookhaven National Laboratory **E**lectron **T**est **A**ccelerator - **CBETA**

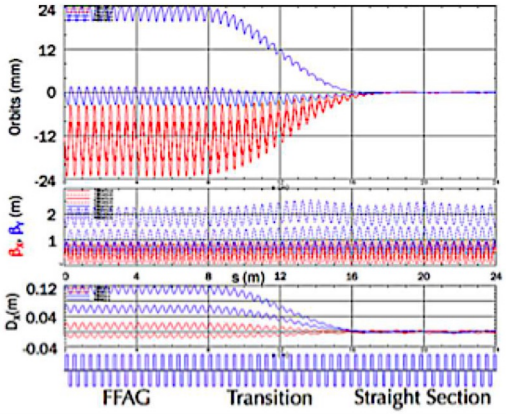


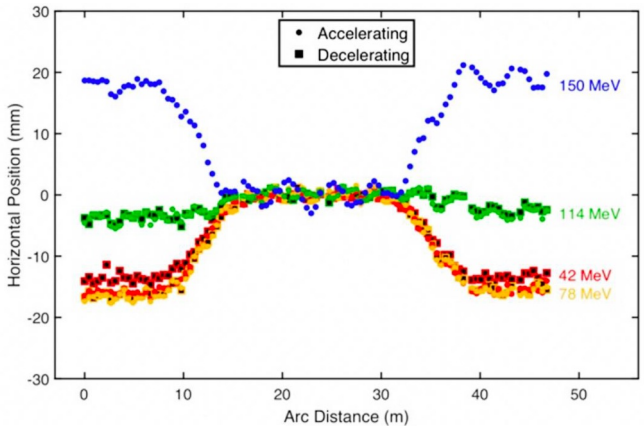
1. ***Full proof of principle for the Non-scaling Fixed Field Alternating Gradient and full Energy Recovery***
2. ***Merging multiple energy orbits into a single straight-line orbit***
3. ***Development of the new permanent magnet technology***







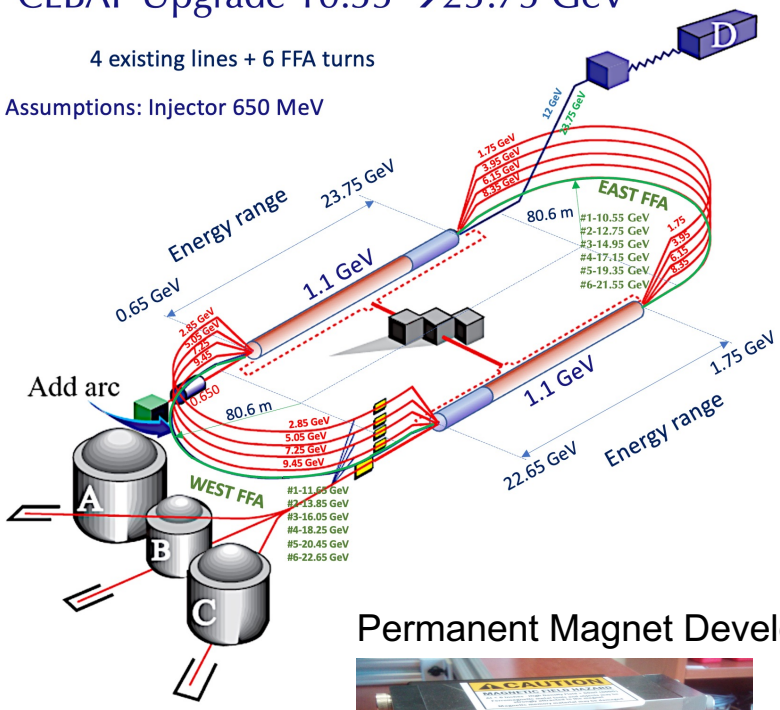




Brookhaven National Laboratory

A. Accelerator R&D for the CEBAF energy upgrade from 12-23 GeV with a single FFA beam line (following the CBETA success)

CEBAF Upgrade 10.55 →23.75 GeV



Lattice Functions in a Cell for the EAST-FFA arc

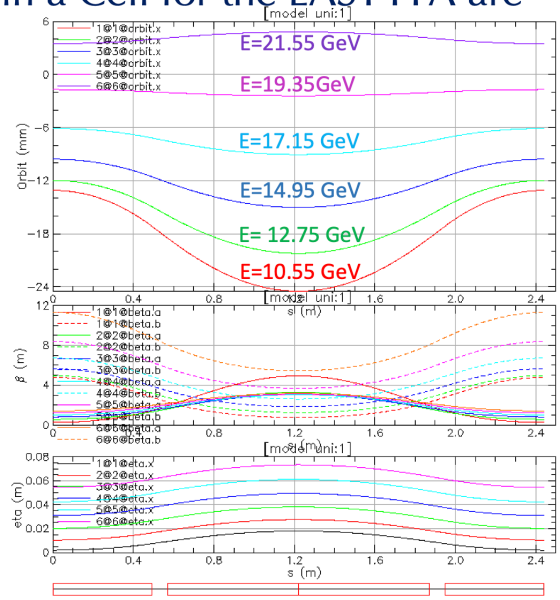
L_{CELL}=2.440255 m

Magnet Properties:
Focusing Magnet QF
GF= -68.55 T/m
QLF= 1.296 m
θ_F= -0.024771371
B_F= -1.28151
B_{FMAX}=-1.611 T

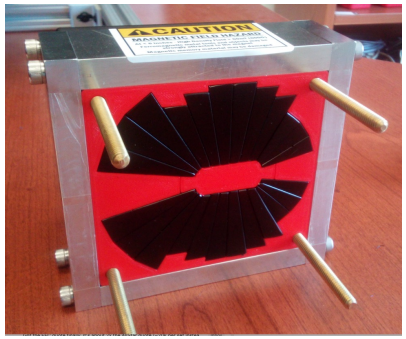
Defocusing Magnet BD
GD= 72.4 T/m
BLD= 0.964255246
θ_D= -0.005504749
B_D= -0.382754996
B_{DMAX}=-1.624 T

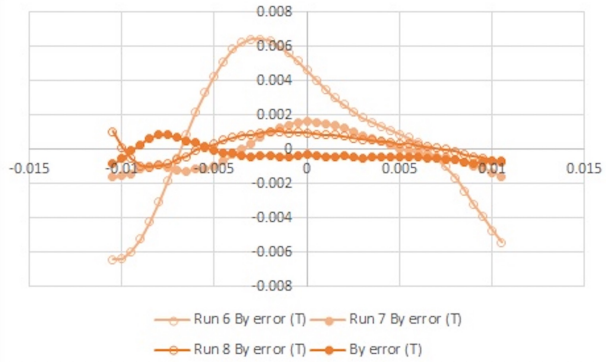
Total Synchrotron Radiation Lost In the East arc from five passes:

E_{LOSS}=432.7 MeV



Permanent Magnet Development





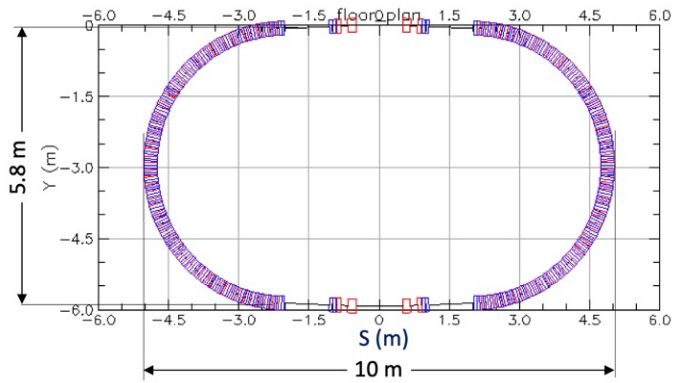
Total Synchrotron Radiation Loss from both: East and West arc:

432.71 MeV
525.33 MeV

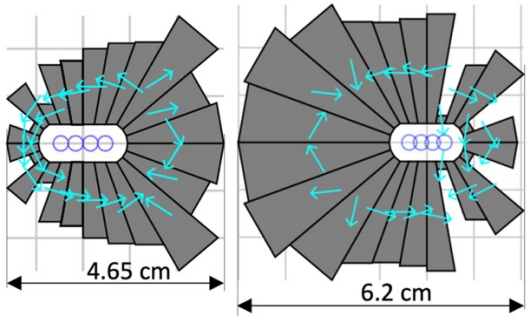
958.04 MeV

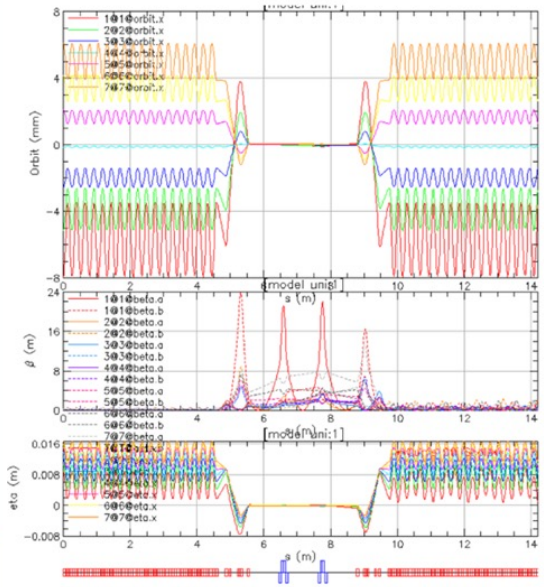
Brookhaven National Laboratory

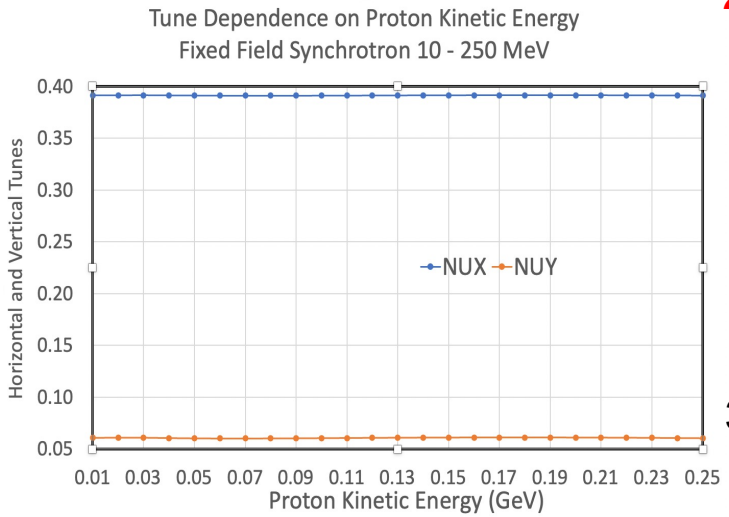
B. Fast Cycling Synchrotrons with Fixed Betatron Tunes and Fixed Magnetic Field



Small permanent magnets







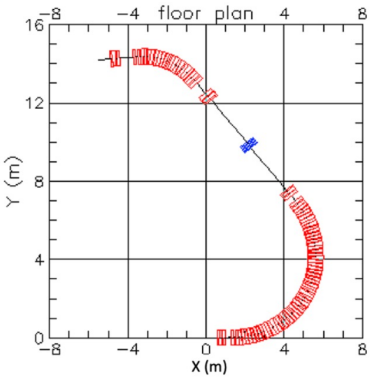
APPLICATIONS and ADVANTAGES:

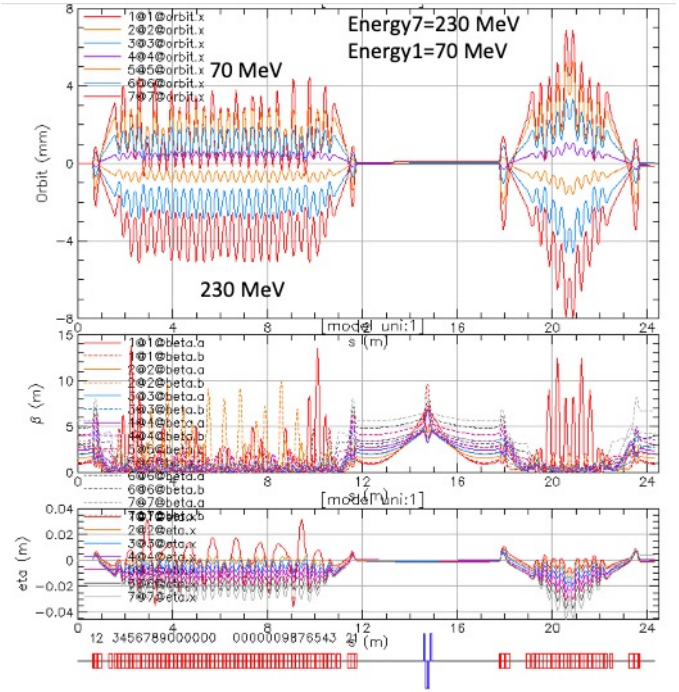
1. **Significant Power Consumption Savings** due to Fixed Magnetic Field
2. **VERY FAST ACCELERATION as it depends only on RF**
   - 2.1 RHIC INJECTORS upgrade
   - 2.2 ERLs for ion cooling
   - **2.3 Synchrotrons for EIC** (reduction in cost, savings in power, large dynamical aperture, small magnets)
3. **SPIN-OFFS** in Medical applications
4. Proton Drivers

C. SPIN-OFFS from the nuclear physics research in Fast Cycling Synchrotrons:

C.1. Permanent Magnets for the EIC Electron Cooling ERL
C.2. Medical Applications in proton cancer therapy: FLASH beam lines, fast cycling proton synchrotron 10-250 MeV and Proton permanent magnet gantry
C.3. Permanent Magnets for the next Generation Synchrotron Light Sources
C.4. Muon Collider research

Large energy acceptance beam lines





Permanent Magnet **Gantry** for the FLASH proton cancer therapy