

# Power Saving Accelerator

Demand of low CO<sub>2</sub> production and environment affinitive  
accelerator

permanent magnet or superconducting magnet accelerator  
and more

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# demand of low CO<sub>2</sub> production accelerator

Physics society can be supported by Citizen.

In return,

Physics society must support Citizens in need.

Nowadays, High energy physics can not be grown as in the  
past.

Innovation in Energy saving, affinitive to Environment and

demand of low CO<sub>2</sub> production accelerator  
required first time in a history

1. "Still river systems" 10 T synchrocyclotron
2. permanent cyclotron magnet(berkeley, our group at NIR)
3. permanent magnet FFAG
4. stronger superconducting cyclotron(ACCLEL/Varian)
5. pulsed superconducting synchrotron(GSI, CERN)
6. DWA(Lawrence Livermore)
7. RFI(linac systems)
- and finally
8. CBS (Cold Beam Source)((BINP&kumada)
9. Magnet in Magnet concept(kumada)

MONARCH<sup>250</sup>

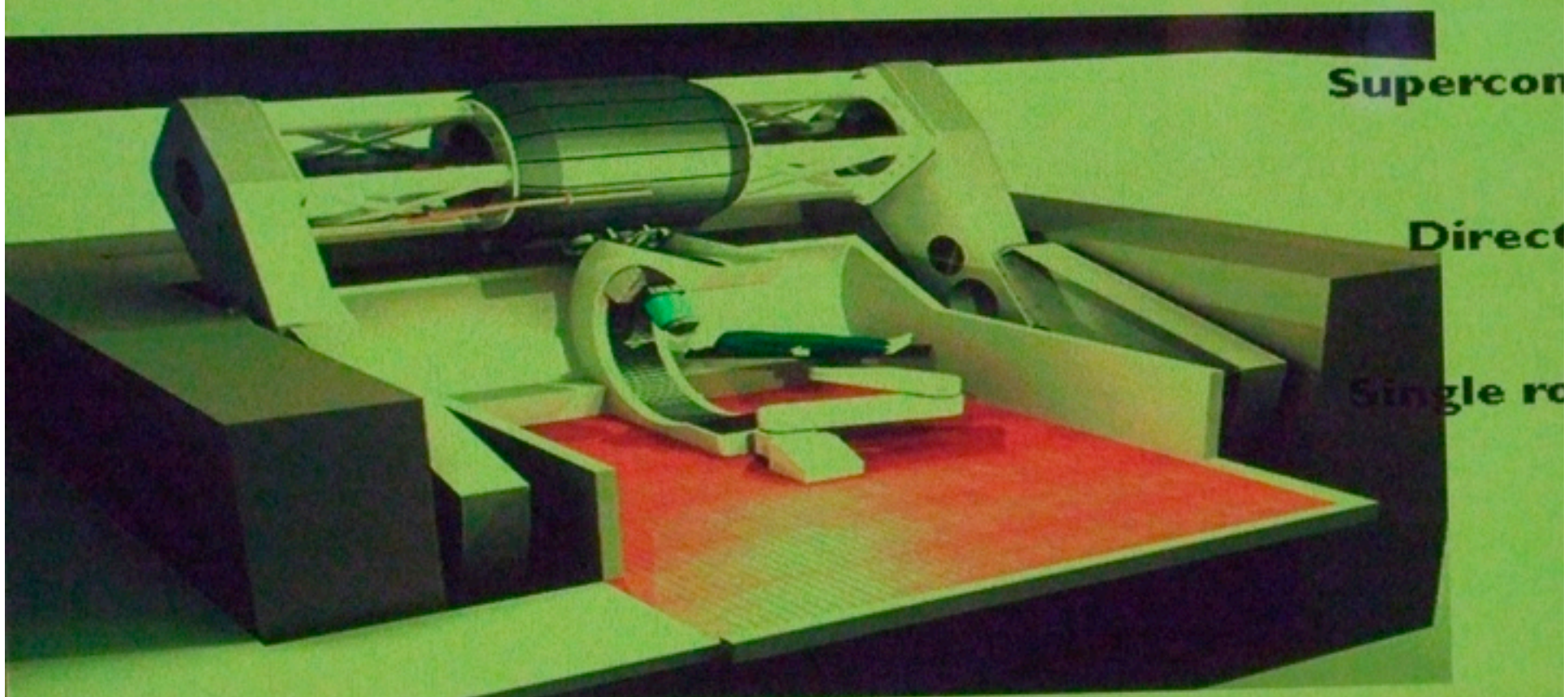
COMP  
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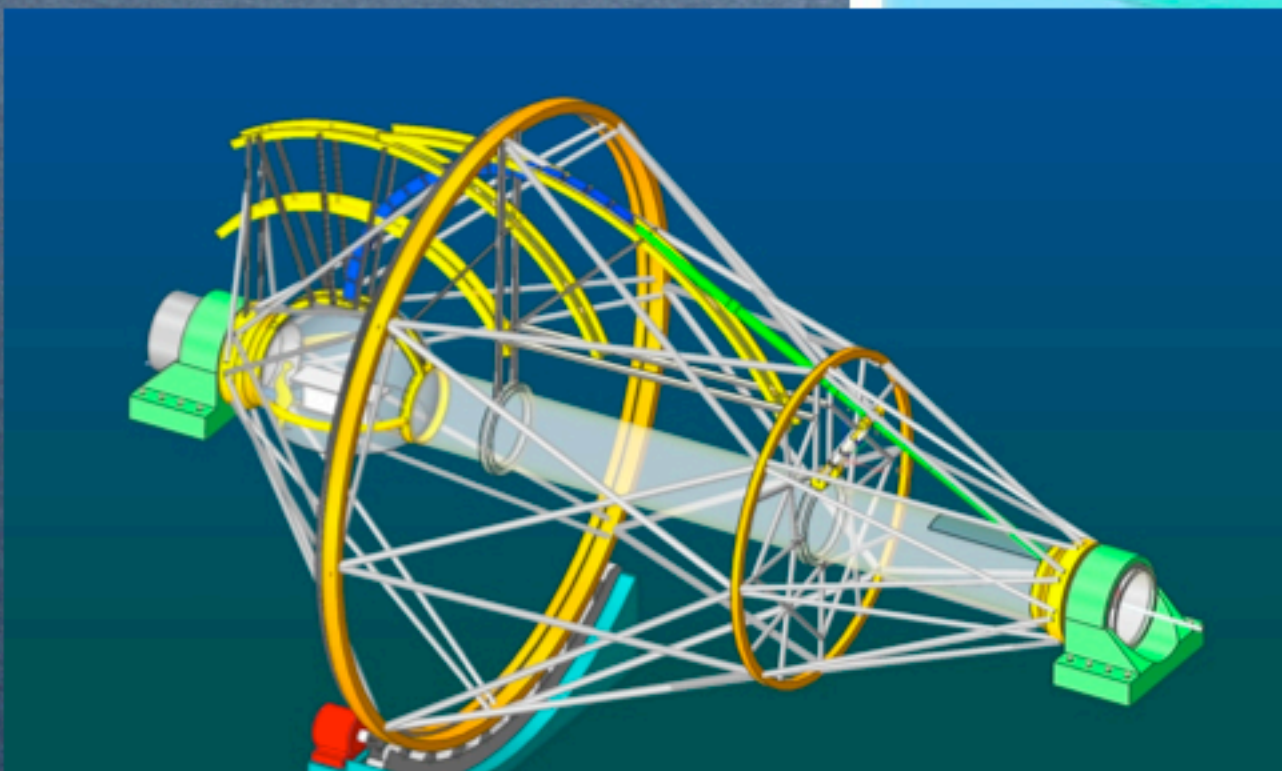
Direct

Single ro

SHAPING THE FUTURE



CBS from BINP



demand of low CO<sub>2</sub> production accelerator and state of

permanent magnet: 1.5 Tesla is relatively easy.  
even 5 Tesla is possible.

while

copper electromagnet: 1.5 Tesla is the highest.

4.5 Tesla pulsed superconducting magnet become available

10 Tesla synchro-cyclotron magnet is at hand (press  
announcement may 2008)

demand of low CO<sub>2</sub> production accelerator

Difficulties in the past Permanent Magnet:

1. DC field but temperature dependent which means magnetic field is not stable enough
2. degradation in accelerator by irradiation of beam
3. Switch on and off is not possible.
4. changing field strength is not possible
5. assembly is very difficult



demand of low CO2 production accelerator

said problems can be solved by having a combination of  
North pole and South pole.

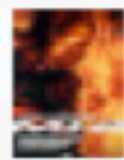
“magnet in pair”  
(patent)

Examples are shown by Kumada, Iwashita, Antokhin.

## Permanent Cyclotron Magnet



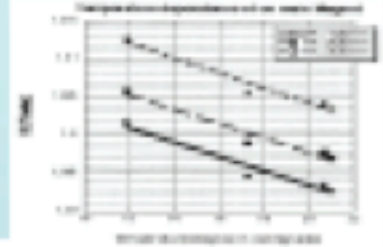
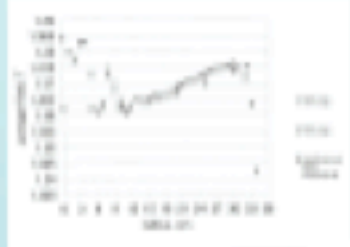
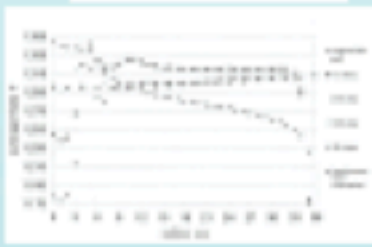
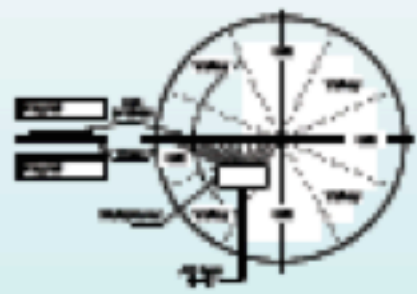
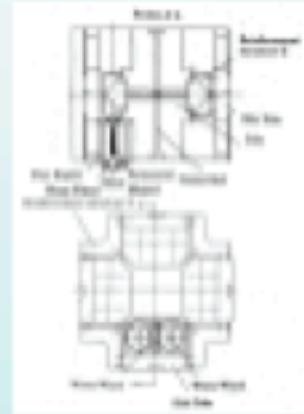
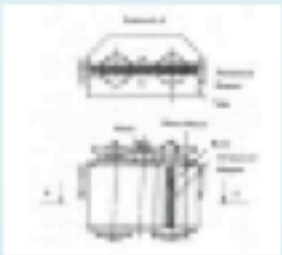
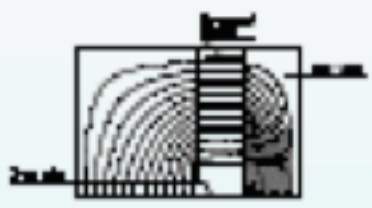
**R. Asatkin, M. Kuznetsov, Y. Ibrakhimov, S. Wilson, S. Matsumoto, T. Fujisawa, I. Ichikawa, K. Hoshino, V. Ibrakhimov, K. Sugiyama and H. Shimizu.**



Abstract: This paper describes the design and construction of a permanent magnet for the National Ignition Facility (NIF) cyclotron. The magnet is a permanent magnet cyclotron (PMCC) and is used to accelerate deuterium ions to a maximum energy of 100 MeV. The magnet is composed of two main parts: a central region and an outer region. The central region is a permanent magnet with a maximum field of 1.0 T. The outer region is a permanent magnet with a maximum field of 0.5 T. The magnet is made of a special steel alloy and is designed to be highly resistant to radiation damage. The magnet is currently being tested at the NIF facility.

**TABLE I**  
 Summary of PMCC Magnet

Average field, T	0.2
Maximum field, T	1.0
Field uniformity, %	±0.5
Field stability, %	±0.5
Field ripple, %	±0.5
Field drift, %	±0.5
Field life, yr	10



This work was supported by the National Natural Science Foundation of China (Grant No. 10274030) and the National Ignition Facility (NIF) program. The authors would like to thank the NIF staff for their assistance during the magnet assembly.



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demand of low CO<sub>2</sub> production accelerator

Electron cooling is a strong tool for power saving.

CBS(Cold Beam Source) is such an example where ion beam size is less than a 1 mm.

Total weight of magnet can be ultimately light.  
Also enables flexible state of the art beam extraction.

Power Efficiency by carbon ion  
(single fraction treatment of carbon vs. 35 fraction of

demand of low CO<sub>2</sub> production accelerator

power saving of magnet is not enough.

Total power saving of accelerator is demanded.

Linac must be high gradient(100MeV/m) and compact  
(Dialect Wall Accelerator by Livermore/Tomotherapy)

Power saving of cavity (Iwashita)

Higher efficiency of Water Cooling, air conditioning of  
accelerator components are mandatory.

demand of low CO<sub>2</sub> production accelerator

All conventional lights can be replaced by solid state  
LED lightings.

power consumption of lighting is typically 20 % of electric

Innovation of lighting begun:

(100 lumen/W LED light is now available and still  
at a slope of improvement.)



demand of low CO<sub>2</sub> production accelerator



for a sake of sustaining society, a current state  
of the art of the accelerator design  
must be reconsidered from a viewpoint of  
improving Global Warming.

Thank you.