TRIUMF's MANDATE, 2000-2005

- Maintain the TRIUMF laboratory as a national facility for sub-atomic physics and provide support for an on-going experimental program at TRIUMF, including the auxiliary programs in materials science, life sciences, and medical therapy.
- Construct and operate a new accelerator facility (ISAC 1, 2) to provide for an innovative research program in nuclear physics and astrophysics, materials science and nuclear medicine.
- Act as Canada's main connection with CERN and supplying components, which will form Canada's contribution to the new CERN accelerator, the Large Hadron Collider, and the ATLAS detector at Geneva, Switzerland.
- Provide infrastructure support to the whole of the Canadian sub-atomic physics program as Canada's primary center for sub-atomic physics research.
- Maximize the economic benefits of the Federal Government's investment in TRIUMF to Canadian companies through pro-active technology transfer activities, contracts and procurement policies.

PROPOSED MANDATE, 2005-2010

- The TRIUMF laboratory will operate as Canada's national laboratory for sub-atomic science.
- The laboratory will provide and further develop world-leading facilities for experimental programs in nuclear physics, nuclear astrophysics, particle physics, material science, life sciences, and medical sciences. These facilities will exploit the high power cyclotron operated by the laboratory and the new accelerator complex developed for ISAC. The facilities will provide Canadian scientists with opportunities to develop national and international programs.
  - The facilities will exploit in particular intense radioactive beams and intense muon and pion beams, the driver for these beams being the 500 MeV cyclotron. In particular, there should be world-leading facilities to exploit the intense muon beams for material science.
- The laboratory will continue to act as Canada's main connection with CERN by developing and operating a data analysis center on behalf of the ATLAS-Canada community working at the CERN-LHC accelerator.
- Provide infrastructure support to the whole Canadian sub-atomic scientific program as Canada's primary center for sub-atomic science.
- Maximize the economic benefits of the Federal Government's investment in TRIUMF to Canadian companies through pro-active technology transfer activities, contracts and procurement policies.

A 10-Year Plan for TRIUMF

Jess H. Brewer - 21 Sept 2002

What is needed is a firm grasp of the obvious. - M. Williams

- **Planning Backwards from 2015**
- **A Modest Proposal: Design Study for a Surface Muon Source in the Proton Hall**
- **An Immodest Proposal: Design Study for a 1 MW FFAG Synchrotron**

Planning Backwards from 2015

- **2015**: *(a) Exciting new facilities begin operation*
  or *(b) Laboratory shuts down*

- **2010**: *(a) Next 5YP starts: build new facilities*
  or *(b) Still thinking about what to do next*

- **2005**: *(a) Start serious design studies for* **2010**
  or *(b) Just exploit existing capabilities*

- **Today**: *Decision point for* **2005**

Rationale

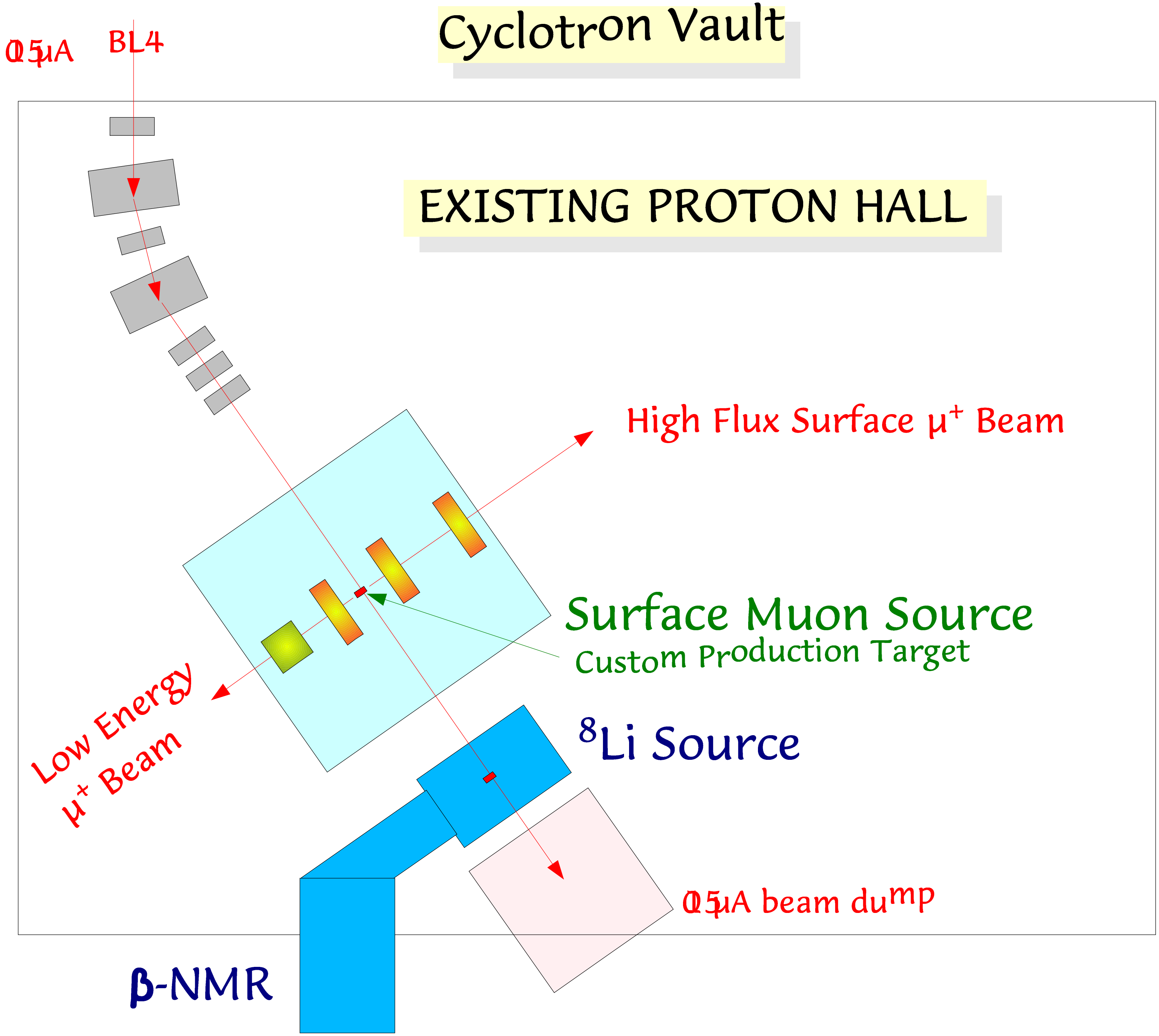
- TRIUMF is an Accelerator Laboratory.
- Despite 10 x lower intensity, TRIUMF competes successfully with PSI and holds a secure position as the Western Hemisphere's only μSR facility.
- The present TRIUMF cyclotron can make more beam than we can dump.
- You snooze, you lose.

A MODEST PROPOSAL:

- We must explore new ways to make more muons (and utilize them more effectively).
- We must have another ISAC source (or more).
- We are not ready to actually build anything in 2005–2010.

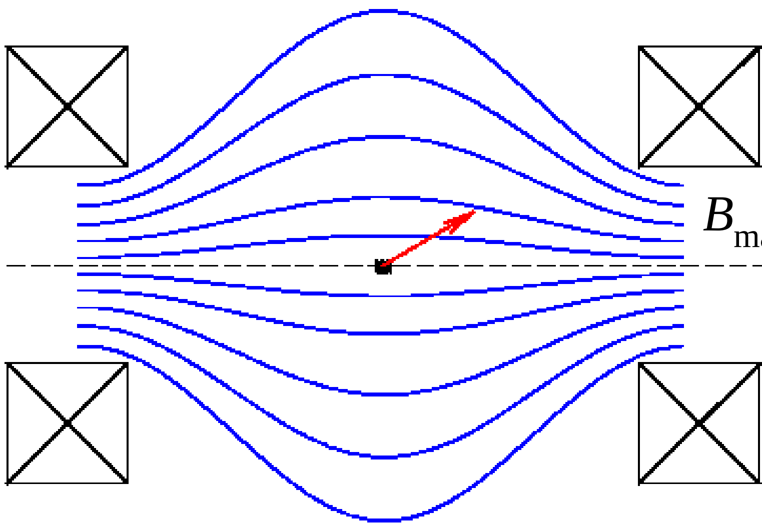
We therefore propose a serious and aggressive

DESIGN STUDY of SPECIALIZED HIGH INTENSITY PRODUCTION TARGETS for the Proton Hall.


Cyclotron Vault
µA
BL4
EXISTING PROTON HALL
High Flux Surface μ+ Beam
Surface Muon Source
Custom Production Target
Low Energy
μ+ Beam
8Li Source
µA beam dump
β-NMR

One possible design:
Leaky Magnetic Bottle

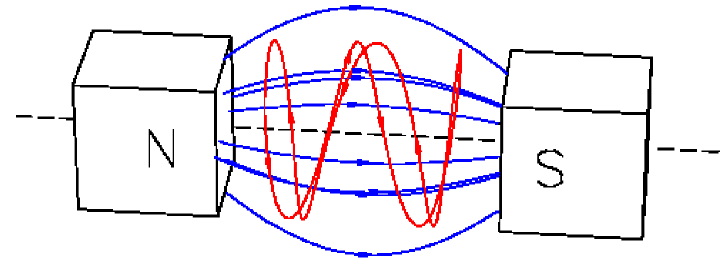
Place production target in a field between two rad-hard coils (proton beam into page).



$_{crit}$ ~ 35^o $_{escape}$ ~ 1.5 sr

Reflection criterion:

$$\left|\frac{v_{0_\parallel}}{v_{0_\perp}}\right| = |\cot\theta_0| < \sqrt{\frac{B_{\max} - B_0}{B_0}}$$



Low energy pions return to skin of production target (textured to make every surface both an entrance and an exit surface).

Surface muons escape if $_0 <$ $_{crit}$ (equivalent to an acceptance of 1/8 of entire 4π solid angle).

Net improvement over conventional surface muon channels ~ factor of **200**

Schedule & Costs

- **Working Backward:**
  - 201 Construction
  - 2009: Finalize details
  - 2008: Next 5YP firm
  - 2007: Converge
  - 2006: Choose winners
  - 2005: Develop designs
  - 2004: Recruit people

- **People Costs:**
  - Beam Optician $75K/y
  - Engineer $75K/y
  - Technician $50K/y
- **Other Costs:**
  - Prototypes $300K
  - Test Expts $200K
- **TOTAL** $ 1.5 M
  (2005-10)

A LESS MODEST PROPOSAL:

- TRIUMF is an Accelerator Laboratory.
- Mori's group at KEK has mastered the FFAG (Fixed Field Alternating Gradient) Synchrotron and will share it with us.
- A 1 mA, 1 GeV beam makes muons & more.

We therefore propose a serious and aggressive

Design Study of a

1 MW FFAG Synchrotron

FFAG : Fixed-Field Alternating Gradient Synchrotron

Proton Driver for Muon Source

Yoshiharu Mori (KEK)

Needs for large beam power & rapid acceleration

1. Large Beam Power
   - Proton Driver:
     - secondary particle production (K,μ,π,n,RI.....)
     - spallation neutron source
     - ADS for nuclear energy breeding
2. Rapid Acceleration
   - Acceleration of short-lived particles:
     - muon ---- Neutrino Factory, Muon Collider
     - unstable nuclei

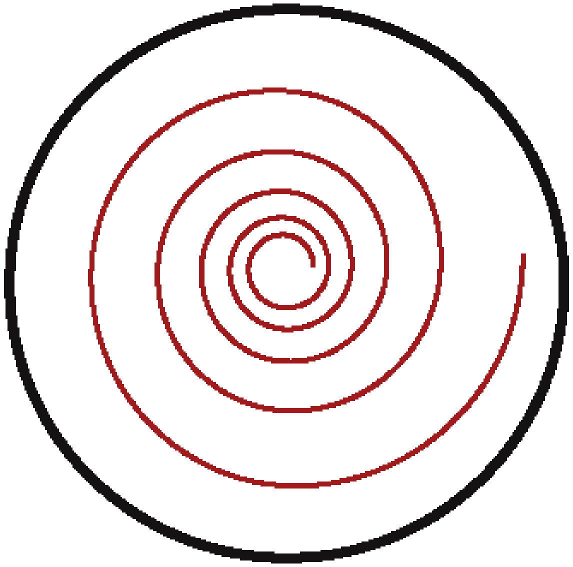
   ENERGY : 1 ~ 10 GeV, CURRENT : ~ mA

Proton Driver for Pulsed Muon Source : Specifications

Beam energy	~1GeV
Beam power	~1MW (ave. cur. ~ 1mA)
Beam rep. rate	~10kHz
Bunch width	<100ns

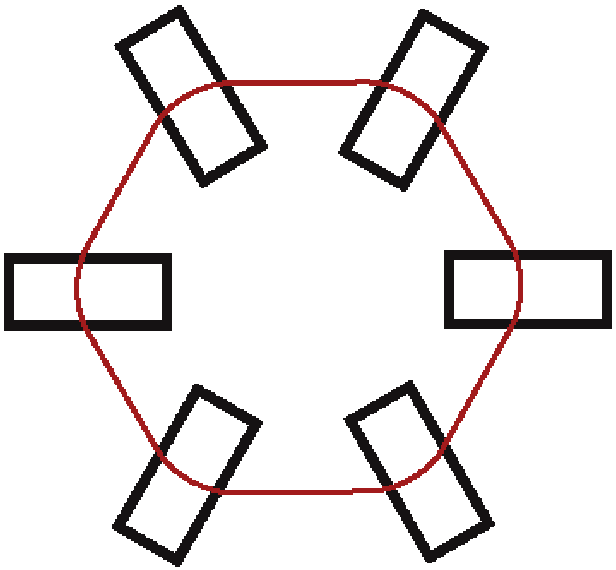
Compact, Low cost......

Originaly presented to School,London,June 24-28, 20002



Cyclotron

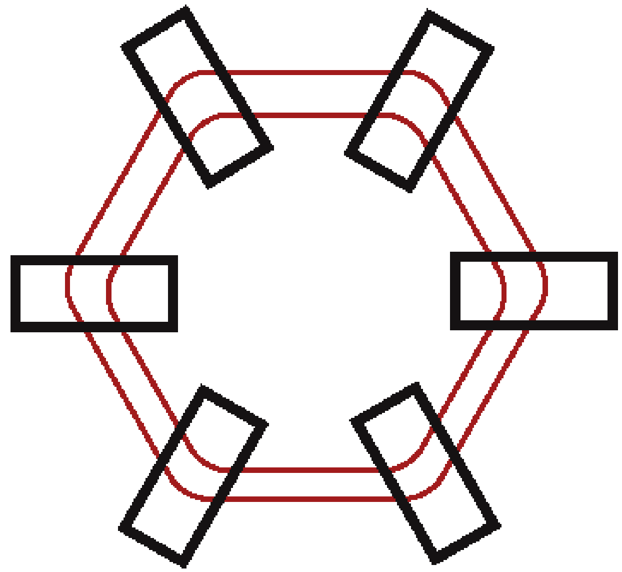
*isochronous



Synchrotron

*const. closed orbit

(varying mag. field)



FFAG

*varying closed orbit

(const. mag. field)

FFAG Accelerator

Comparison with ordinary synchrotron

	FFAG	ord. Synchrotron
1. Magnetic Field	Static (Fixed)	Time varying
2. Closed Orbit	Moving	Fixed
3. Focusing	Strong	Strong
4. Duty Factor (Repetition Cycle)	Large ~10-50% (~>1kHz)	Small ~1 % (~10Hz)
5. Space charge/Instability	Not critical (small particle numbers per bunch)	Severe

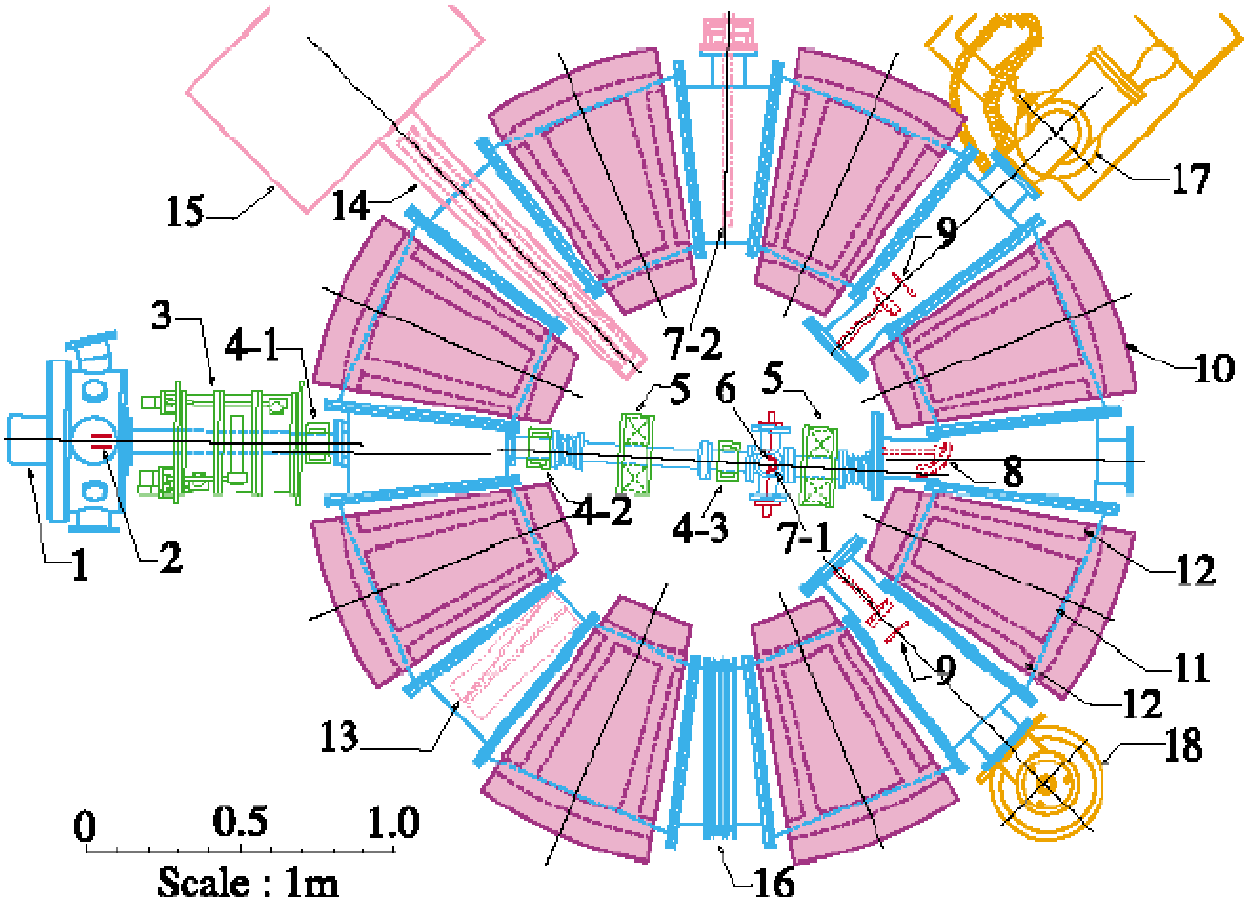
Problems to be solved:

* complicated magnetic field ---> 3D codes(TOSCA etc.)

* RF system : high field & rapid tuning

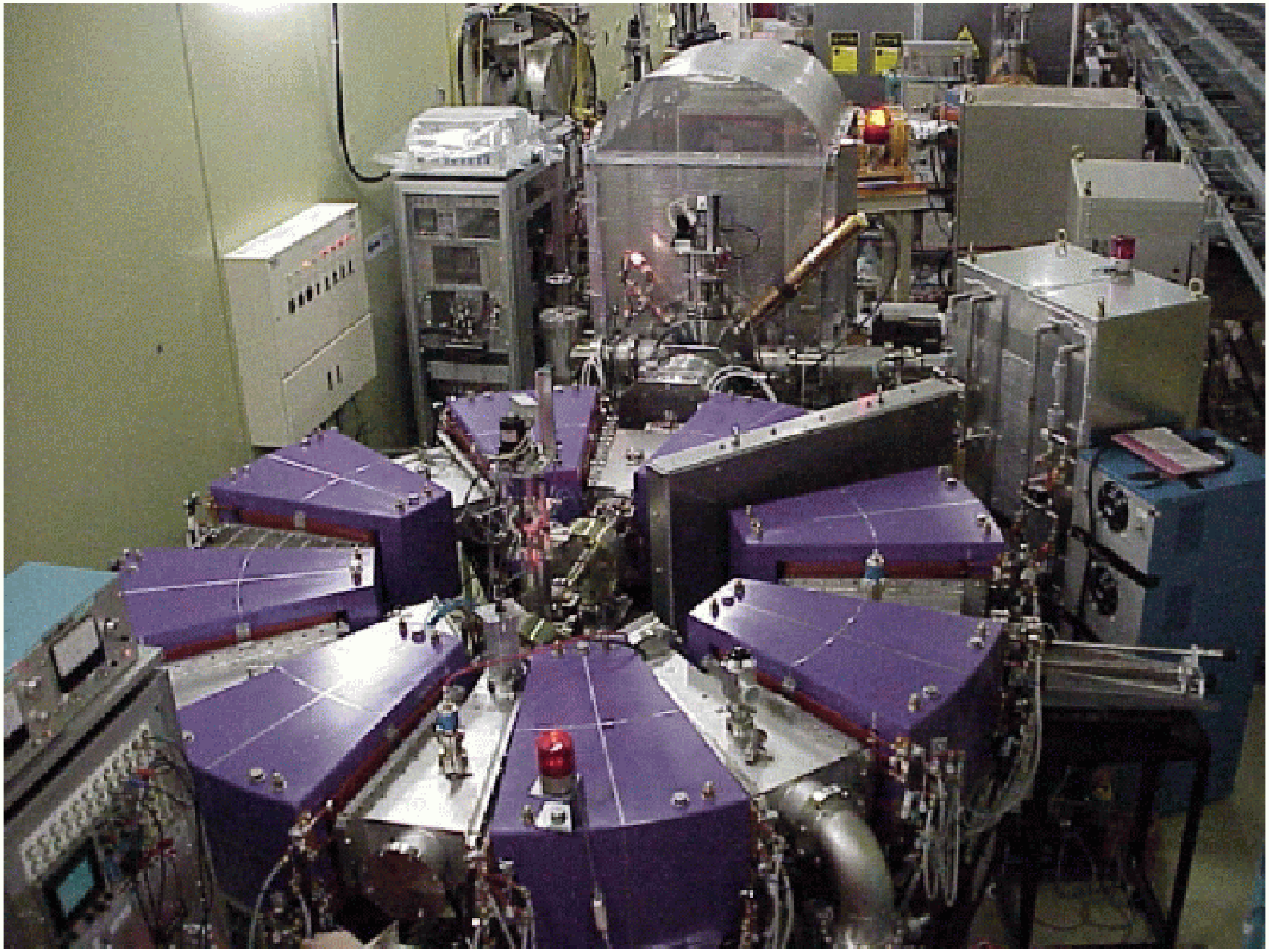
--> " High Gradienet & Broad Band RF Cavity"

PoP proton FFAG accelerator 12 MeV

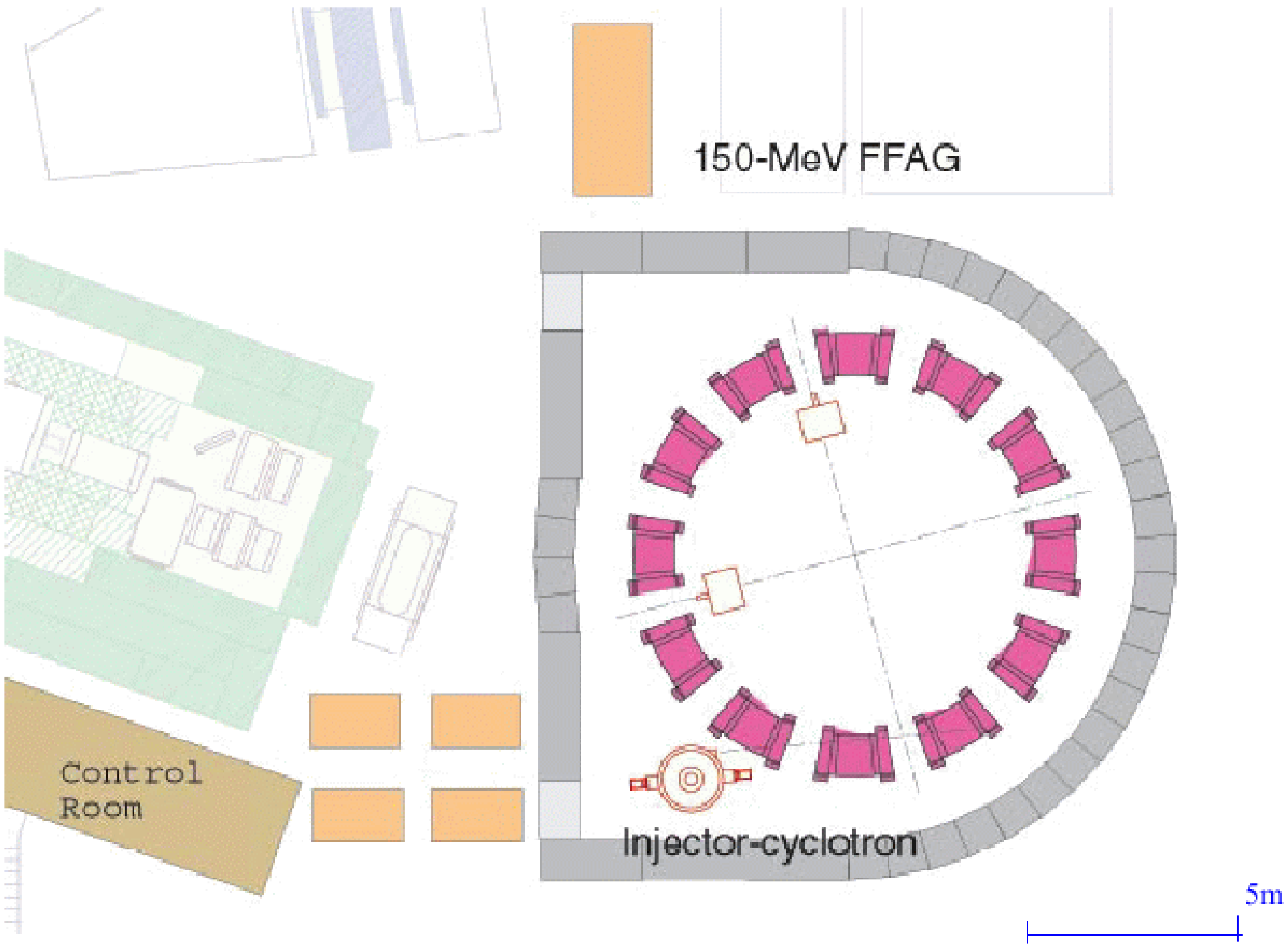


1: ion source
2: chopper electrode
3: triplet-quadrupole magnet
4: steering magnet
5: solenoid magnet
6: beam slit
7: Faraday cup
8: septum electrode
9: bump electrode
10: sector magnet
11: F-magnet pole
12: D-magnet pole
13: beam position monitior
14: RF cavity
15: RF amplifier
16: vacuum bellows
17: turbo molecular pump
18: cryopump

PoP proton FFAG model 12 MeV

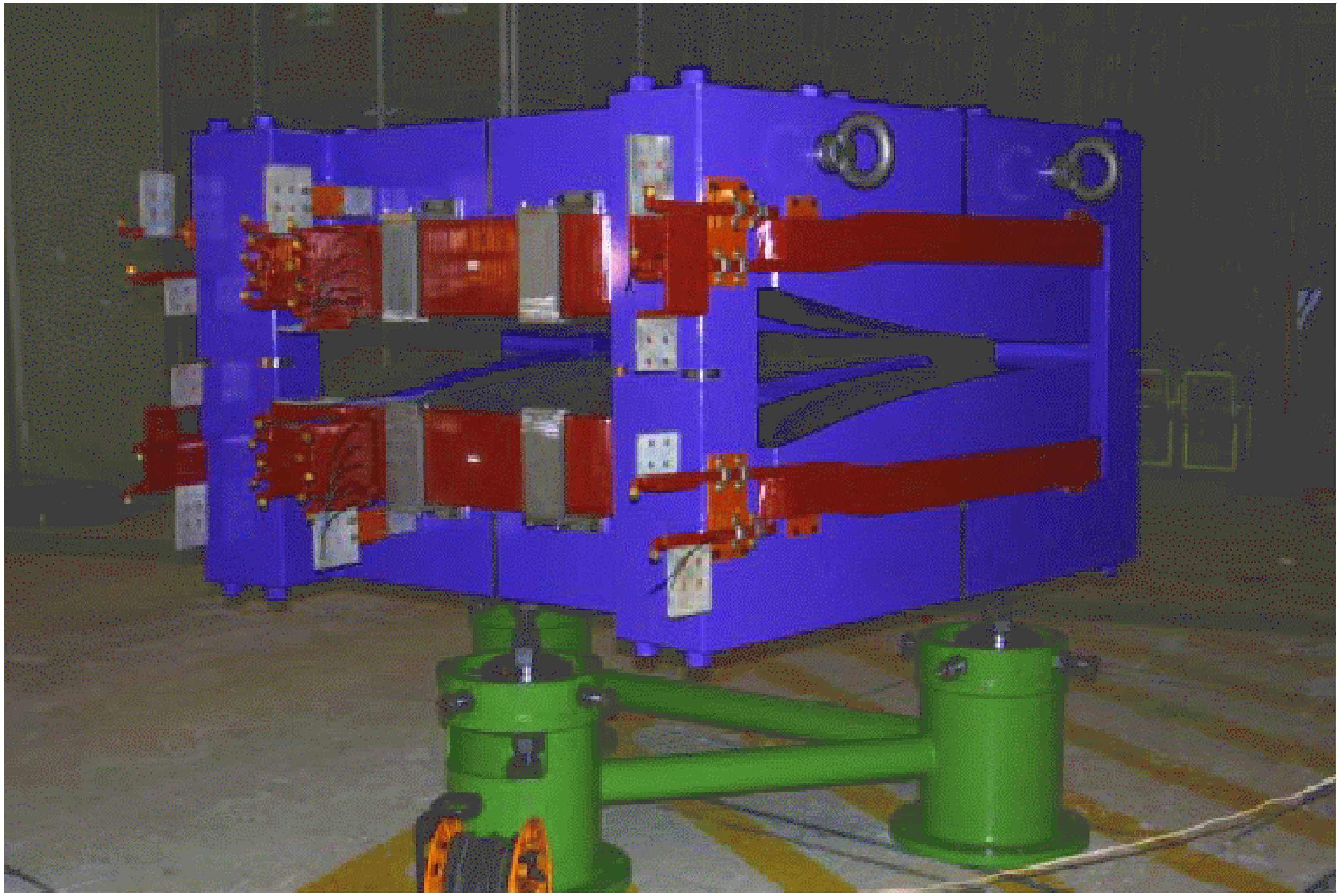


150-MeV proton FFAG accelerator



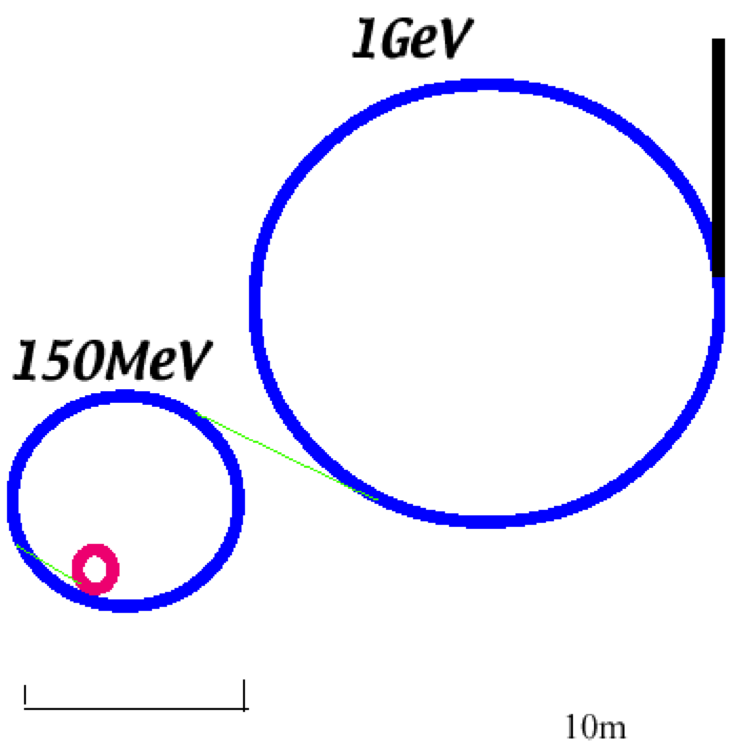
Under construction at KEK

Magnet of 150-MeV proton FFAG



The next step:

1GeV-1MW-10kHz FFAG Proton Driver



Energy	150MeV-1GeV
Intensity	6x1011ppp
Rep. Rate	10kHz (1kHz x10)
Ave. Current	1mA (Beam Power 1MW)
Radius	~16m
k	25
# of cell	48
rf freq.	5.43MHz - 8.08MHz
rf voltage	~850kV
bunch width	~40ns

Estimated cost ~ US$20M

Schedule & Costs

- **Working Backward:**
  - 201 Construction
  - 2009: Finalize details
  - 2008: Next 5YP firm
  - 2007: Converge
  - 2006: Choose winners
  - 2005: Develop designs
  - 2004: Recruit people

- **People Costs:**
  - Accel. Physicist $80K/y
  - 2 Engineers $160K/y
  - 2 Technicians $100K/y
- **Other Costs:**
  - Prototypes $500K
  - Test Expts $500K
- **TOTAL $ 2.7 M (2005-10)**

Conclusions

- Remember, these are just DESIGN STUDIES! The real work/money starts in 2010-15.
- If we don't start NOW, it's time to go home.
- A lot of people invested their careers in making TRIUMF a reality so you could enjoy the results. Will you "pay it forward" now?
- Please decide by November when I have to choose whether to take early retirement.

AFTERWORD

- Throughout the Town Meeting, it was clear that many people had other ideas for new major facilities that were at the same stage (proposed Design Study) as those described in this presentation. This is as it should be. A Town Meeting is not the occasion to decide which designs should be seriously studied, much less what the conclusions of those studies should be.

- Ideally, a 5-Year Plan should include the following categories:
  - Maintenance & Operation of existing facilities and programs.
  - Construction & Commissioning of completed engineering designs.
  - Engineering Design of new facilities chosen by thogough evaluations.
  - Concept Evaluation: Comparison of scientific potential, technical feasibility and probable cost of competing proposals for new facilities.

- Traditionally the final category has been relegated to semi-democratic processes such as this Town Meeting and the prior efforts of self-organized groups of Users. While new initiatives must always have "grass roots" origins, these partisan efforts must evaluated and compared much more thoroughly than is possible in 1 year of panic before each 5-Year Plan. A step is missing.

- I therefore propose that TRIUMF create a standing LRPC to fulfill this role. This body would receive proposals asynchronously and review them full time.