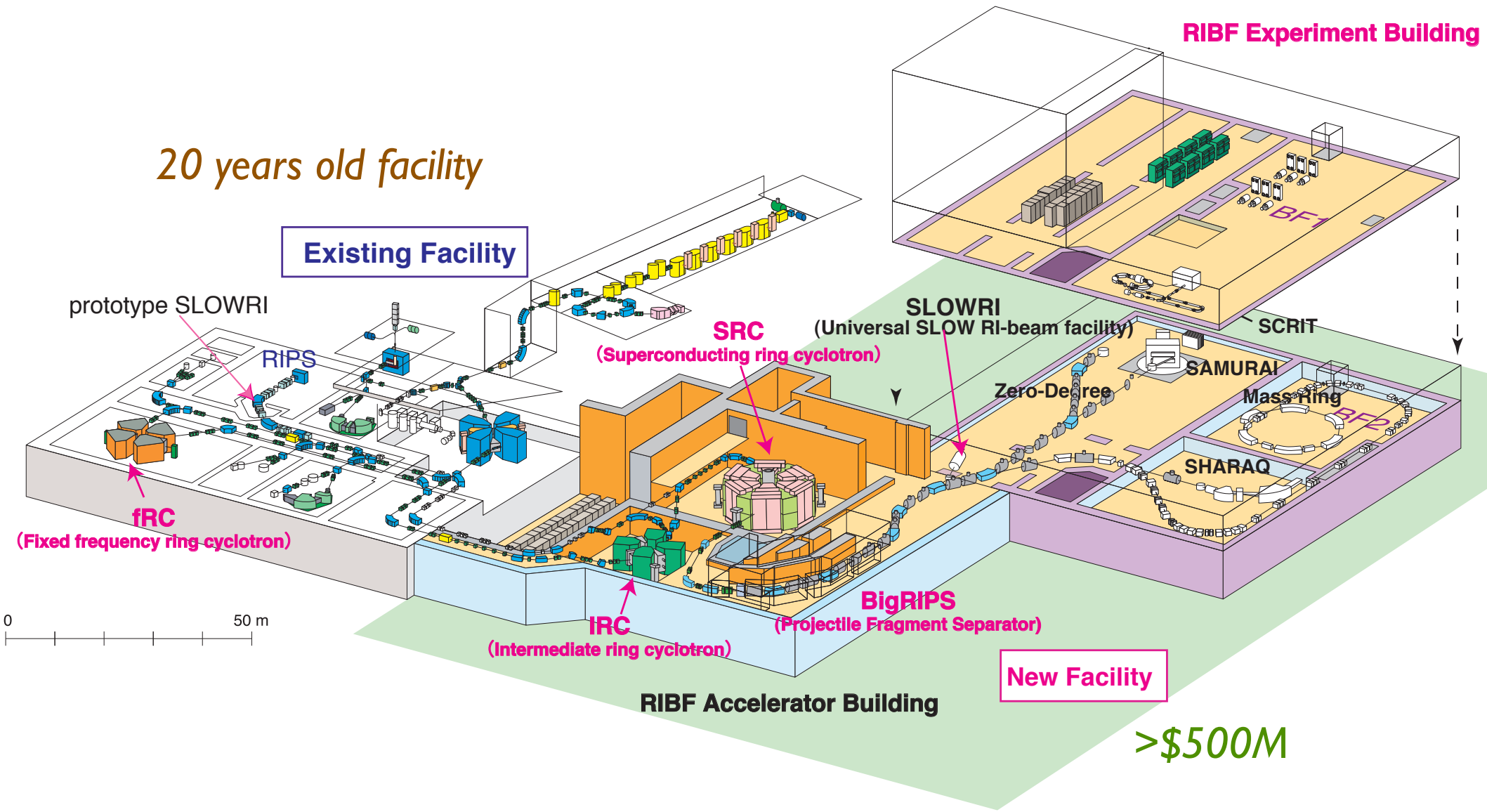
理研RIBFと汎元素低速RI-beam施設(SLOWRI)

～物性研究への利用のすすめ～

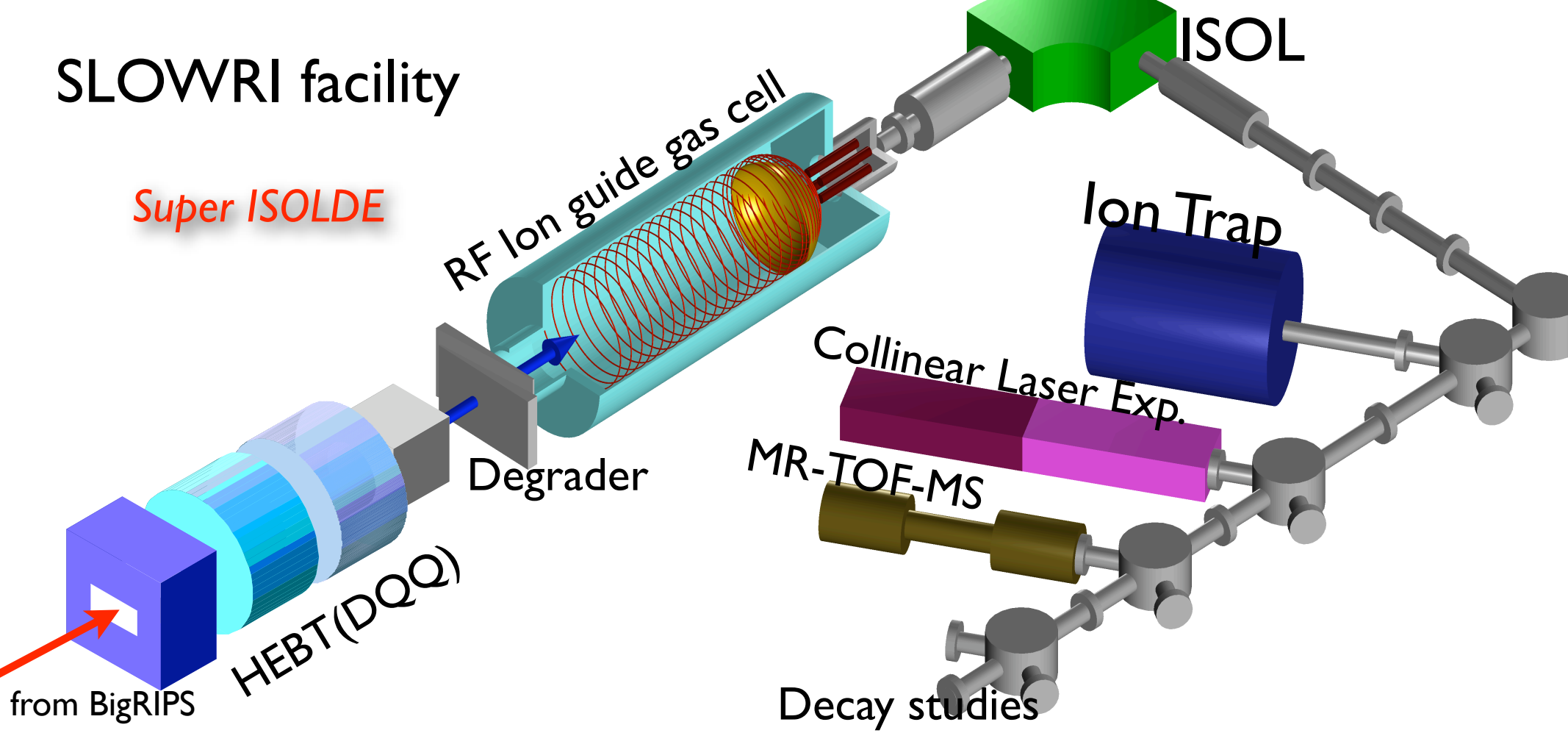
理研　　和田道治

RIBF - RI Beam Factory -



SLOWRI facility

Super ISOLDE

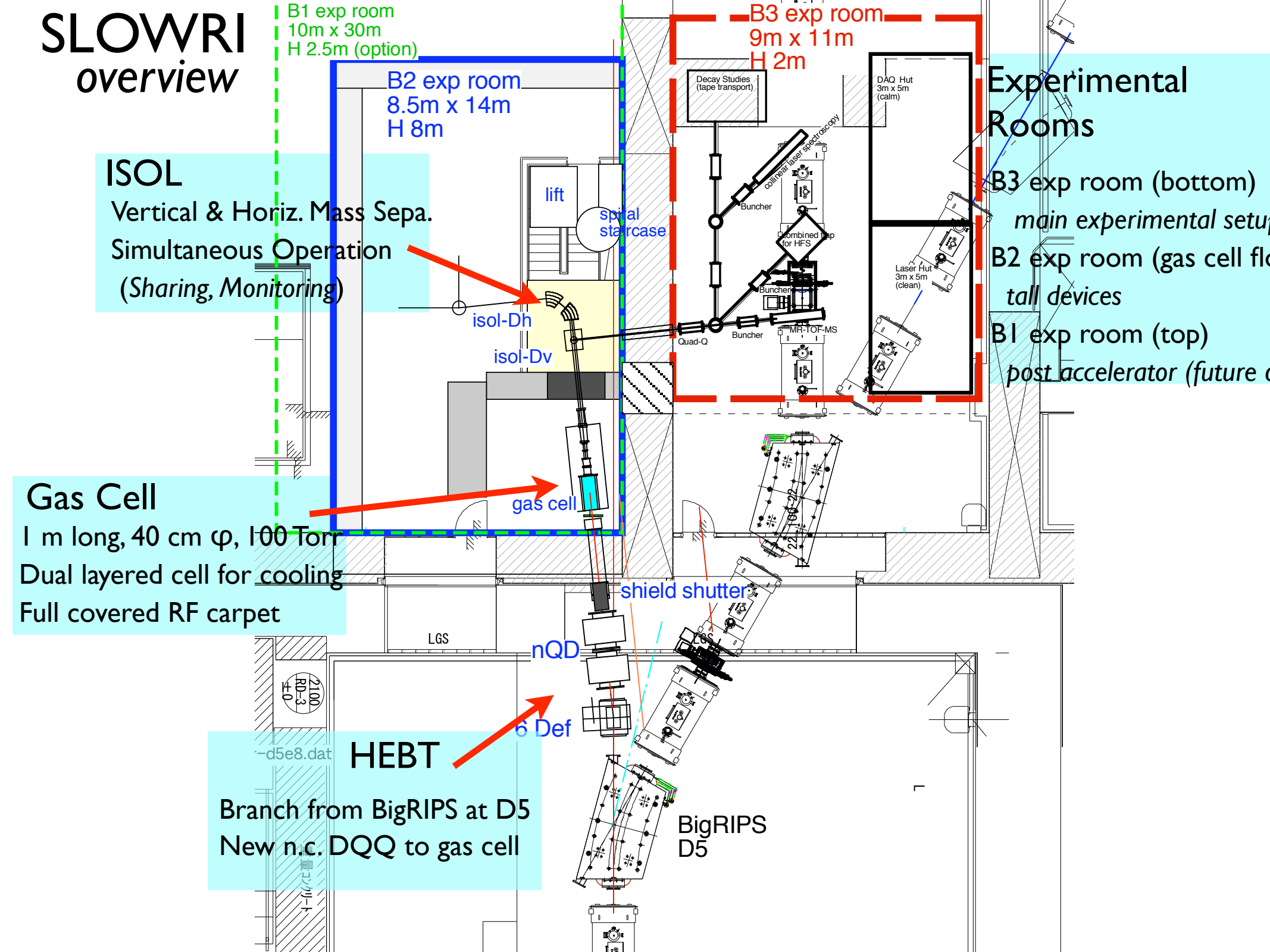


1. Wide Range of Nuclides
   No Chemical Processes in Production & Separation
2. High Purity
   No Isobar No Isotone Contamination
3. Small Emittance
4. Variable Beam Energy
   1-50 keV Slow Beam, <1eV Trapped RI, 1MeV/u (future option)
5. Human Accesibility during On-line Exp.

SLOWRI = Phase 2

prototype facility is at present RIPS

SLOWRI *overview*



ISOL

Vertical & Horiz. Mass Sepa.

Simultaneous Operation

(*Sharing, Monitoring*)

Gas Cell

1 m long, 40 cm φ, 100 Torr

Dual layered cell for cooling

Full covered RF carpet

HEBT

Branch from BigRIPS at D5

New n.c. DQQ to gas cell

Experimental Rooms

B3 exp room (bottom)

main experimental setup

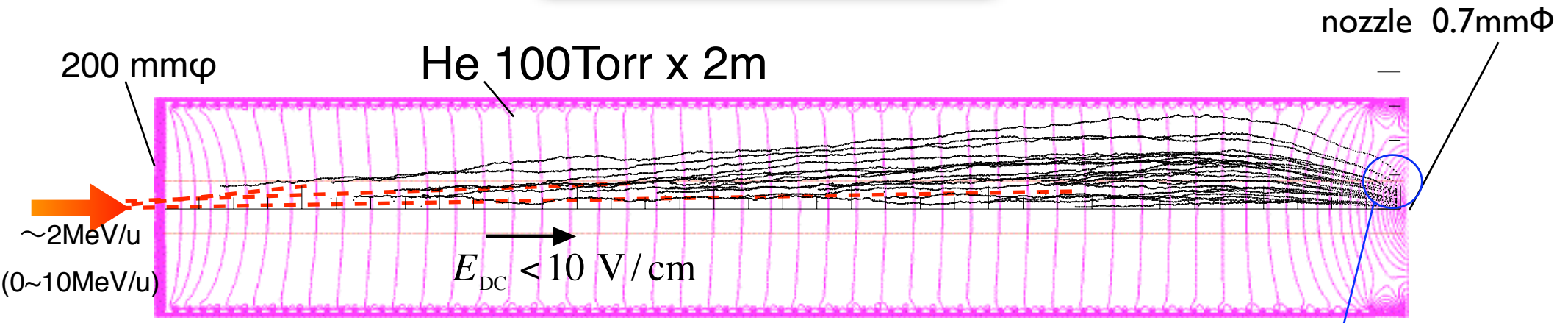
B2 exp room (gas cell flo

tall devices

B1 exp room (top)

post accelerator (future

RF Ion Guide™



Static Field:

transports ions

$$v = \mu E_{DC}$$

μ: mobility

$\sim 150\ \mathrm{cm^2/Vs}$

~~finally stick to the cathode~~

RF gradient Field:

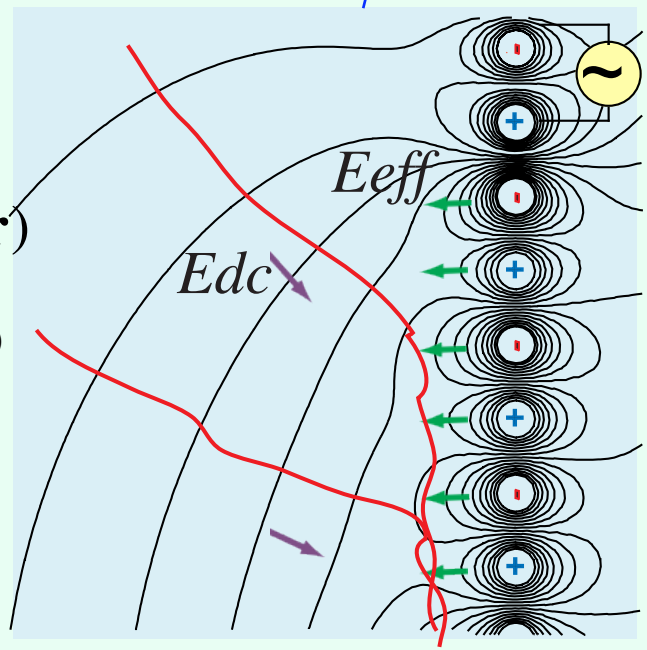
Ion Barrier

$$\bar{F} = -\frac{e^2}{4m}\frac{1}{(\Omega^2 + 1/\tau_v^2)}\nabla \mathbf{E}_{rf}^2(\mathbf{r})$$

$(\mathbf{E}(\mathbf{r},t) = \mathbf{E}_{rf}(\mathbf{r})\cos(\Omega t)$, τ_v: relax time)

$$E_{\text{eff in gas}}^{\max} = \frac{m\mu^2 V_{rf}^2}{e r_0^3}$$

$2r_0 \approx$ electrode distance



RF-Carpet

M.Wada et al, NIM B204 (2003) 570.

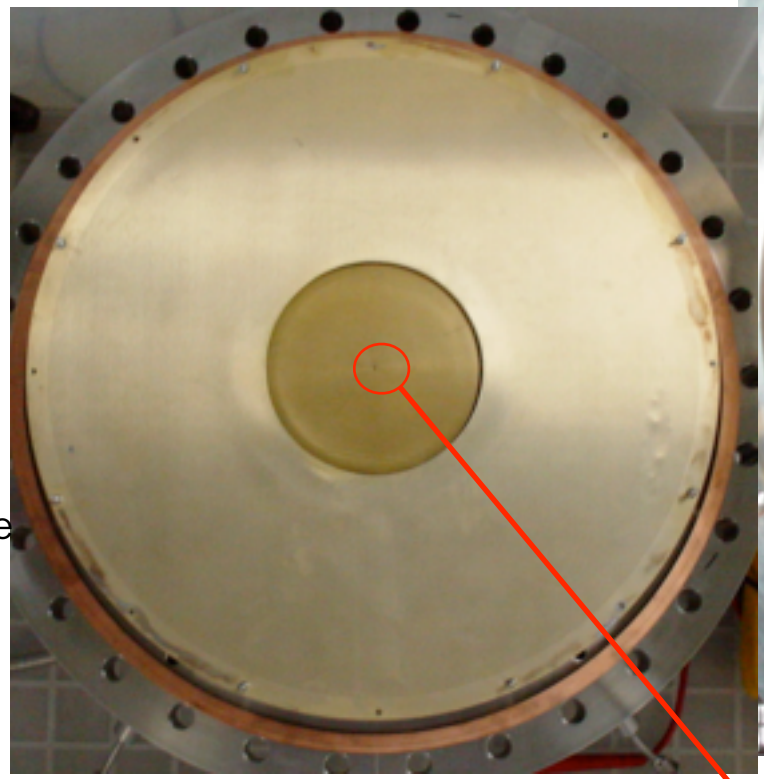
Photo Gallery

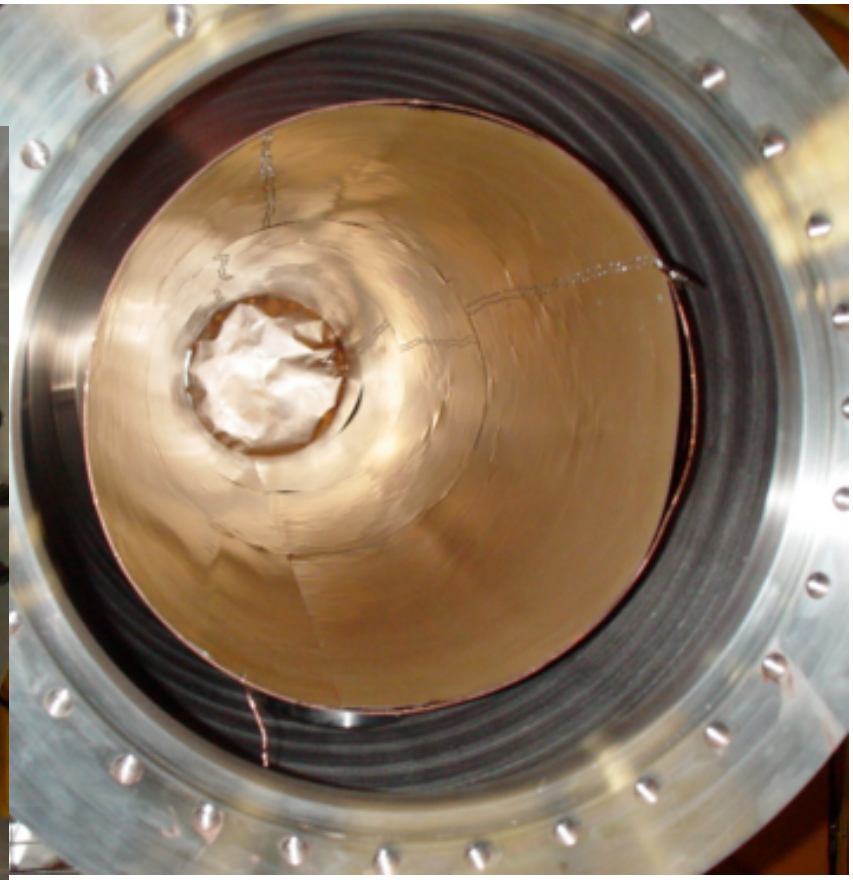
OPIG rf octopole beam guide made of CFRP

SPIG

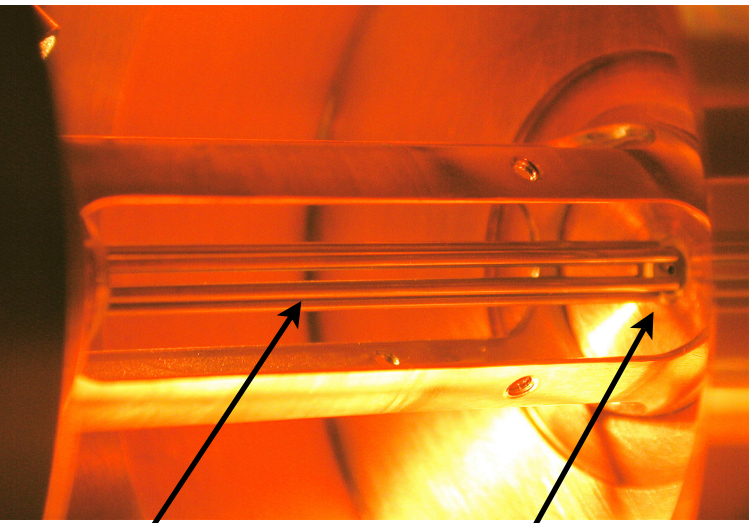
RF six-pole ion beam guide made of 6-0.8 mmϕ Mo rods transports ions to high vaccum.

22MHz 200V





Cylinder DC-Electrodes in Gas Cell

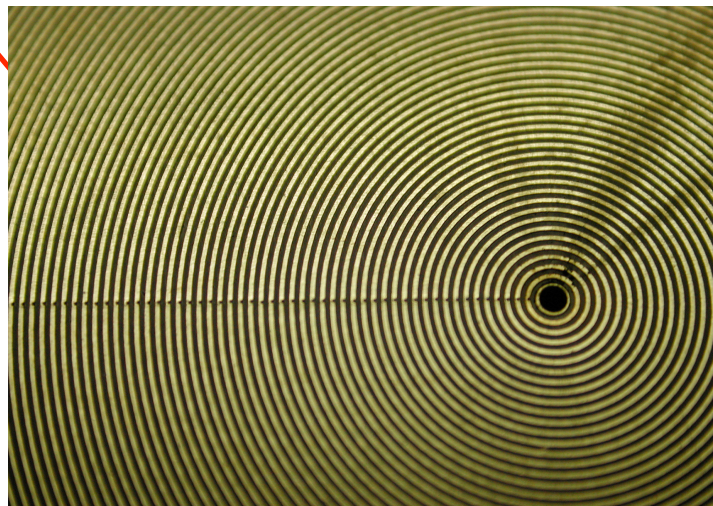


SPIG & Nozzle

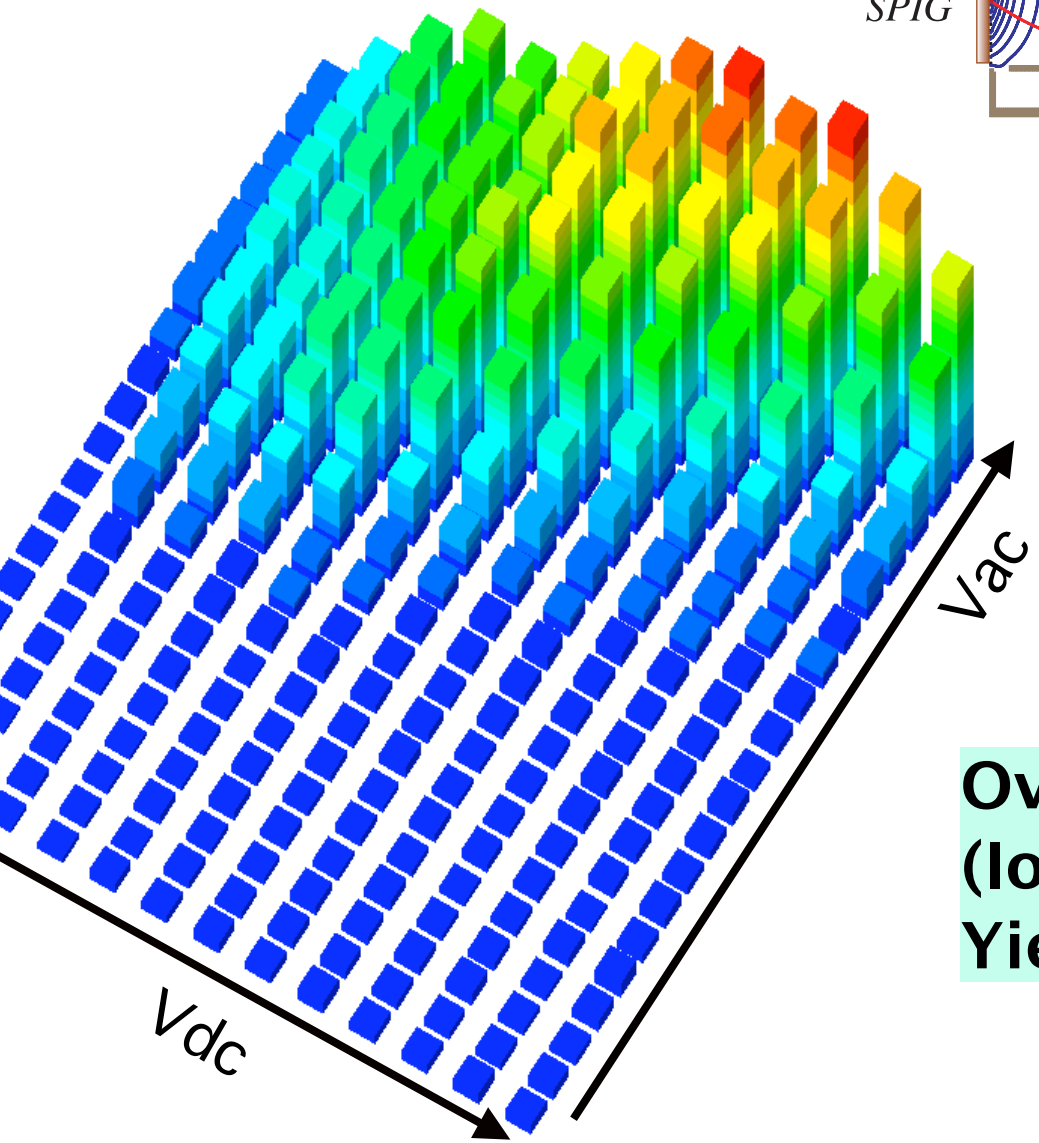
RF Carpet

Central part is made of RF ring-electrodes with 0.28mm interval. An exit of 0.7 mmϕ is located at the center.

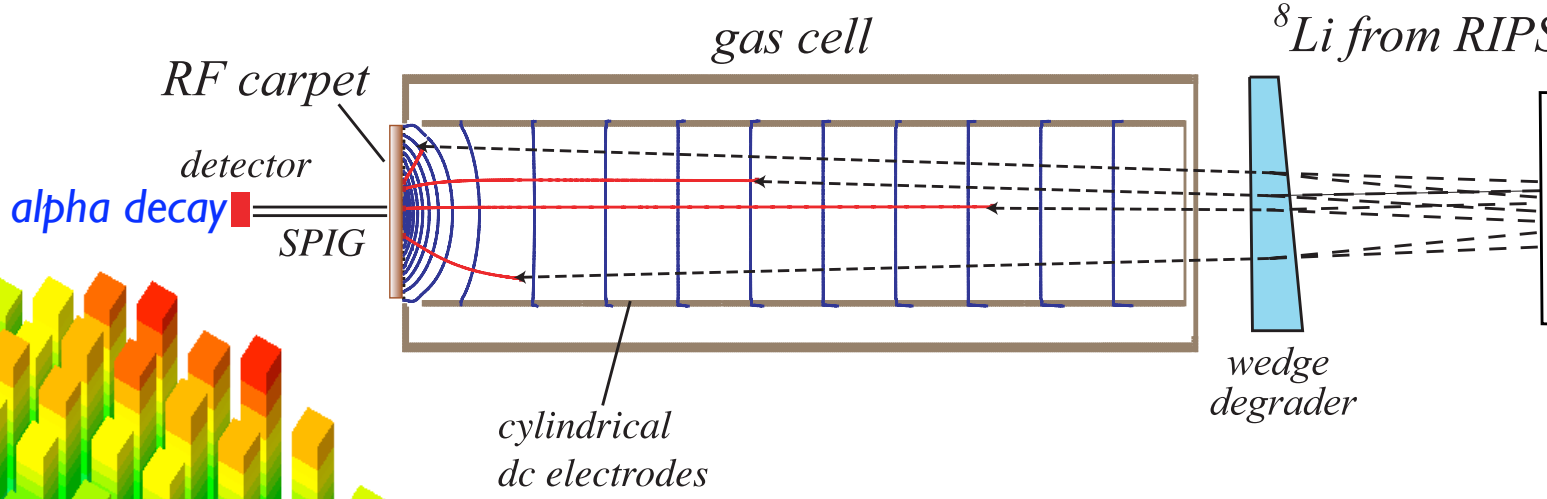
13MHz 150V



Yield and efficiency of slow Li-8 ions



AC-DC Dependence of Yield



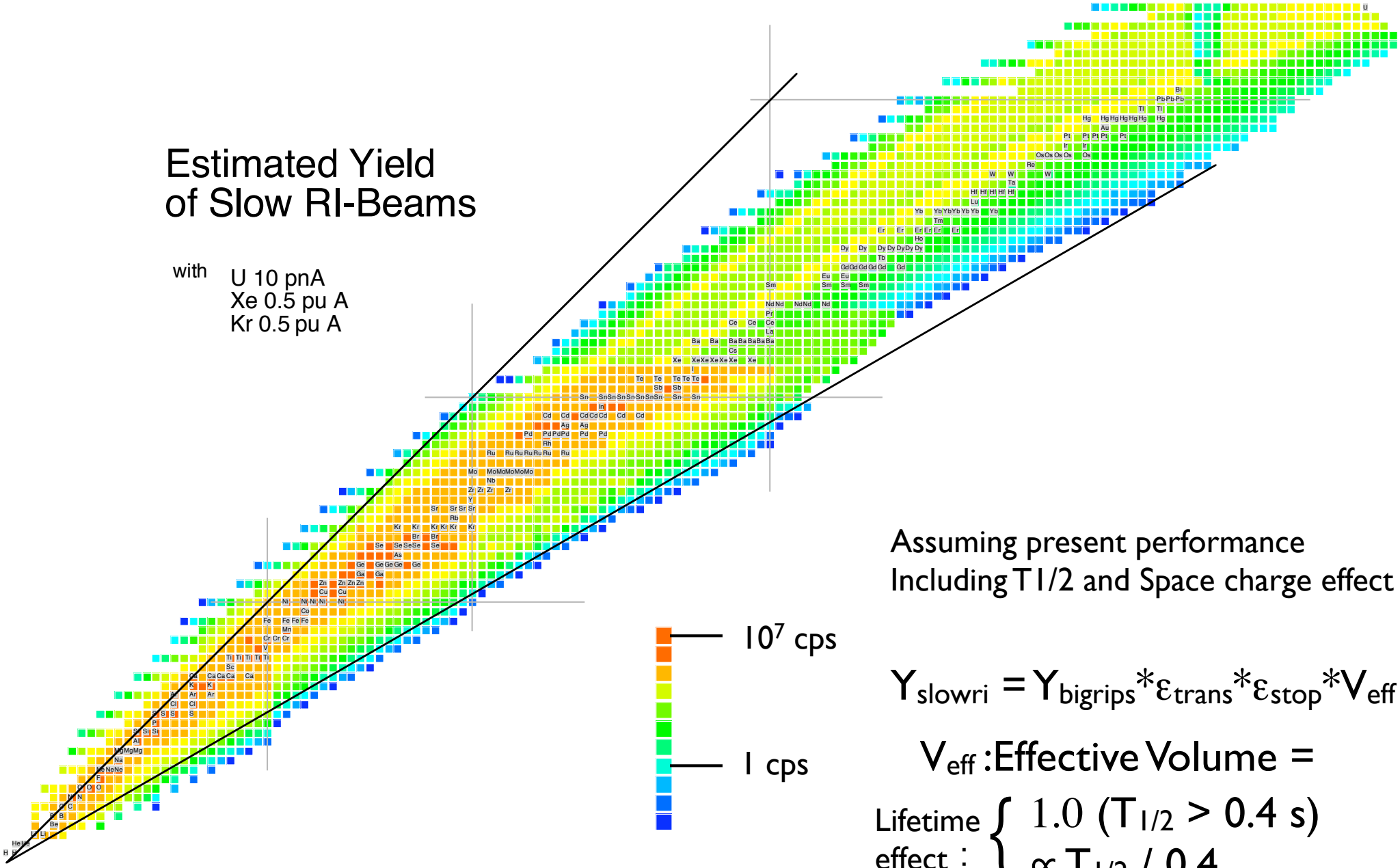
~100 A MeV 8Li ions from RIPS
^{8}Li: delayed alpha decay
reliable measurements
very light ion

Overall Efficiency: ~5% max
(Ion guide Efficiency: ~33% max)
Yield of 8Li: 24 kcps max

M. Wada et al, NIM B204(2003)570
M. Wada, NIM A532(2004) 40
A. Takamine et al, RSI 76(2005) 103503

Estimated Yield of Slow RI-Beams

with U 10 pnA
Xe 0.5 pu A
Kr 0.5 pu A



10^7 cps

1 cps

Assuming present performance
Including T1/2 and Space charge effect

$$Y_{slowri} = Y_{bigrips} * \varepsilon_{trans} * \varepsilon_{stop} * V_{eff}$$

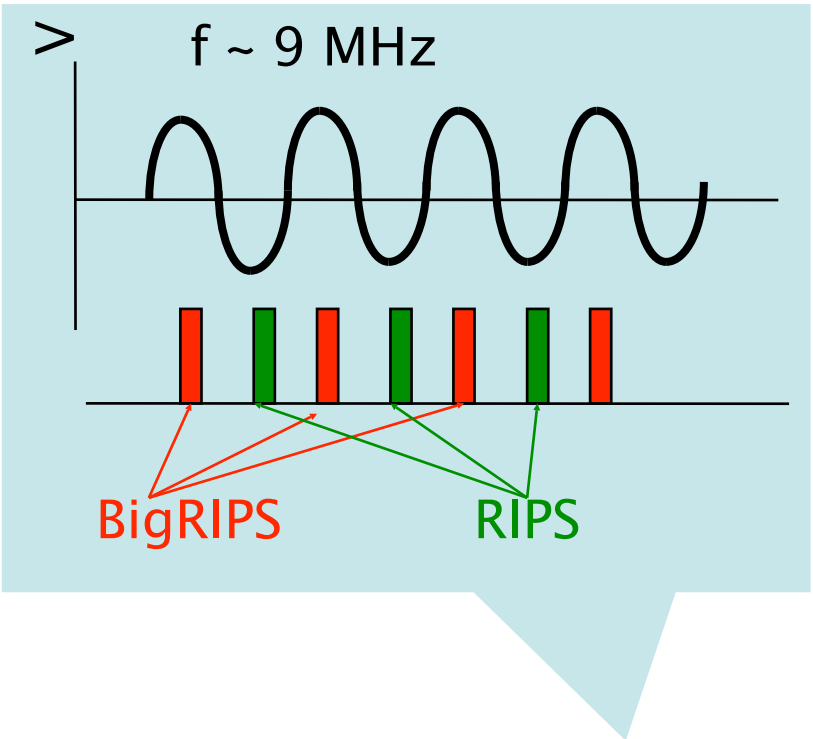
V_{eff} : Effective Volume =

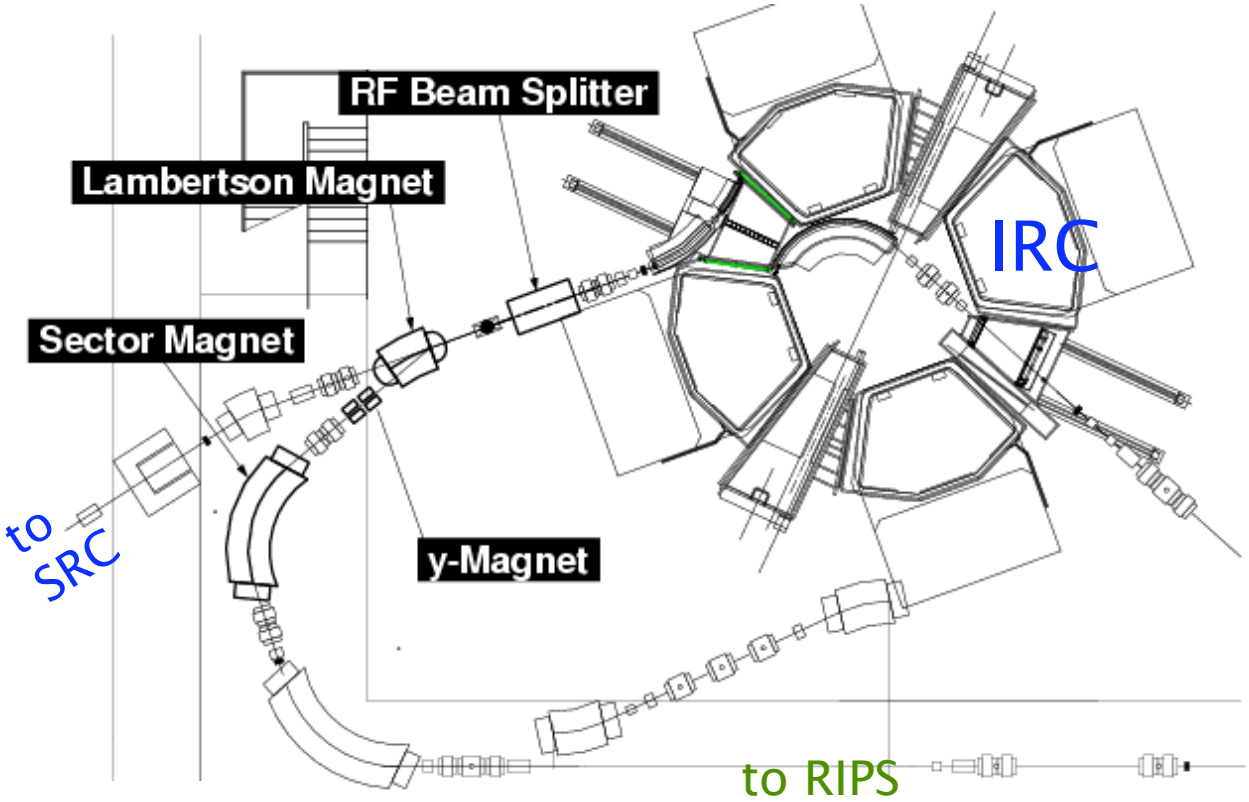
Lifetime effect : $\begin{cases} 1.0 \ (T_{1/2} > 0.4 \text{ s}) \\ \propto T_{1/2} / 0.4 \end{cases}$

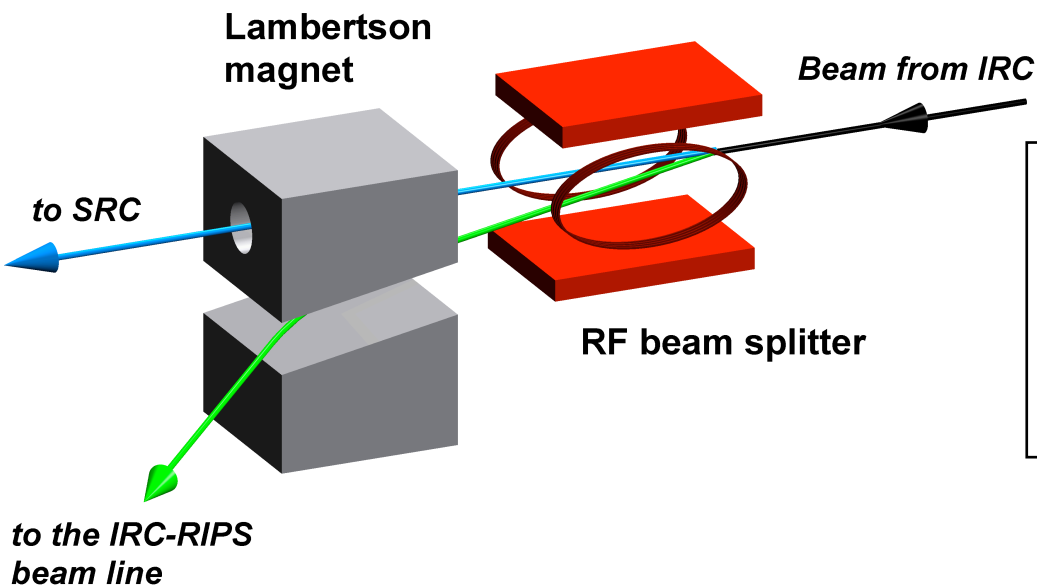
Space-charge effect : $\begin{cases} 1.0 \ (E_{deposit} < 4.3 \text{ MeV} * 10^4 \text{ /s}) \\ \propto E_{deposit}^{-0.5} \end{cases}$

$E_{deposit} \approx$ 1.2A MeV/ion (>Na)

Beam sharing by RF BEAM-SPLITTER + Lambertson magnet



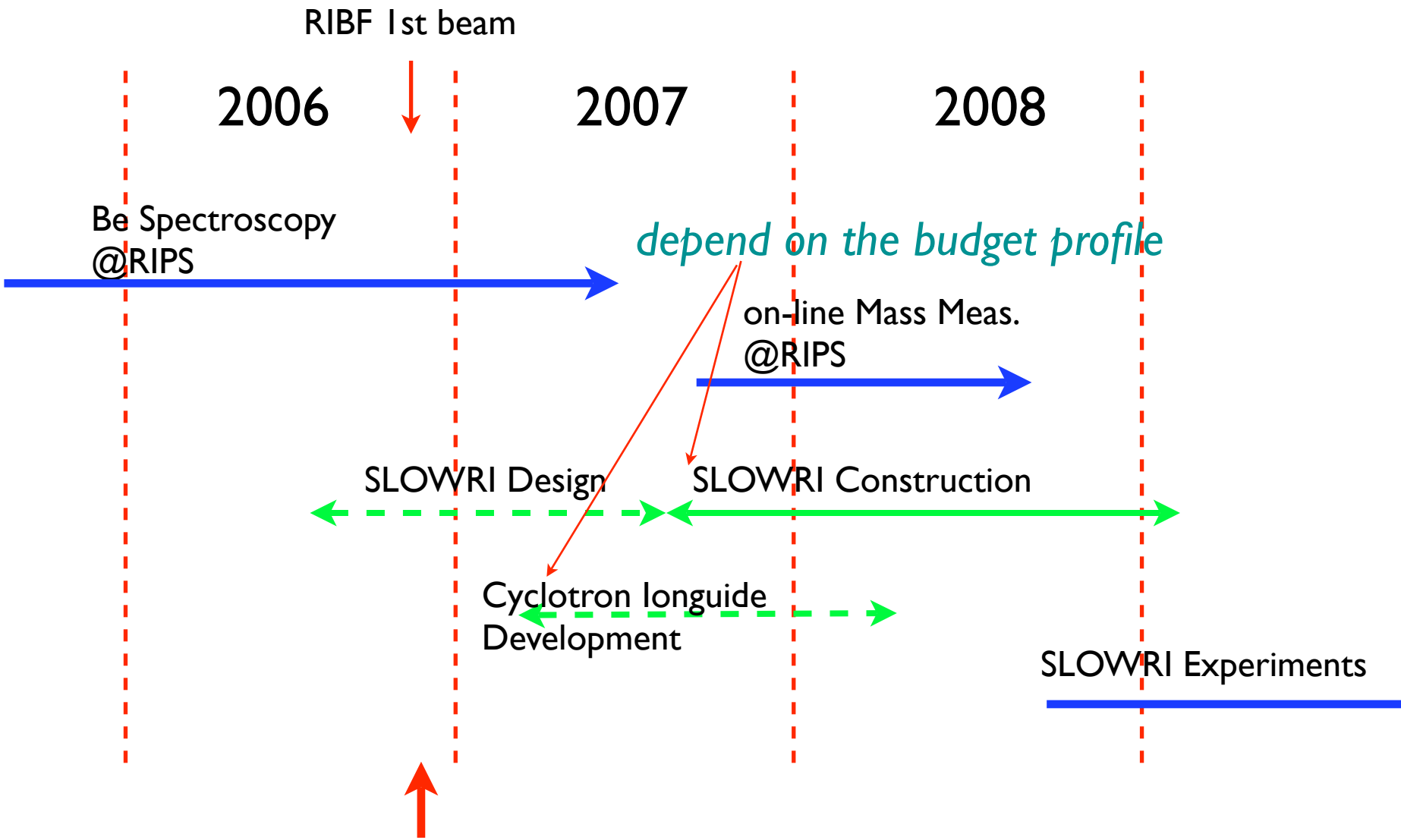




Lambertson Magnet	
Pole Gap	: 40 mm
Radius	: 2500 mm
Bending angle	: 20°
Path Length	: 870 mm
Magnetic field	: 1.7 T

courtesy by H.Ueno

Schedule



International PAC for RIBF

LoI, Proposals are welcome