Proposal to develop Polarized Nuclear Beam (^{3}He and ^{6}Li)

Yasuhiro SAKEMI

For RCNP Polarized Nuclear Beam Collaboration

Contents :

Future Plan

- Short range(3years) : (Cyclotron Facility) Polarized Nuclear Beam
- Middle range :
- Long range(10years) :

Will be presented at workshop on future plan (Jul.-25/26)

Procedure

1.	Jun.-20(today)	: discuss physics, technical issues, collaboration, budget	: feedback to LOI etc
2.	Jul.-25/26	: Workshop on Future Plan at RCNP	: presentation
3.	Aug. or Sep.	: LKB, Paris	: collect technical info.
4.	PPAC on Jul.-25 / Oct.	: LOI / presentation of proposal at PPAC	: decision / suggestion
5.	**核運委**	:	: final judgment

Total Cost = 7000 **万円**

Time Line = Construction : 2003 start ~ 2005 end (total 3 years)

(1) 3 years to construct polarized ^{3}He / ^{6}Li ion source

(2) another 2 years for the experiment and physics output

(3) Stable polarized ^{3}He / ^{6}Li beam**を共同利用に供給する。**

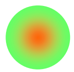
Physics Prospects

New Beam : Polarized Nuclear Beam (^{3}He and ^{6}Li) ⇒ Physics : Pions in Nuclei

Chiral Symmetry ~ Pion

Vacuum : Spontaneously broken ~ Pion as Goldstone boson → **Nucleus (finite density) : Partially restored** → **High Density Matter : Restored**

Nucleon

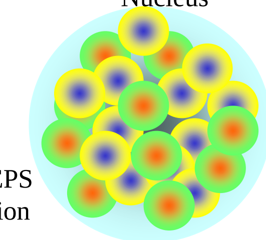


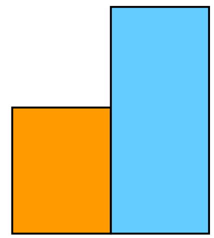
$$\partial^\mu A^i_\mu(x) = m_\pi^2 f_\pi \pi^i(x) \neq 0$$

$$\langle 0|\bar{q}q|0\rangle \approx (-250MeV)^3 \neq 0$$

Sea Quark Flavor Asymmetry / Hadron Structure @LEPS
~ Meson Cloud around Nucleon / Hadron Mass Reduction

Nucleus



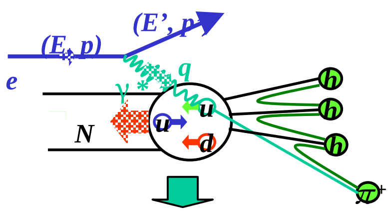


Simple transition to study the pion behavior in the nucleus

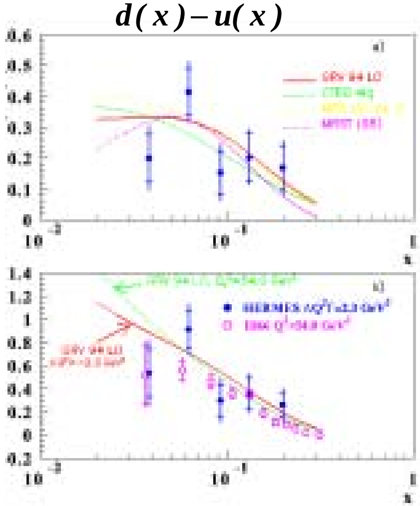
1. Gamow-Teller states (GT) :
   ΔS=1, ΔL=0 ~ interaction from pi/rho-meson exchange
   Polarized ^{3}He beam ⇒ separate pi / rho response to GT
2. Pion-like 0^- states :
   Carry a quantum number of pion
   Polarized ^{3}He/^{6}Li beam ⇒ 0^- state search/identify

Appeared Phenomena

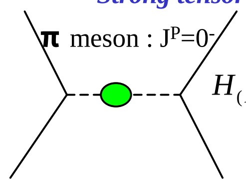
1. Meson Cloud in Nucleon : Sea Quark Flavor Asymmetry
~ Drell-Yan process / lepton-DIS



$$\bar{d}(x) - \bar{u}(x)$$



2. Nuclear force mediated by pion
~ Strong tensor force



$$H_{(N.R.)}^{pv} = -\frac{f_p}{u_p}\left(\psi^+\sigma\psi\right)\cdot\nabla\phi$$

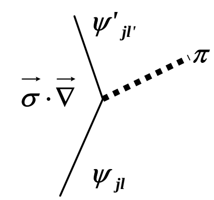
$$V^\pi(1,2) = -\sum_{a=1}^{3}\left(\frac{f}{\mu_\pi}\tau_a^{\ 1}\sigma_1\cdot\nabla_1\right)\left(\frac{f}{\mu_\pi}\tau_a^{\ 2}\sigma_2\cdot\nabla_2\right)\frac{e^{-u_\pi r_{12}}}{4\pi r_{12}}$$

$$V^{OPEP}(1,2) = -m_\pi c^2 f^2(\tau_1\cdot\tau_2)\left[(\sigma_1\cdot\sigma_2)Y(x) + S_{12}Z(x)\right]$$

$$\vec{\sigma}\cdot\vec{\nabla}$$

3. Mean field theory with pion-nucleon coupling
~ Finite pion density in the nuclear surface

Include pion exchange explicitly in the mean field

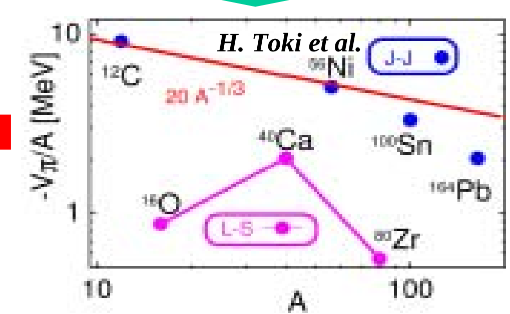


$$\psi_{jl} \Rightarrow \xi\psi_{jl} + \zeta\psi'_{jl'}$$

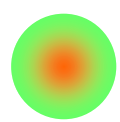
$$\psi'_{jl'} \propto (\vec{\sigma}\cdot\vec{\nabla})\psi_{jl}$$

$$(l' = l \pm 1)$$

$$\left[i\alpha\cdot\nabla + \gamma_0(M + g_\sigma) + \frac{f_\pi}{m_\pi}\gamma_0\gamma_5\gamma\cdot\tau^a\nabla\pi^a + g_\omega\omega + g_\rho\tau^a\rho^a + e\frac{1+\tau_3}{2}A\right]\psi = E\psi$$



Meson Cloud



P→n+π⁺

Pion Distribution In Nucleus ?

Pion energy ~ Surface like : V~A$^{-1/3}$

Topics 1 : Physics with Polarized ^{3}He Beam

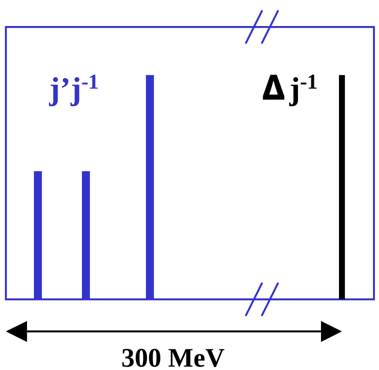
Motivation :

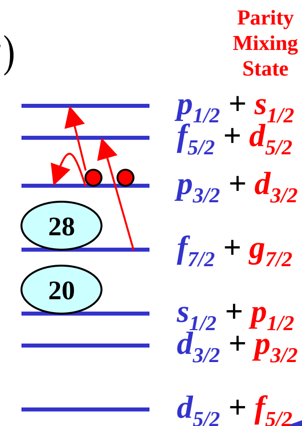
1. Microscopic structure of Gamow-Teller States ~ observed in high resolution (^{3}He,t) : Can not explain with usual shell model
2. Parity mixing state due to pion field in the nuclear medium ~ possible explanation ?

Physics Goal :

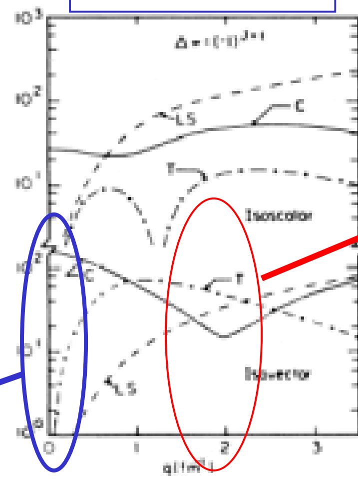
1. Determine the pion response (contribution) to Gamow-Teller states ⇒ obtain the information on parity mixing state
2. Pion distribution in nucleus ~ Surface pion condensation

$$\sigma(q=0) \propto |V_{\sigma\tau}(q=0)|^2 \propto B(GT)$$





Nuclear Interaction



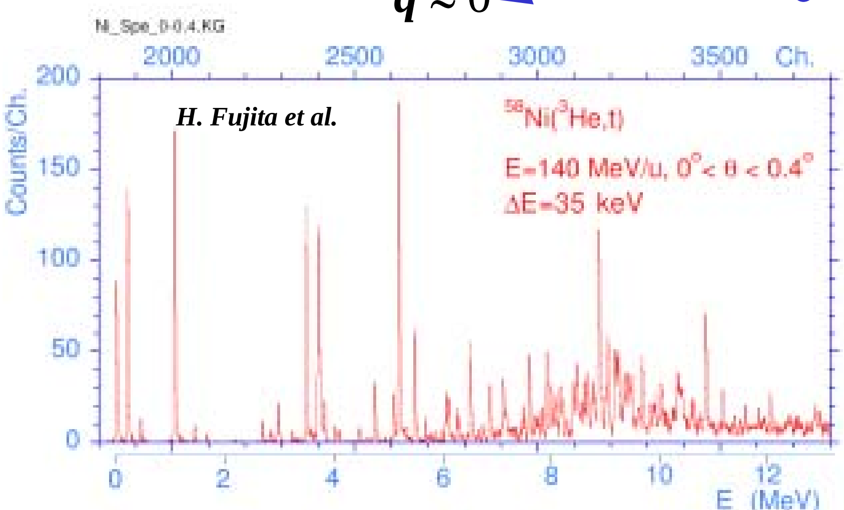
$q \approx 0$

At large q ≠ 0 ,

1. Tensor interaction ~ dominant
2. Pion correlation ~ large
3. Sensitive to pion behavior in nuclei

Spin transfer measurement

1. Separate pion / rho-meson contribution
2. Identify GT states at 0 degree



Simple transition

① Identify spin flip (ΔS=1, ΔL=0) states with Polarization Transfer D_{nn} at 0 degree

② At large q, measure the spin transfer :

$$D_{nn} = \frac{\sigma^t(\hat{n}) - \sigma^t(\hat{Q}) - \sigma^l(\hat{q})}{\sigma^t(\hat{n}) + \sigma^t(\hat{Q}) + \sigma^l(\hat{q})} = \frac{-1}{1 + 2\sigma^t/\sigma^l}$$

③ Determine transition density :

$$\frac{\sigma^t}{\sigma^l} = \left| \frac{\rho^t{}_{fi,\tau}}{\rho^l{}_{fi,\tau}} \cdot \frac{V^t{}_\tau(q)}{V^l{}_\tau(q)} \right|^2$$

④ Discuss the parity mixing state and pion distribution

$$\rho^l{}_{fi,\tau} = \left\langle I_f M_f \left| \sum_j exp[iq \cdot r_j] \sigma_j \cdot q \tau_j \right| I_i M_i \right\rangle$$

$$\rho^t{}_{fi,\tau} = \frac{1}{\sqrt{2}} \left\langle I_f M_f \left| \sum_j exp[iq \cdot r_j] \sigma_j \times q \tau_j \right| I_i M_i \right\rangle$$

Topics 2 : Search for 0$^-$ state with Polarized Nuclear Beam

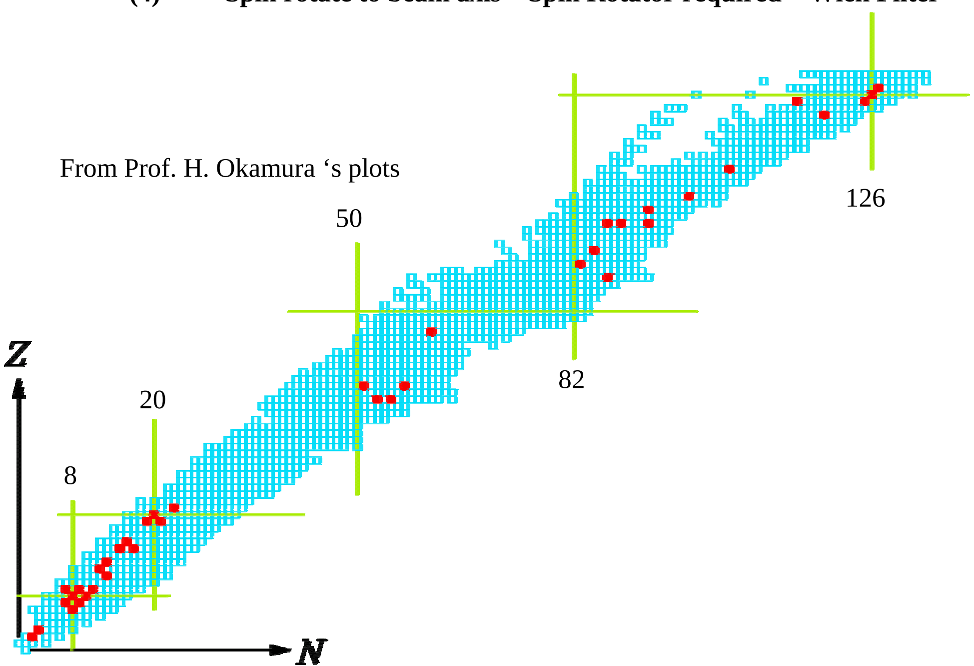
Motivation
1. $J^P=0^-$ excitations : carry the simple Pion-like quantum number ⇒ will have a pion correlation in the nucleus
2. 0^- state is not clearly separated ⇒ poor data , limited
3. (p,n) data by Orihara et al. ~ low incident energy ⇒ large difference between data and DWBA at large q ~ signature of pionic field ?

Physics Goal
1. 0^- states search with high resolution charge exchange reaction (^{3}He,t) and (^{6}Li,^{6}He)
2. Polarized beam ~ Powerful tool to identify 0^- states with spin observables
3. Pion correlation in the nucleus

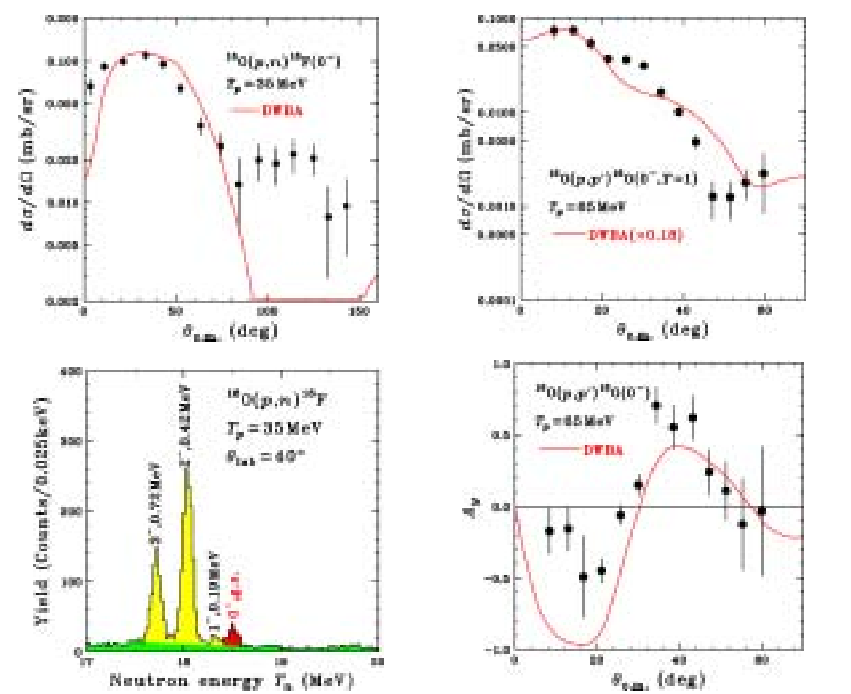
Spin Observables = Tool for 0- state Search/Identification
1. Polarized (^{3}He,t)
   (1) Spin transfer
   (2) High resolution charge exchange reaction
2. Polarized (^{6}Li,^{6}He)
   (1) ^{6}Li ~ easy for optical pumping
   (2) ^{6}He ~ bound state = high efficiency / high resolution measurement
   (3) Analyzing Power : $A_{ZZ}=-2$ for 0^- state
   (4) Spin rotate to beam axis ~ Spin Rotator required ~ Wien Filter

$$D_{nn} = \frac{-1}{1+2\,\sigma_t/\sigma_l} \rightarrow -1$$ *If longitudinal character ~ dominant*

From Prof. H. Okamura 's plots



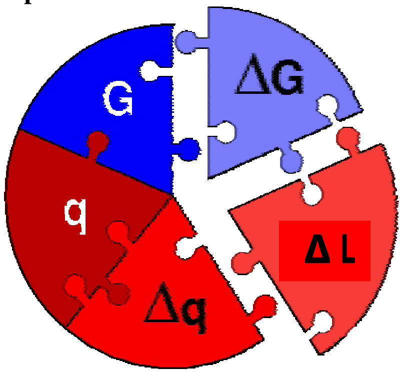
(p,n) data (p,p') data



H. Orihara et al., PRL 49, 1318 (1982) *K. Hosono et al., PRC 30, 746 (1984)*

Topics 3 : Possible extension with Polarized ^{3}He : Nucleon Structure

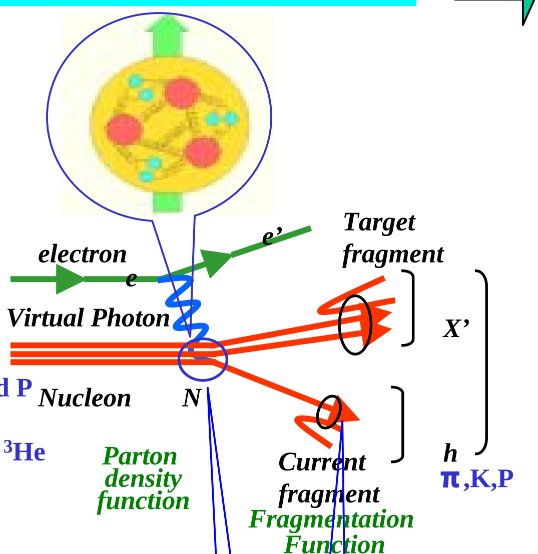
Spin structure of Nucleon



Sea Quark Polarization

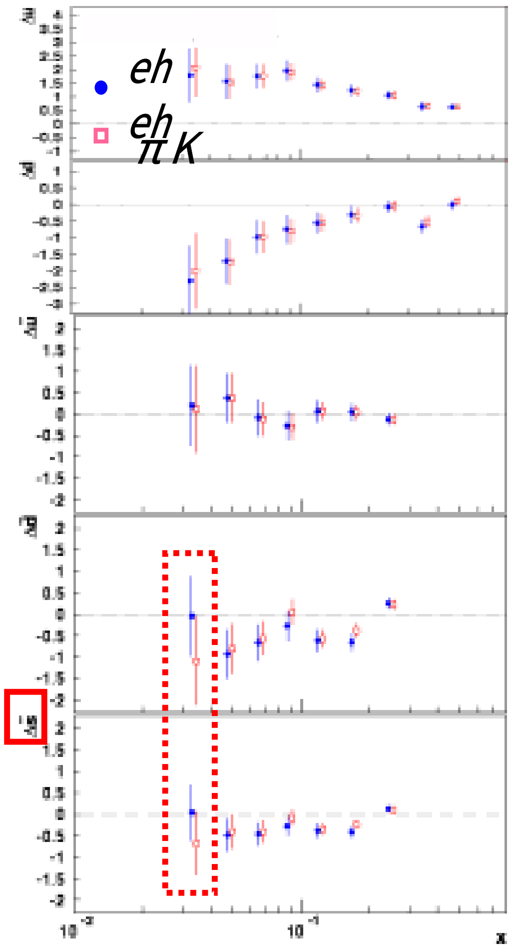
ΔS(x) , ΔS(x), Δu(x), Δd(x) , Δq(x)

Polarized P
+
Polarized ^{3}He

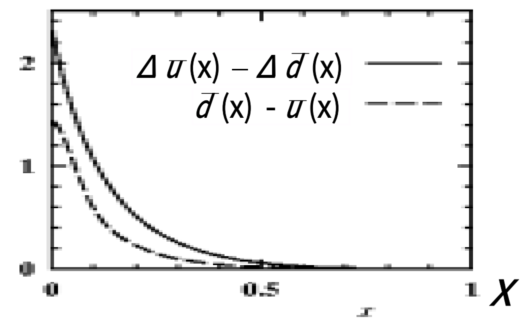


$$A_1^h(x,z)=\sum_f \frac{e_f^2 \cdot q_f(x)\cdot D_f^h(z)}{\sum_{f'} e_{f'}^2 \cdot q_{f'}(x)\cdot D_{f'}^h(z)} \times \frac{\Delta q_f(x)}{q_f(x)}$$

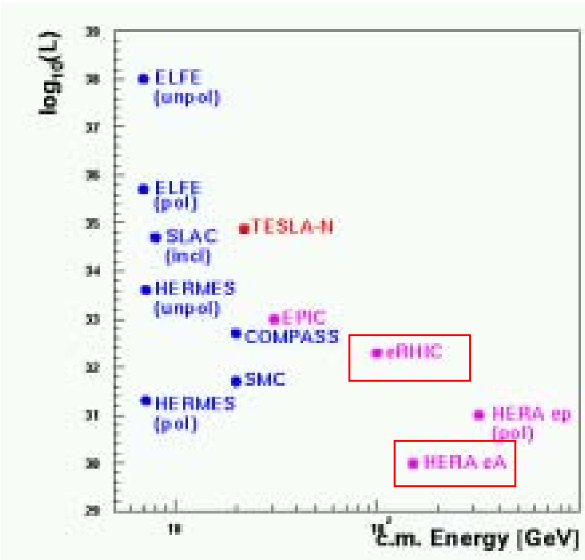
$$\vec{A}=P\bullet\vec{Q}$$



Polarized sea flavor asymmetry
-Large 1/Nc expansion
-Chiral Quark Soliton Mode



Sea quark / Gluon polarization
⇔ small x region
⇒ polarized lepton + polarized ^{3}He collider



Summary of Physics Programs

Chiral Symmetry in the Nuclear/Hadron Physics
~ Pions in Nucleus : Nuclear Structure

Nucleon Structure

New Beam = Polarized Nuclear Beam
(H, D, ^{3}He, ^{6}Li, …)
Polarization Transfer Measurements

Hadron Structure @ LEPS

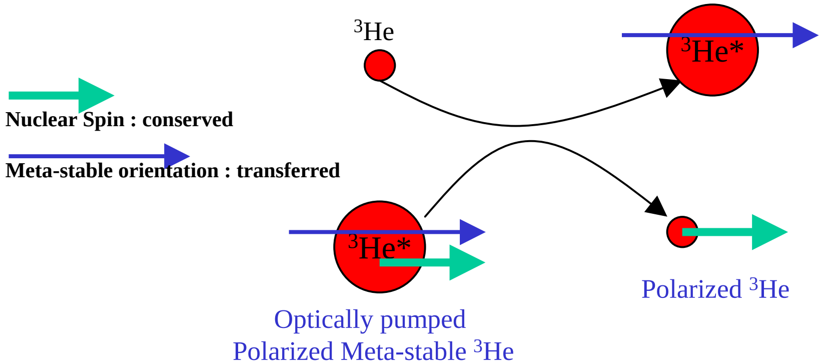
High Resolution	**Charge Exchange**	**Polarization**	**Decay Particle**
High resolution (^{3}He,t) ↓ Microscopic structure of GT states	Polarization transfer (p,n) measurement ↓ Quenching of GT strength / Longitudinal/Transverse response	Exclusive measurement with (p,2p) ↓ Medium modification of Nuclear force	Decay particle measurement

#	Beam	Topics	Physics Goal	Facility	Impact	Priority
1	^{3}He	Response Function of GT transition	Pion distribution in the nucleus	RCNP		
2	^{3}He	Search for Pion-like 0- states	Pion condensation precursor	RCNP		
3	^{3}He	Polarized ^{3}He – Nucleus elastic scattering	(K.Hatanaka) Origin of LS force in the nucleus	RCNP		
4	^{3}He	Polarization transfer of ^{3}He inelastic scattering	(Y.Fujita)	RCNP		
5	^{3}He	Astrophysical topics	(M.Fujiwara/M.Tanaka)	RCNP		
6	^{3}He	Stripping / Pickup reaction measurement	(M.Fujiwara) Nuclear structure	RCNP		
7	^{3}He	Coherent Pion Production with (^{3}He,t)	Nuclear force and pion condensation	RCNP/J-PARC		
8	^{3}He	Polarized Drell-Yan Process	Sea quark polarization at high x	J-PARC		
9	^{3}He	Polarized lepton-^{3}He DIS	Flavor decomposition at small x	e-RHIC / HERA		
10	^{3}He	Ion trap of polarized ^{3}He ion	Detection of negative energy squeezed state	RCNP		
11	^{6}Li	Search for Pion-like 0^- states	(H.Okamura) Pion correlation in the nucleus	RCNP		
12	^{6}Li	Polarized ^{6}Li – Nucleus elastic scattering	(K.Hatanaka) Origin of LS force in the nucleus	RCNP		
13	^{6}Li		(K.Hatanaka) Cluster structure	RCNP		

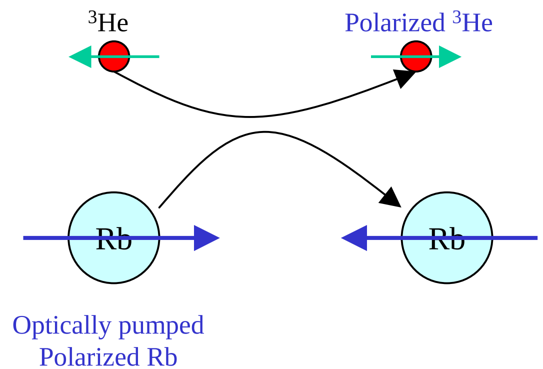
Overview of Polarized ^{3}He Ion Source and Target Projects in the world

Polarize ^{3}He atoms using optical pumping method

1. Meta-stable Exchange Optical Pumping (ME)
~ developed by Colegrove, Schearer, and Walters
Phys. Rev. 132 (1963) 2561

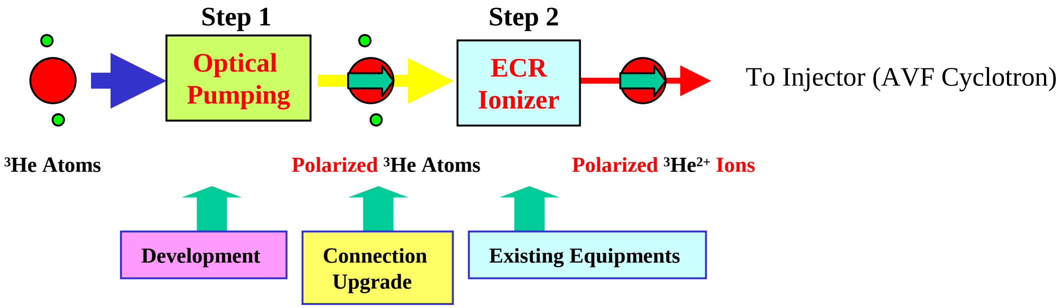


2. Spin Exchange Optical Pumping (SE)
~ developed by Bouchiat, Carver, and Varnum
Phys. Rev. Lett. 5 (1960) 373



	Institute	Polarization	Intensity	Used for	Methods	Reference
Polarized Ion Source	Rice	11 %	8 uA (3He+)		ME	Phys.Rev.Lett.20 (1968) 738
	RCNP (by Prof. M. Tanaka)	5.5 %	2 uA (3He+)	Nuclear Physics	OP/EP/SE	Many Publications
	Birmingham	70 %	4 uA	Nuclear Physics	Lamb shift	Phys.Rev.Lett.31(1073)109
	Saclay/Manitova/…			Stopped		
Polarized Target	Bates@MIT, CEBAF / CalTech			External target	ME	
	IUCF / MIT			Internal target	ME	NIM A274(1989)56
	HERMES@DESY / MIT	54 %	10^{15} atoms/cm^{2}	Internal target	ME	NIM A419(1998)16
		50 %	10^{20} atoms/cm^{2}	External target	SE	Phys.Rev.C36(1987)2244
	SLAC	30~40 %	7×10^{21} atoms/cm^{2}	External target	SE	NIM A356(1995)148
	CNS, RCNP	25 %	2.2×10^{22} atoms/cm^{3}	External target	SE	

Strategy to realize polarized ^{3}He beam



Method = Meta-stable Optical Pumping of ^{3}He (Step1) + ECR Ionizer (Step2)

Advantage :

1. Pure ^{3}He gas
2. High power laser available
3. Room temperature operation
4. Simple configuration
5. What is unique = this combination is unique in the world ⇒ Simple but Difficult !

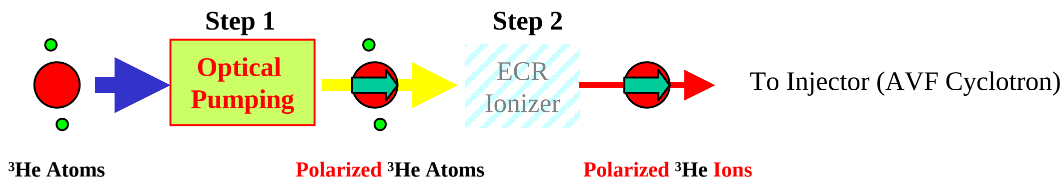
Disadvantage : What should be solved and overcome.

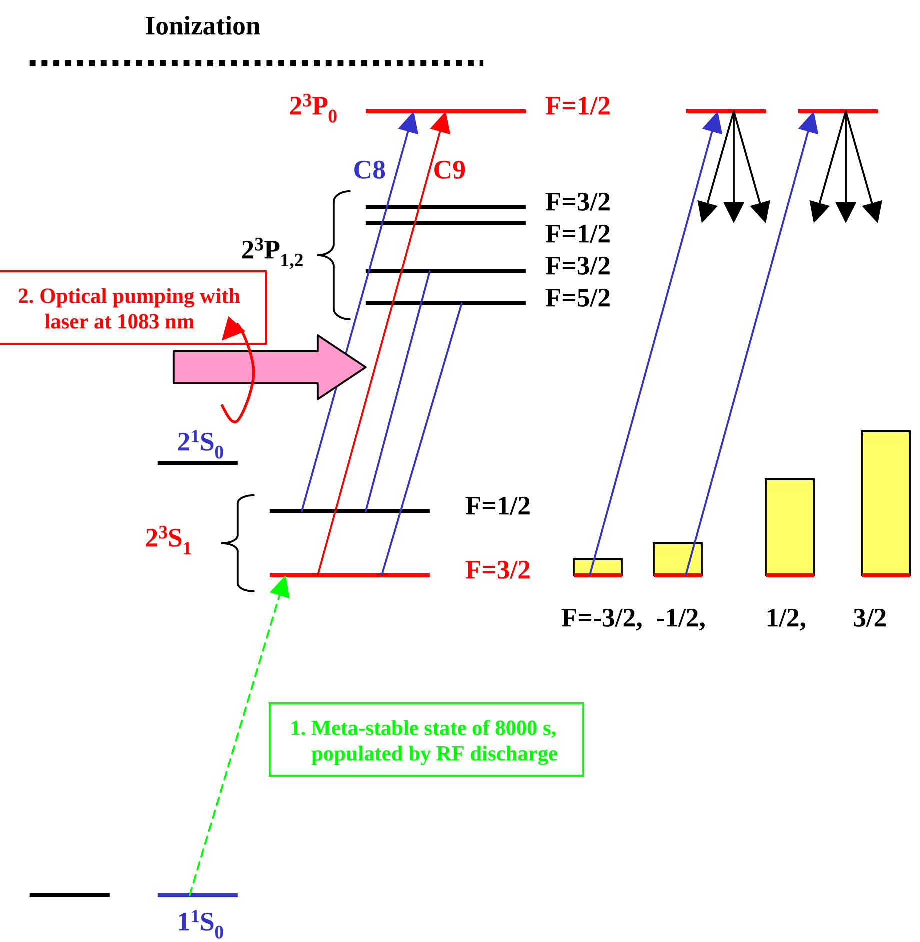
1. Depolarization of ^{3}He atoms in the ECR ionizer
2. Ionization efficiency

Strategy :

1. Apply available modern and standard technology
2. Minimum novel development items ~ focus the development part
3. Procedure :
   - (1) Feasibility check using available equipments/Design work : 2003~2004 : cost LOI/TDR : ***Next Decision***
   - (2) Construction of Polarized 3He Ion Source : 2004~2005 : cost
   - (3) Acceleration Test and Physics Run : 2006~ : cost
4. Others

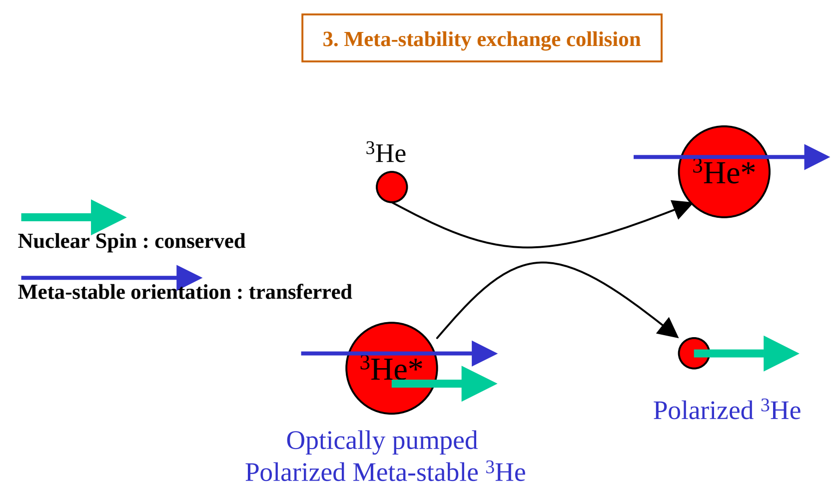
Step 1 : Principle of ^{3}He polarization



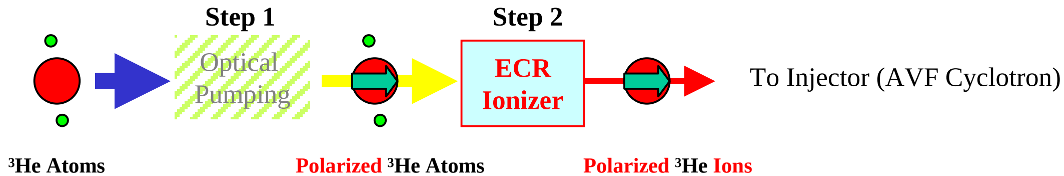


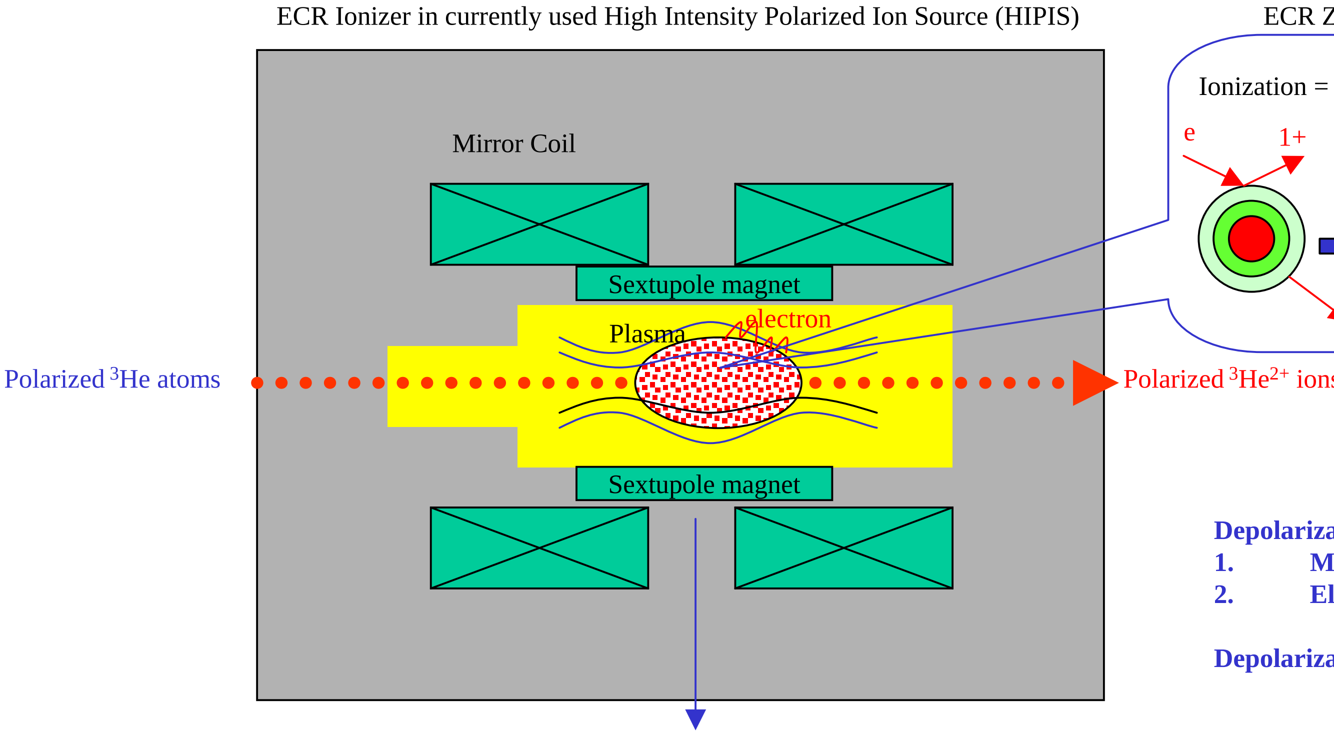
Polarization production process : 3 steps

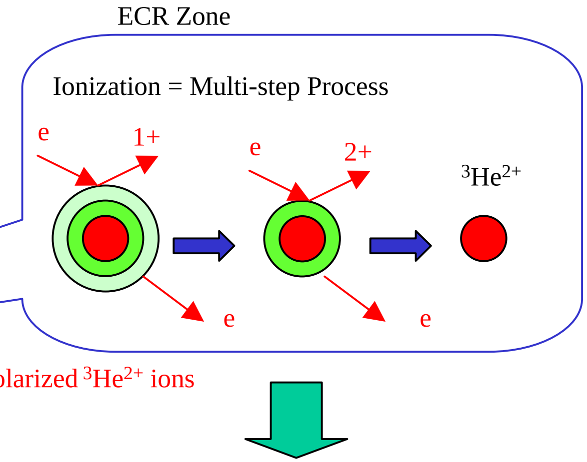
1. Produce meta-stable ^{3}He atoms with RF discharge
   $^3He_{g.s.} \Rightarrow {}^3He\,(2^3S_1)$
2. Coupling to the radiation field with optical pumping
   $^3He^*\,(2^3S_1) \Leftrightarrow {}^3He\,(2^3P_0)$
3. Meta-stability exchange collisions
   $^3He_{g.s.}(1^1S_0\,,\, m_F=-1/2) + {}^3He^*(2^3S_1\,,\, m'_F)$
   $\Leftrightarrow {}^3He^*(2^3S_1,\, m'_F-1) + {}^3He_{g.s.}(1^1S_0\,,\, m_F=1/2)$
4. Others



Step 2 : ECR Ionizer ~ Depolarization and Ionization process





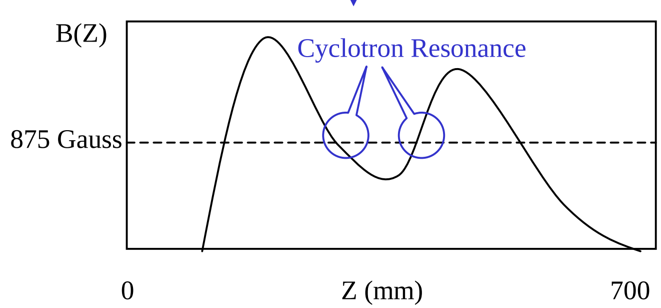


Depolarization

1. **Multi-pole field / RF field**
2. **Electron recombination with ^{3}He ion**

Depolarization mechanism is now studied ….

	High Intensity ECR (HIPIS)
Micro wave RF	2.45 GHz
Resonance field	875 Gauss
Inner diameter of Plasma chamber	80 mm
Chamber length	700 mm



Feasibility Check / How to test

What should be checked experimentally and with simulation (if possible)

1. **Depolarization in the ionizer** : **inject polarized 3He gas supplied by (1) Polarized Target at RCNP or (2) LKB, Paris**
2. **Ionization efficiency** : **inject 4He gas / detect 2+ ions**
3. **Detailed study of ionization mechanism**

Delivered from Mainz to Sheffield in 2001

-magnetized spin box

-Housing a glass vessel

-Relaxation time ~ 50 hours (reproducibly ?)

Feasibility check experiment

Polarized ^{3}He atoms → **ECR ionizer : Ionization ~ complicated multi-step** → **Polarized $^3He^{2+}$ ion** → **Polarimeter**

NMR

(Polarization: P_i, Intensity: I_i)

(Polarization: P_f, Intensity: I_f)

$$P_f = F_P(P_i, Spec(ECR), Others...) = \varepsilon(P) \times P_i$$

$$I_f = F_I(I_i, Sprc(ECR), Others...) = \varepsilon(I) \times I_i$$

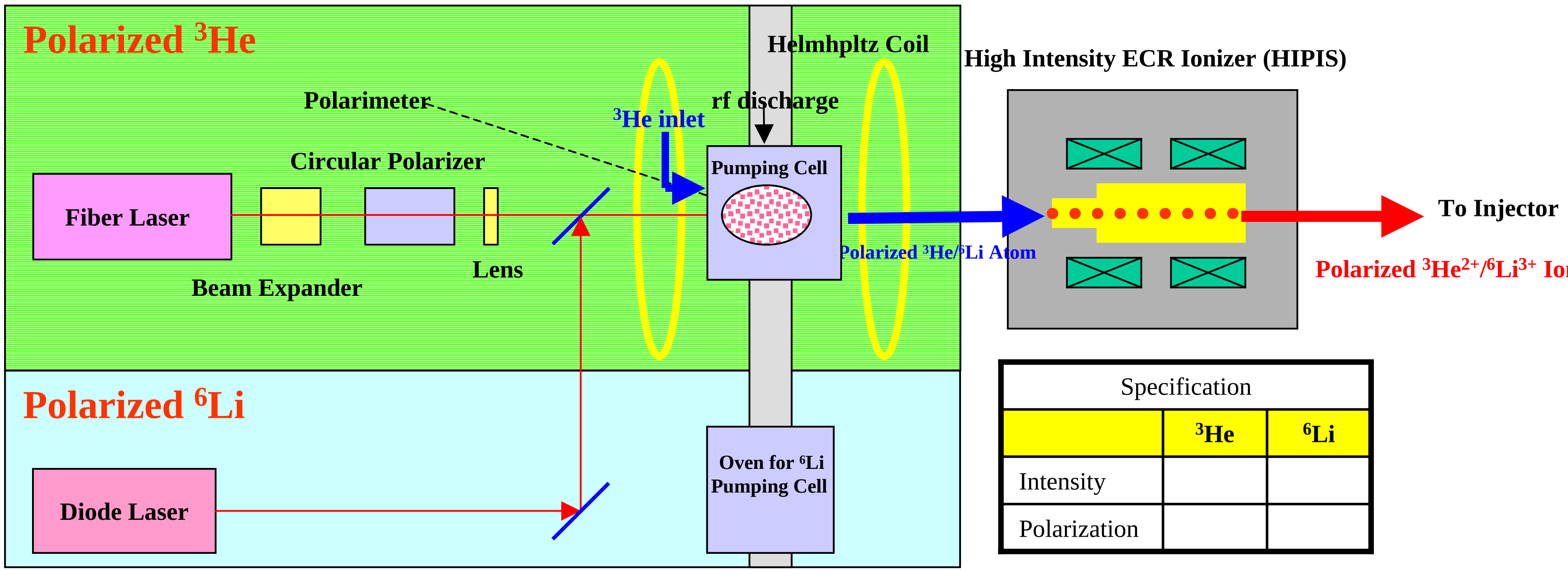
Theoretical / Simulation evaluation

Equipments	Status	Cost	Comments	Contact
Polarized ^{3}He atoms	Cell etc / LKB, Paris ~ Sep.		m.e. optical pumping	Prof. Leduc, Prof. Tastevan / Relaxation Time = 50 hours with special coating
ECR Ionizer	Exists : HIPIS / nanoGun		2.45GHz / 2.45GHz	Prof. Hatanaka / Prof. Shimoda (EN)
Polarimeter	Should be prepared			Prof. Tanaka
Beam line	Exists : HIPIS/EN course			Prof.Hatanaka / Prof. Shimoda (EN)
Readout/DAQ/Control	Should be prepared			

Configuration of Polarized ^{3}He and ^{6}Li Ion Source and Construction Plan

What is New .

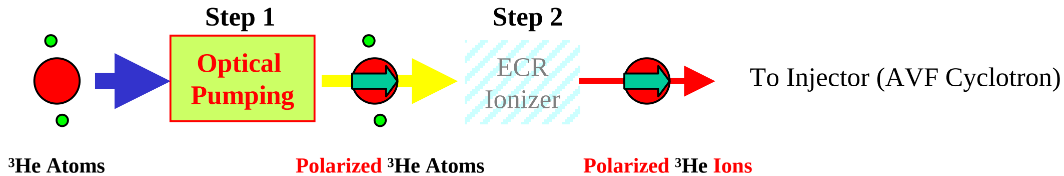
1. ^{3}He : configuration of meta-stable exchange optical pumping + ECR ionizer
2. ^{6}Li : no operated ion source at present



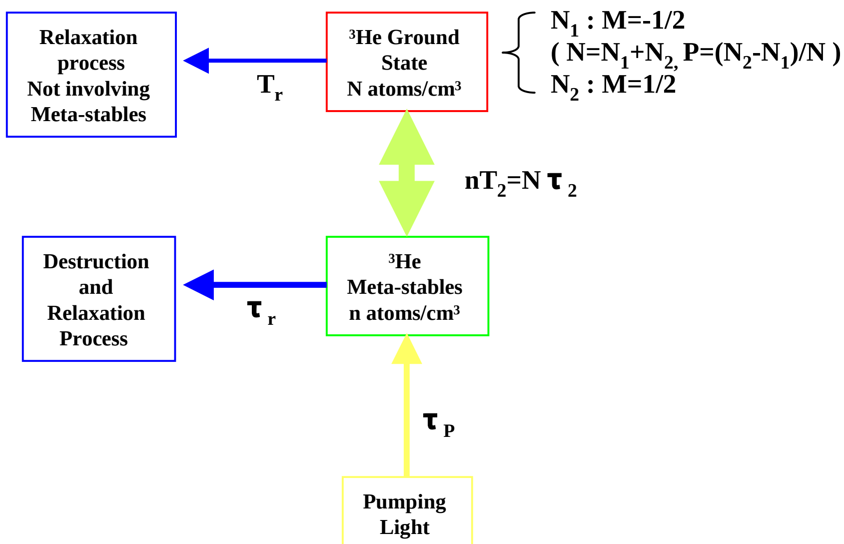
Specification		
	^{3}He	^{6}Li
Intensity		
Polarization		

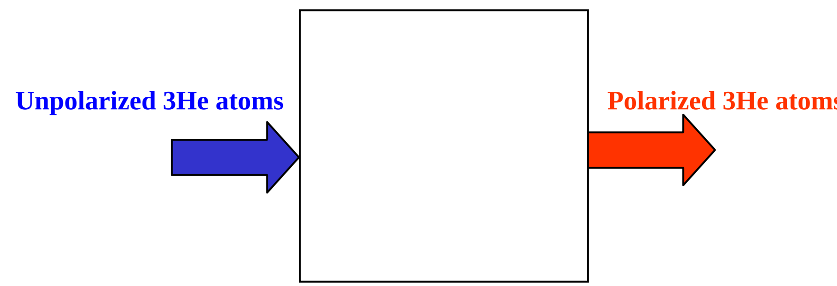
Construction Plan			
	1st year	2nd year	3rd year
Polarized ^{3}He	Feasibility Check	Pumping Laser	Control
		Pumping Cell	
		Gas feed system	
Polarized ^{6}Li	Pumping Laser	ECR ionizer / Magnet	Spin rotator
	Optical devices		Control
	Vacuum system		
	Oven		
	Supporting structure		

Design of Polarized ^{3}He Atom Source



Rate Equation





$$P = P(W, V, \ldots.)$$

Polarization : P ~ depends on

1. **Laser power**
2. **Pumping transition**
3. **3He pressure**
4. **Discharge intensity and frequency**
5. **Cell size and shape**

$$\frac{dp}{dt} = \frac{1-p}{\tau_p} - \frac{p}{\tau_r} + \frac{P-p}{\tau_2}$$

$$\frac{dP}{dt} = \frac{p-P}{T_2} - \frac{P}{T_r}$$

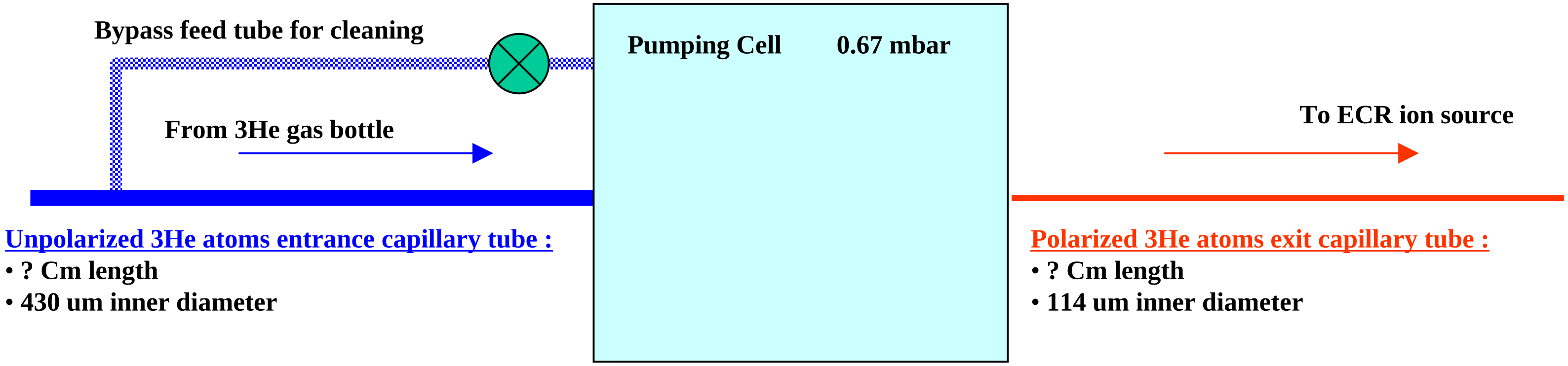
$$p_0 = \left[1 + \frac{\tau_p}{\tau_r} + \frac{\tau_p}{\tau_2}\left(\frac{T_2}{T_r + T_2}\right)\right]^{-1}$$

$$P_0 = \frac{p_0 T_r}{(T_r + T_2)}$$

Polarized Atom Source (1) : Optical Pumping Cell

Polarized ^{3}He atom :

1. Material : Quarts
   - (1) Radiation damage
   - (2) Transmission of laser
2. Cell shape : Cubic / Radial
   - (1) Polarization axis
3. Cell size : large size ~ long residence time ~ large polarization



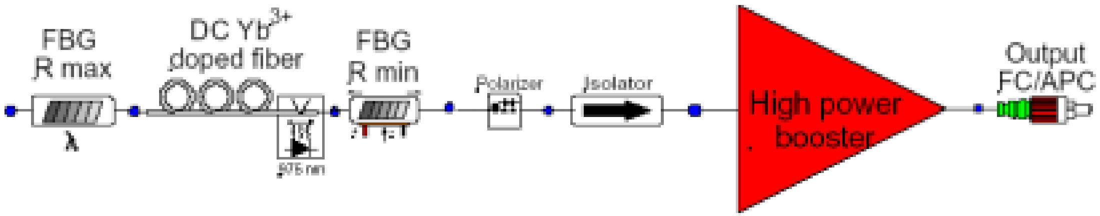
Polarized ^{6}Li atom :

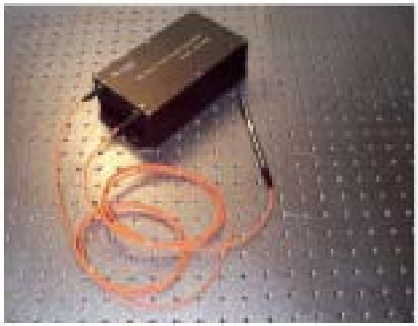
1. ^{6}Li unpolarized beam intensity up
2. Oven

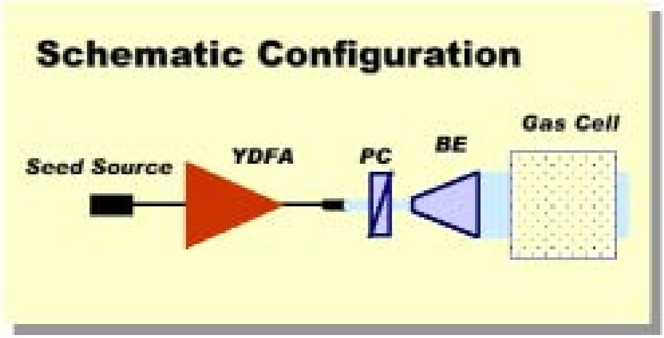
Polarized Atom Source (2) : Laser System

Polarized ^{3}He atom : Doppler linewidth ~ 2 GHz FWHM

1. Fiber Laser ~ High Laser Power / 1083 nm
2. 2 GHz FWHM spectrum
3. Polarization control
4. Tunability : 60 GHz







Polarized ^{6}Li atom :

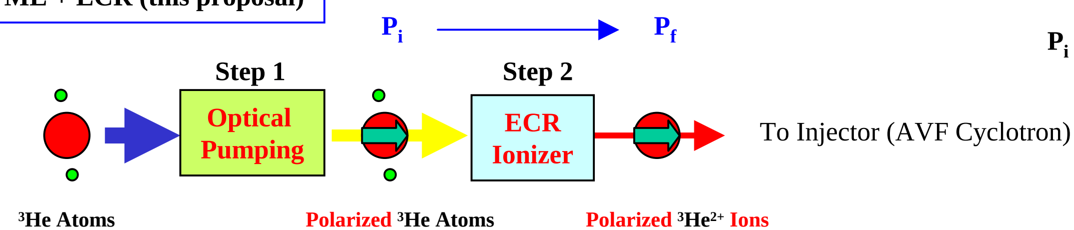
1. Diode Laser

Comparison with other methods of polarized ^{3}He ion source

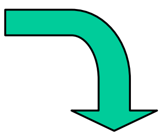
1. Meta-stability Exchange (ME) Pumping + ECR : This proposed system
2. Optical Pumping (OP) / Electron Pumping (EP) / Spin Exchange (SE) Polarized Ion Source : developed by Prof. M. Tanaka

Methods	Developed by	Date	Polarization	Intensity	Comments	
ME+ECR	This proposal	2003 proposed				
OPPIS	Prof. M. Tanaka	1987				
EPPIS	Prof. M. Tanaka	2000	5.5% (^{3}He$^+$)	2 uA	100 uA, Rb (16 %, 5.5$\times$10^{14})	Next Step : LOI proposed .
SEPIS	Prof. M. Tanaka	2000 proposed			New idea	

ME + ECR (this proposal)



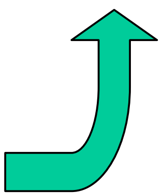
P_i = 54 % (present status @ HERMES)



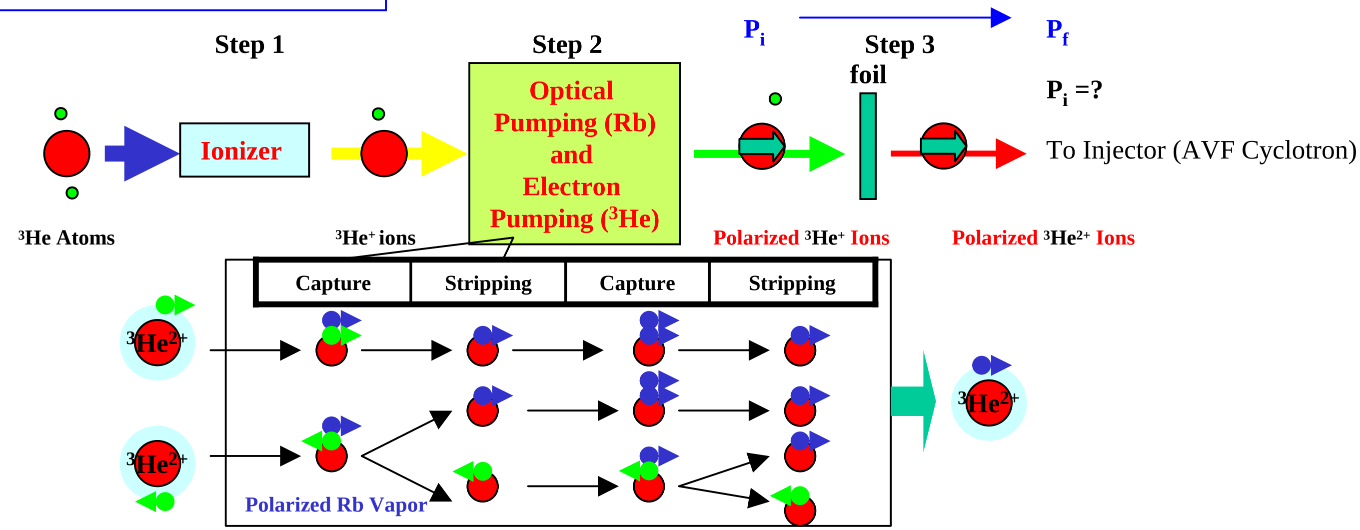
Initial Polarization : P_i

$$P_f = F_P(P_i, Spec(ECR), Others...) = \varepsilon(P) \times P_i$$

$$I_f = F_I(I_i, Sprc(ECR), Others...) = \varepsilon(I) \times I_i$$



SEPIS (Prof. Tanaka's method)



Required costs of polarized ^{3}He and ^{6}Li ion source development

	Components	Parts	Comments	Year	Costs	Resource
Polarized Ion Source (PIS) Common	Magnet		Common	2nd	1,000,000	
PIS/Common	Optical devices for the beam transport		Common	3rd	2,000,000	
PIS/Common	Supporting structure		Common	1st	3,000,000	センター長留め置き申請
PIS/Common	Vacuum system		Common	1st	4,000,000	センター長留め置き申請
PIS/Common	Control		Common	3rd	5,000,000	
PIS/3He	Pumping Laser	Fiber Laser	3He	2nd	11,000,000	
PIS/3He	Pumping Cell	Quarts Cell	3He	2nd	2,000,000	
PIS/3He	Gas feed System		3He	2nd	3,000,000	
PIS/3He	RF discharge system		3He	2nd	1,000,000	
PIS/6Li	Pumping Laser	Diode Laser	6Li	1st	5,000,000	センター長留め置き申請
PIS/6Li	Pumping Cell / Oven		6Li	1st	3,000,000	センター長留め置き申請
PIS/6Li	ECR ionizer (Magnet)		6Li	2nd	20,000,000	
PIS/6Li	Wien Filter (Spin Rotator)		6Li	3rd	5,000,000	
Polarimetry	Pumping Cell Polarimeter	NMR	Feasibility test	1st	2,000,000	センター長留め置き申請
ECR Ionizer	Modification		Feasibility test	1st	1,000,000	センター長留め置き申請
Others needed for feasibility test etc			Feasibility test	1st	2,000,000	センター長留め置き申請
Detector Developments			Detector		Design work	
Total			Without Detector		70,000,000	

Request to RCNP

1. Budget : 合計　7000万円　内、2003年度　500万～2000万円　申請 （2003年：2000万、2004年：3800万、2005年：1200万）
2. Place to setup polarized ion source : East Experimental Hall / Around Ion Source Room
3. Electric power and water etc.. :
4. Man power : Collaboration with other institutes ~ see next slide

Collaboration (not fixed)

Polarized Nuclear Beam Project

Project Leader : K. Hatanaka

Polarized ^{3}He Ion Source

Polarized ^{6}Li Ion Source

PIS Construction : *Y. Sakemi*

Detector Projects : *A. Tamii*

Physics Goal : Pions in Nuclei

- **Total Costs** : 7000万円
- **Time Line** : 5 years = 3 years construction + 2 years Experiment
- **Publications / Physics Outputs** : how many ?

Responsibility	RCNP member	Collaborators	Man Power Weight	Comments
Project leader	K.Hatanaka			
Detector Project	A.Tamii			
Polarized ^{3}He/^{6}Li atom source	Y.Sakemi			
Pumping Cell				
Pumping Laser				
Gas feed system				
ECR Ionizer	S.Ninomiya			
Polarimeter				

Timeline

Long range plan

	2003	2004	2005	2006	2007	2008	2009	2010
Polarized ion source	START / Design Work	Construction	Construction	Physics	Output / END	共同	利用	
Construction Plan	Design : LOI/TDR -^{3}He: Feasibility Test : Ionizer -^{6}Li : Polarized Atom : Laser Judgment for ^{3}He	Development -^{3}He : construction -^{6}Li : ECR Ionizer	Construction Operation Test Acceleration	Experiment	Physics Analysis			
Budget of RCNP								
Budget Resources	外部資金獲得努力	科研費他	科研費他	科研費他	科研費他			
J-PARC@KEK								
RIBF@RIKEN					Experiment			
RHIC@BNL					e-RHIC			
HERA@DESY				HERA end	TESLA / e-A ?			

2003 schedule

Month	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
HIPIS / EN course			Prepare					Prepare	Test	
Polarized 3He gas			Deliver					Produce		
LKB@Paris			Visit							
Construction										
LOI/TDR					Complete					
PPAC/Workshop		Proposal				Discussion			LOI/TDR	
核運委						?				
Judgment										

Summary

1. Physics Motivation and Goal

- **(1) New Beam** — **Polarized Nuclear Beam (^{3}He and ^{6}Li)**
- **(2) New Physics** — **Pion distributions in Nucleus**

2. Short range project ~ 5 years from construction to physics outputs

3. Extension to other field of nuclear physics projects (J-PARC/RHIC-Spin)

4. Physics Outputs / Impact （◎／○／△／×）

- **(1) Private** ○
- **(2) RCNP** ○
- **(3) Nuclear Physics Community**
- **(4) International**

5. Extensive discussions ~ Priority of all proposed projects at RCNP

6. Strategy : Total 7000万円 , construction 3 years

- **(1) 1st Year : ^{3}He ~ Feasibility Check / ^{6}Li ~ devices for optical pumping : 2000万**
- **(2) 2nd Year : ^{3}He ~ judged, construction / ^{6}Li ~ ECR Ion Source : 3800万**
- **(3) 3rd Year : Construction completed / Operation Test / Acceleration : 1200万**

7. Next Step ~ LOI/TDR to PPAC , Discussions and Judgment at PPAC

Please give me 3 years .