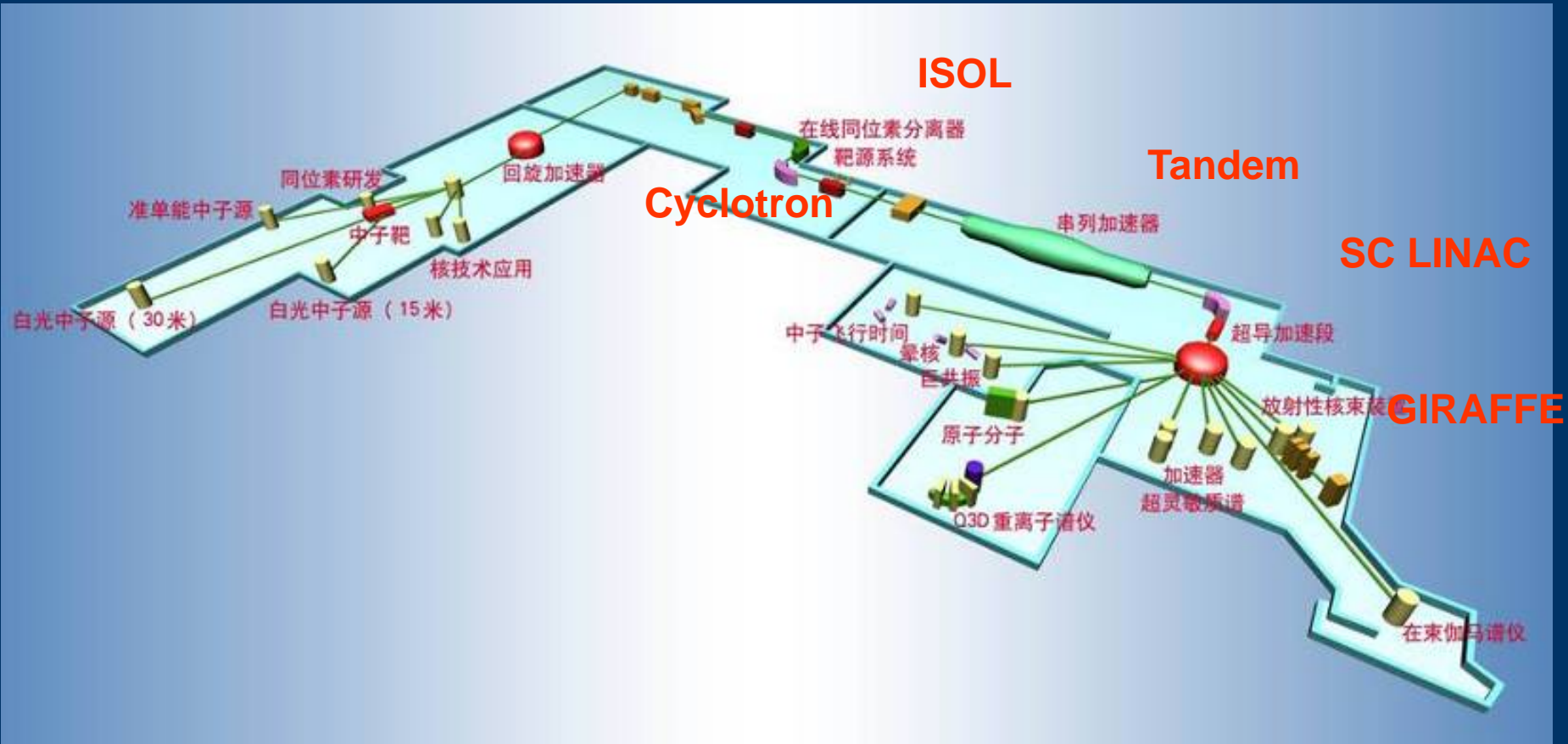


# Discussion on LUNA collaboration

**Weiping Liu**  
**CIAE, China Institute of Atomic Energy**  
LUNA round table meeting  
Feb. 10-11, 2011

# Where we are



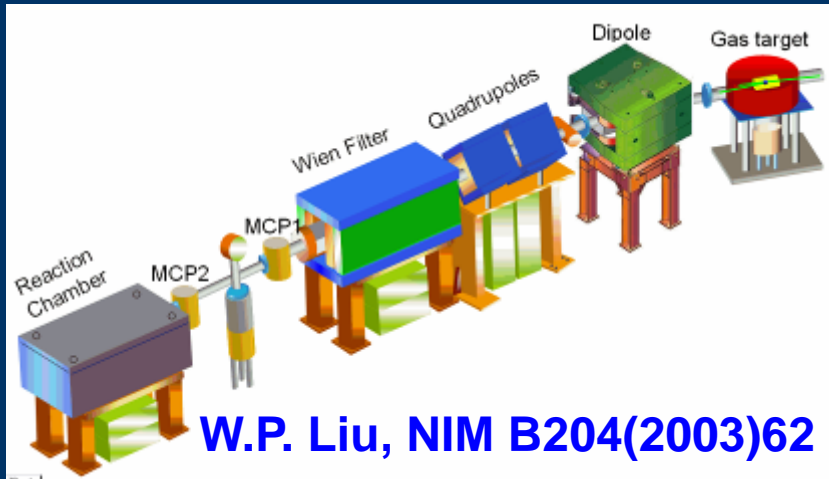
Now: 15MV Tandem with experimental facilities

2013: 100 MeV 200  $\mu$ A proton cyclotron

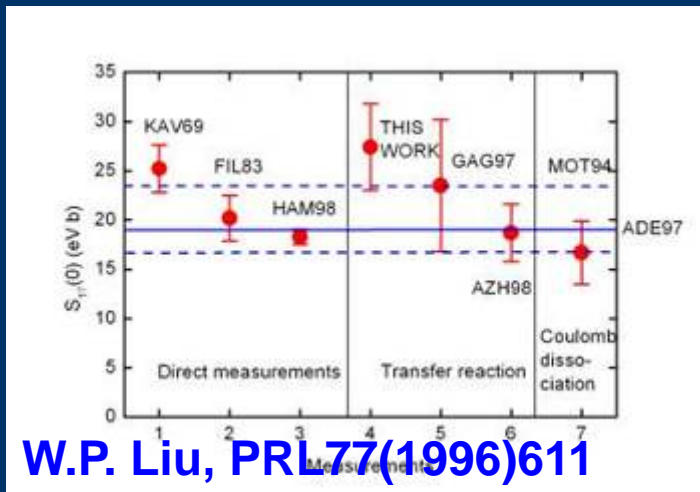
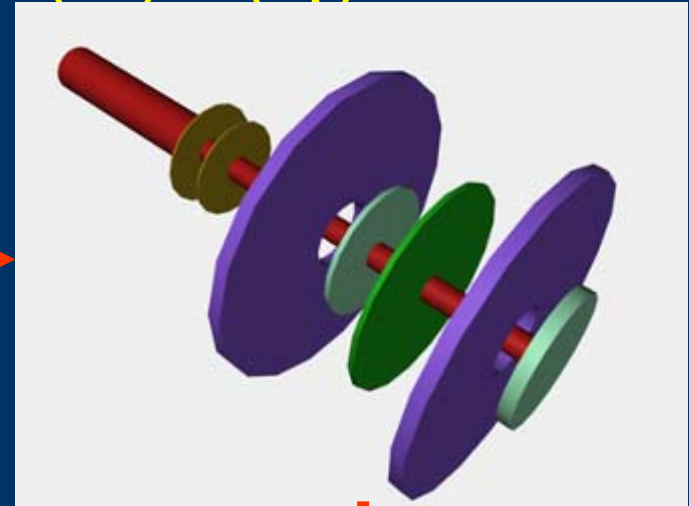
20000 resolution ISOL, 2 MeV/q super-conducting LINAC

# Indirect method for ${}^7\text{Be}(p,\gamma){}^8\text{B}$

## RIB production: GIRAFFE



## (d,n) or (d,p) measurement



$$\left(\frac{d\sigma}{d\Omega}\right)_{\text{exp}} - \left(\frac{d\sigma}{d\Omega}\right)_{\text{CN}} = \sum_{j_l j_f} (C_{l j_l}^d)^2 (C_{l j_f}^{12\text{N}})^2 \frac{d\sigma_{l j_l j_f}^{\text{DW}}/d\Omega}{b_{l j_l}^2 b_{l j_f}^2},$$

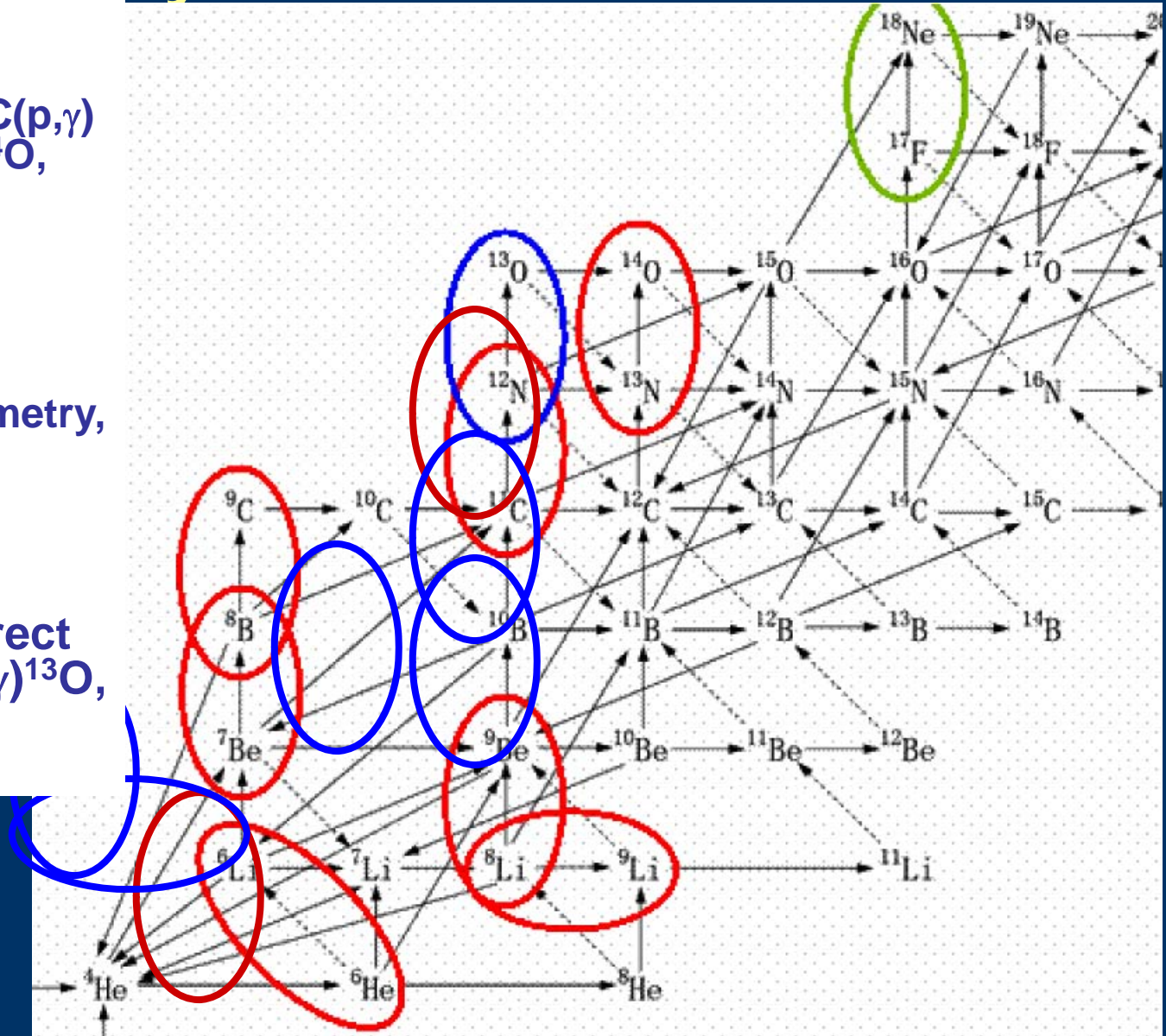
$$\sigma_t = \frac{16\pi}{9} \left(\frac{E_\gamma}{hc}\right)^3 \frac{1}{\hbar v} \frac{e_{\text{eff}}^2}{k^2} \frac{(2j_f + 1)}{(2I_1 + 1)(2I_2 + 1)} C_{l j_f}^2 \times \left| \int_{R_N}^{\infty} r^2 dr f_{l j_l}(kr) W_{n, l_f + 1/2}(2\kappa r) \right|^2,$$

## Astrophysical reaction rates

## ANC or Spec factor

# Summary of reaction studied

- Method used
  - ANC,  
 ${}^7\text{Be}(p,\gamma){}^8\text{B}$ ,  ${}^{11}\text{C}(p,\gamma){}^{12}\text{N}$ ,  
 ${}^{12}\text{N}$ ,  ${}^{13}\text{N}(p,\gamma){}^{14}\text{O}$ ,  
 ${}^8\text{Li}(p,\gamma){}^9\text{Be}$
  - Spec-factor,  
 ${}^8\text{Li}(n,\gamma){}^9\text{Li}$ ,  
 ${}^6\text{Li}(n,\gamma){}^7\text{Li}$ ,  
 ${}^{12}\text{C}(n,\gamma){}^{13}\text{N}$
  - Charge symmetry,  
 ${}^8\text{B}(p,\gamma){}^9\text{C}$ ,  
 ${}^{26}\text{Si}(p,\gamma){}^{27}\text{P}$
- Direct method,  
 ${}^{33}\text{S}$ ,  ${}^{11}\text{C}(p,\gamma){}^{12}\text{N}$ ,  
DRAGON, Indirect  
method,  ${}^{12}\text{N}(p,\gamma){}^{13}\text{O}$ ,  
CRIB



# Why LUNA

- Only location now for direct physics, others still have long way to go
- New support to nuclear astrophysics
  - Have some experience
  - Extend our range of study
- To be prepared for future china underground development

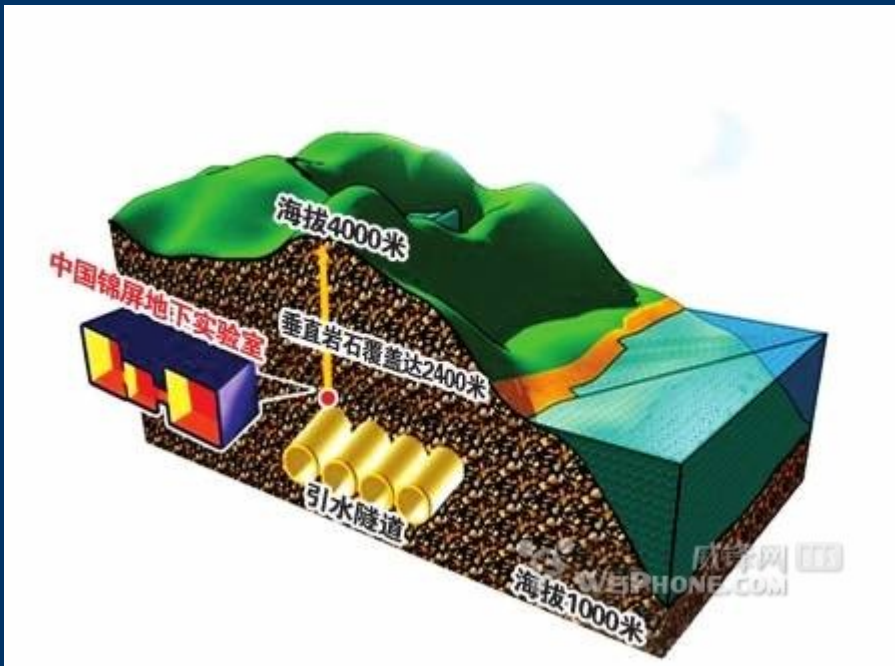


# Underground physics in China



Dec. 2010  
2400 m rock  
Sichuan  
20 min by car (18 Km tunnel)  
Digging for hydro-electronic power plant  
40X6X6 mm<sup>2</sup> now

Now dark mater R&D  
2 universities  
20 kg HpGe  
Apply national project  
Possibility of nuclear astrophysics part in future



# Suggestions

- LUNA's excellencies should be extended by MV project, not only meaningful to INFN, but also to the international underground nuclear astrophysics
- Green light to MV is essential
- Early time schedule is important, real competition will be 5 or more year later, time widow for MV now is very important
- INFN support of major facility like accelerator is main driving force
- Publicize the detailed MV project so that outside people can be involved and convinced
- Dividing into work packages is a good way to organize international collaboration

# Collaboration with LUNA

- Contribution to future LUNA 400kV experiment
  - Man power supported by INFN-CIAE agreement
  - Man power supported by own support, e.g. to  $^{22}\text{Ne}$  experiment, start by Dr. Lian
- Contribution to MV project
  - Gas target etc at home to contribute in kind
  - Detector possibility
  - Even larger component will be very difficult but can be considered
- Financial considerations
  - Existing nuclear astrophysics project(6 years, 1 MEuro)
  - Apply fund for instrumentation (e.g. gas target ) to NSFC(4 years, 0.2 MEuro)



# steps

- Know the progress and show in interest
  - This round table meeting
- Learn the 400 kV and MV progress
  - Sign MOU
  - Based on MOU, apply instrumentation funds (2013 may determine) and send people
- Extend INFN-CIAE agreement
  - To LNGS
  - Send people from our own funds
- Possible proposal of new experiment and instrumentation (e.g. RMS)

# Contents

- Introduction of current work
  - China, underground
  - Local works
- Consideration of collaboration
  - Find comment interest
  - Apply funds to government
- Participating 400kv experiment
  - $^{22}\text{Ne}$  etc
- Join MV project
  - Gas target etc