70 MeV~100 MeV Quasi-monoenergetic neutron reference fields in China

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Layout of QMN in CIAE

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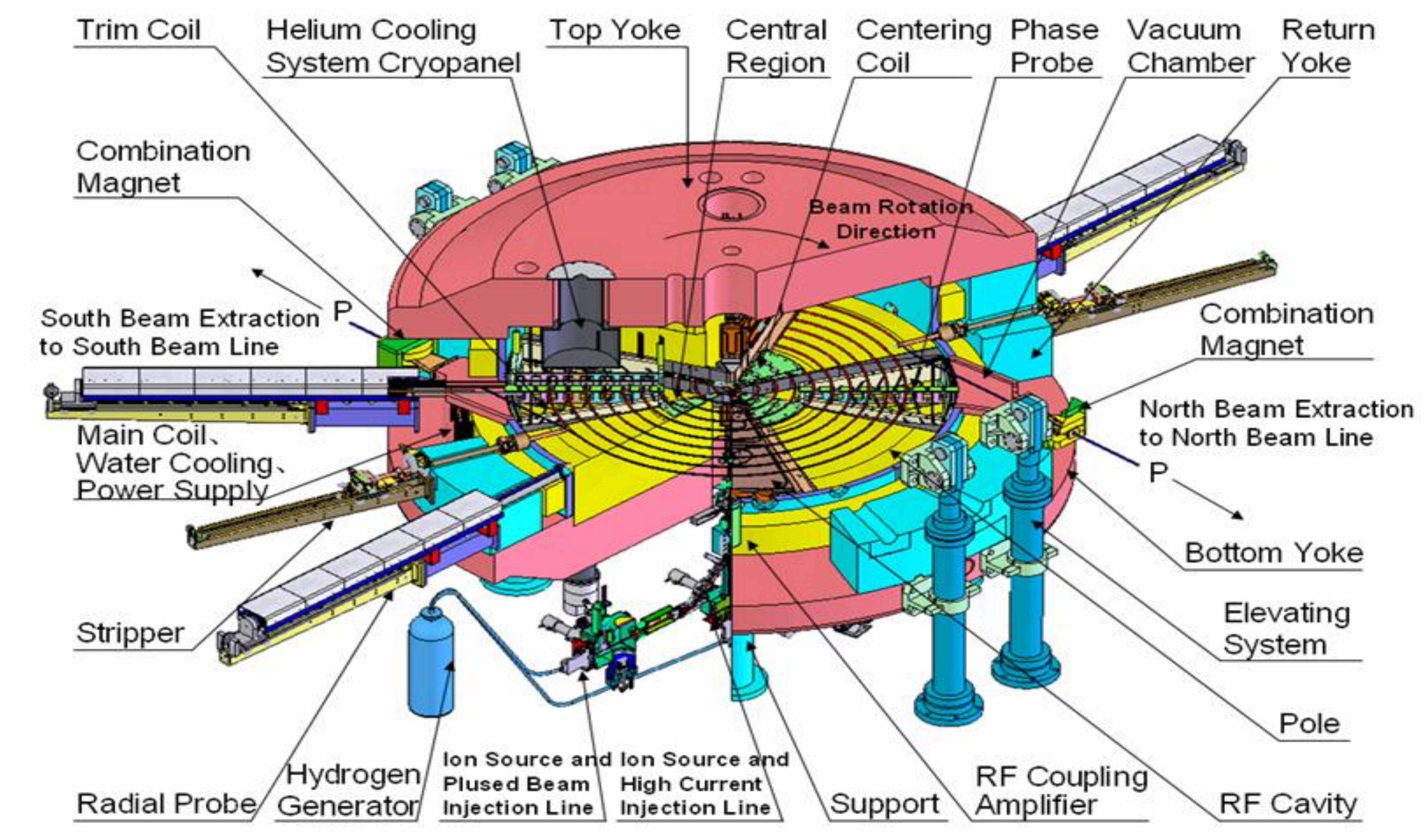
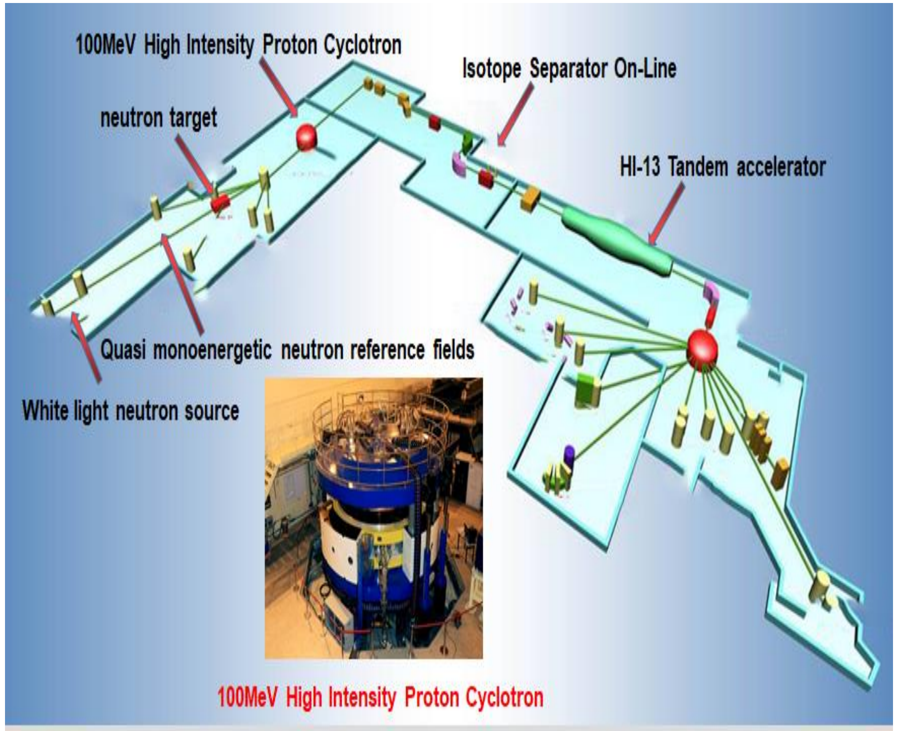
General View of the 100 MeV Cyclotron



Layout of QMN in CIAE

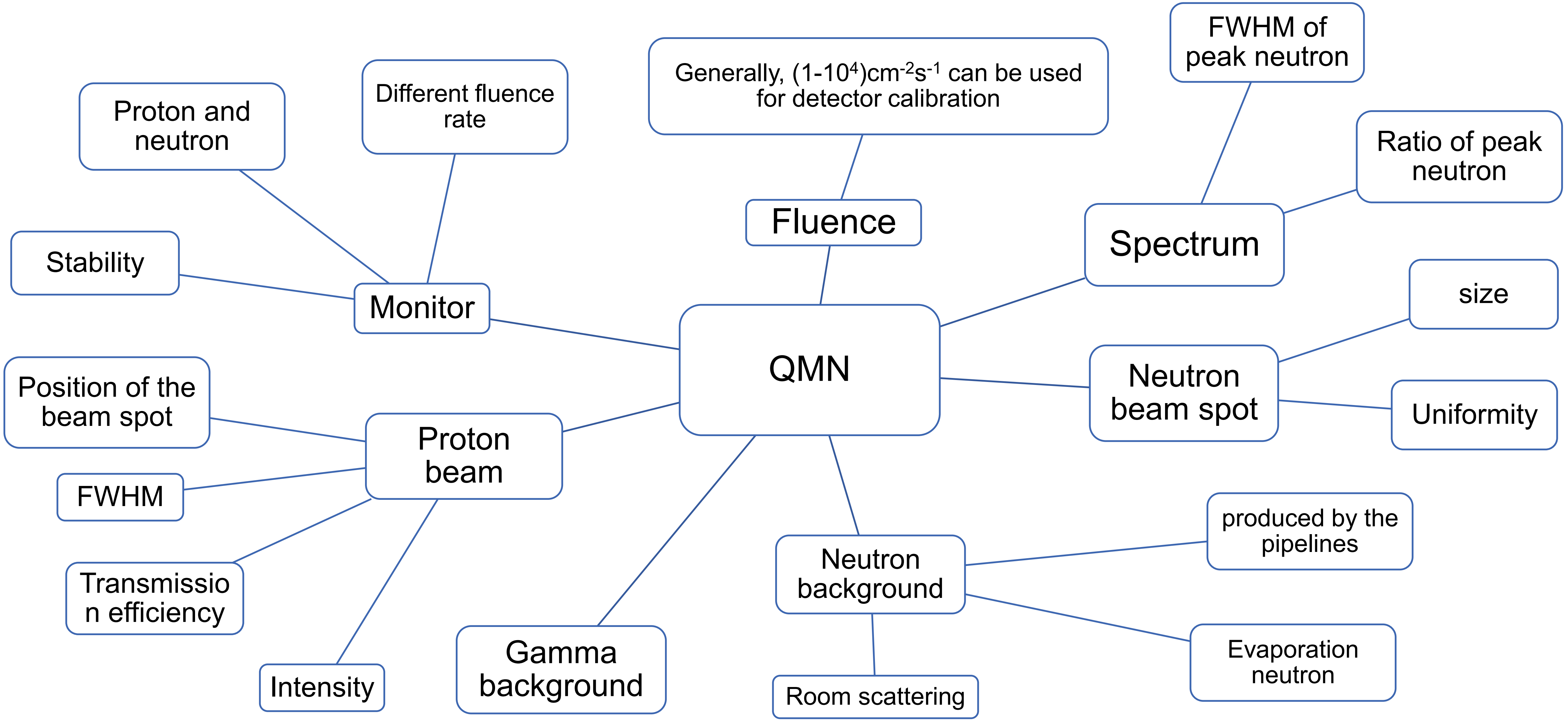
- Proton extracted and transported in two common lines simultaneously (north and south lines)
- 6 beam lines
  - ✓ North hall
    - ➢ N1 beam dump/ beam line testing
    - ➢ N2: radioactive ion-beam, inject into 13 MV tandem accelerator
    - ➢ N3: produce isotope for medicine
  - ✓ South hall
    - ➢ S1: quasi monoenergetic neutron source



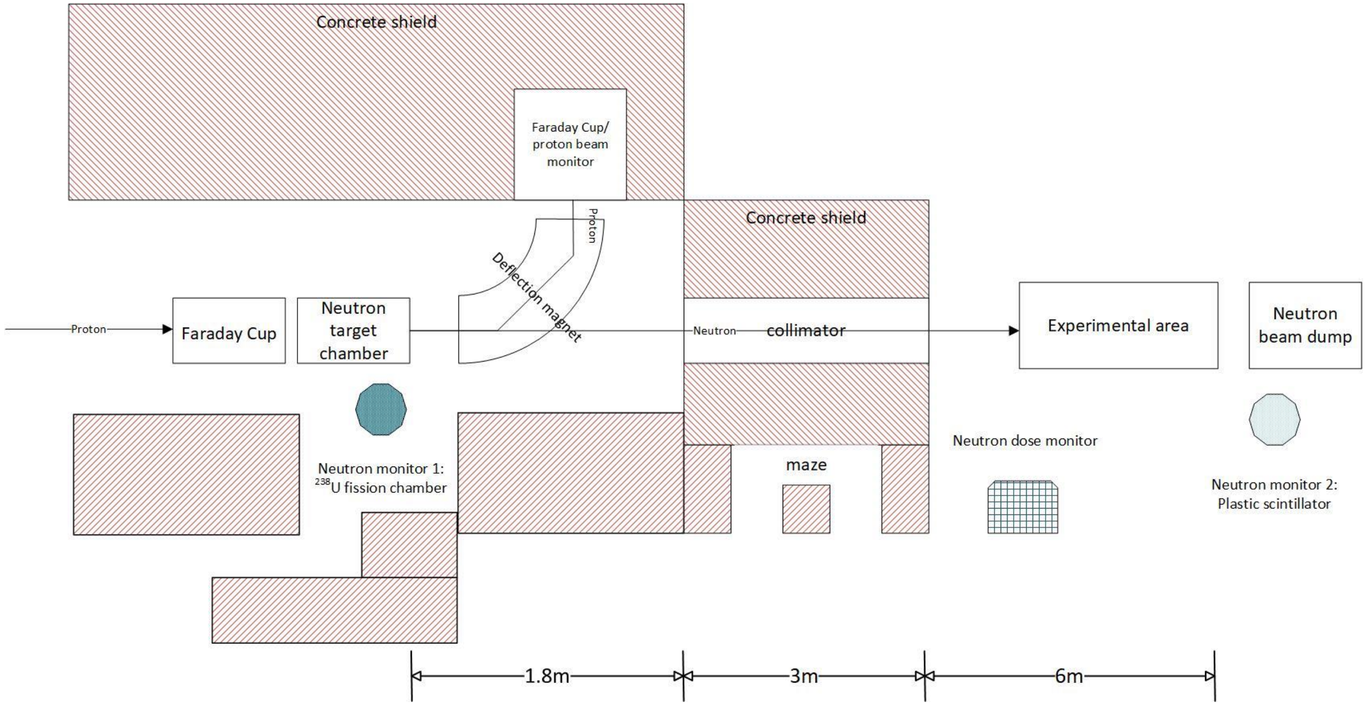
- ✓ South hall
  - ➢ S2: white light spectrum neutron source
  - ➢ S3: proton radiation beam for radio-biological and single event effect testing of electronic device

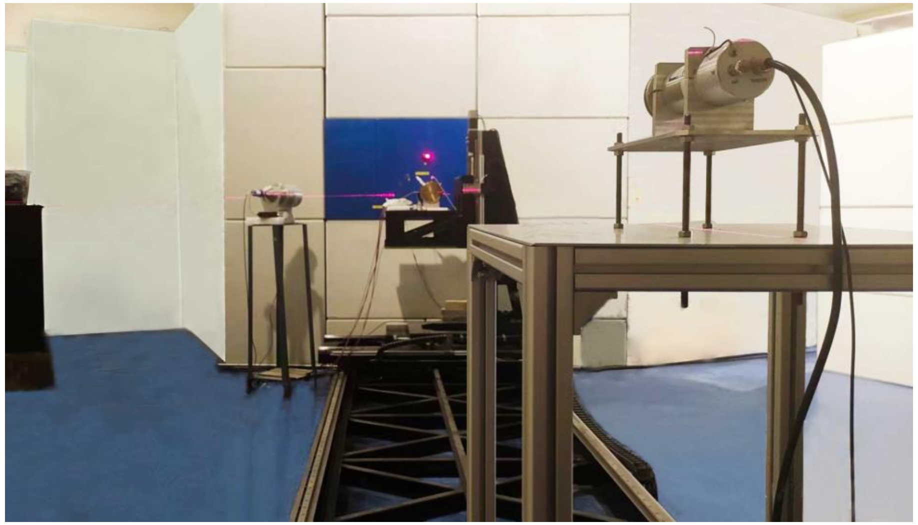
Layout of QMN in CIAE

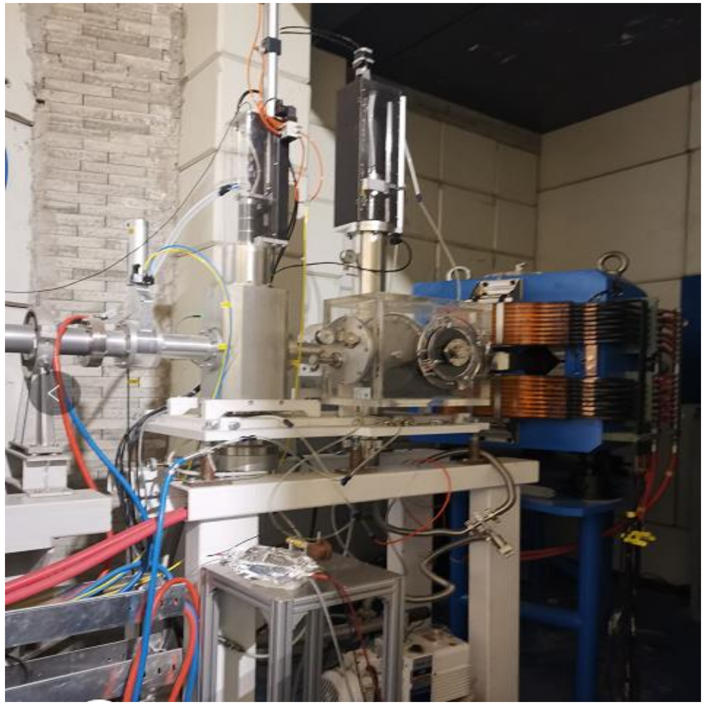
What were we thinking about when designing a QMN?



Layout of QMN in CIAE





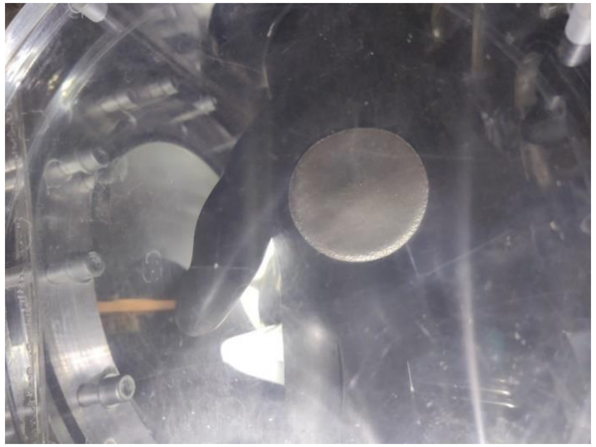


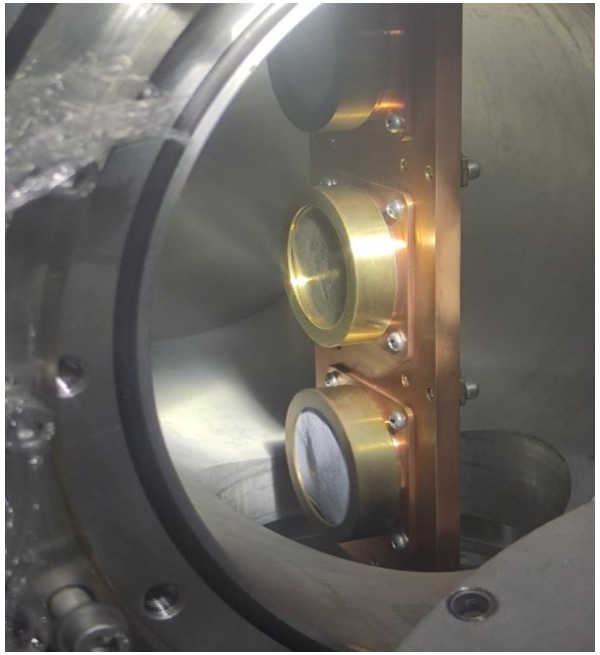
- Proton from two quadrupole magnets， faraday cup transports into target chamber, bending into beam dump (embedded in concrete shielding wall)
- Collimators: two layers, inside: iron 1m ×1m×3m , 15 cm diameter aperture, outside concrete;
- Proton beam spot on target: 2 cm
- Distance from target to collimator: 1.8 m
- Maximum experimental distance along beam: 6 m

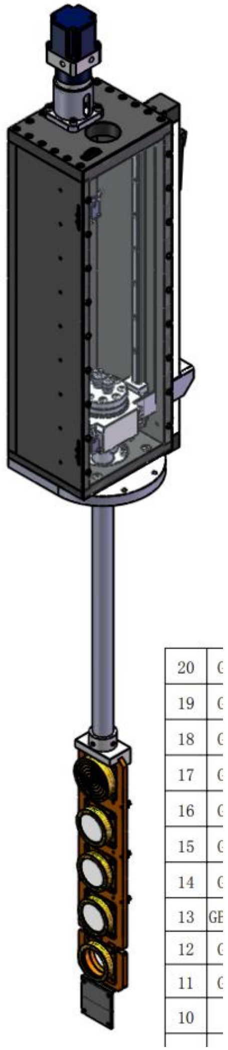
Layout of QMN in CIAE

- Target chamber
  - The Chamber is filled with 1.1atm Argon （prevent oxidation）
  - five targets on the plate
    - 3 metal Lithium targets
    - 1 Fluorescent target
    - 1 Blank target
  - The target frame made of brass
  - The back of the target frame is water-cooled

Neutron energy/MeV	70	80	90	100
Target thickness/mm	4	5	6	6







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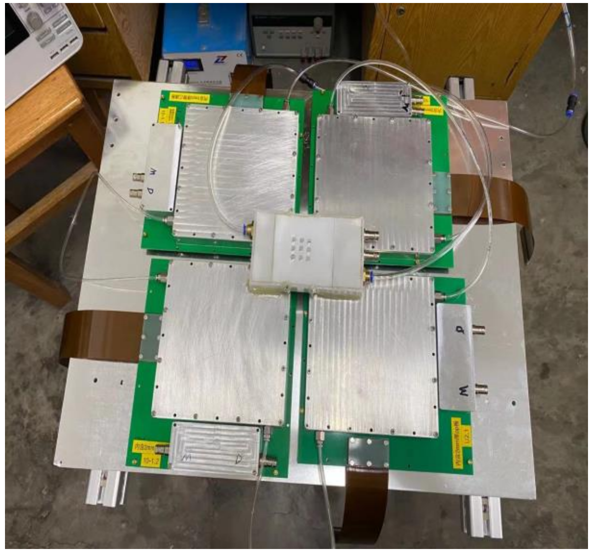
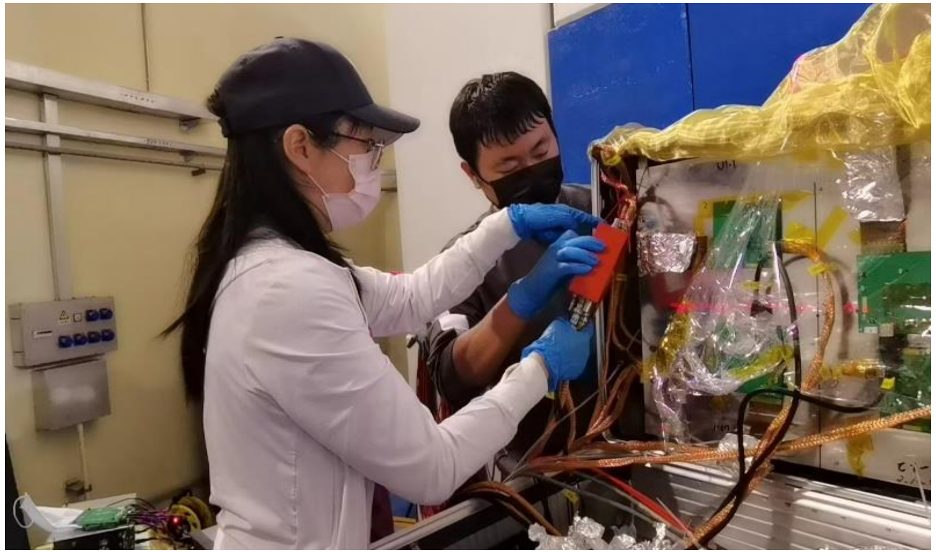
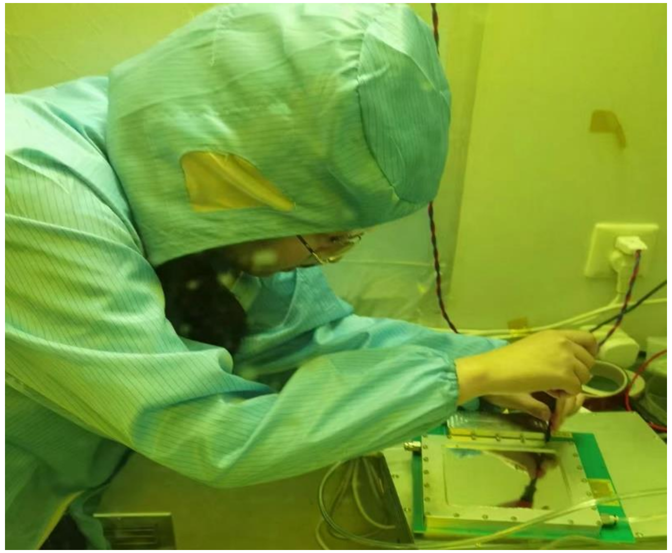
Experiment results

◻ Neutron beam profile

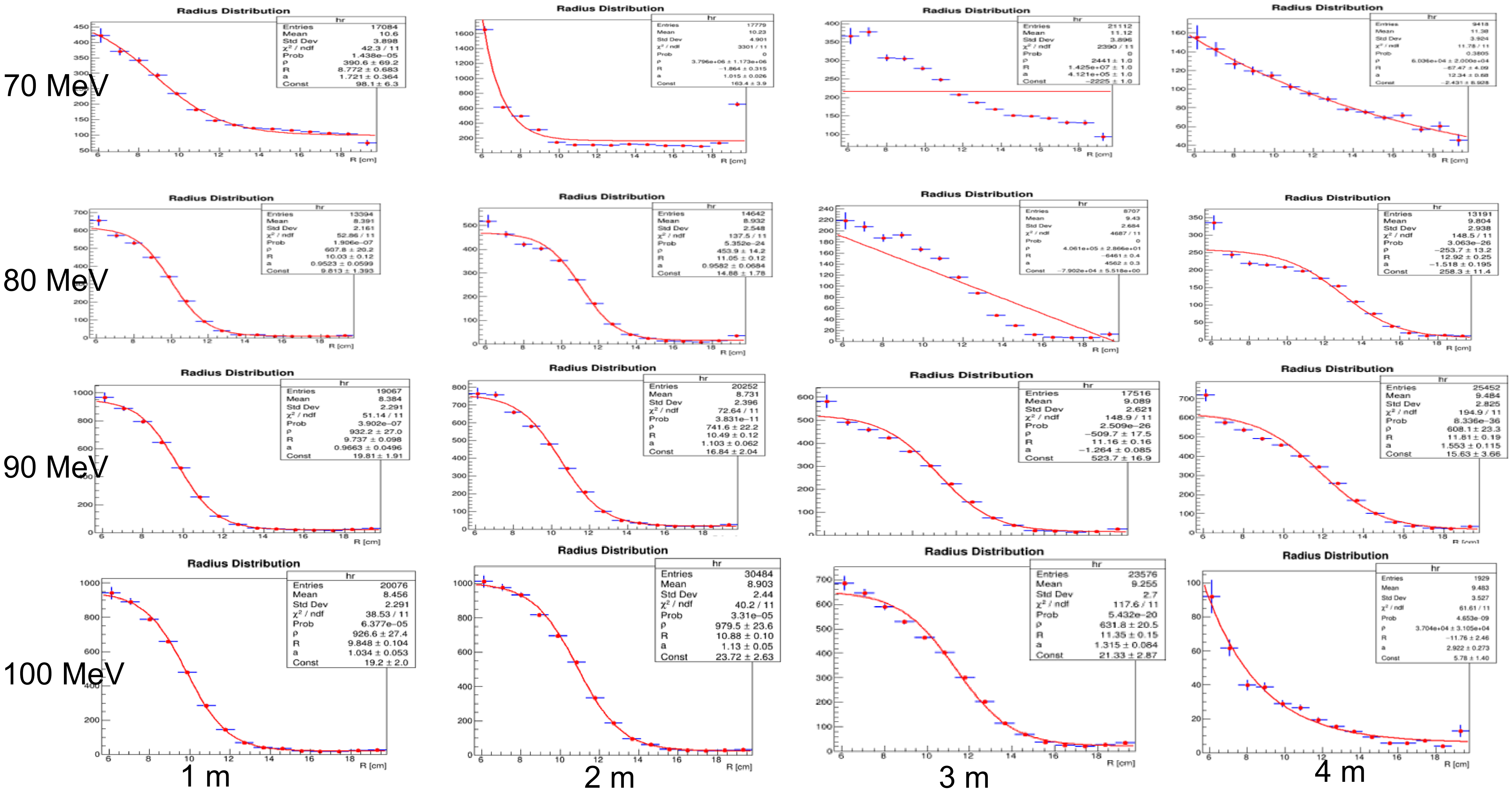
- Micromegas detectors, 512 channels, 64 + 64 strips (orthogonality) for readout , 10 cm × 10cm area per detector, 4 detectors for measurements.
- at 0.5 m, 1 m, 1.5 m, 2 m, 2.5 m, 3 m, 4 m positions.





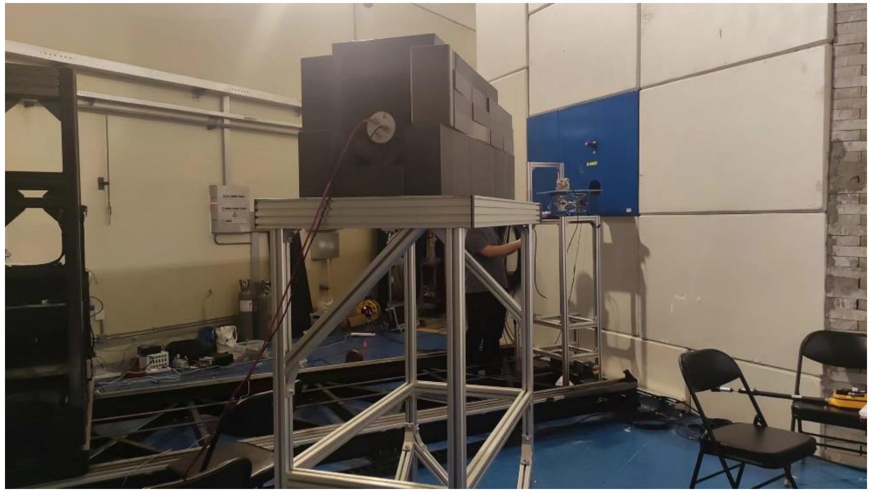


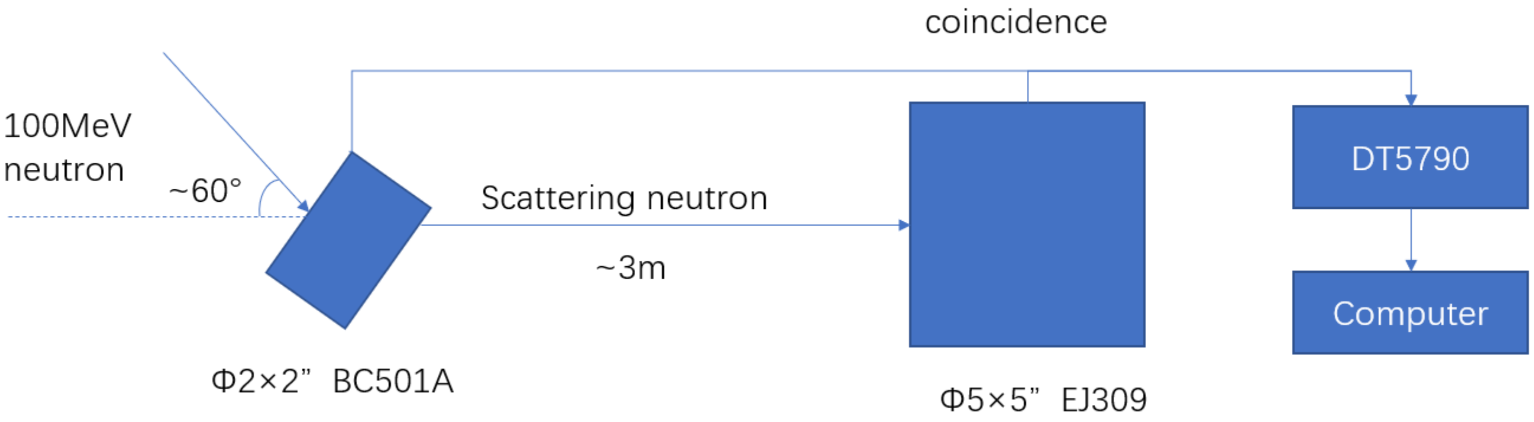
Experiment results



Experiment results

- **Neutron spectrum measurement**
  - DC beam mode, TOF method with two liquid scintillation detector, one for start, one for stop gate signal
  - TOF detector1: BC501A, 2” diameter, detector2: EJ309, 5” diameter; coincidence electronic: CAEN 5790;
  - Angles between secondary neutron and neutron beam line are 57°, 57°, 59° at 70 MeV, 90 MeV, 100 MeV
  - Secondary neutron flight lengths are 3.46 m, 3.00 m, 3.00m at 70 MeV, 90 MeV, 100 MeV
  - Detector2 use shielding B-PE to reduce the background of coincidence event.





Experiment results

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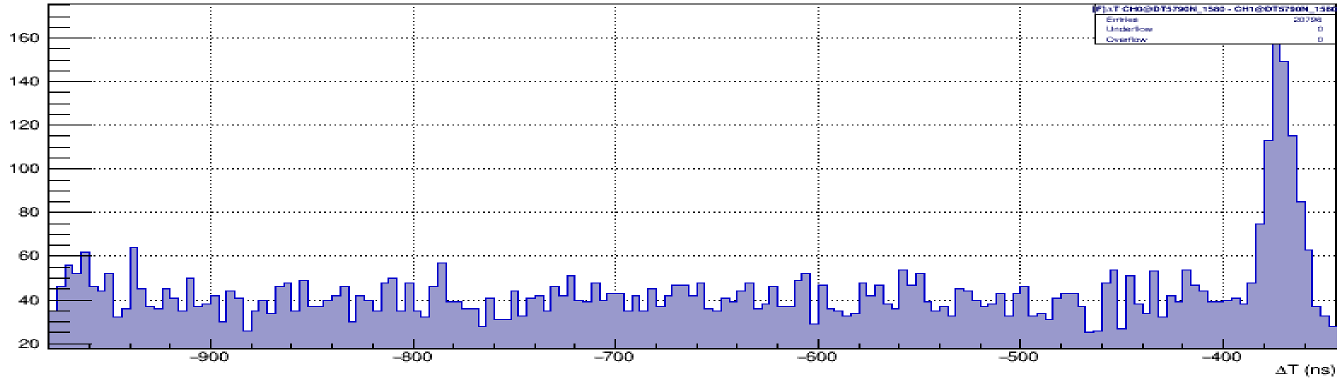
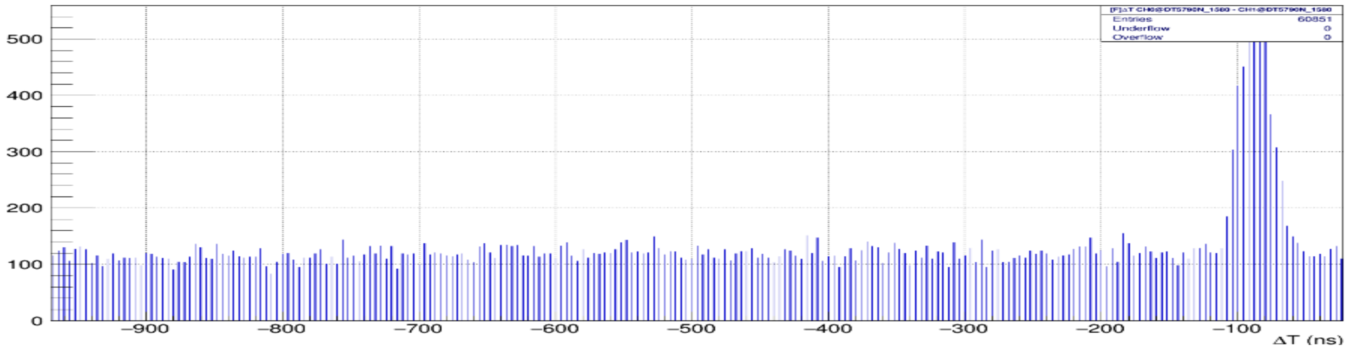
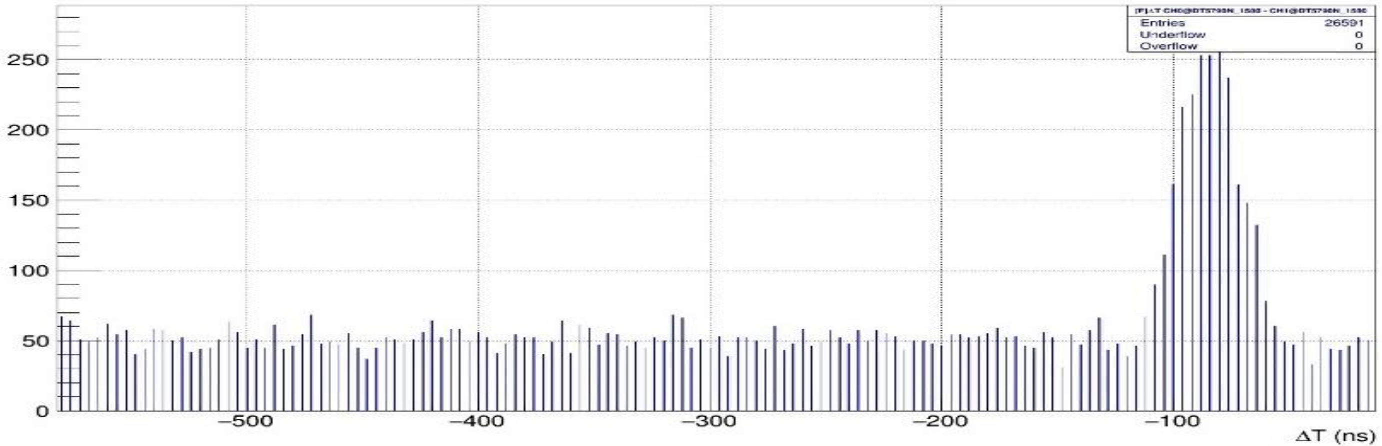
70MeV



90MeV



100MeV

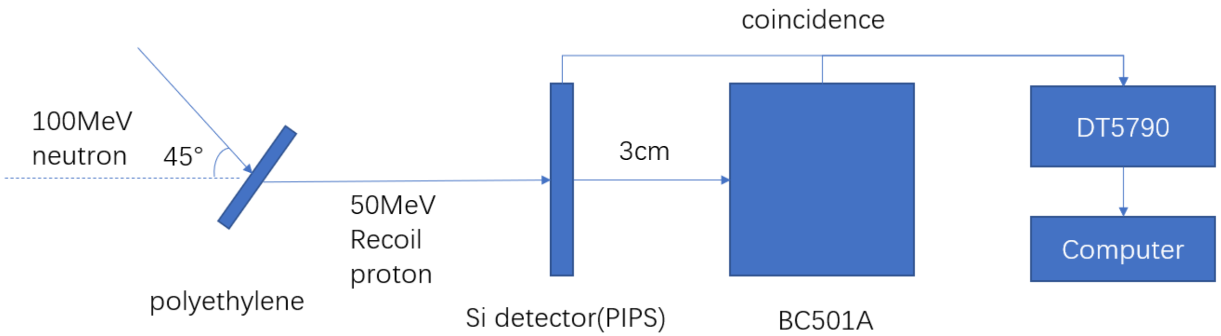


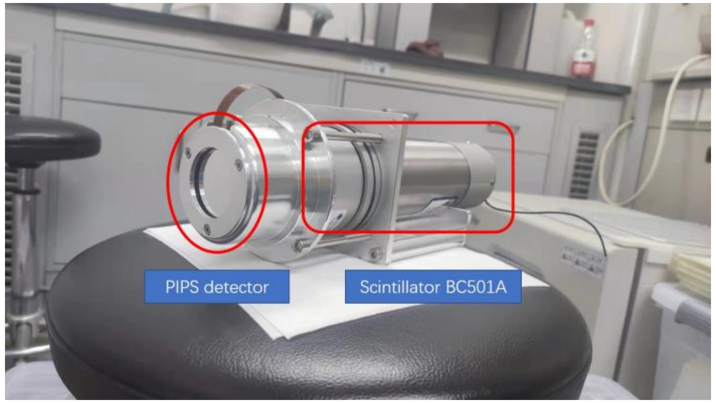
TOF Spectrum

Experiment results

Neutron fluence absolute measurement: PRT

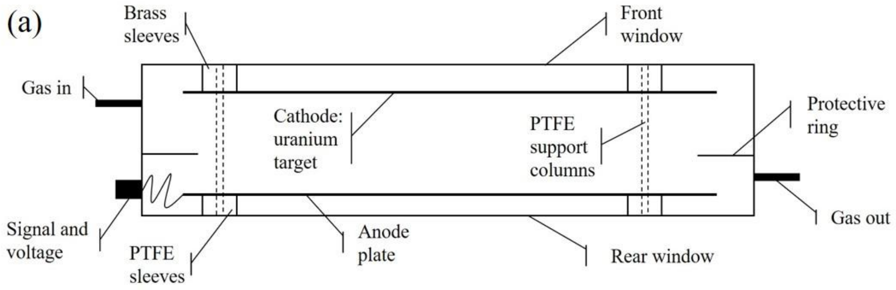
- ΔE-E telescope,
- polyethylene convertor Φ38 mm×1 mm;
- ΔE detector: silicon, Φ40 mm×1.5 mm;
- E detector: BC501A Φ2” × 2”;





Neutron fluence absolute measurement: FC

- Natural uranium;
- U target area diameter Φ100mm;



Experiment results

- Fluence response and measurement results: PRT

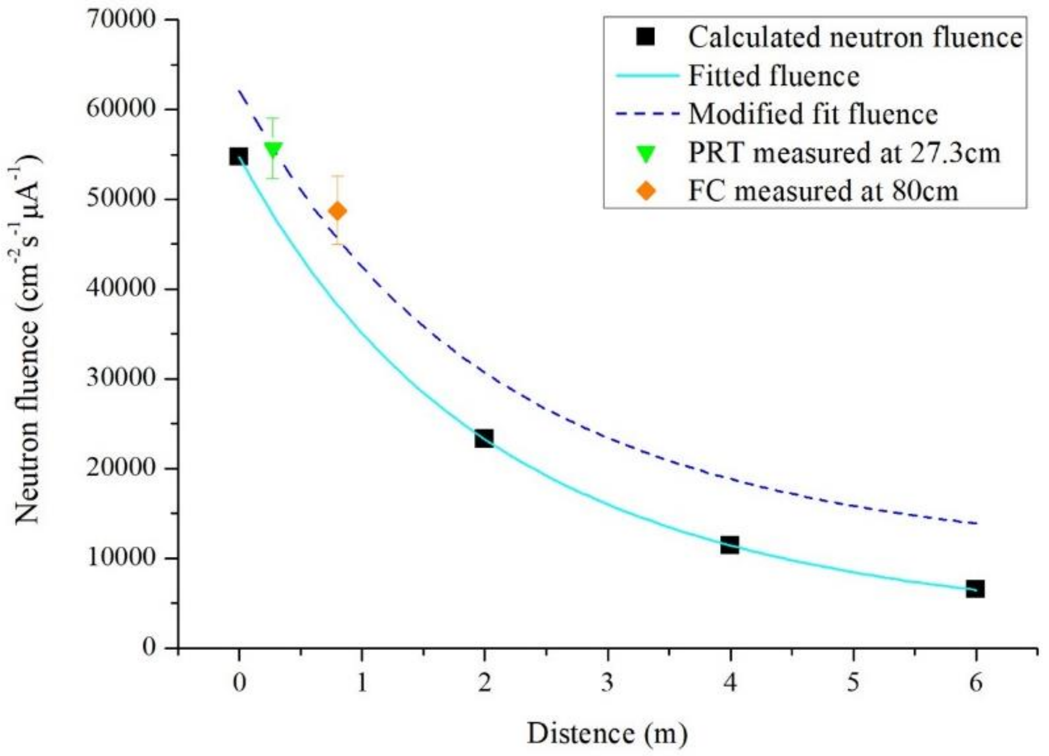
Energy/ MeV	100	90	80	70
Response/ cm^2	8.72E-06	1.06E-05	1.23E-05	1.55E-05
Fluence /cm^{-2} $s^{-1}\mu A^{-1}$	5.34E+04			5.57E+04

Measurement point: 25 cm outside of collimator

- Fluence response: FC

Energy/ MeV	100	90	80	70
Response/ cm^2	1.57E-04	1.57E-04	1.57E-04	1.57E-04
Fluence /cm^{-2} $s^{-1}\mu A^{-1}$	4.87E+04	6.31E+04		5.57E+04

Measurement point: 80 cm outside of collimator



- **The light blue solid line :**The variation of fluence rate under different distances was simulated.
- **The dark blue dashed line :**The entire blue solid line was raised to coincide with the PRT results.

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Next plan

Fluence measurements:

- Use the same measurement point of PRT and FC
- Adjust the distances between polyethylene, silicon and the scintillator, and search for a more optimized solution

Spectra measurements:

- Use a device with a higher sampling rate (DT5751)
- Adjust the distances between the two scintillators, and search for a more optimized solution
- Pulse beam !!!.

Thanks for your attention

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