陽子散乱による崩壊閾値上下を結ぶ E1、M1強度分布測定

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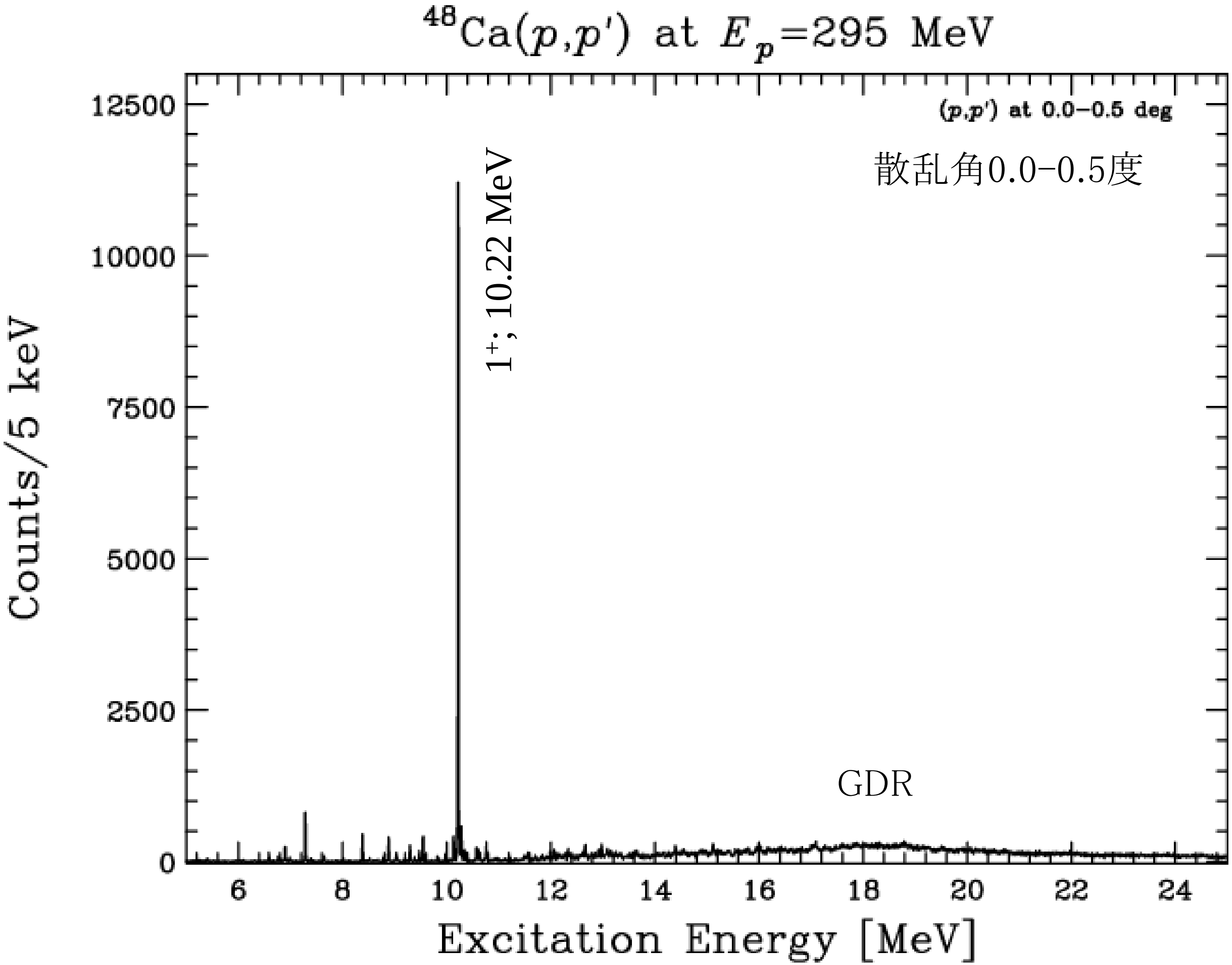
  - A=4系の(狭い)GT励起状態の探索

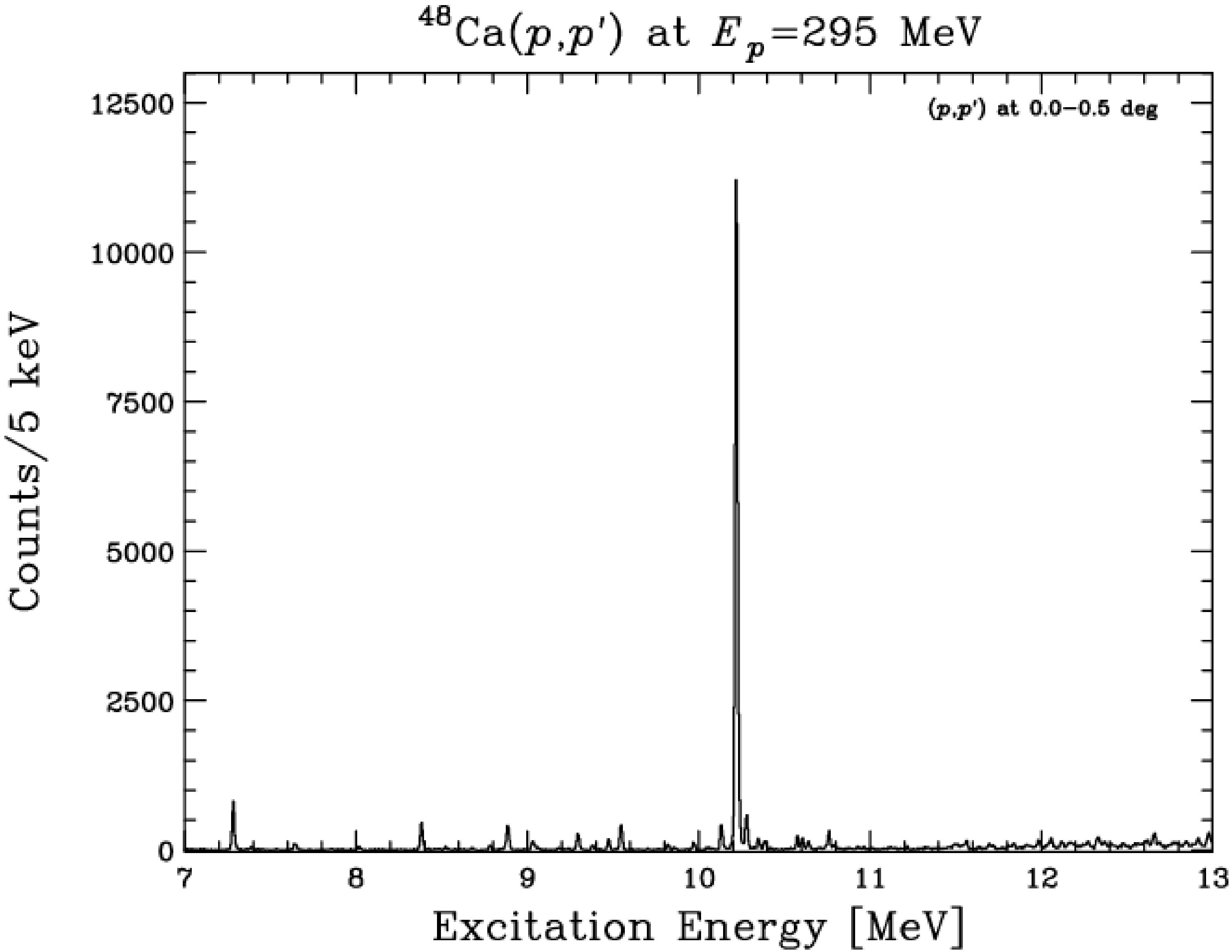
話の要点:

陽子非弾性散乱を測定して、安定核の
E1,M1遷移強度分布を測る。

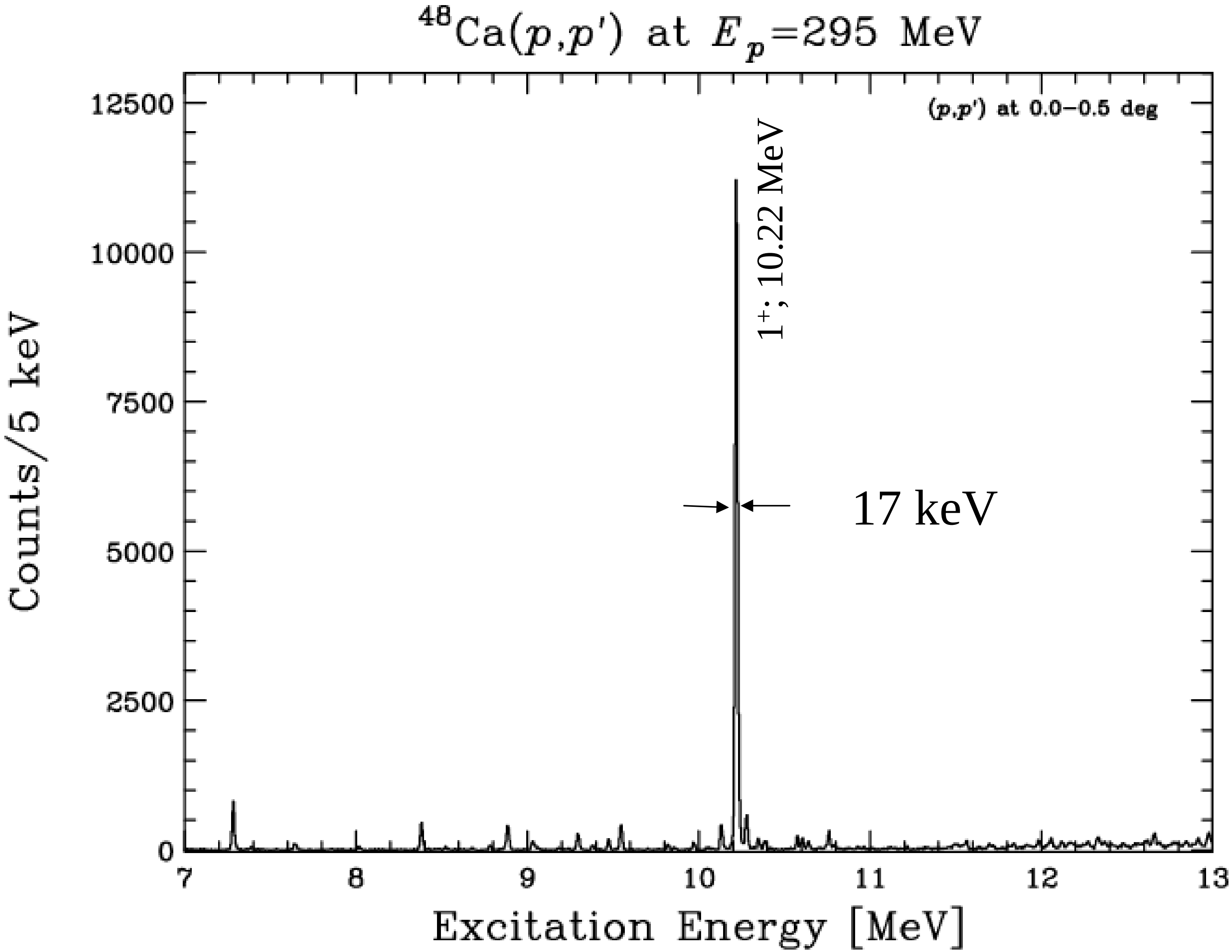
どんなデータか…

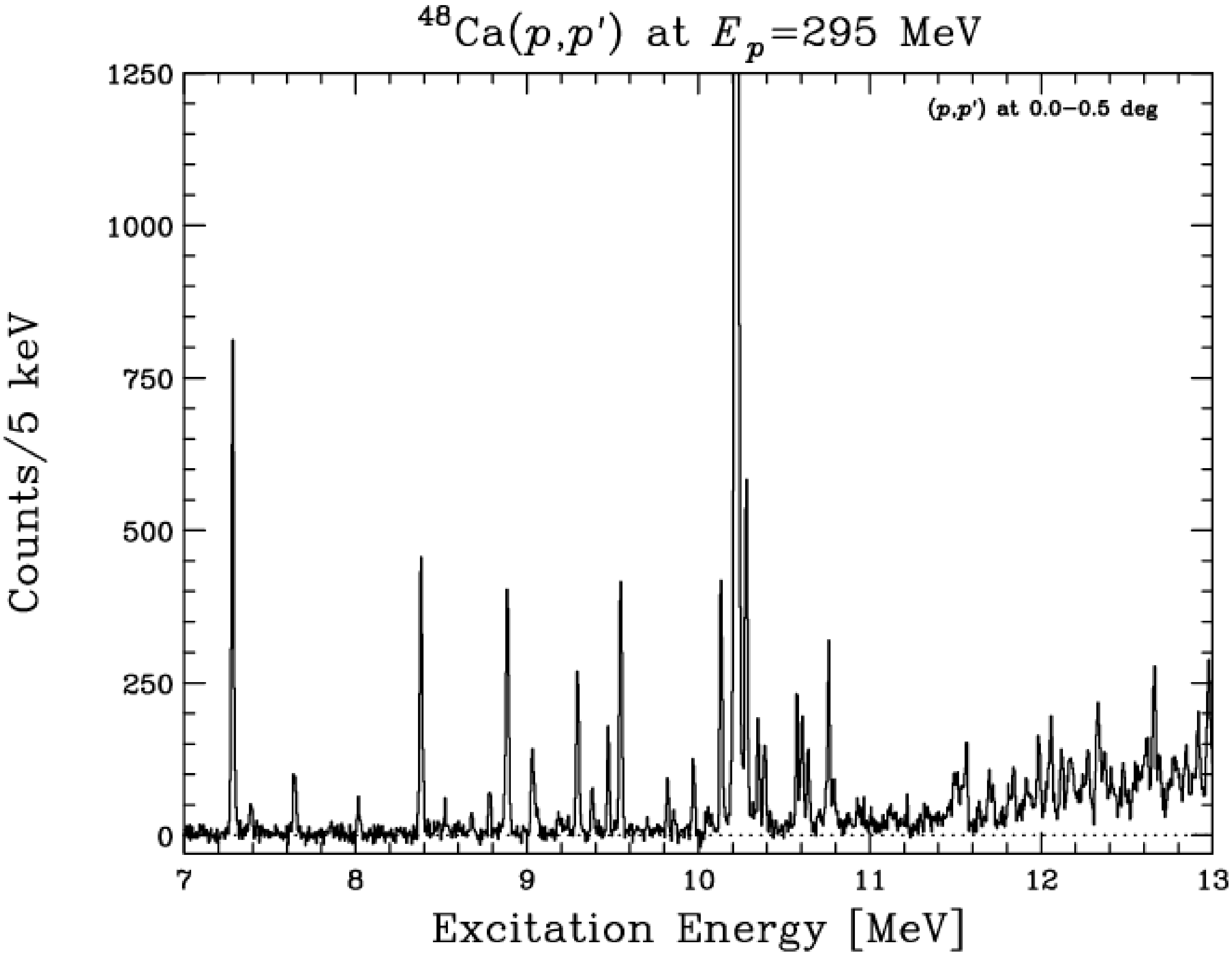


^{48}Ca(p,p') at E_p=295 MeV
(p,p') at 0.0-0.5 deg
散乱角0.0−0.5度
1+; 10.22 MeV
GDR
Counts/5 keV
Excitation Energy [MeV]
12500
10000
7500
5000
2500
0
6
8
10
12
14
16
18
20
22
24

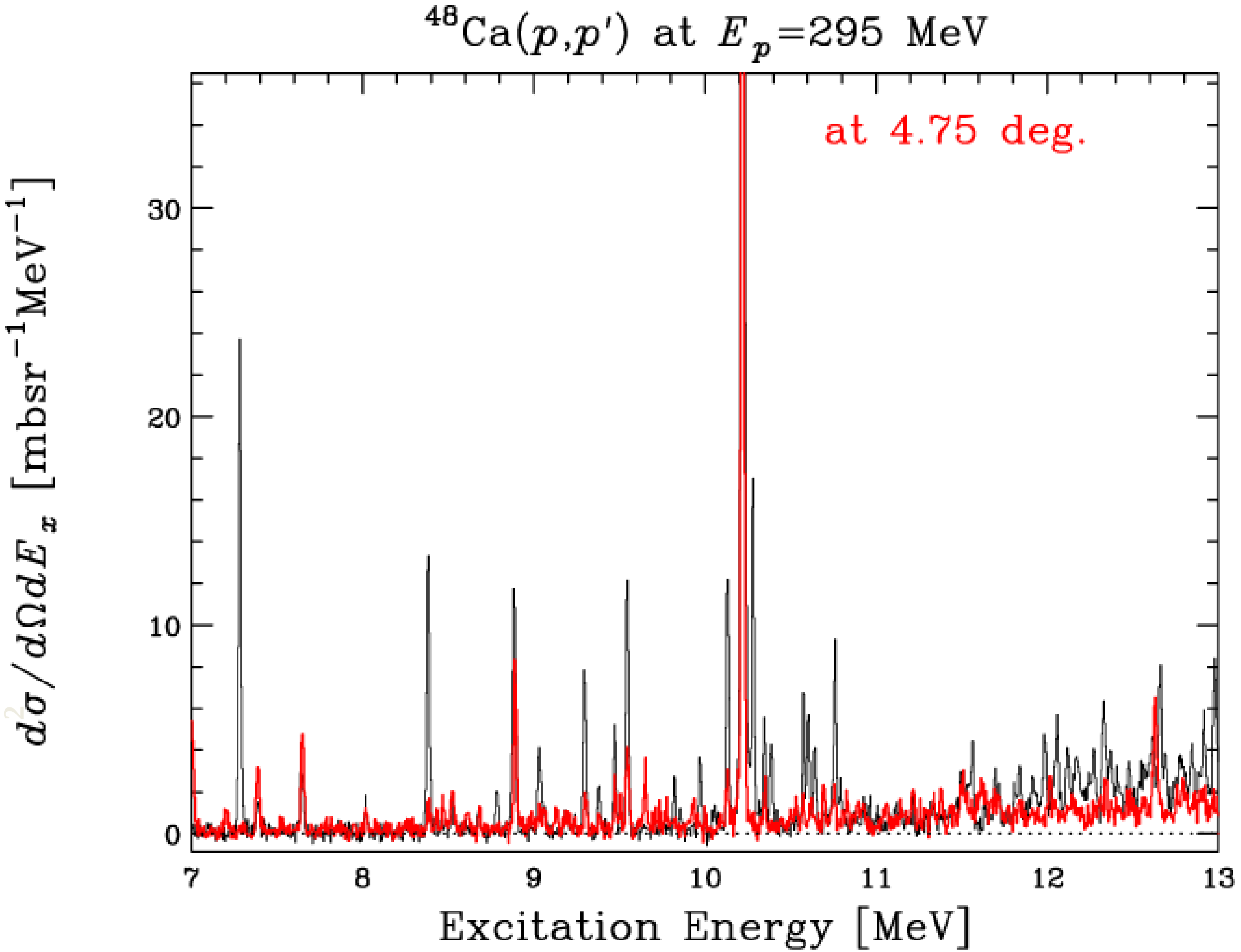


^{48}Ca(p,p') at E_p=295 MeV
(p,p') at 0.0−0.5 deg
Counts/5 keV
12500
10000
7500
5000
2500
0
7
8
9
10
11
12
13
Excitation Energy [MeV]

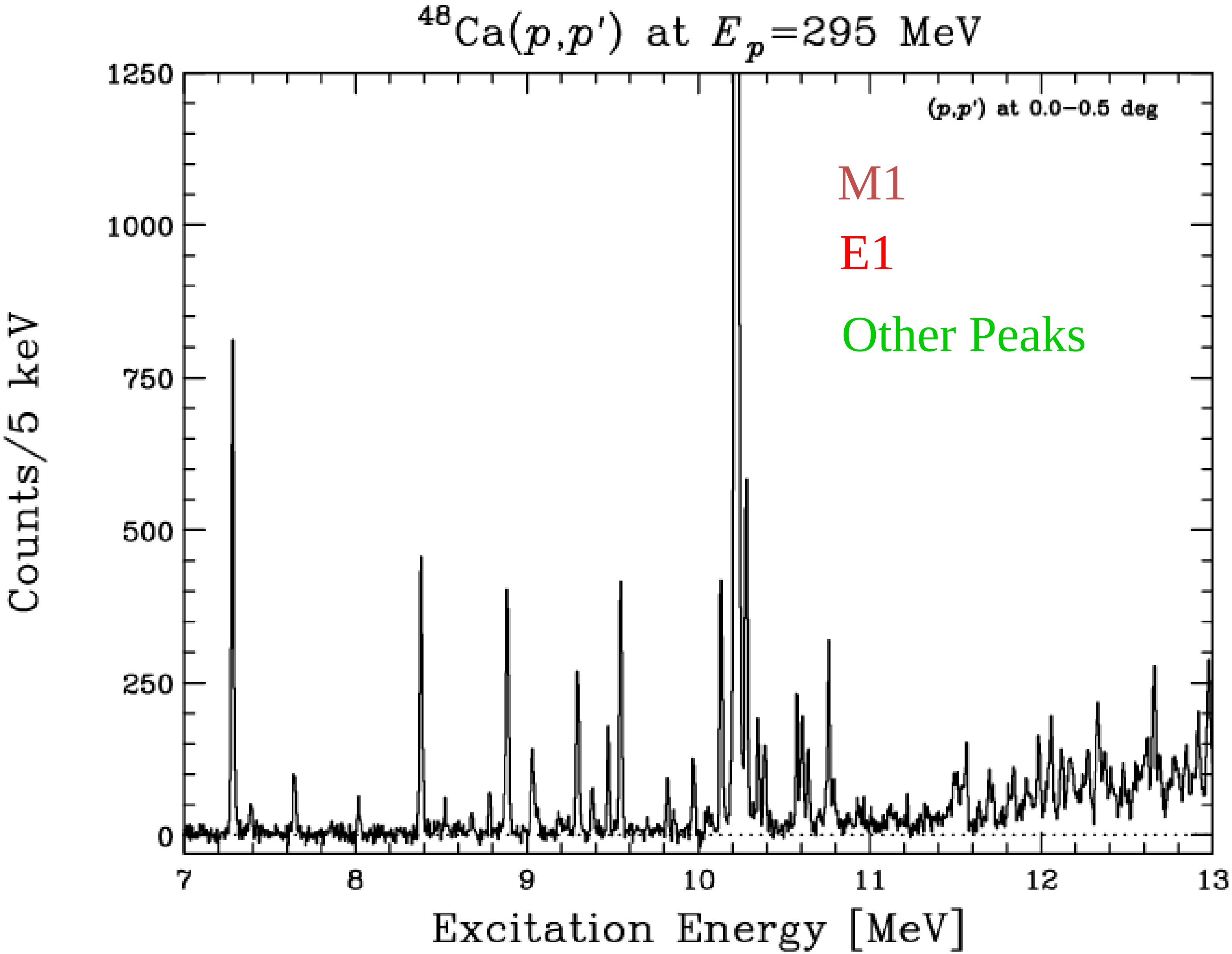

^{48}Ca(p,p') at E_p=295 MeV
(p,p') at 0.0–0.5 deg
1+; 10.22 MeV
17 keV
12500
10000
7500
5000
2500
0
Counts/5 keV
7
8
9
10
11
12
13
Excitation Energy [MeV]

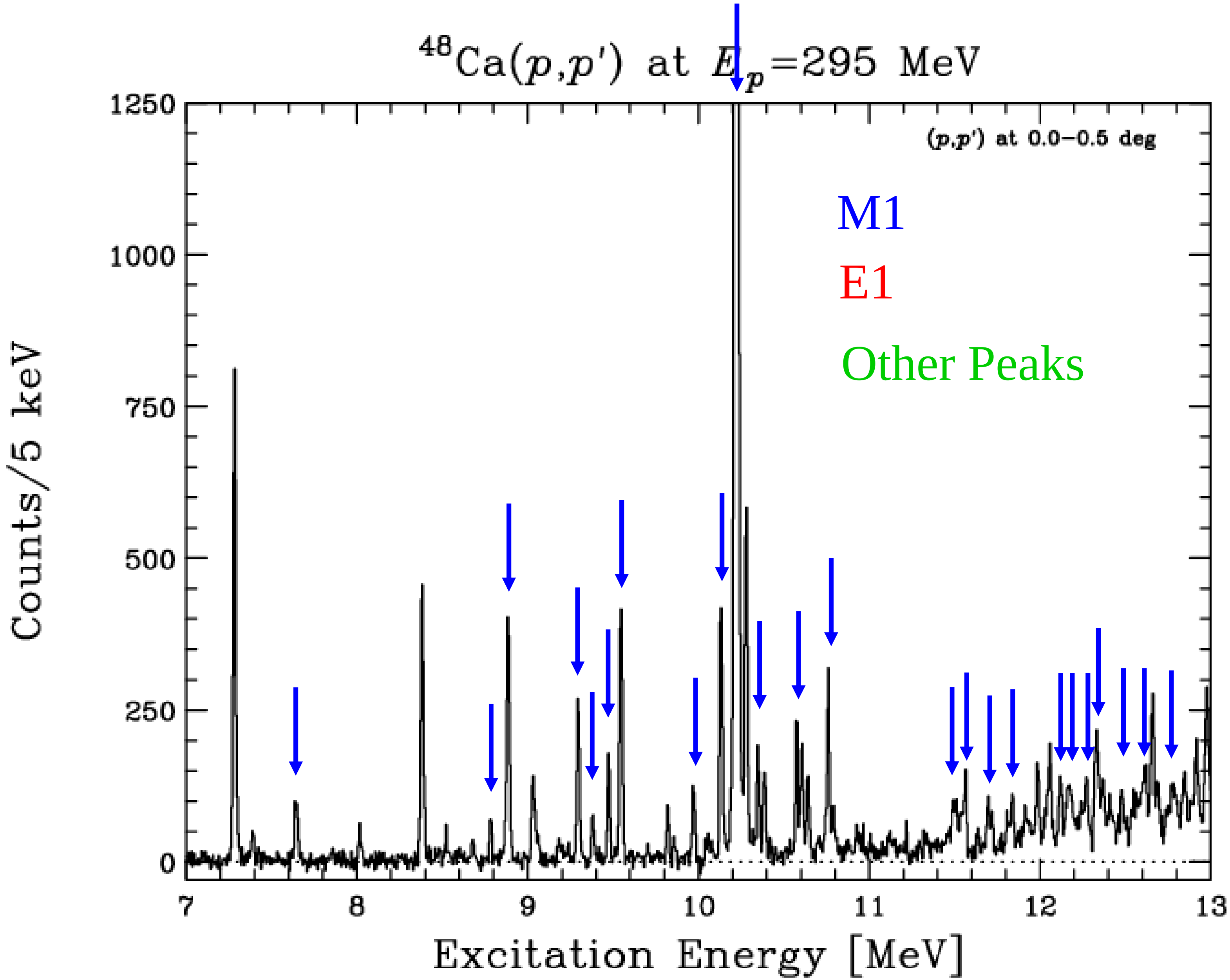


^{48}Ca(p,p') at E_p=295 MeV
(p,p') at 0.0–0.5 deg
Counts/5 keV
1250
1000
750
500
250
0
7
8
9
10
11
12
13
Excitation Energy [MeV]

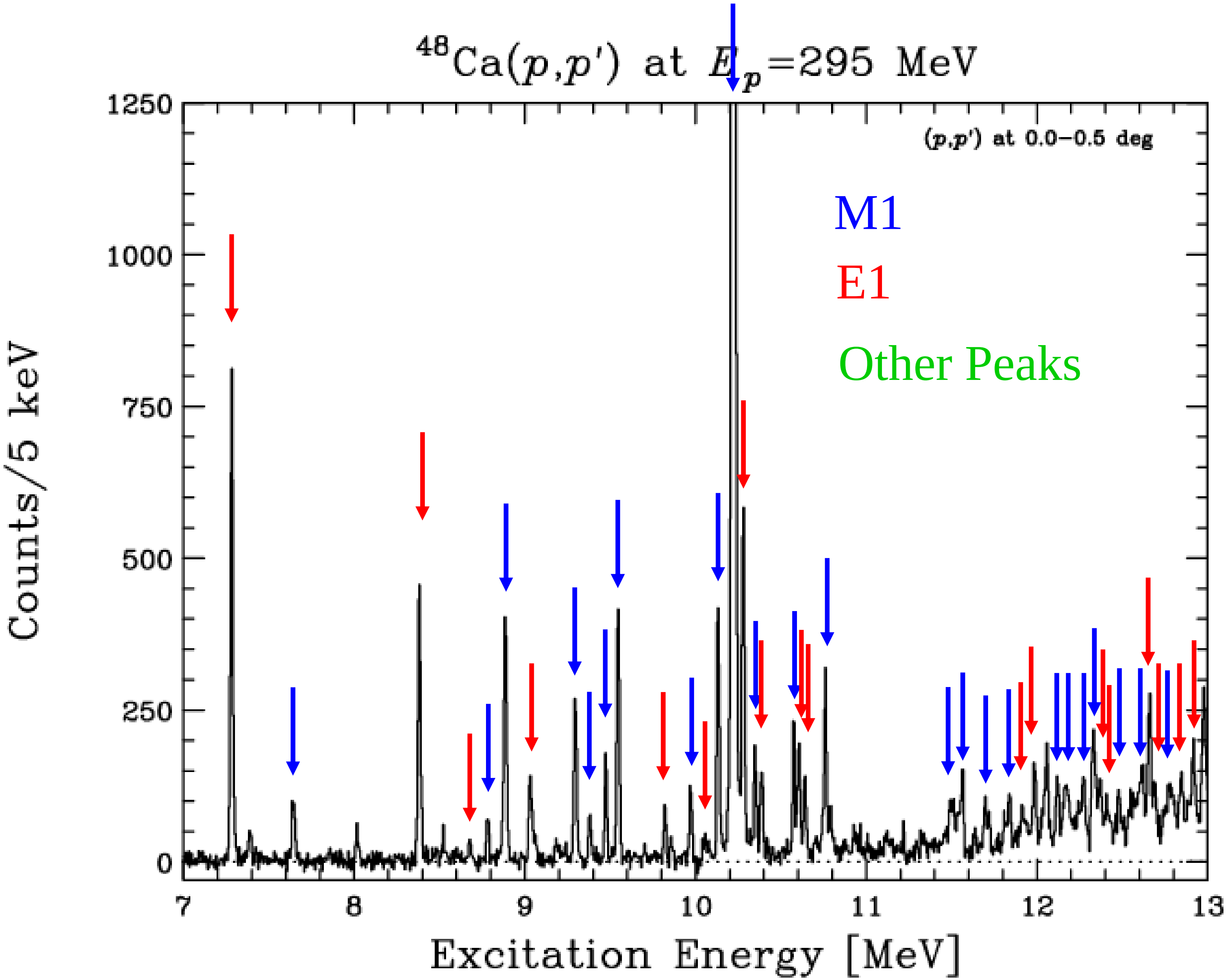


^{48}Ca(p,p') at E_p=295 MeV
at 4.75 deg.
30
20
10
0
7
8
9
10
11
12
13
Excitation Energy [MeV]
$d\sigma/d\Omega dE_x$ [mbsr^{-1}MeV^{-1}]

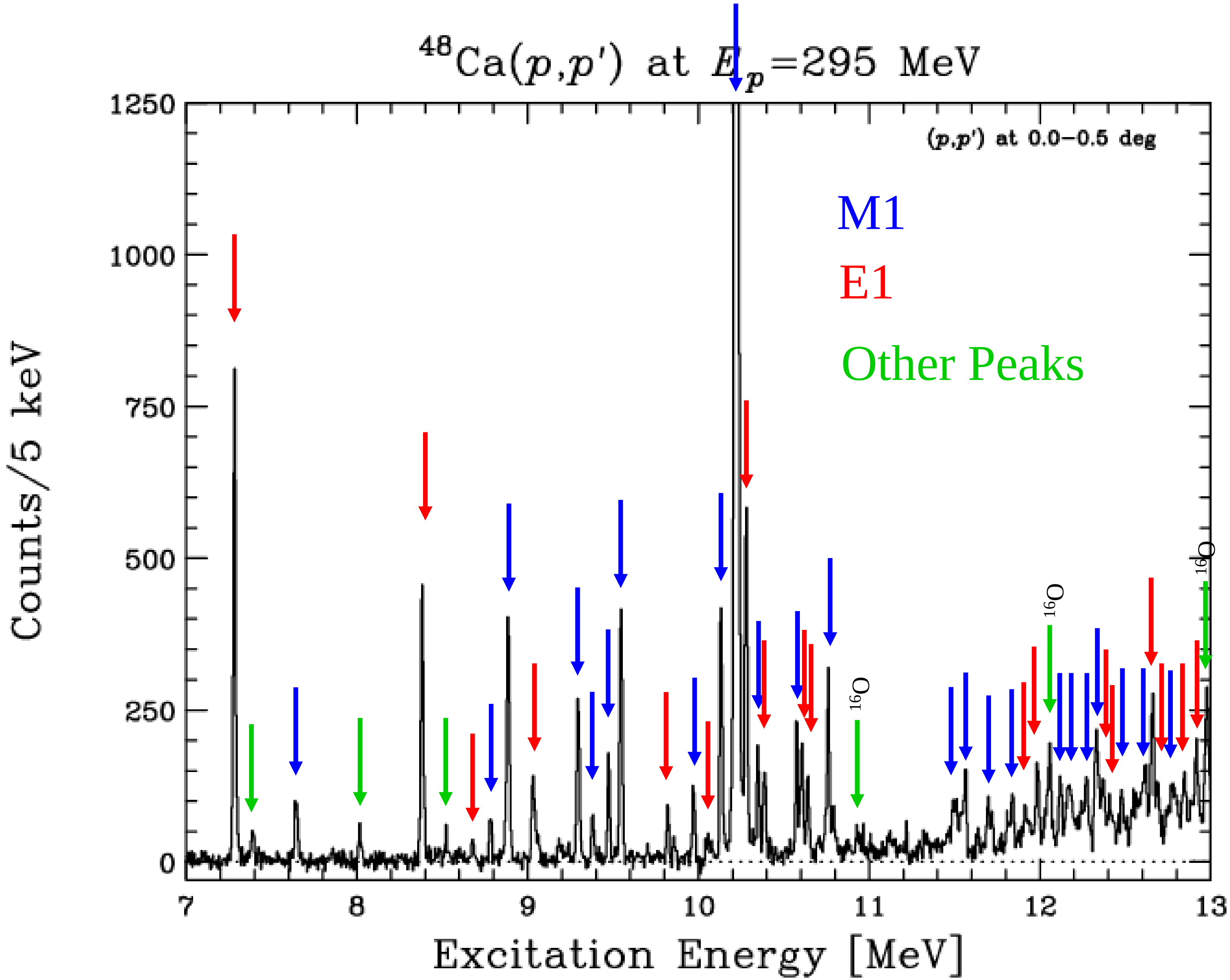

^{48}Ca(p,p') at E_p=295 MeV
(p,p') at 0.0–0.5 deg
M1
E1
Other Peaks
Counts/5 keV
1250
1000
750
500
250
0
7
8
9
10
11
12
13
Excitation Energy [MeV]



^{48}Ca(p,p') at E_p=295 MeV
(p,p') at 0.0–0.5 deg
M1
E1
Other Peaks
Counts/5 keV
Excitation Energy [MeV]
1250
1000
750
500
250
0
7
8
9
10
11
12
13



48Ca(p,p') at Ep=295 MeV
(p,p') at 0.0−0.5 deg
M1
E1
Other Peaks
Counts/5 keV
1250
1000
750
500
250
0
7
8
9
10
11
12
13
Excitation Energy [MeV]



⁴⁸Ca(p,p') at Ep=295 MeV
(p,p') at 0.0–0.5 deg
M1
E1
Other Peaks
16O
16O
16O
Counts/5 keV
Excitation Energy [MeV]
0
250
500
750
1000
1250
7
8
9
10
11
12
13

W. Steffen *et al*, NPA404(1983)413; (*e*,*e*') at Darmstadt and Mainz

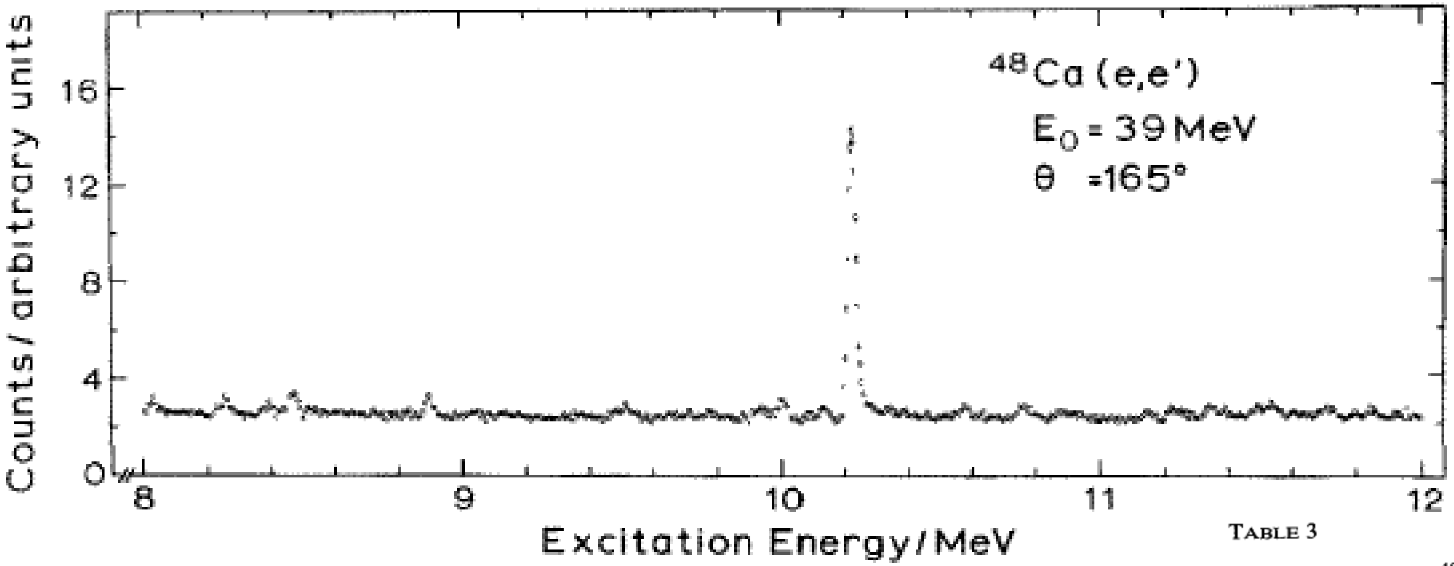
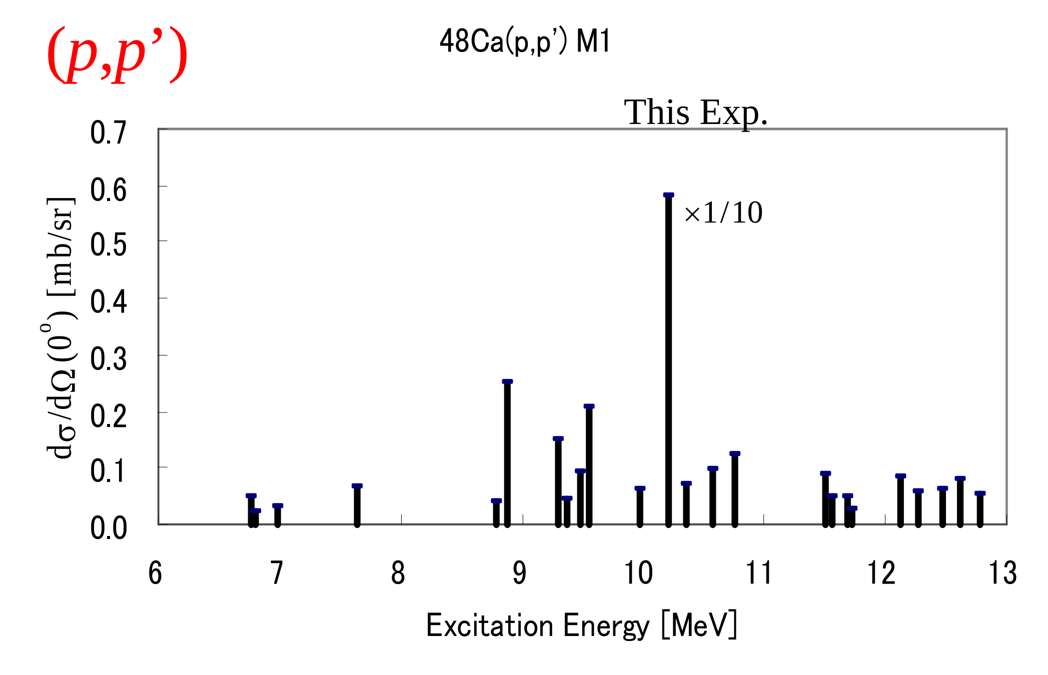


TABLE 3

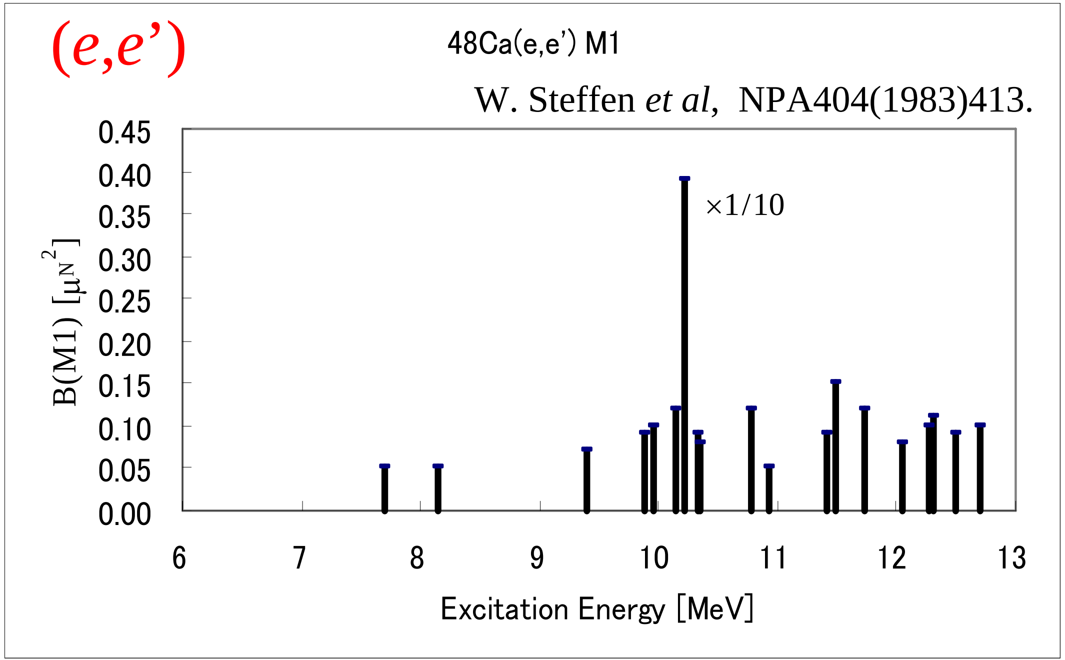
M1 ground-state transition strengths in ^{48}Ca between $E_x \approx$ 7.7–12.7 MeV

E_x (MeV)	B(M1, k)↑ (μ_N^2)
7.696	<0.05
8.150	<0.05
9.392	<0.07
9.885	<0.09
9.954	<0.10
10.138	0.12±0.03
10.225	3.9 ±0.3
10.330	0.09±0.04
10.354	0.08±0.04
10.782	0.12±0.04
10.930	0.05±0.02
11.410	<0.09
11.490	0.15±0.03
11.728	0.12±0.04
12.055	0.08±0.03
12.270	0.10±0.05
12.310	0.11±0.03
12.493	0.09±0.04
12.700	0.10±0.05

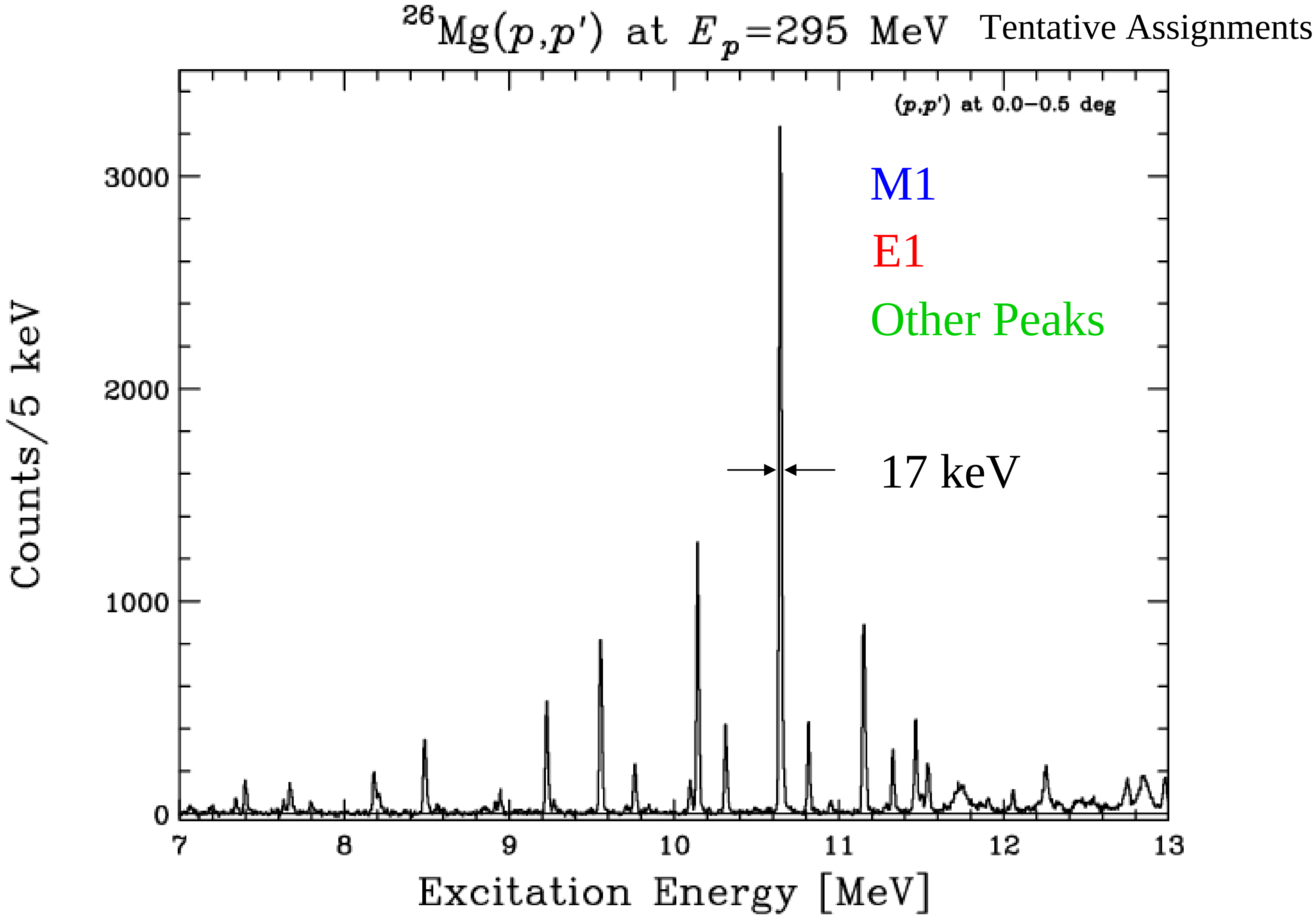
19 1^+ states were identified.



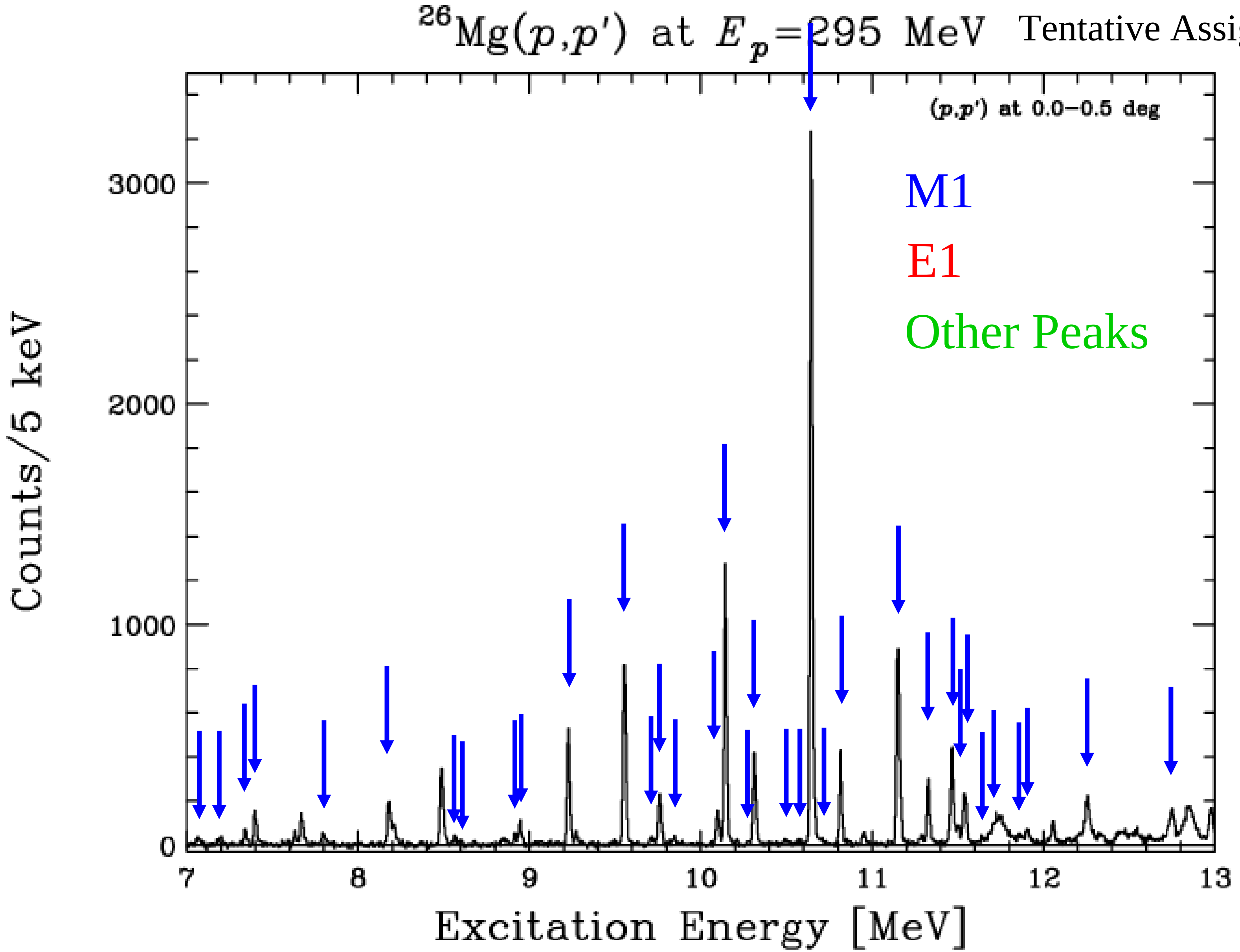
$\propto B(\sigma)$

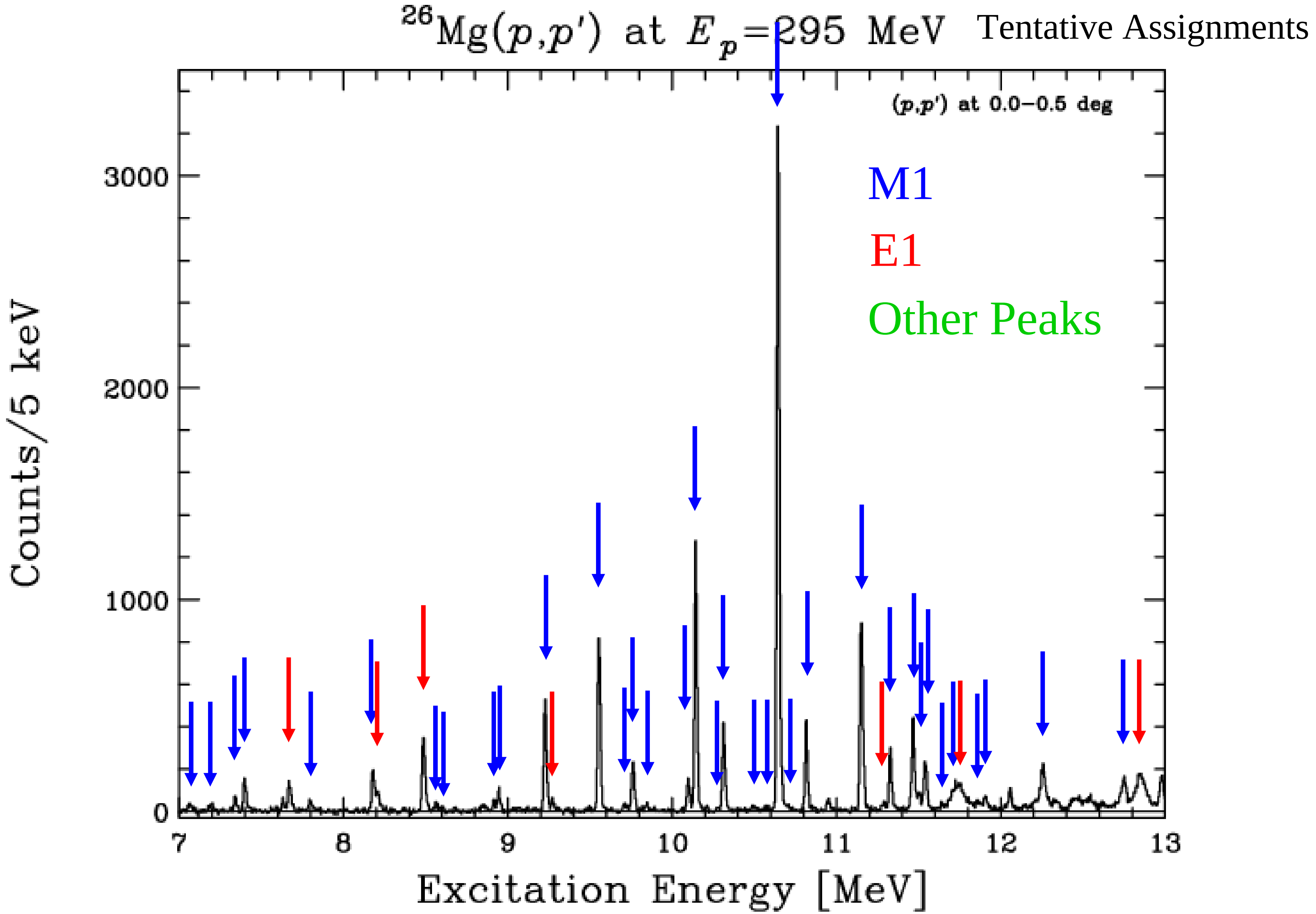


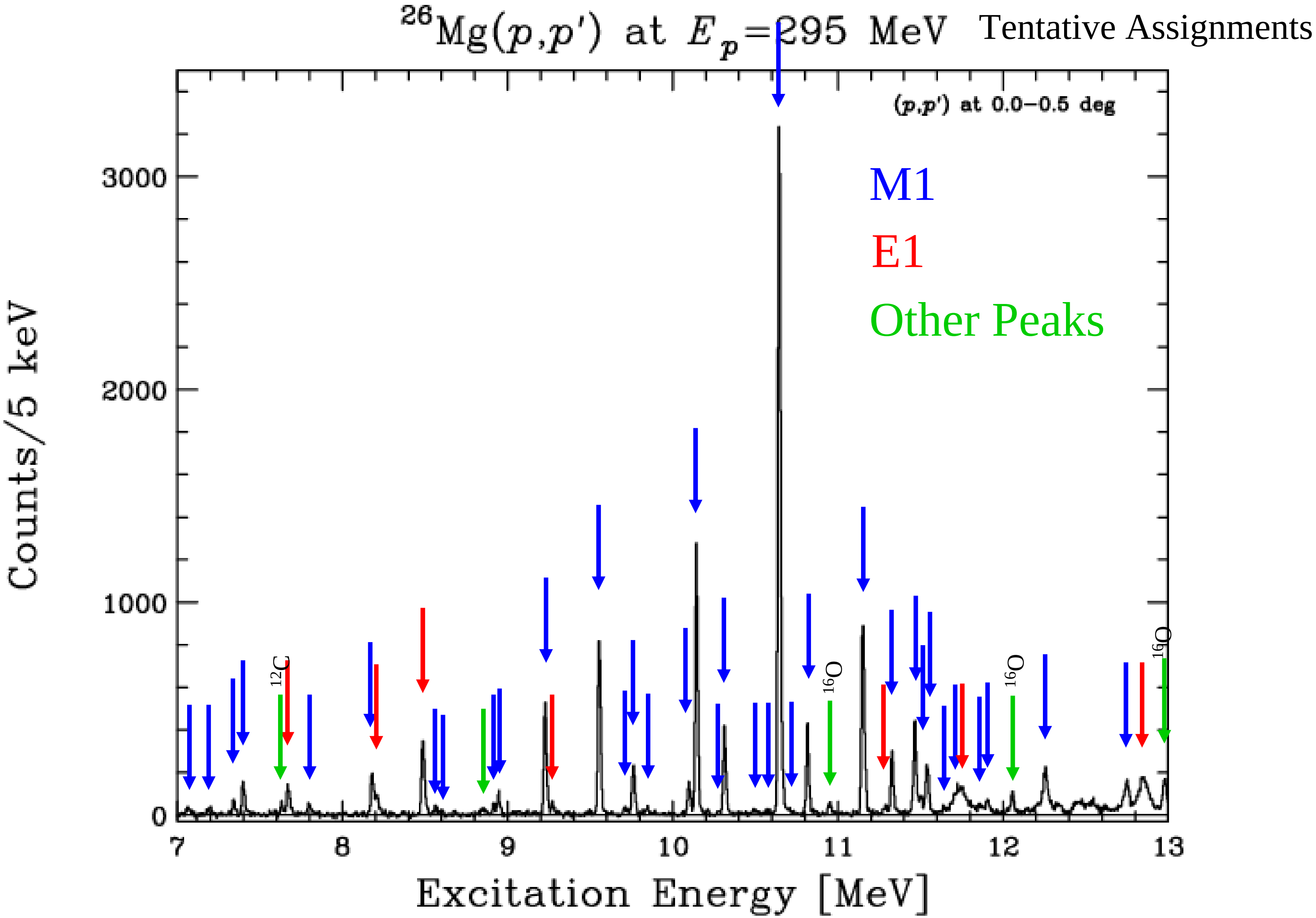
$B(M1)$


^{26}Mg(p,p') at E_p=295 MeV
Tentative Assignments
(p,p') at 0.0–0.5 deg
M1
E1
Other Peaks
17 keV
Counts/5 keV
Excitation Energy [MeV]
0
1000
2000
3000
7
8
9
10
11
12
13

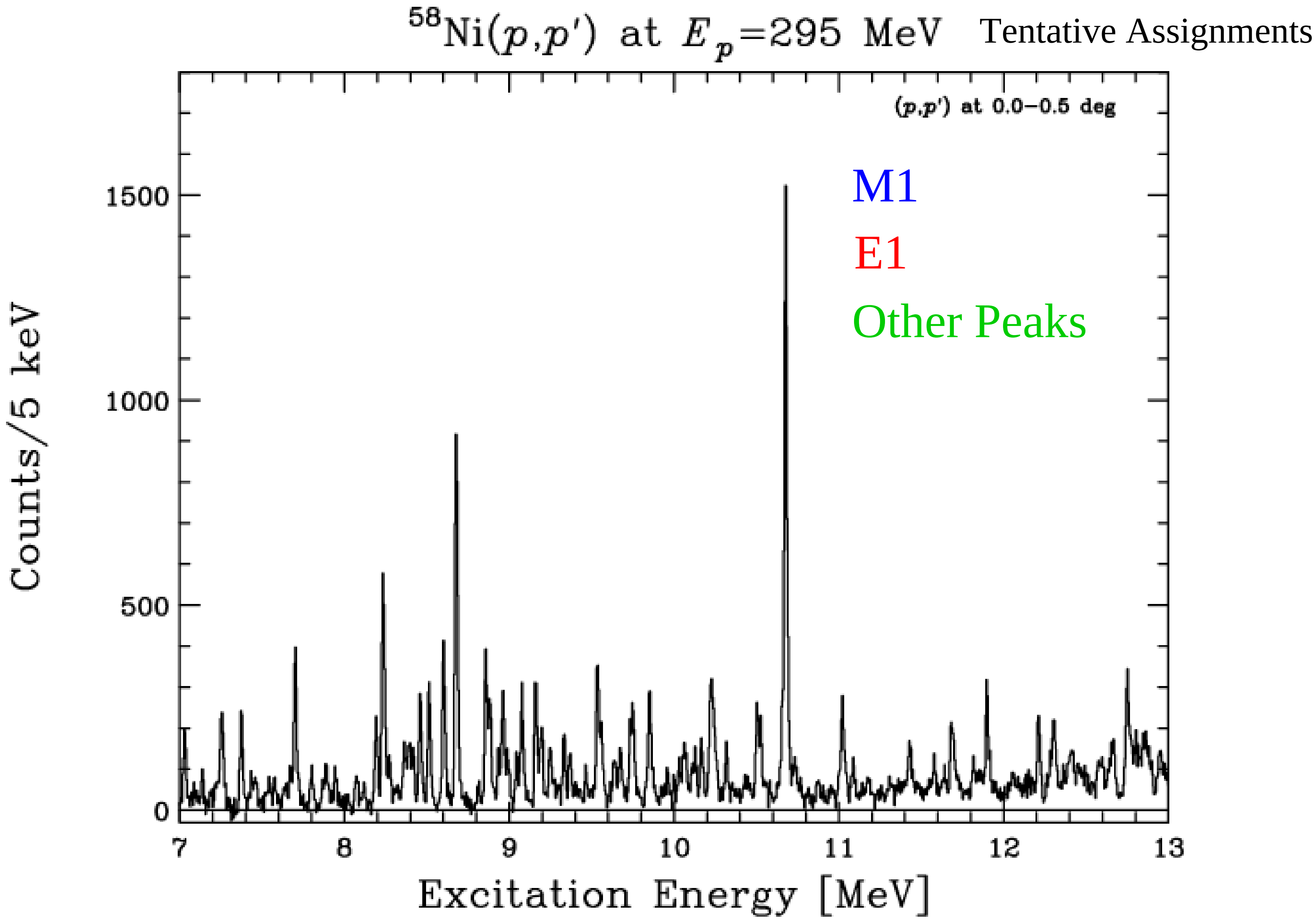
Tentative Assignments



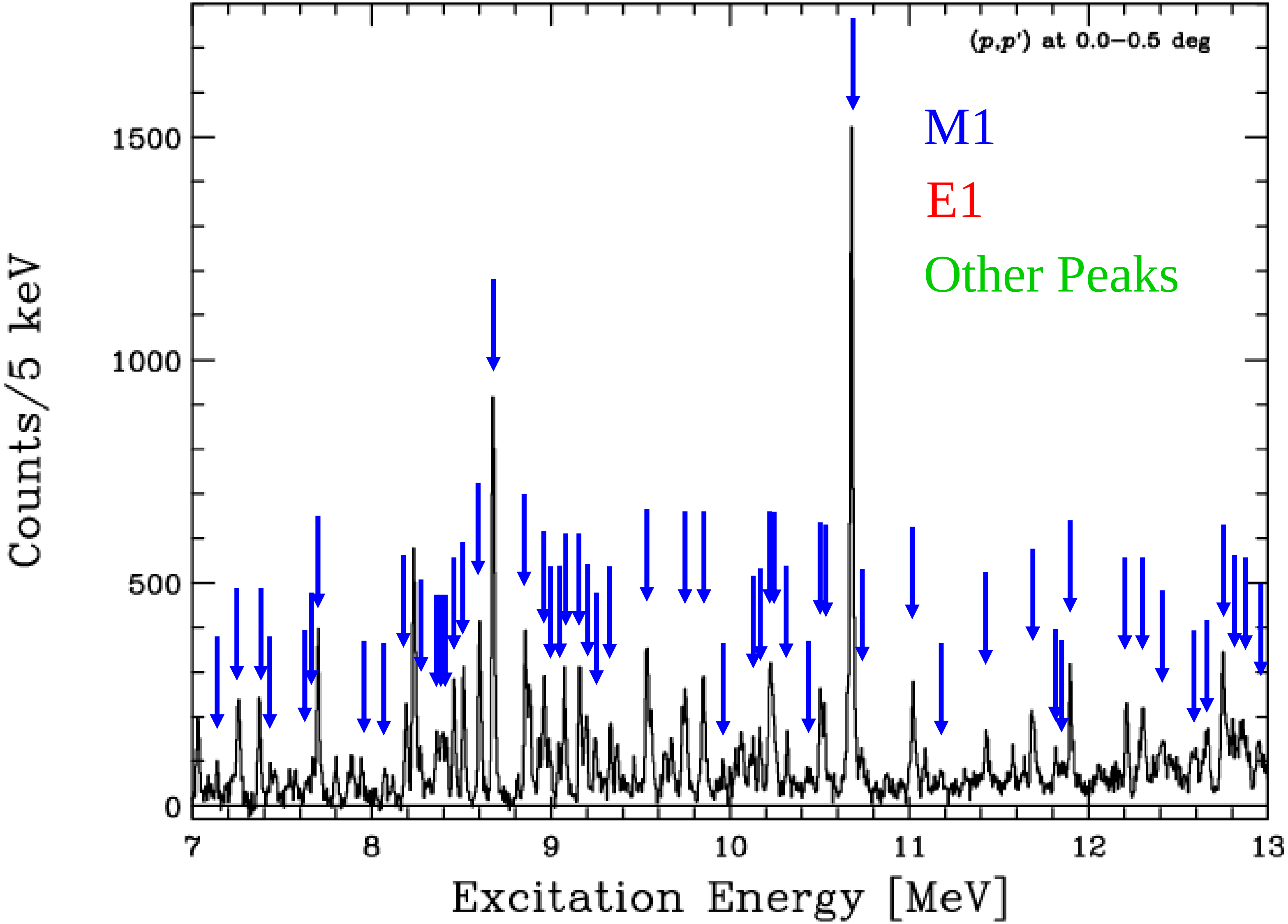

^{26}Mg(p,p') at E_p=295 MeV
Tentative Assignments
(p,p') at 0.0–0.5 deg
M1
E1
Other Peaks
Counts/5 keV
3000
2000
1000
0
7
8
9
10
11
12
13
Excitation Energy [MeV]

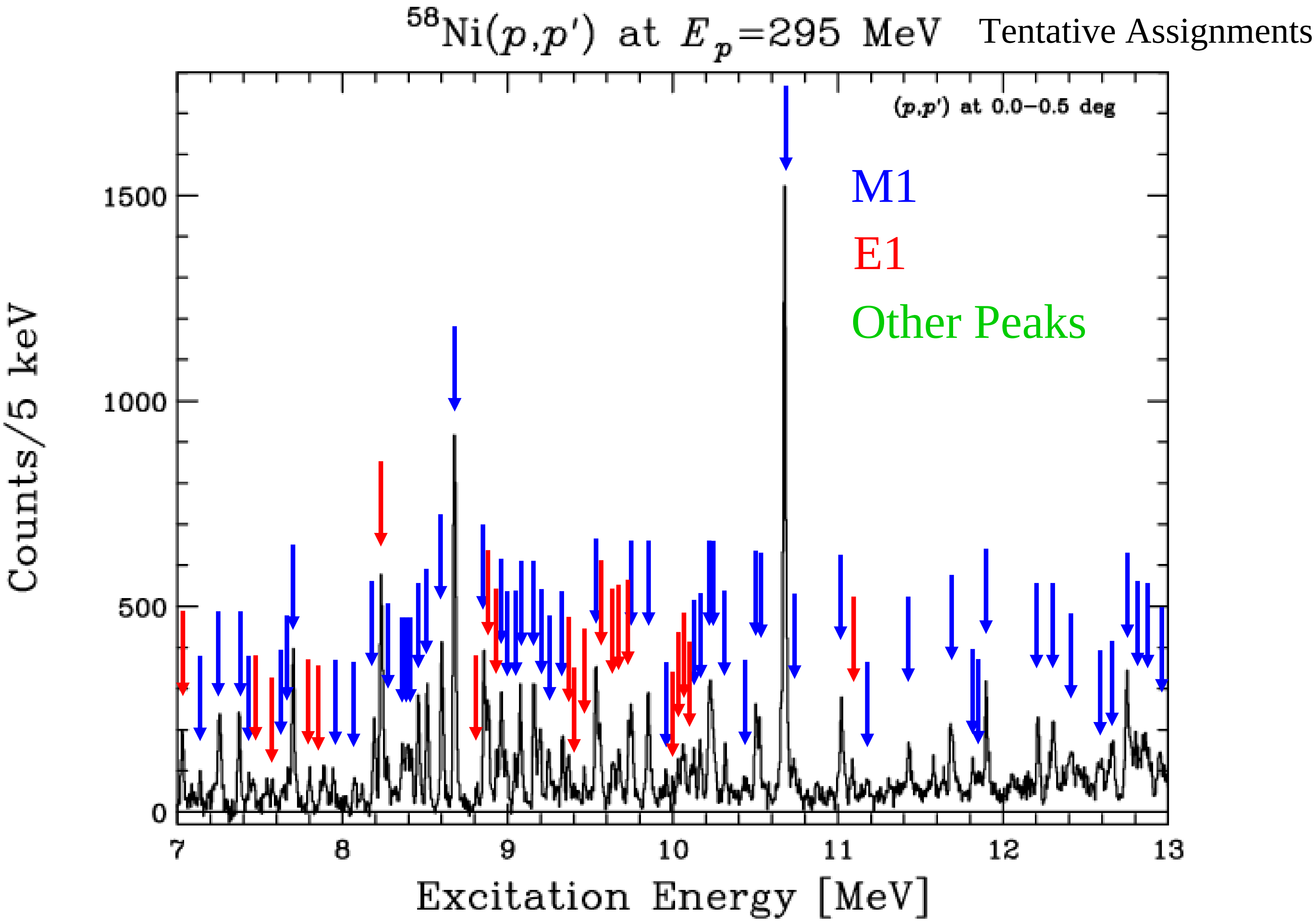


26Mg(p,p') at Ep=295 MeV
Tentative Assignments
(p,p') at 0.0–0.5 deg
M1
E1
Other Peaks
12C
16O
16O
16O
Counts/5 keV
0
1000
2000
3000
7
8
9
10
11
12
13
Excitation Energy [MeV]

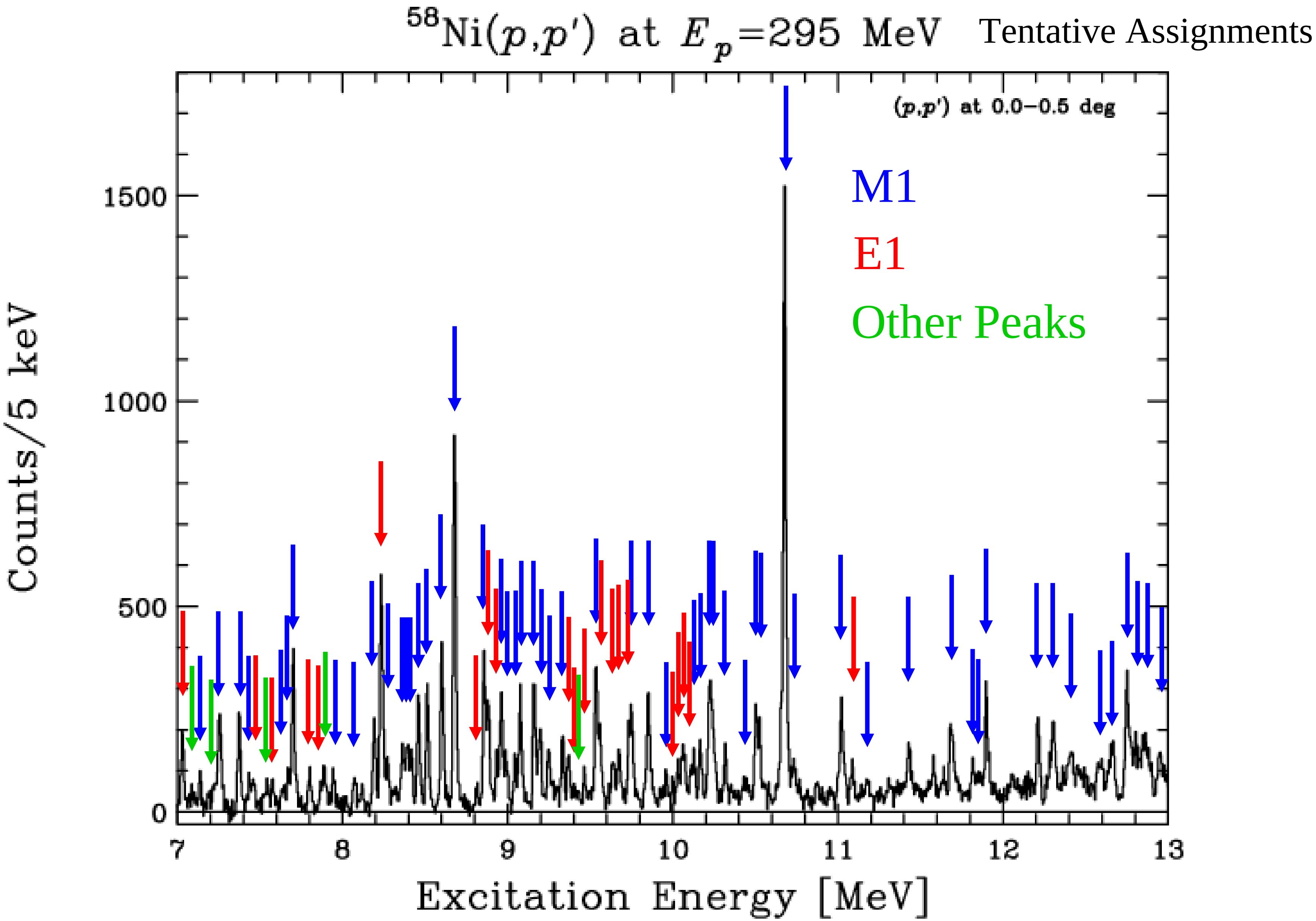

^{58}Ni(p,p′) at E_p=295 MeV
Tentative Assignments
(p,p′) at 0.0–0.5 deg
M1
E1
Other Peaks
Counts/5 keV
1500
1000
500
0
7
8
9
10
11
12
13
Excitation Energy [MeV]

^{58}Ni(p,p') at E_p=295 MeV Tentative Assignments



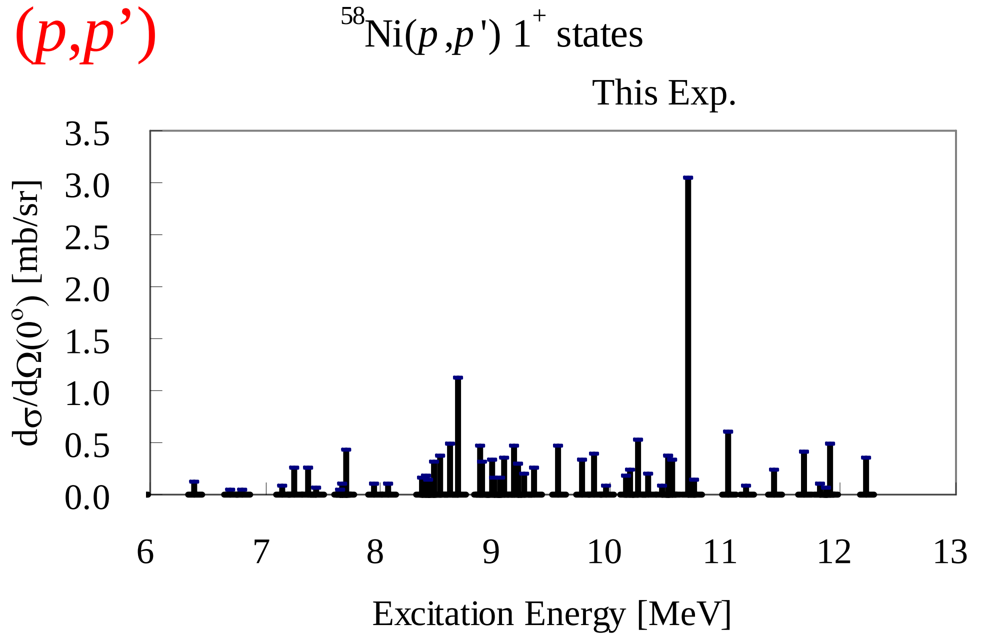


^{58}Ni(p,p') at E_p=295 MeV
Tentative Assignments
(p,p') at 0.0–0.5 deg
M1
E1
Other Peaks
Counts/5 keV
0
500
1000
1500
7
8
9
10
11
12
13
Excitation Energy [MeV]

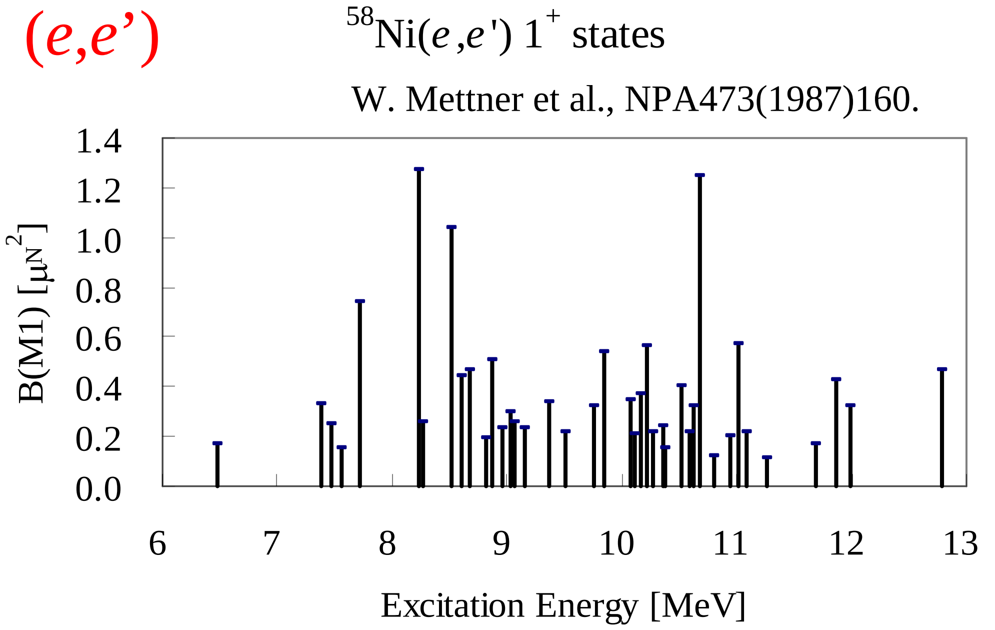


^{58}Ni(p,p') at E_p=295 MeV
Tentative Assignments
(p,p') at 0.0–0.5 deg
M1
E1
Other Peaks
Counts/5 keV
0
500
1000
1500
7
8
9
10
11
12
13
Excitation Energy [MeV]

(*p*,*p*')



(*e*,*e*')

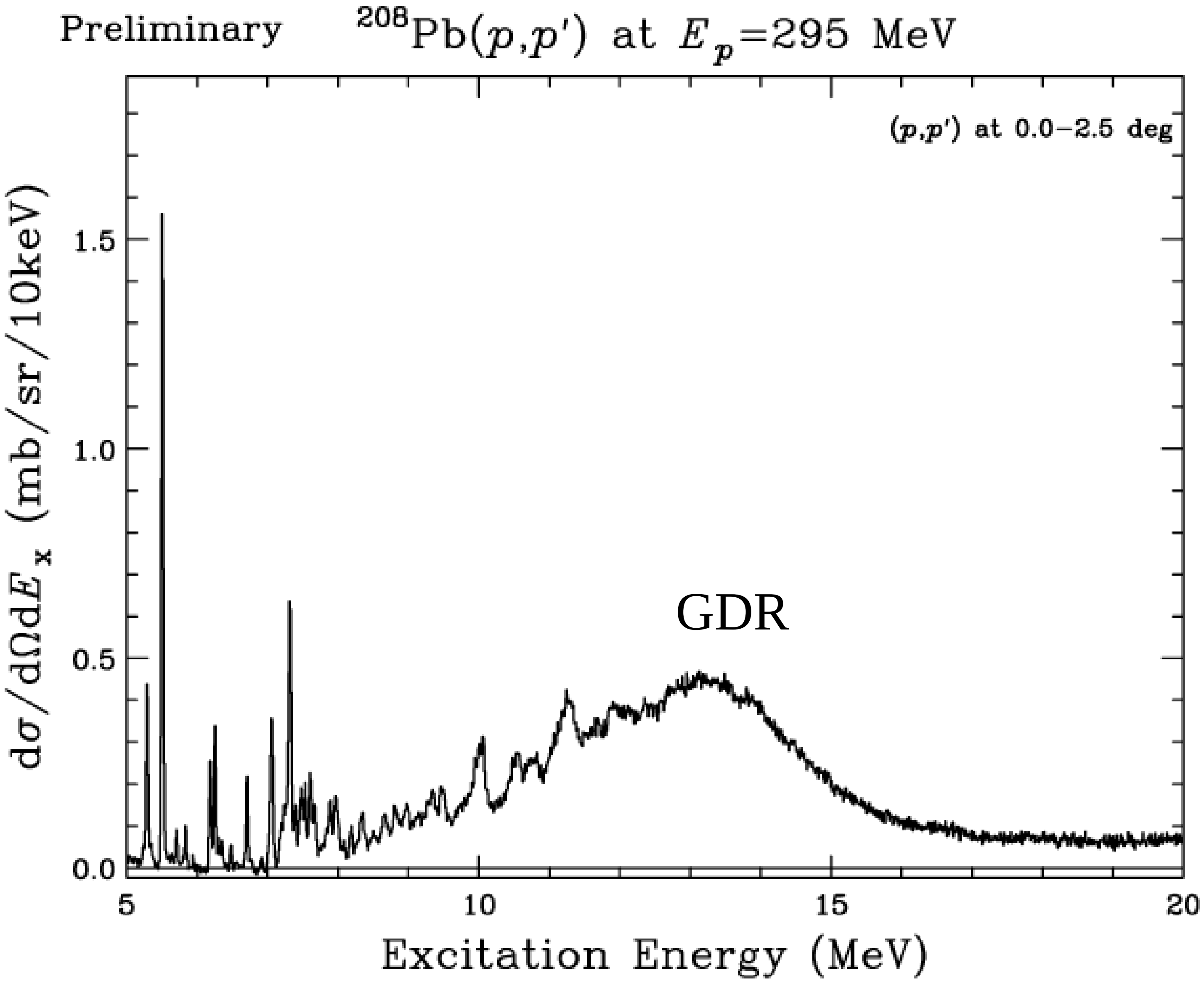


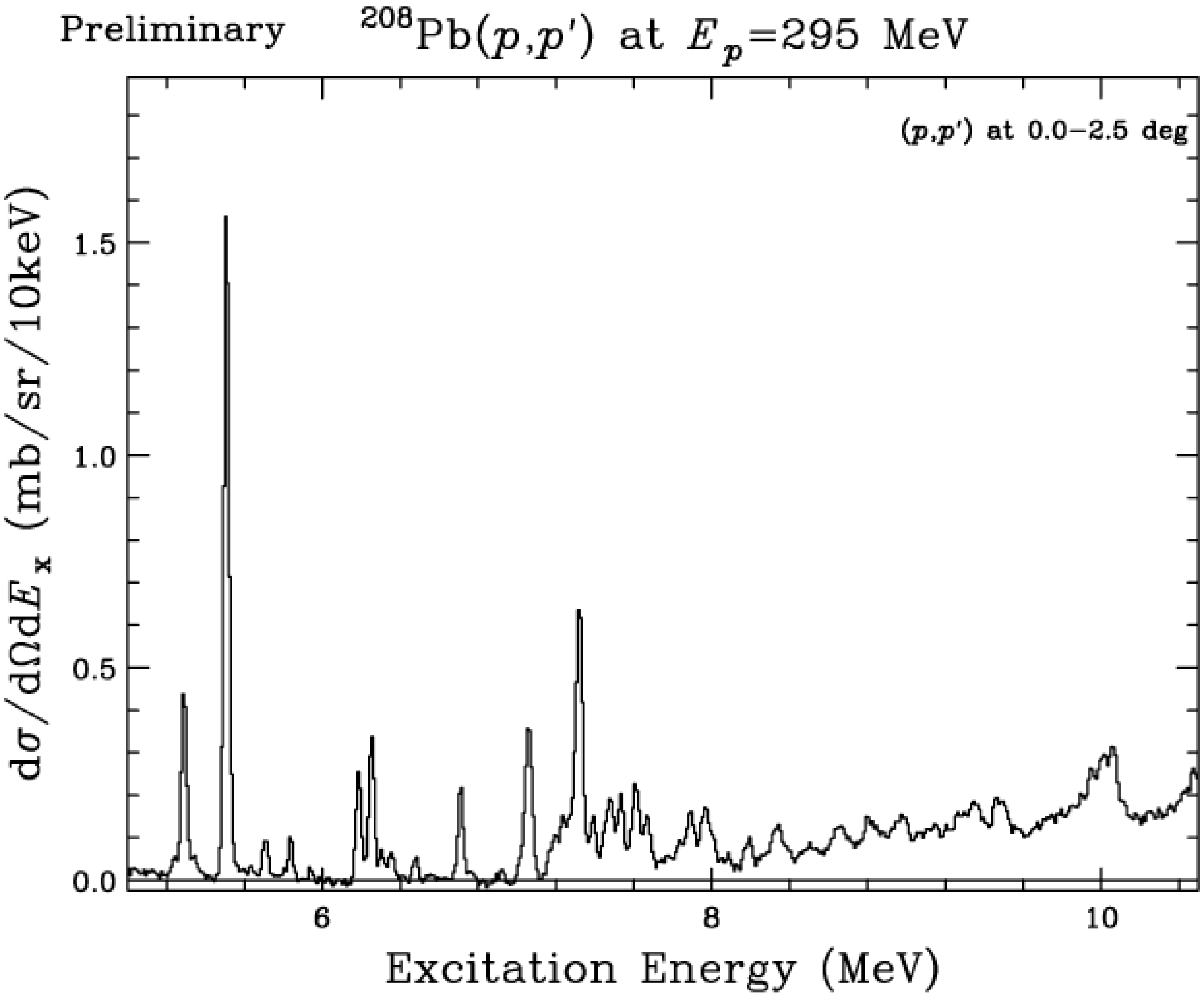
Differences come from:
orbital par of the M1 operator

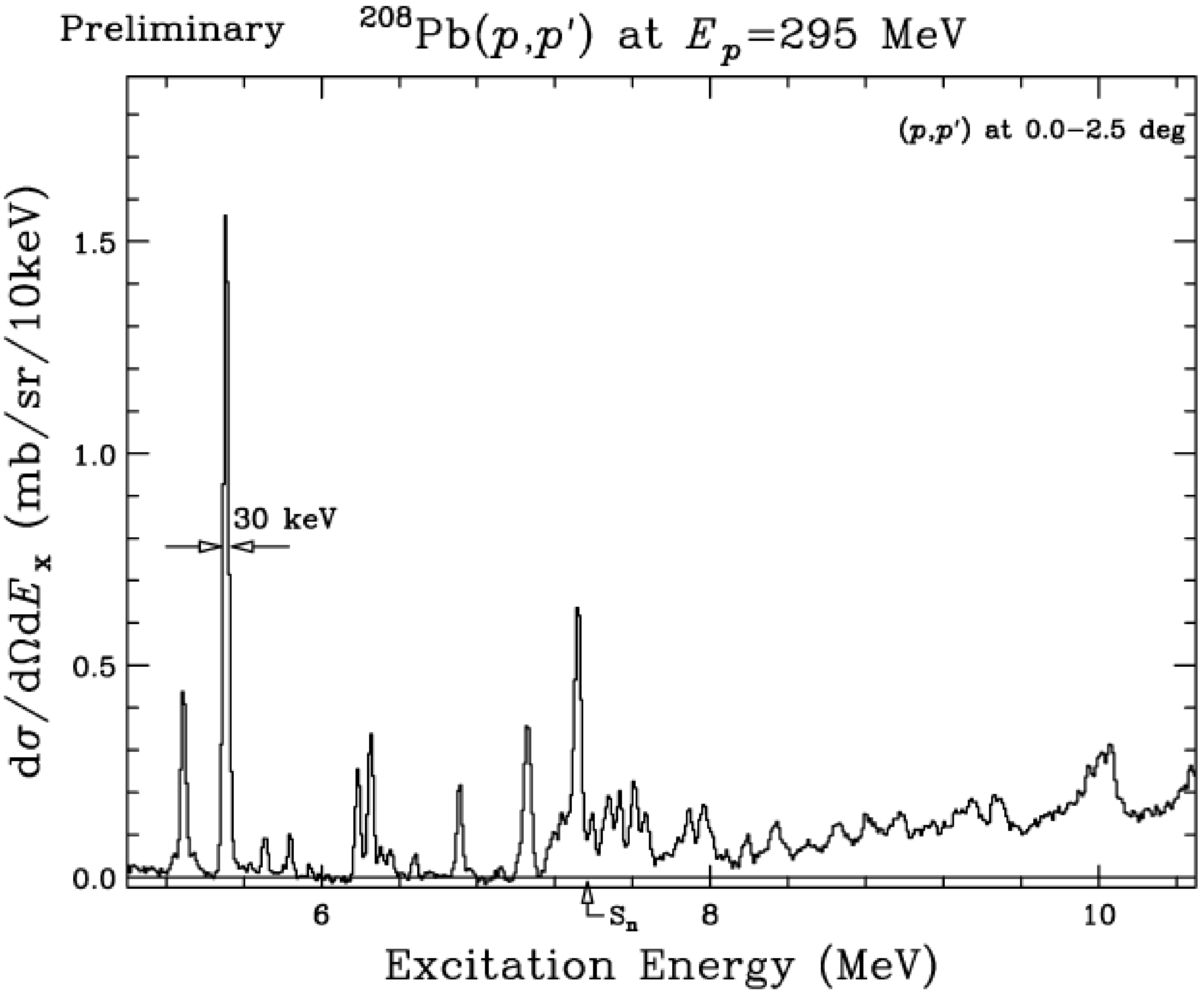
↓

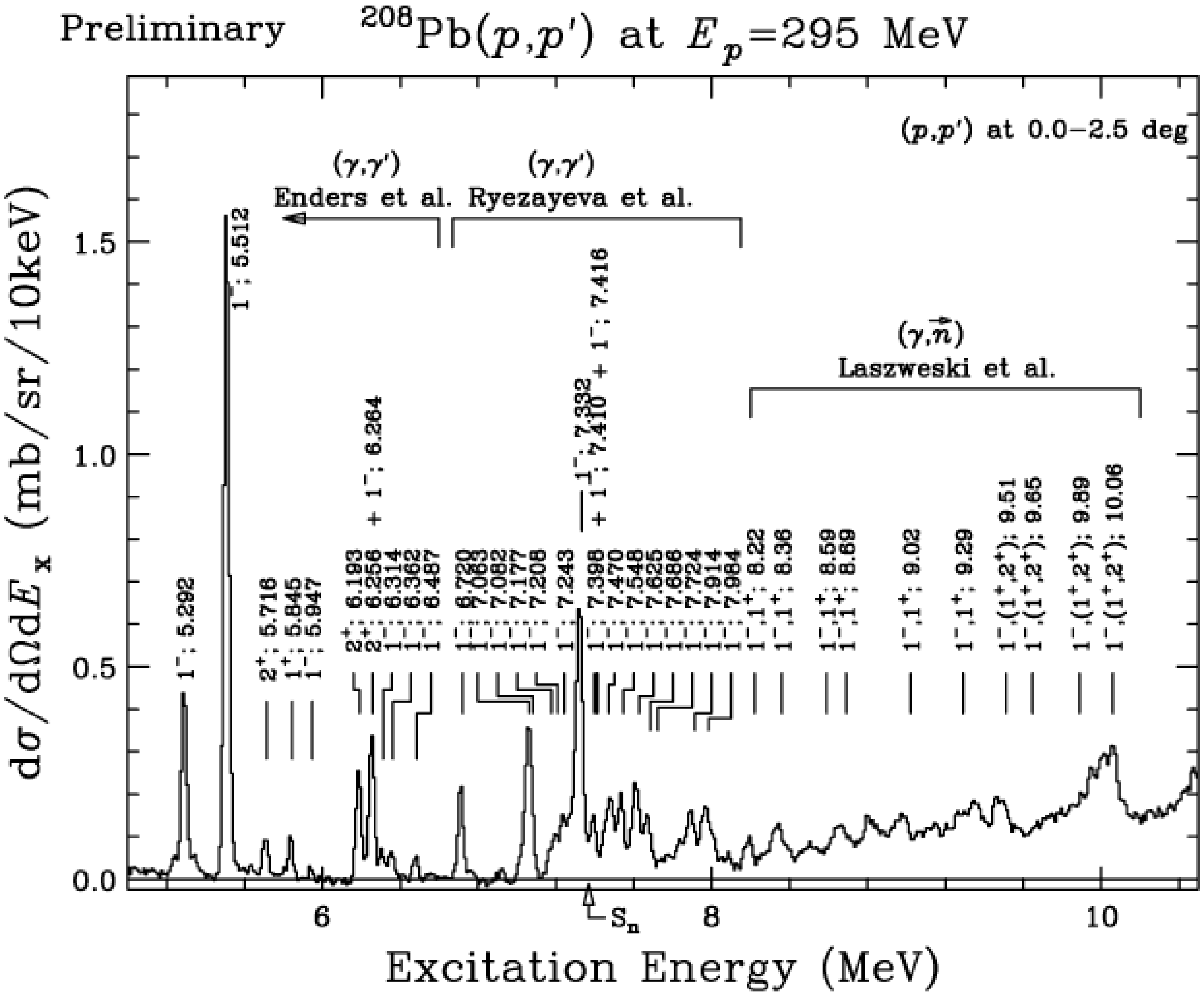
Extraction of general trend by checking the orbital contribution in each state.

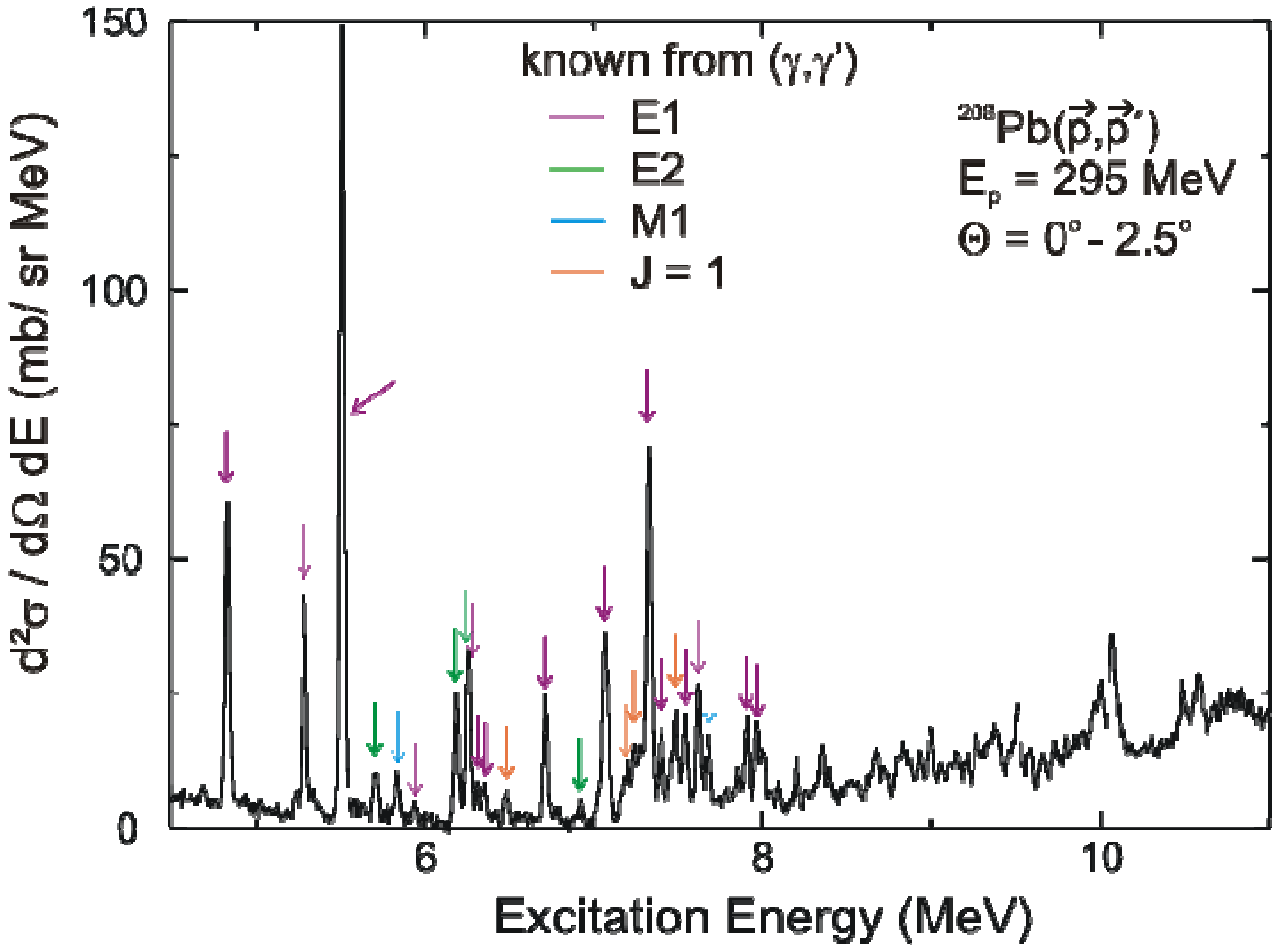
B(σ): (p,p')
B(M1): EM probes
orbital part: combination


Preliminary
^{208}Pb(p,p') at E_p=295 MeV
(p,p') at 0.0–2.5 deg
dσ/dΩdE_x (mb/sr/10keV)
0.0
0.5
1.0
1.5
5
10
15
20
Excitation Energy (MeV)
GDR

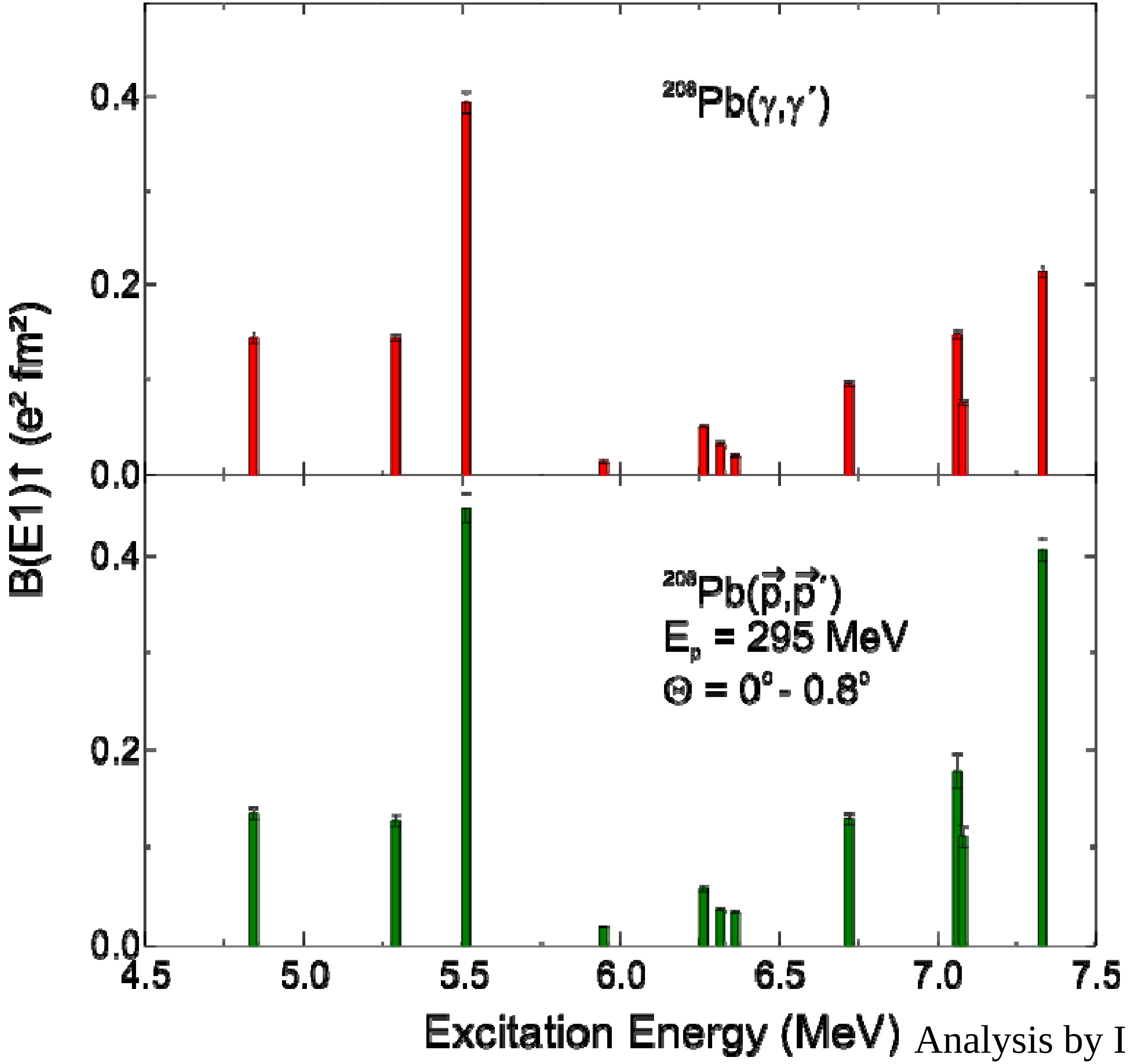

Preliminary
^{208}Pb(p,p') at E_p=295 MeV
(p,p') at 0.0–2.5 deg
dσ/dΩdE_x (mb/sr/10keV)
0.0
0.5
1.0
1.5
6
8
10
Excitation Energy (MeV)


Preliminary
^{208}Pb(p,p') at E_p=295 MeV
(p,p') at 0.0–2.5 deg
30 keV
dσ/dΩdE_x (mb/sr/10keV)
1.5
1.0
0.5
0.0
6
8
10
S_n
Excitation Energy (MeV)

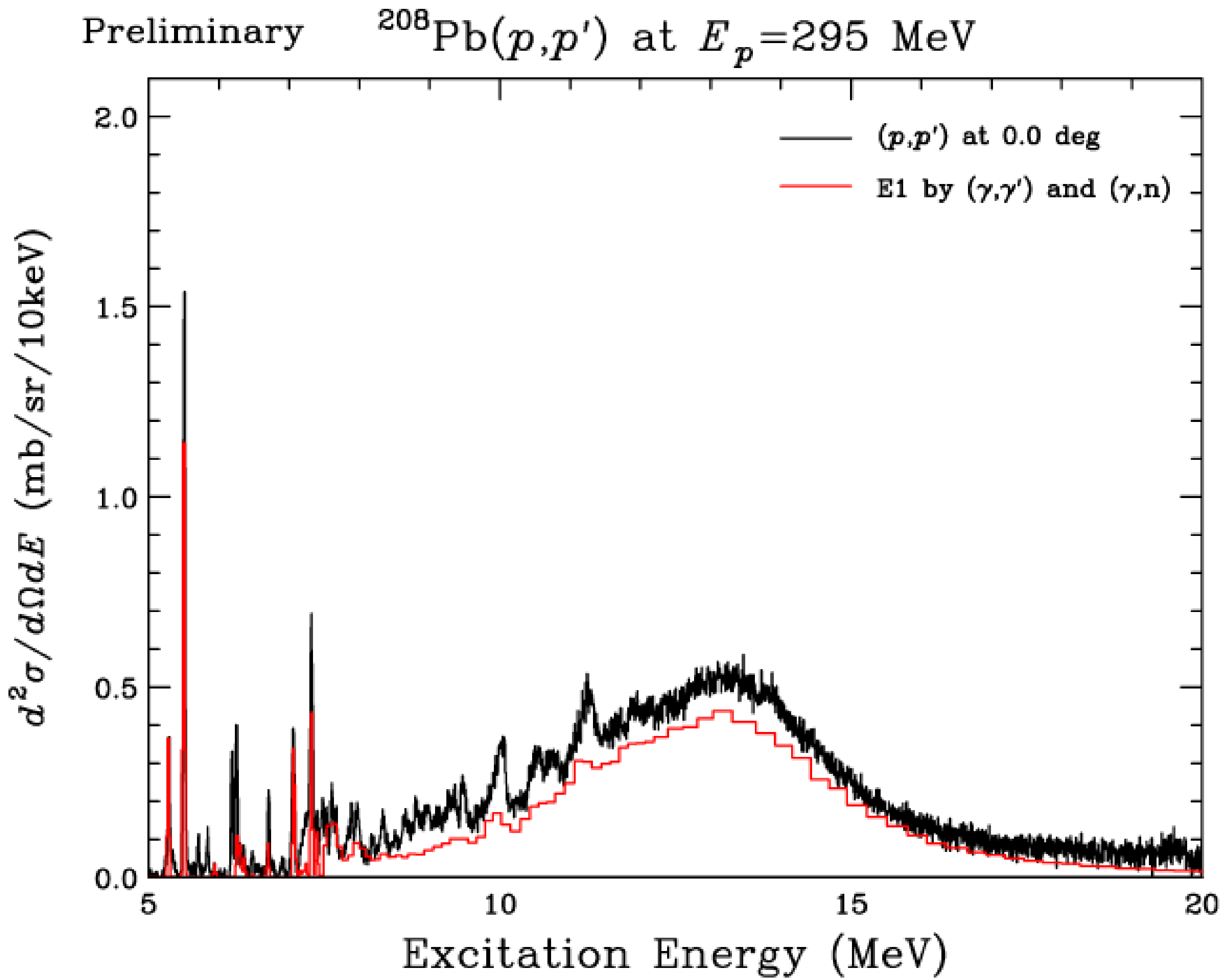

Preliminary
208Pb(p,p') at Ep=295 MeV
(p,p') at 0.0–2.5 deg
(γ,γ')
Enders et al.
(γ,γ')
Ryezayeva et al.
(γ,n)
Laszweski et al.
dσ/dΩdEx (mb/sr/10keV)
Excitation Energy (MeV)
Sn
1⁻; 5.292
1⁻; 5.512
2⁺; 5.716
1⁺; 5.845
1⁻; 5.947
1⁻; 7.332
+ 1⁻; 7.410 + 1⁻; 7.416
+ 1⁻; 6.264
1⁻,1⁺; 8.22
1⁻,1⁺; 8.36
1⁻,1⁺; 8.59
1⁻,1⁺; 8.69
1⁻,1⁺; 9.02
1⁻,1⁺; 9.29
1⁻,(1⁺,2⁺); 9.51
1⁻,(1⁺,2⁺); 9.65
1⁻,(1⁺,2⁺); 9.89
1⁻,(1⁺,2⁺); 10.06



Analysis by I. Poltoratska, TU-Darmstadt

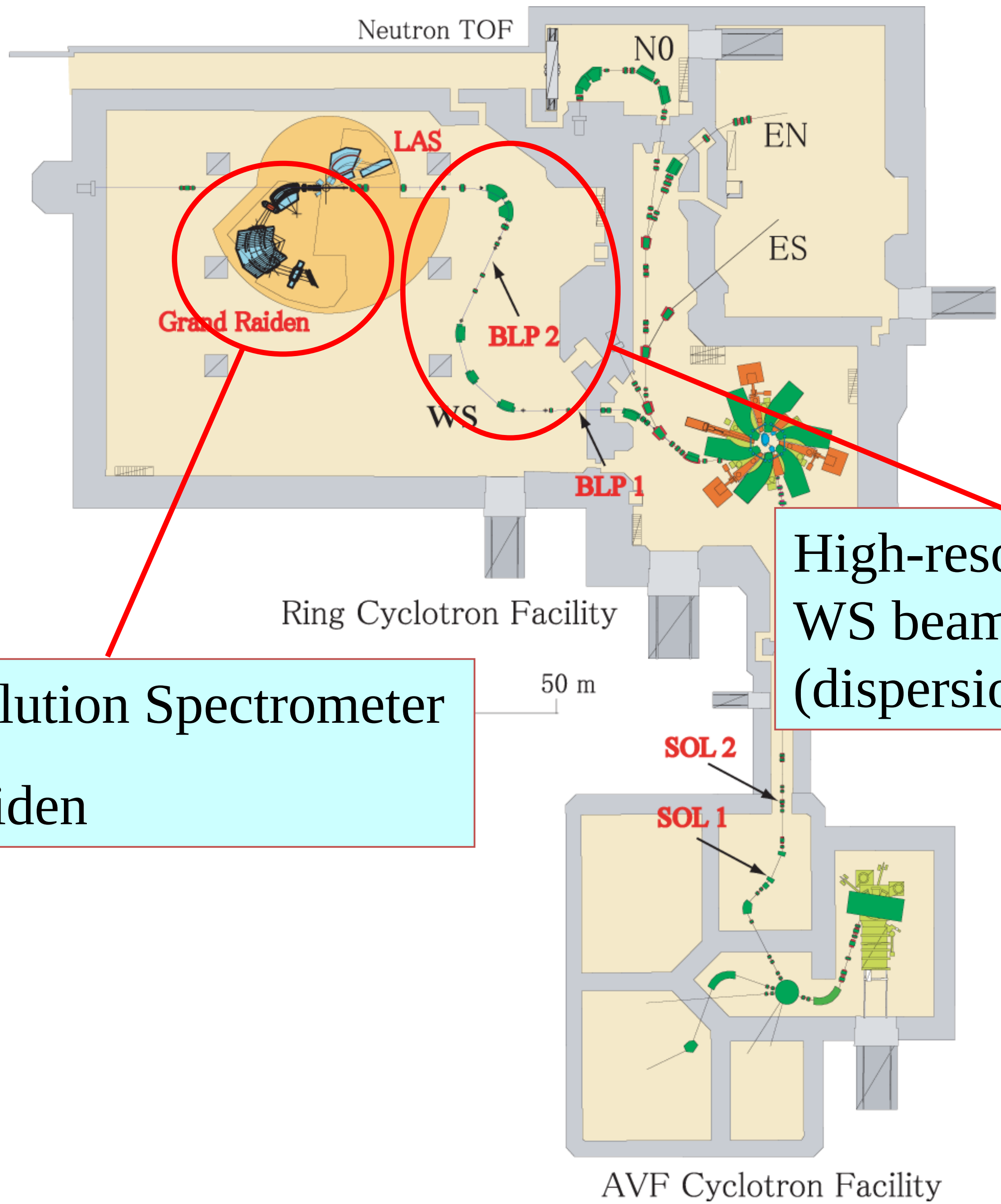


Analysis by I. Poltoratska,
TU-Darmstadt


Preliminary
^{208}Pb(p,p') at E_p=295 MeV
(p,p') at 0.0 deg
E1 by (γ,γ') and (γ,n)
d²σ/dΩdE (mb/sr/10keV)
Excitation Energy (MeV)
2.0
1.5
1.0
0.5
0.0
5
10
15
20

実験手法

A. Tamii *et al*., NIM A605, 326 (2009)



High-resolution Spectrometer

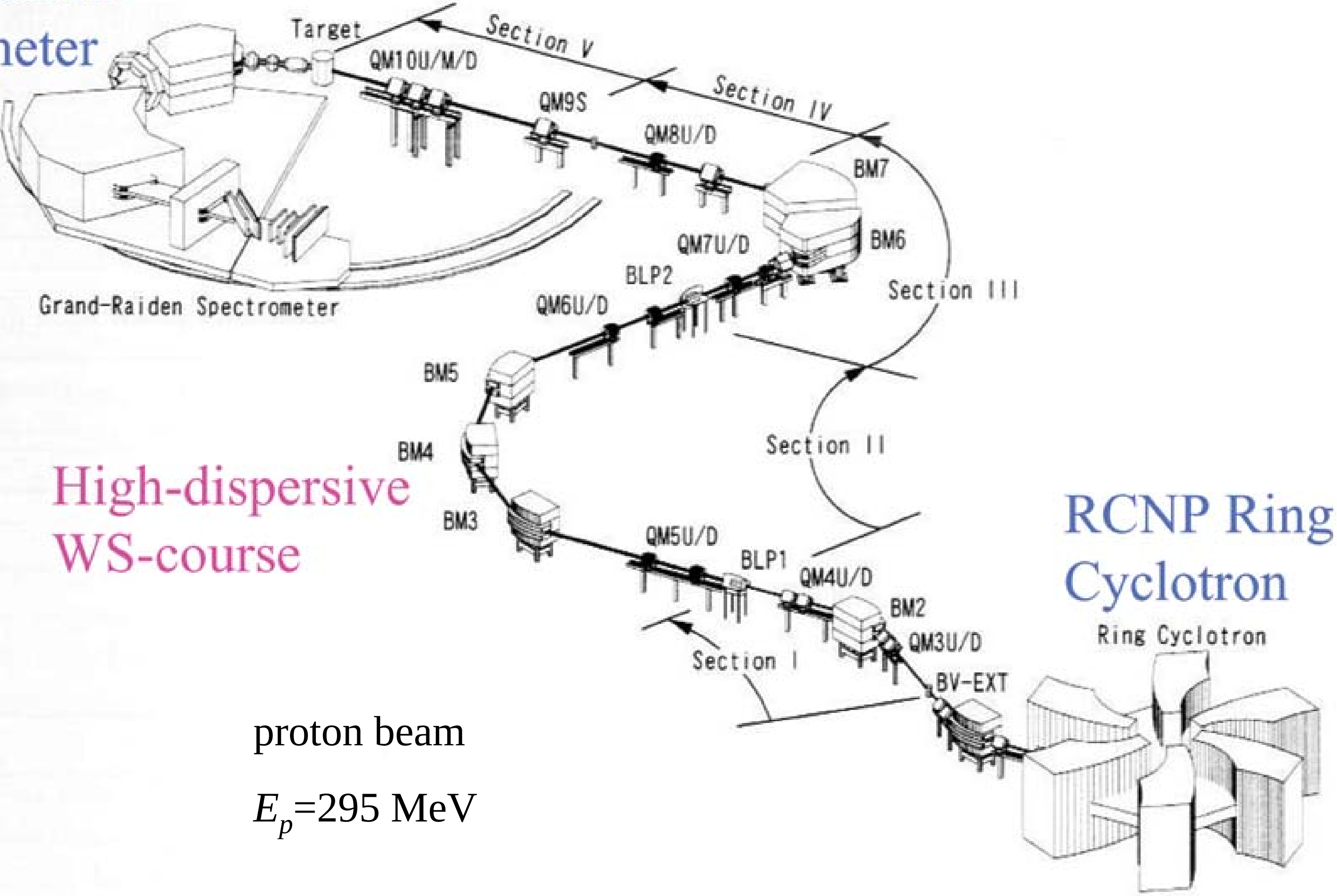
Grand Raiden

High-resolution
WS beam-line
(dispersion matching)

Beam line WS-course

T. Wakasa et al., NIM A482 ('02) 79.

Grand-Raiden Spectrometer

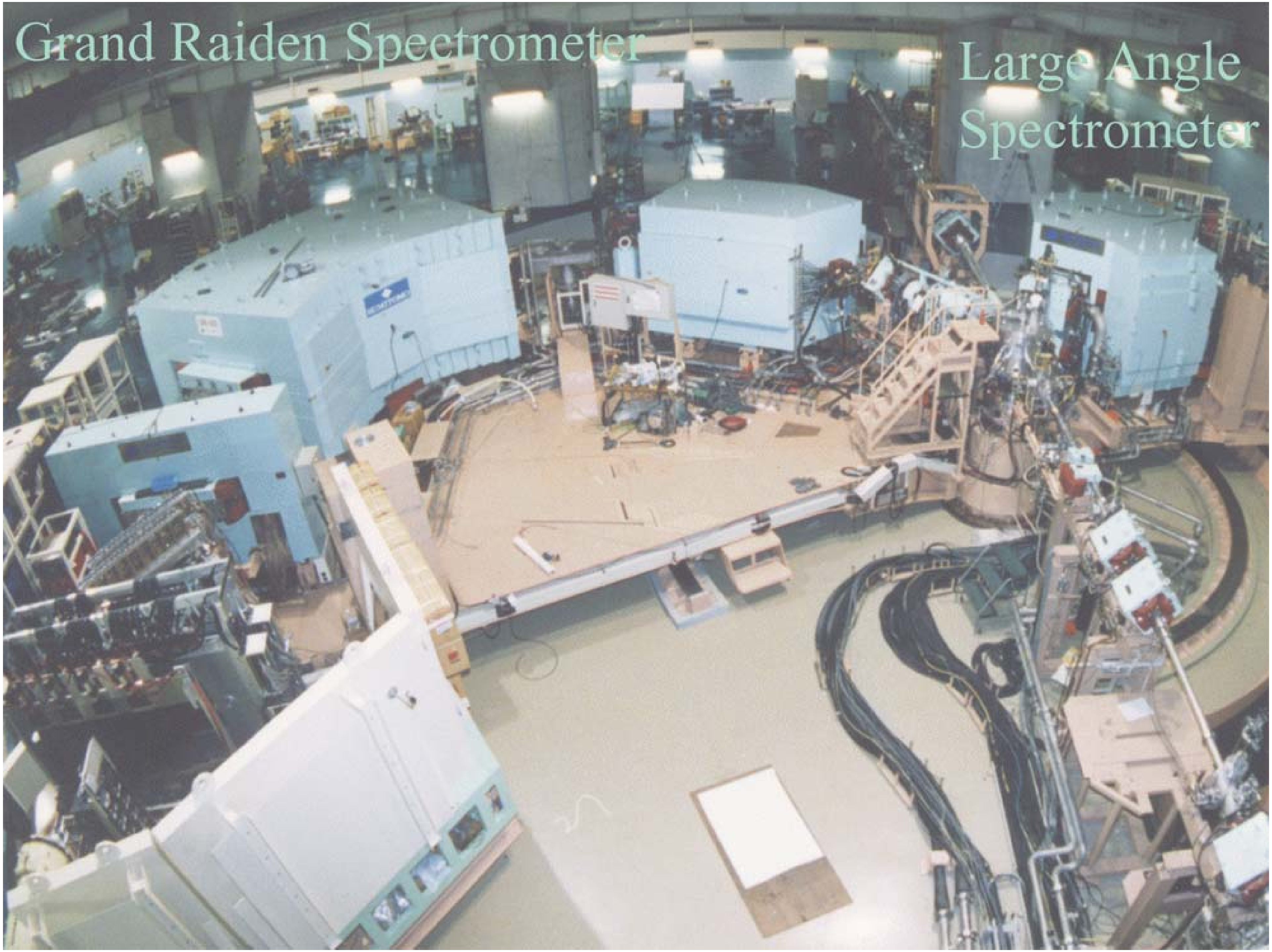


High-dispersive WS-course

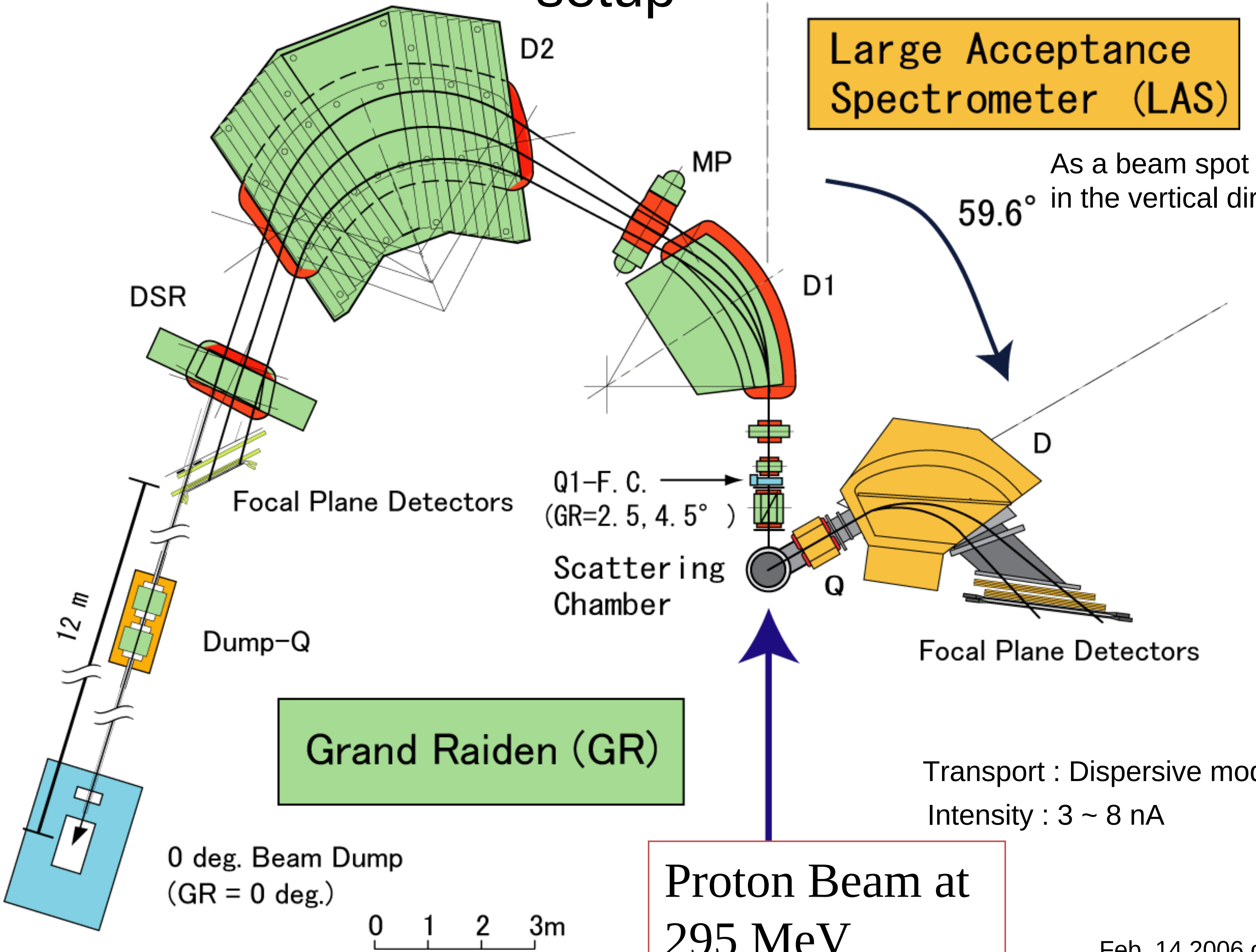
RCNP Ring Cyclotron

proton beam

E_p=295 MeV


Grand Raiden Spectrometer
Large Angle
Spectrometer

Spectrometers in the 0-deg. experiment setup



Large Acceptance Spectrometer (LAS)

As a beam spot monitor in the vertical direction

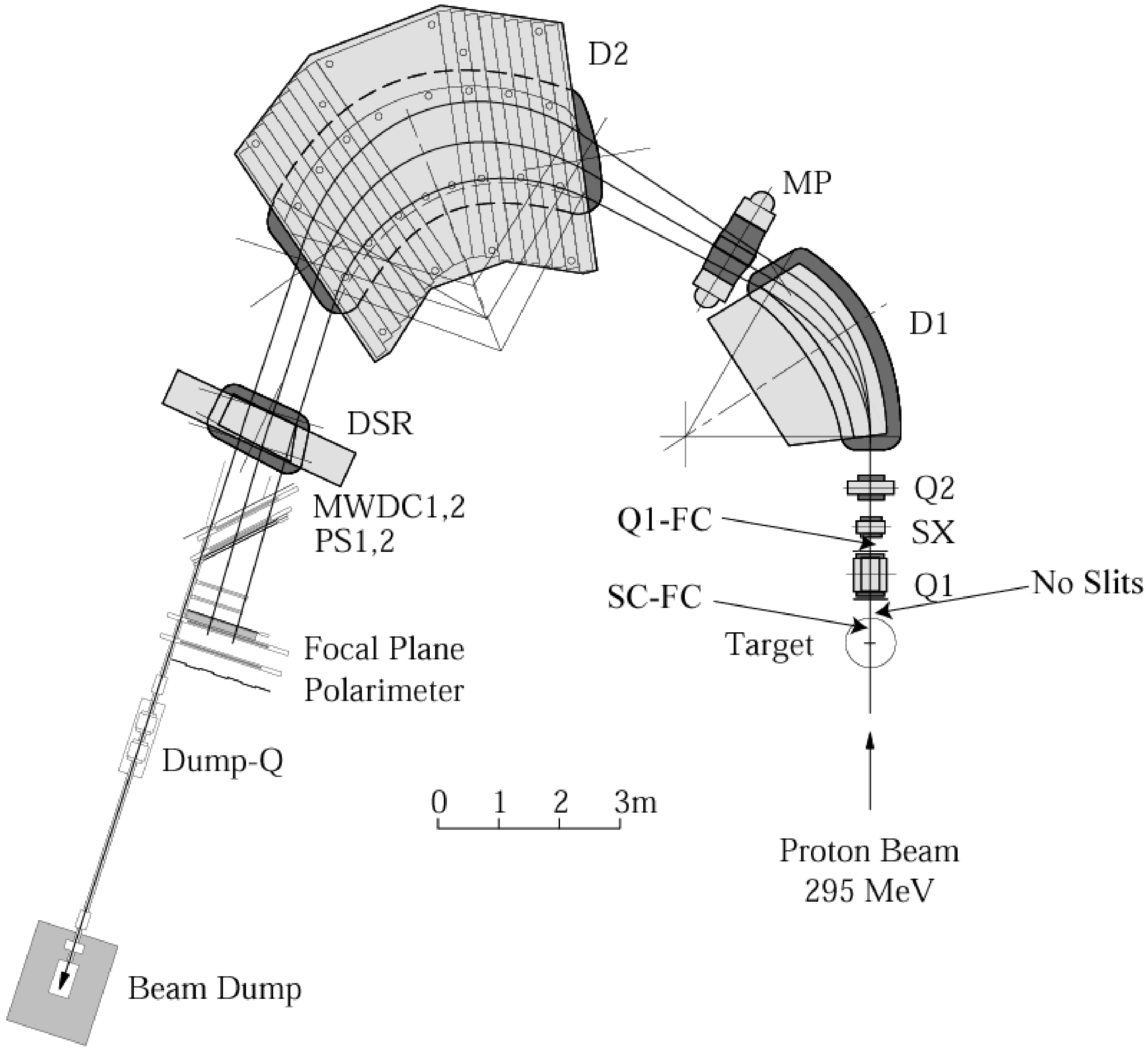
Grand Raiden (GR)

Transport : Dispersive mode

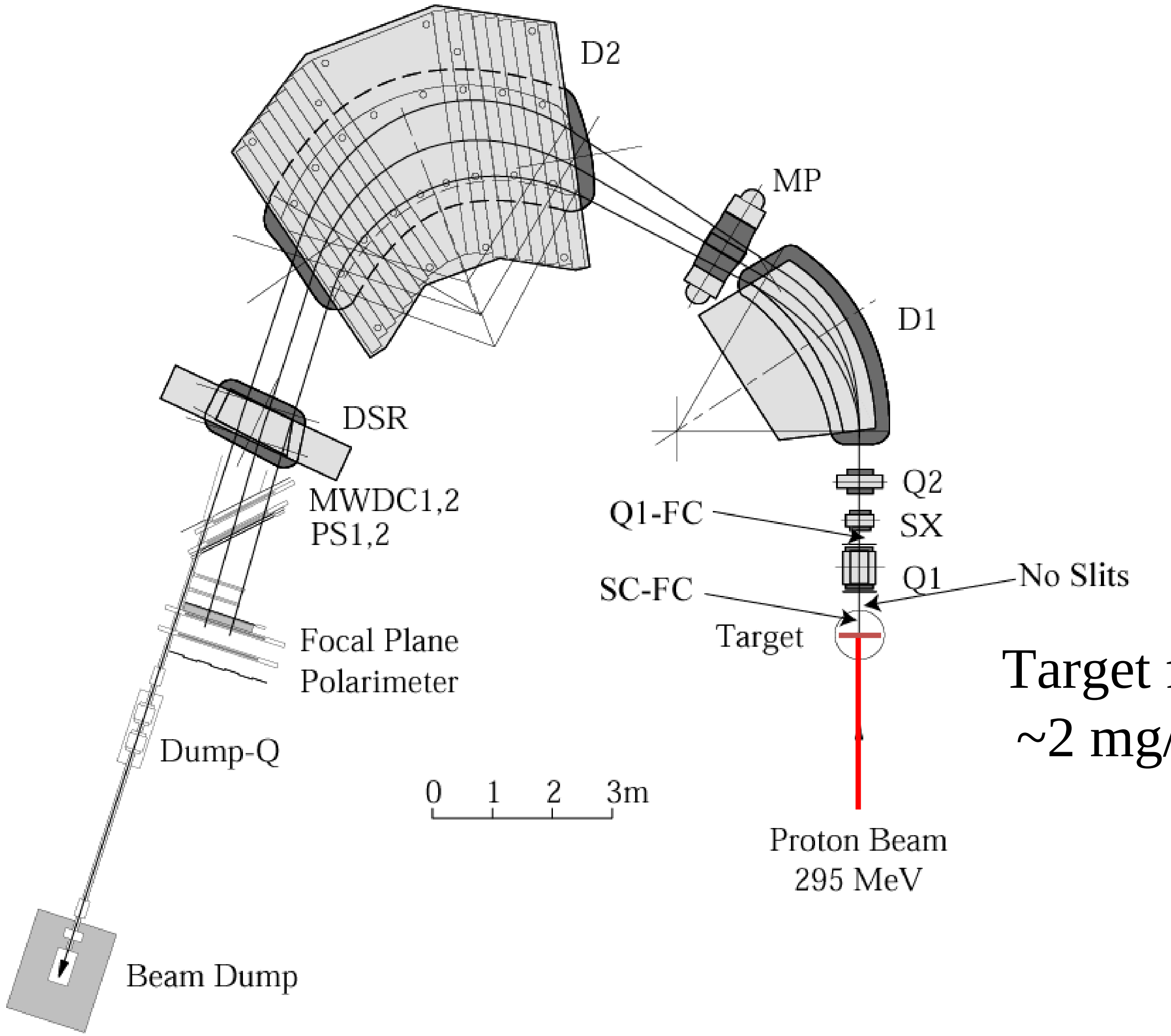
Intensity : 3 ~ 8 nA

Proton Beam at 295 MeV

Grand Raiden in the 0deg Measurement Setup

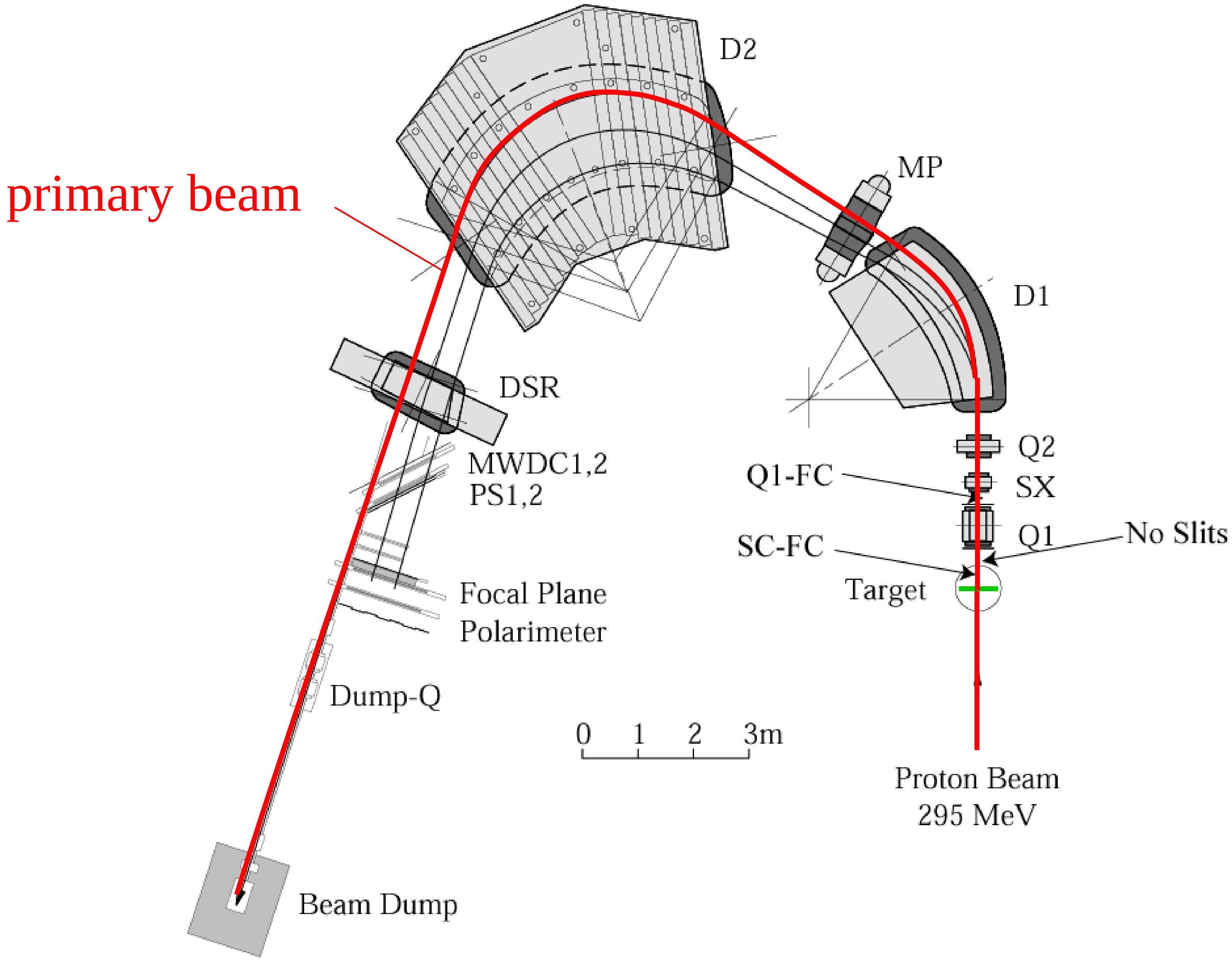


Grand Raiden in the 0deg Measurement Setup

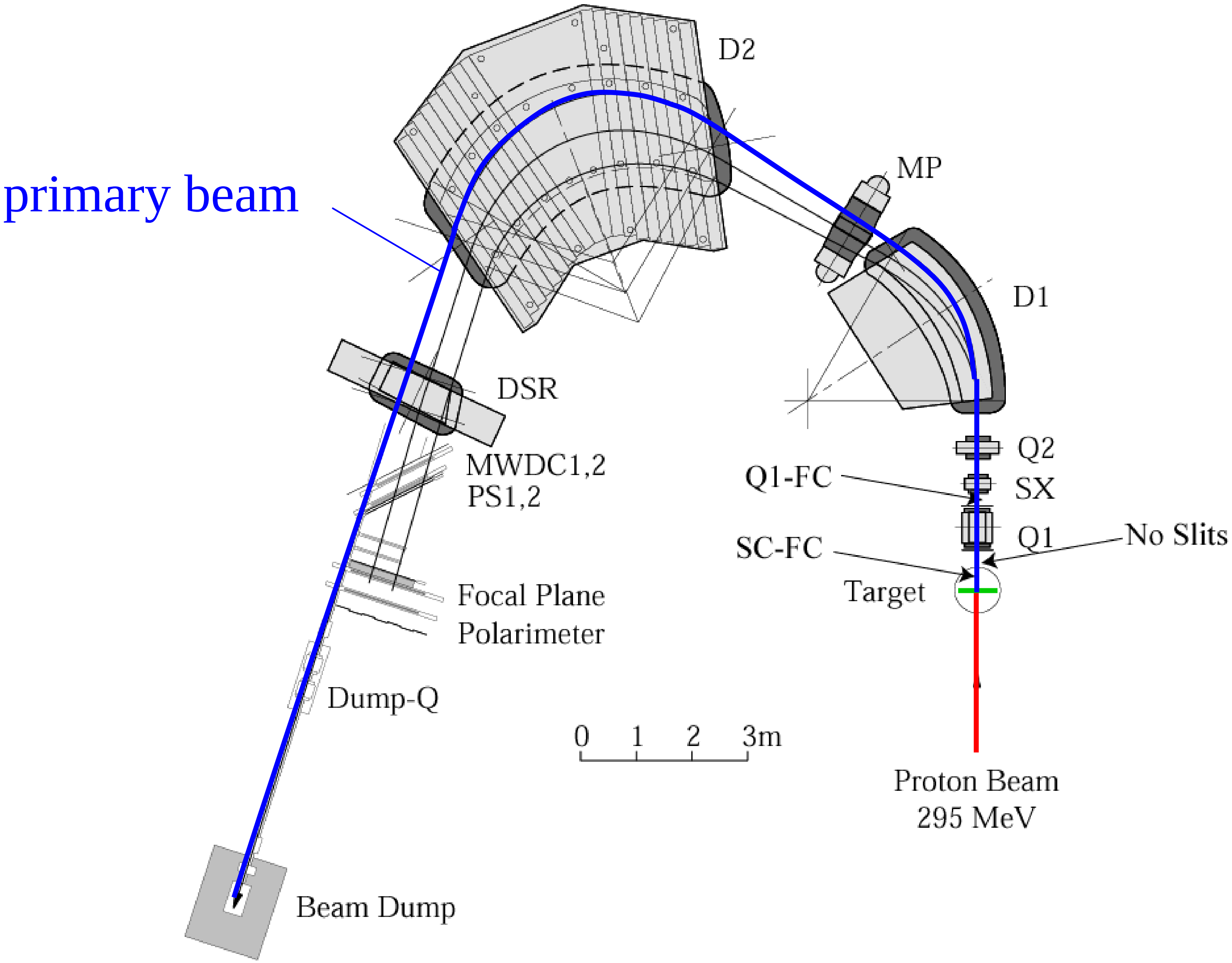


Target foil:
~2 mg/cm^2

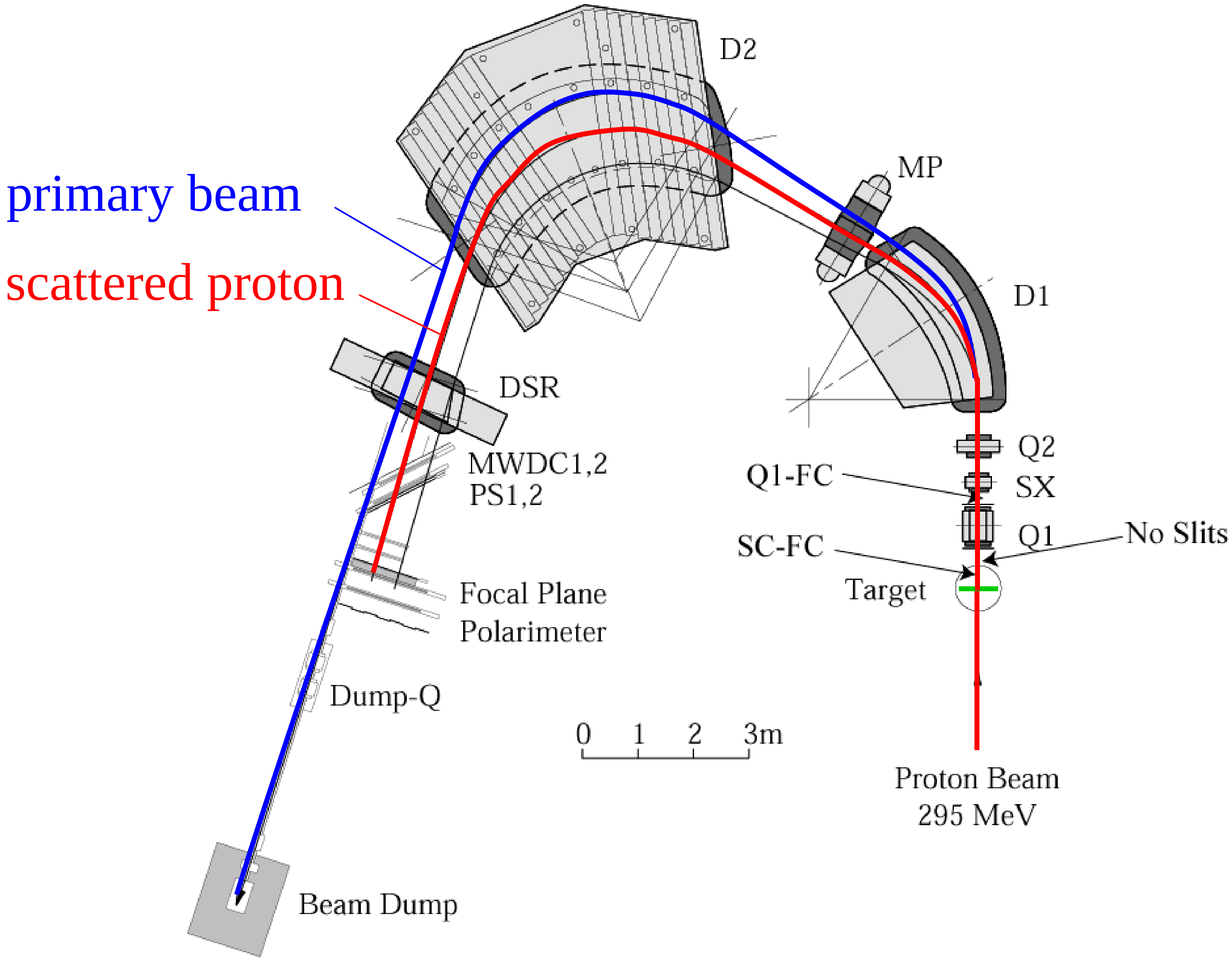
Grand Raiden in the 0deg Measurement Setup



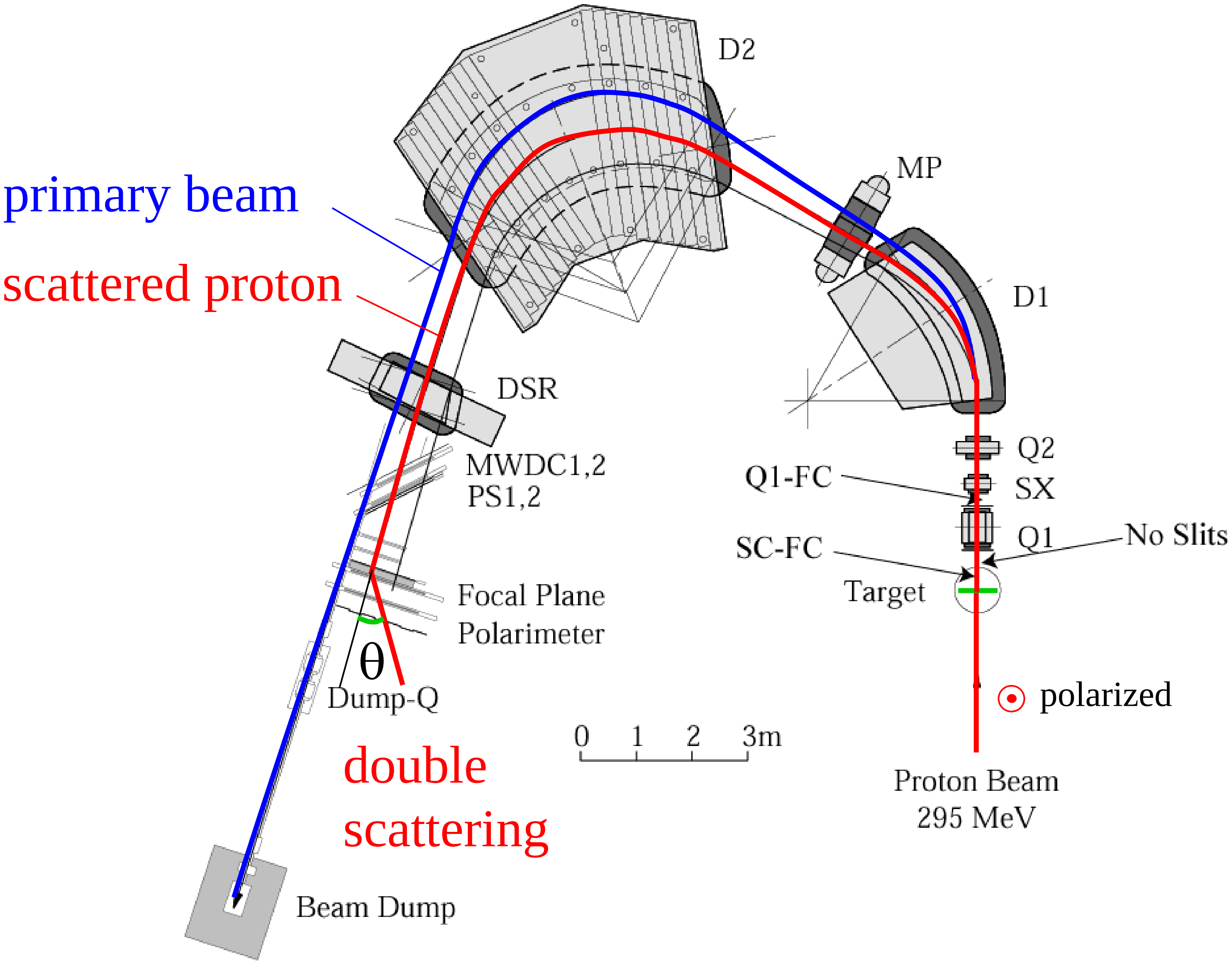
Grand Raiden in the 0deg Measurement Setup



Grand Raiden in the 0deg Measurement Setup



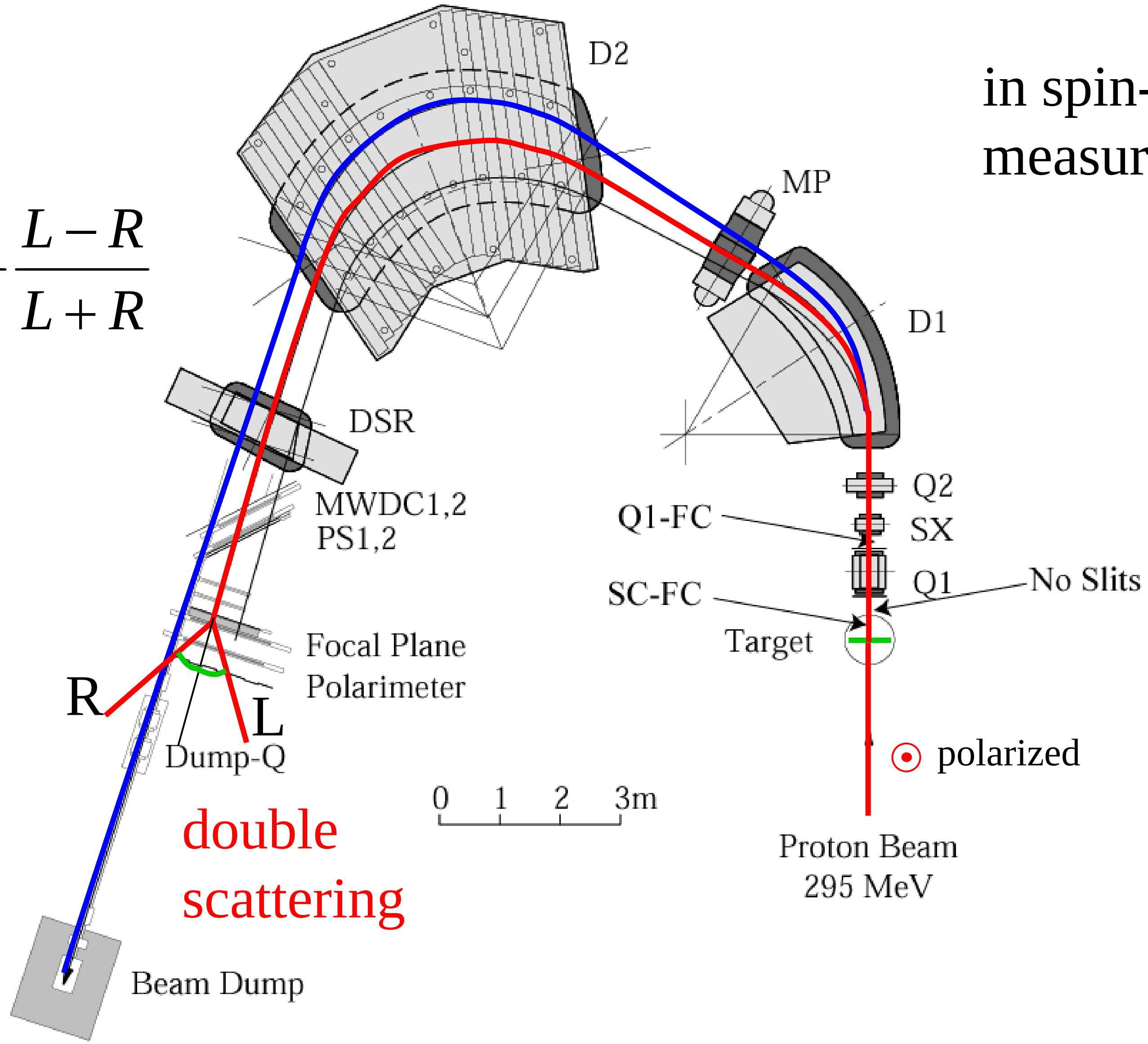
Grand Raiden in the 0deg Measurement Setup



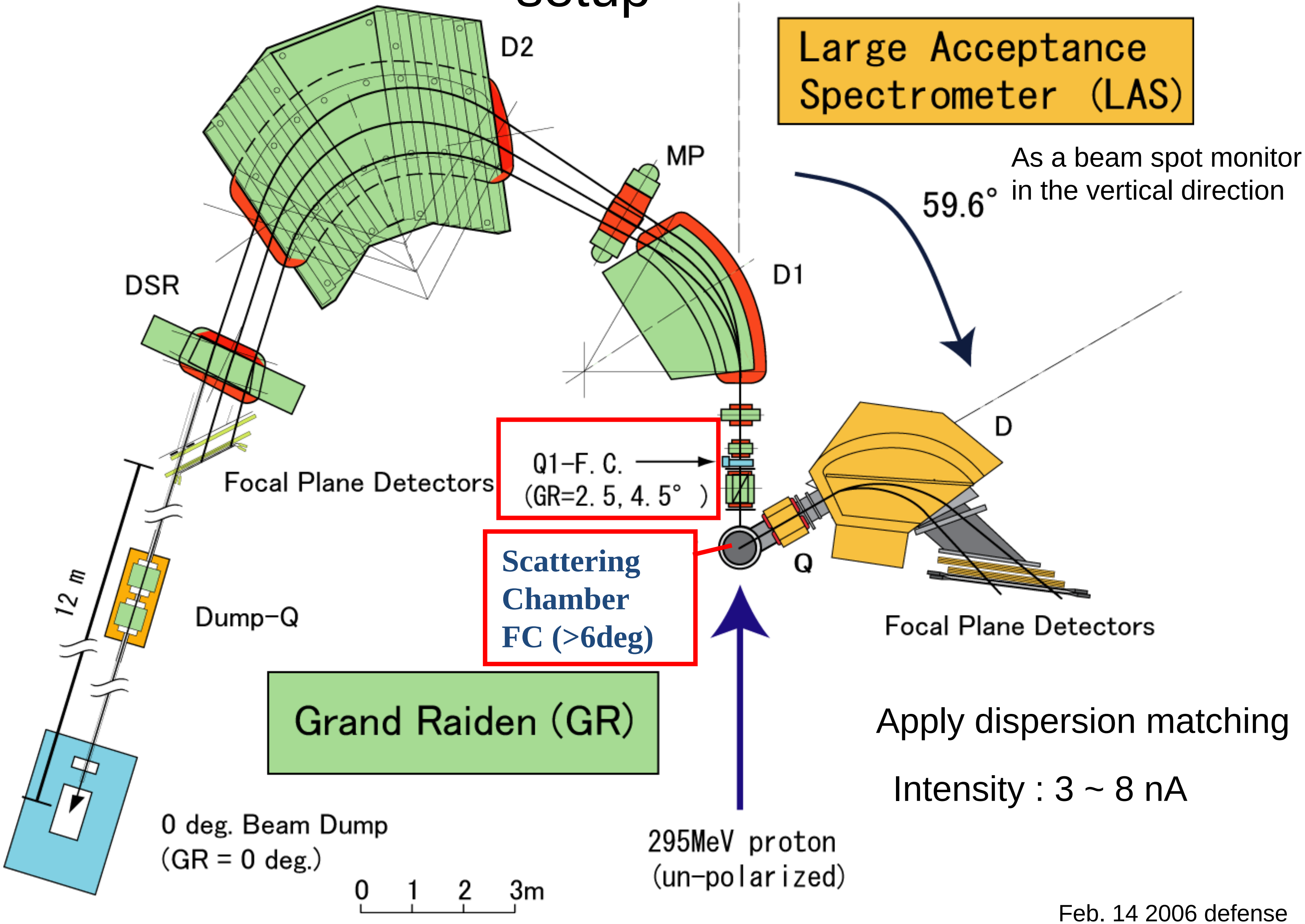
Grand Raiden in the 0deg Measurement Setup

in spin-transfer measurements

$$p_{y'} = \frac{1}{A_y}\frac{L-R}{L+R}$$



Spectrometers in the 0-deg. experiment setup



Apply dispersion matching

Intensity : 3 ~ 8 nA

Beam Tuning

- Beam energy spread was checked by ^{197}Au(p,p_0) elastic scattering in the achromatic transport mode

  40-60 keV (FWHM) at E_p=295 MeV

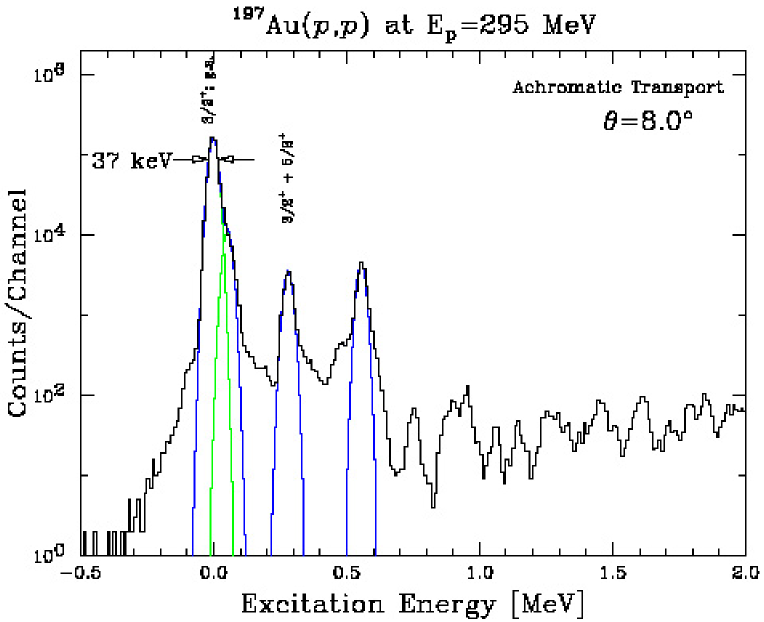
  It corresponds to a beam spot size of
  3~5 mm on target
  in the dispersive transport mode.

- Halo free beam tuning at 0 deg. (achro. beam)
  Single turn extraction of the AVF cyclotron

- Tuning of dispersion matching

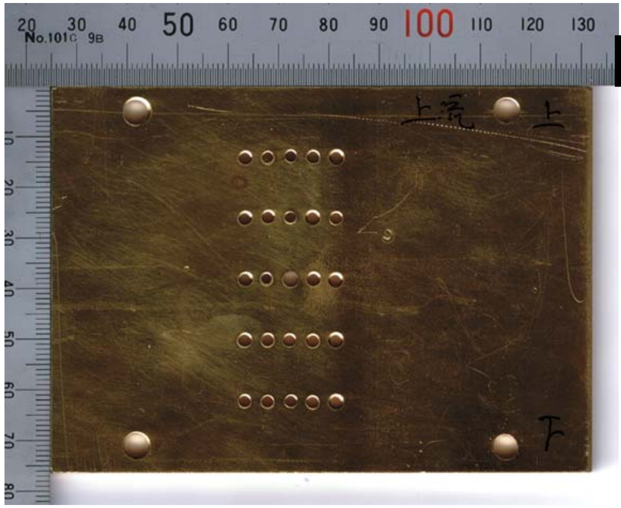
  20 keV (FWHM) at E_p=295 MeV

It takes ~2 days for the beam tuning.



Beam spot in the dispersive mode

Reconstruction of scattering angles (sieve-slit analysis)

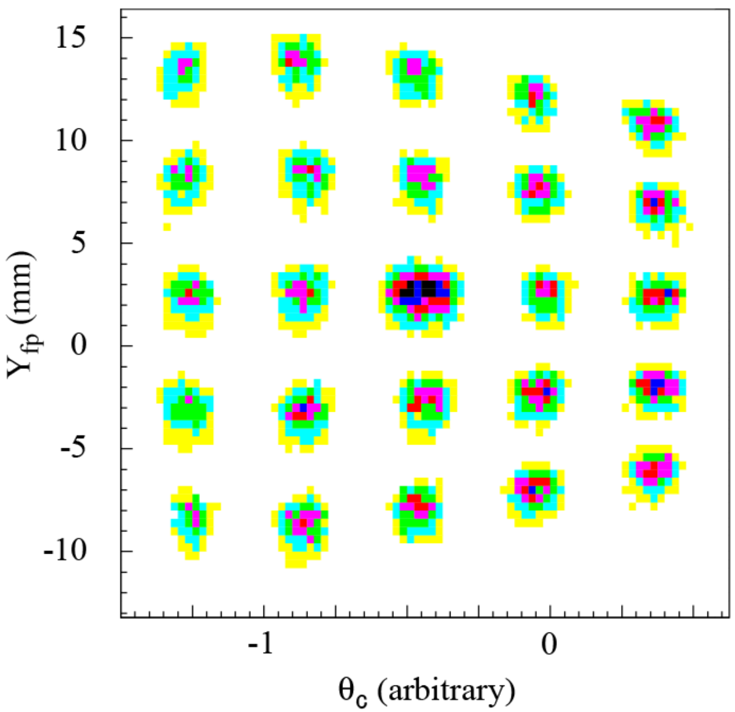


←

a sieve-slit was placed at the entrance of GR

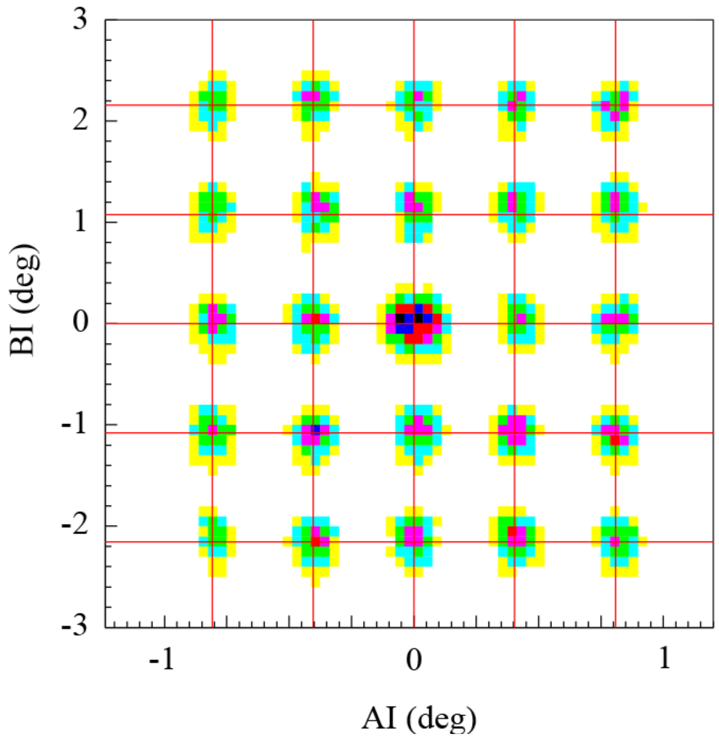
B= +1.0%, X_{fp}= -460 mm,
E_x=~6 MeV at 0deg
$\Delta\phi$ = 0.5 deg, $\Delta\theta$ = 0.15 deg

Image at the focal plane



→

Reconstructed image



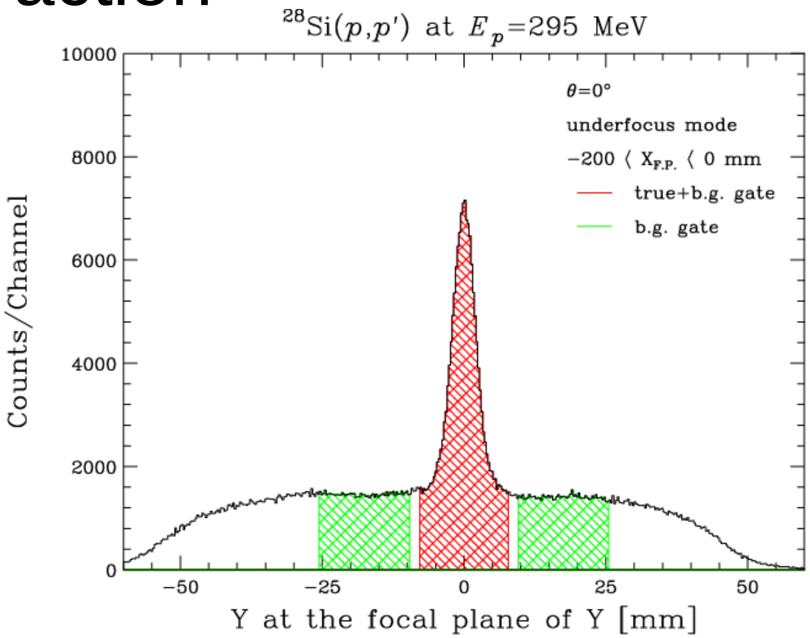
Background Subtraction

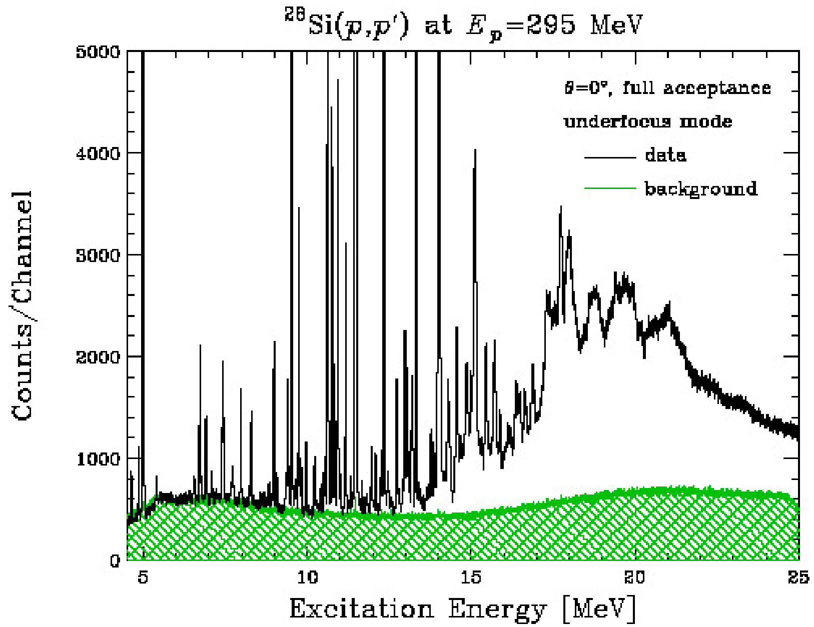
Vertical positions projected at the vertical focal plane were calculated.

Linear shape of the background in the Y position spectrum was assumed.

Background subtraction was applied by gating the Y position with true+b.g. and b.g. gates.

The background shape is well reproduced by this method.





陽子非弾性散乱

その特徴

E1/M1遷移強度測定手法

原子核の電磁応答

- (γ , γ ’) … (粒子崩壊) 閾値より下
  - 非偏光 γ ビーム
    - Bremsstrahlung
  - 偏光 γ ビーム
    - Off-Axis Bremsstrahlung
    - Laser Compton Backward Scattering
  - (終状態の) γ 偏光系
- (γ ,n) …(中性子崩壊) 閾値より上
  - 偏光/非偏光ビーム
  - 中性子偏極度計
- Coulomb Excitation 脱励起 γ 線観測… (粒子崩壊) 閾値より下
- Coulomb Dissociation …(中性子崩壊) 閾値より上
- (e,e’) … 崩壊閾値上下

＋ 陽子（d, α, etc.）ビーム非弾性散乱(超前方角)

陽子非弾性散乱による原子核のE1/M1電磁応答の測定

特徴

- 陽子ビームによる標的原子核(安定核)のクーロン励起(E1)、核力励起(M1)
- 散乱角0度(断面積最大)を中心に、連続的に後方まで測定可能
- Missing-Mass Spectroscopy ... 励起状態の崩壊様式に依存しない。
- 高分解能測定（20keV）

メリット

- 崩壊様式に依存しない。全遷移強度の測定。励起状態の幅は全崩壊幅に対応。
  崩壊閾値上下を区別せず測定ができる。Cascade decay の影響を受けない。
- 高分解能(20keV)で、5-25 MeVの広い励起状態に渡って一度に測定可能。
- 検出効率が測定励起状態の全範囲で高く一定 (80-90%)
- 一次ビームの強いビーム強度での測定(統計量を得やすい。1標的1日)。
- “大量”(~gram)のIsotope Enriched標的を要しない。
- Multipolarity 決定に角分布を利用。パリティ決定には偏極実験を要す。

デメリット

- M1,その他のMulti-Polarityの励起状態の寄与が混じり得る。
- 標的は比較的薄い(1-5mg/cm2)。高分解能を出すため。
- E1励起でも核力の影響を完全には無視できないかもしれない。
- 散乱断面積から遷移強度への換算が完全には確立していない。反応機構が複雑。
  遷移強度の絶対値の規格化に他のプローブのデータが必要？（特にM1 ）

陽子非弾性散乱による原子核の電磁応答の測定

メリット or デメリット:

•偏極移行量(偏極ビーム&散乱陽子の偏極測定)の測定によりスピン非反転励起 **(Coulomb Excitation of E1)**とスピン反転励起**(M1)**を分離できる

•**M1**励起散乱断面積は、B(M1)でなく**B(σ)**と**(**近似的**)**比例関係にある。
電磁プローブの実験とは直接は比較できない。異なる情報を取得できる。

IS/IV 1+ 遷移強度とクエンチング

H. Matsubara *et al.*

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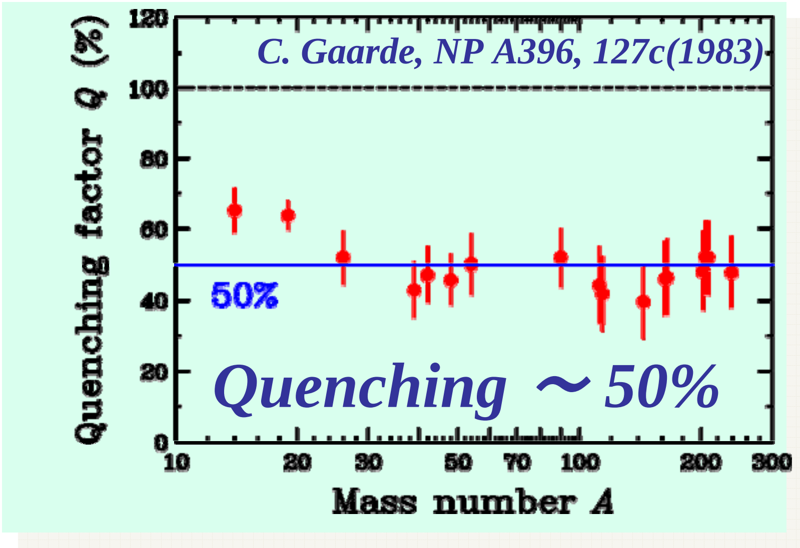
Quenching of the GT strengths

Gamow-Teller (GT) quenching problem:
The observed GT strengths are systematically smaller the sum-rule value.

GT sum rule : $S_{\beta^-} - S_{\beta^+} = 3(N - Z)$

Quenching Factor

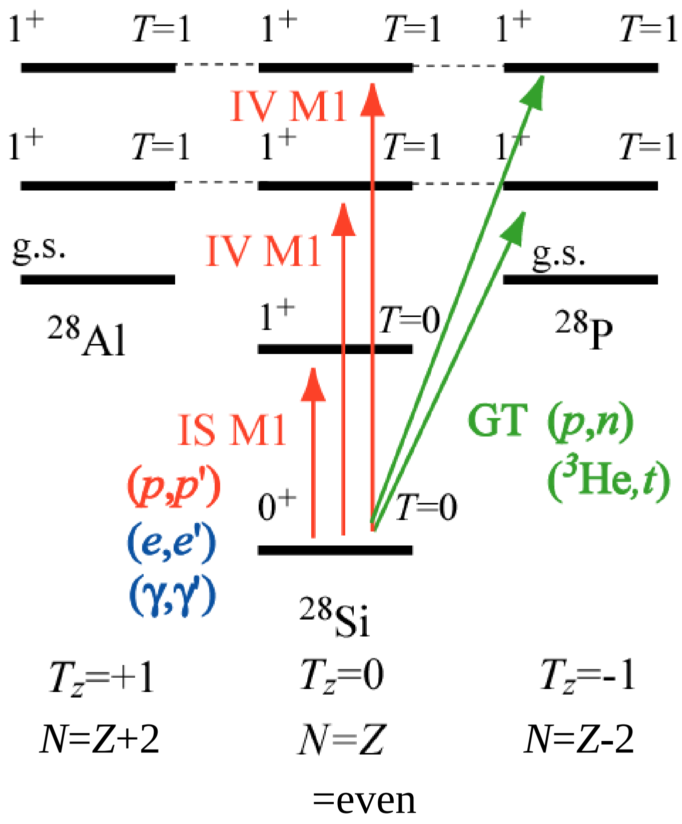
$$Q \equiv \frac{Strength(\text{exp.})}{Strength(theory)}$$



By sophisticated measurements and analysis of (p,n) and (n,p) reactions
50 → 88% of the strength was observed in ^{90}Zr upto E_x=50 MeV
T. Wakasa *et al*., PRC55(1997)2909 K. Yako *et al*., PLB615(2005)193

2 quenching schemes:
- Mixing of multi-particle multi-hole states ← dominant contribution
- Mixing of Δ-hole states

M1 excitations and analogous excitations



IS: Isoscalar $\Delta T=0$ σ

IV: Isovector $\Delta T=1$ στ

Isovector (ΔT=1) M1 excitation is analogous to GT.

➡ Similar quenching is expected

Isoscalar (ΔT=0) M1 excitation: Δ-h mixing does not take place

➡ Different quenching between isoscalar and isovector excitations?

Study of isoscalar/isovector M1 excitations over the sd-shell region

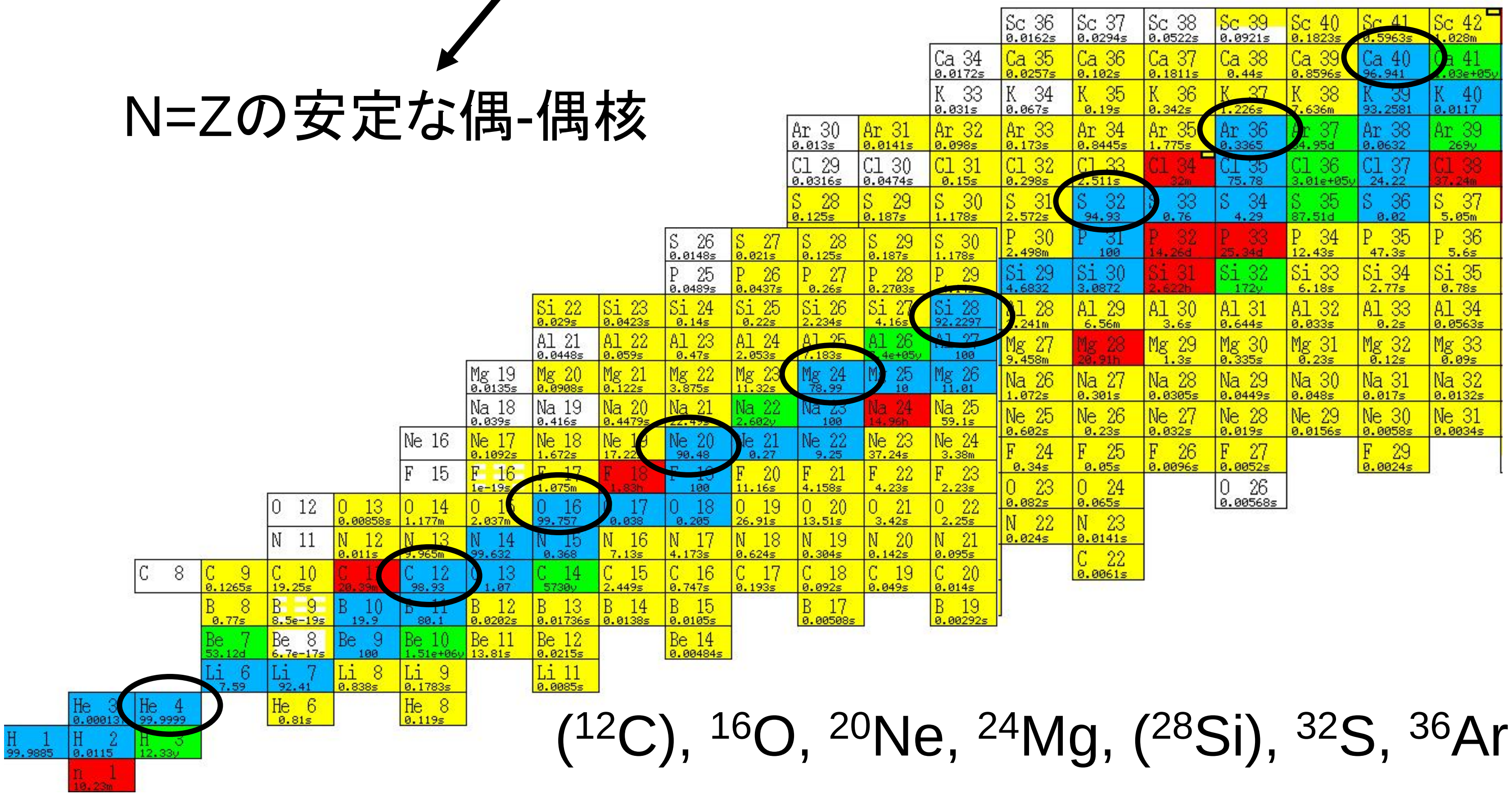
For all the N=Z even-even stable nuclei over the sd-shell (isoscalar/isovector excitations do not mix to each other)

^{16}O, ^{20}Ne, ^{24}Mg, ^{28}Si, ^{32}S, ^{36}Ar, ^{40}Ca

^{16}O: Ice target (H_2O)
^{32}S: Cooled target (for preventing sublimation)
^{36}Ar: Gas target
^{20}Ne: Cooled gas target

- 1^+のIS、IV遷移を同時に分離して観測
  －＞(*p,p'*)測定で g.s.が 0^+, T=0 の核子

N=Zの安定な偶-偶核



(^{12}C), ^{16}O, ^{20}Ne, ^{24}Mg, (^{28}Si), ^{32}S, ^{36}Ar, ^{40}Ca

開発1

- 高分解能測定用 H_2O, ^{32}S標的

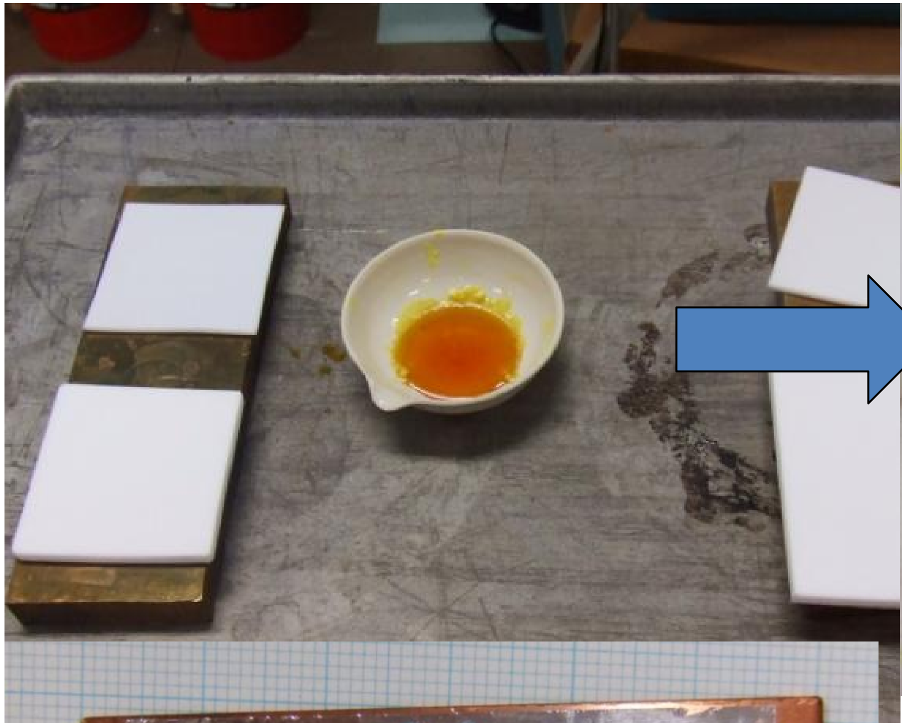
with 液体窒素冷却標的機構

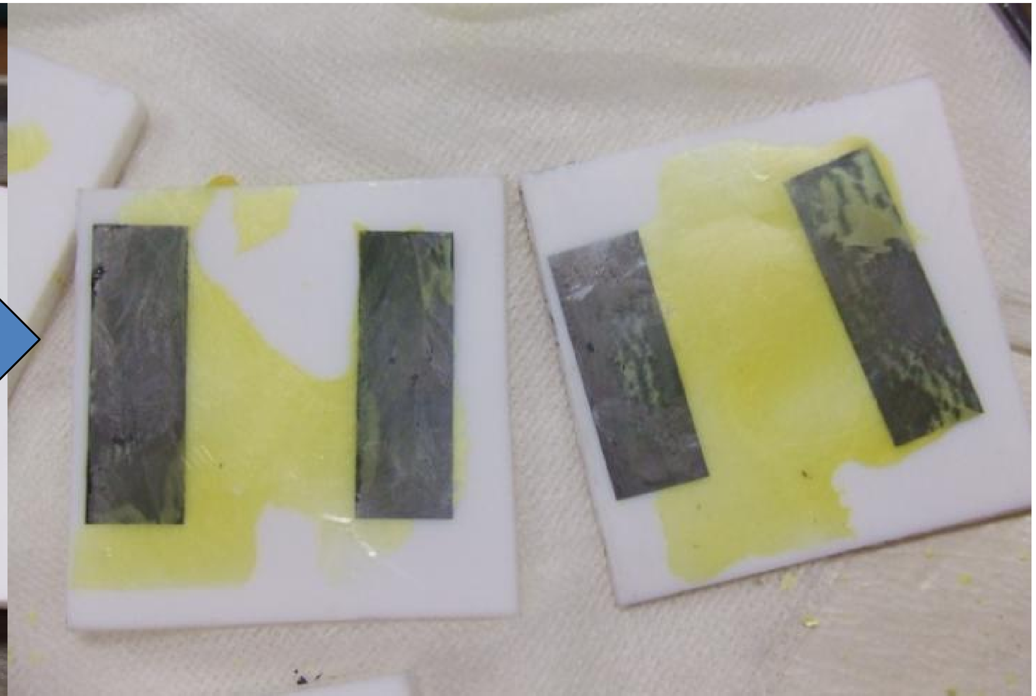
T. Kawabata *et al*., NIMA 459 (2001) 171.

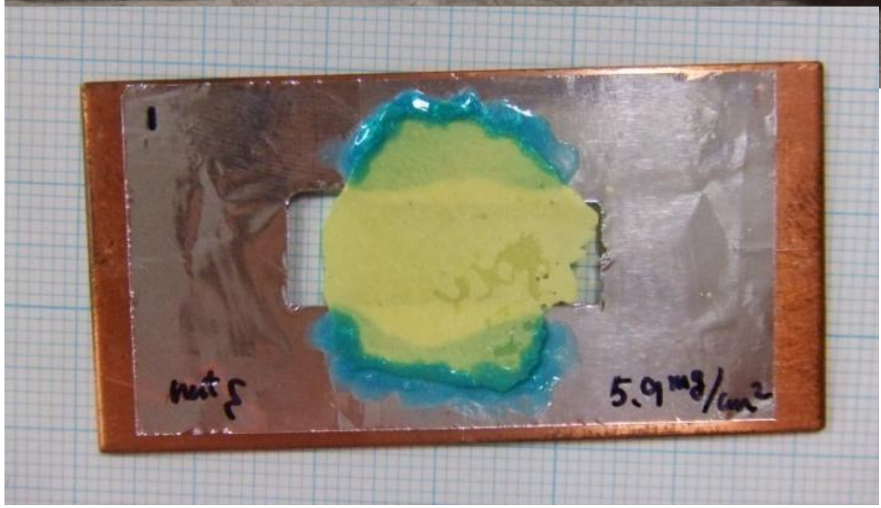
10 mg/cm^2 くらい

硫黄の薄膜製作

- 低い沸点(112.8℃)



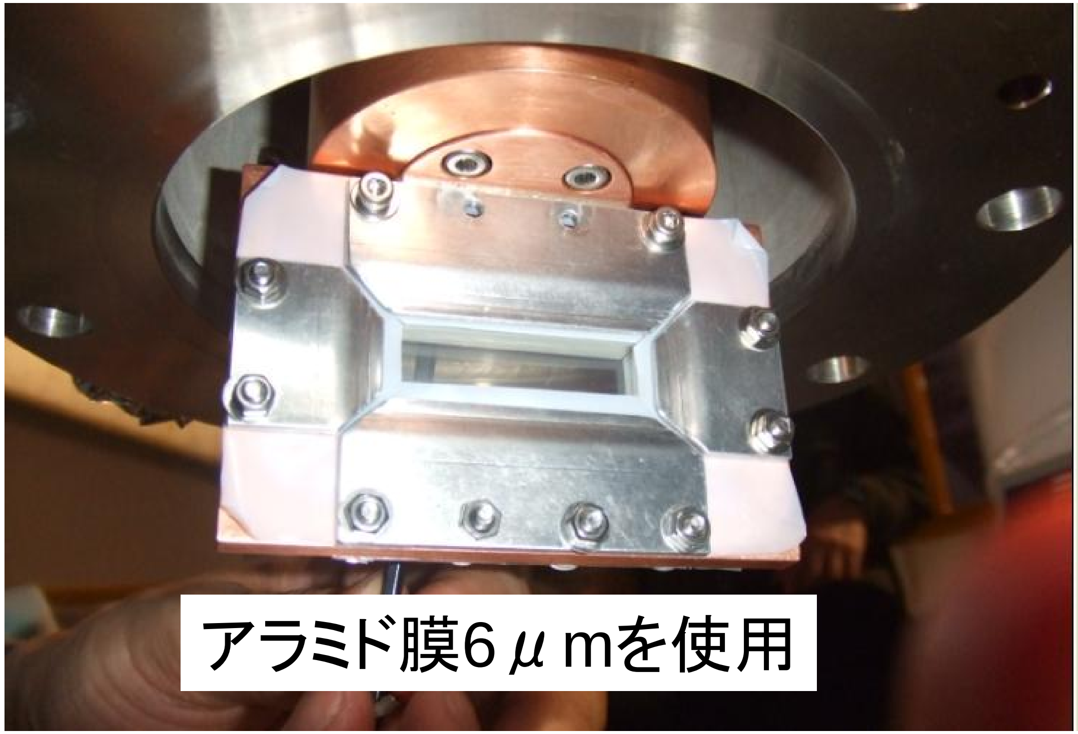




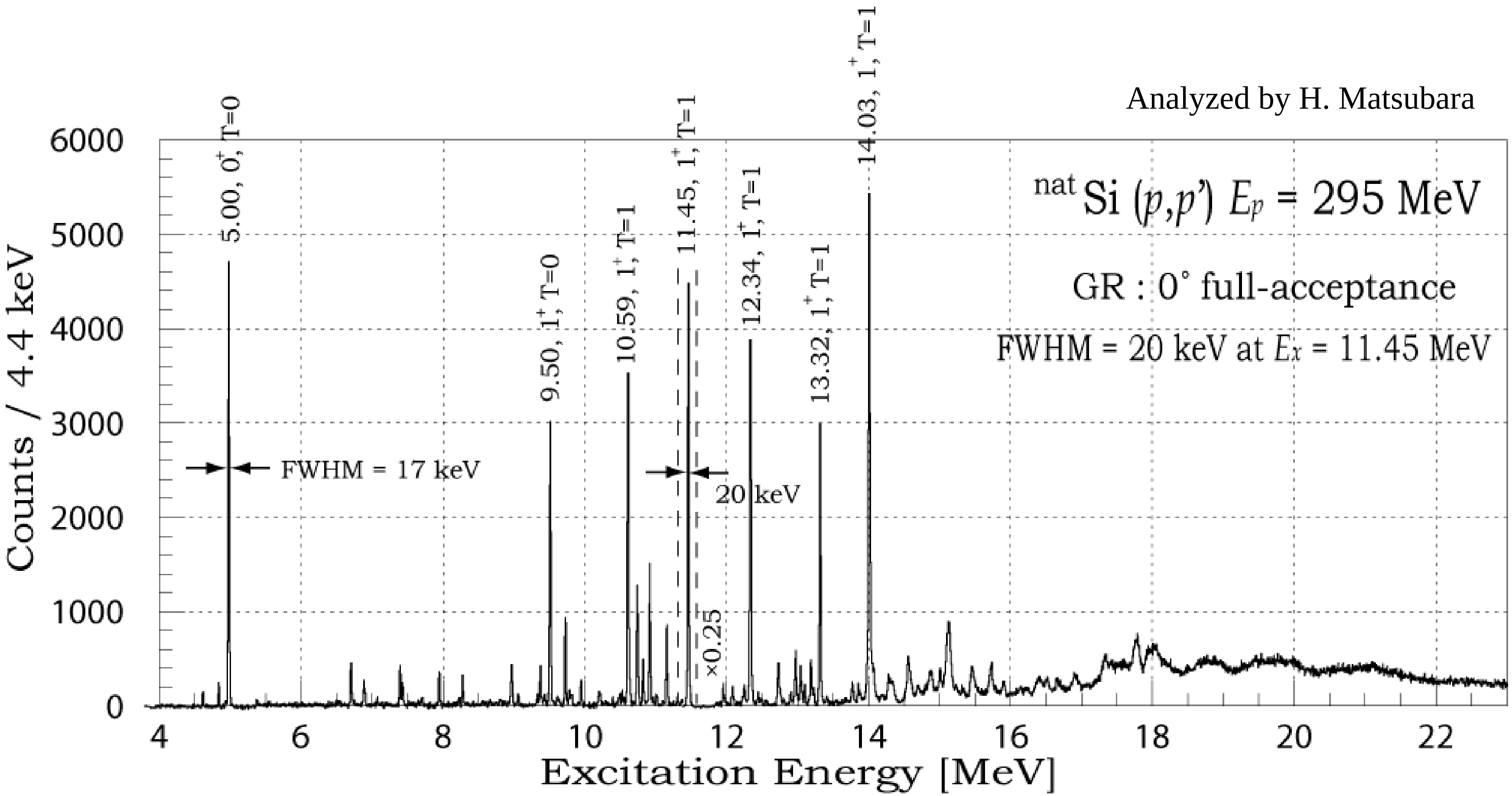
6 mg/cm^2 くらい

開発2　気体標的機構

- 高分解能測定対応（<30keV　at < 6 deg）
- 液体窒素で冷却
- ガス回収機能 (^{36}Ar)



Inelastic Proton Scattering from ^{28}Si at 0 degrees



Angular Distribution of IS and IV 1^+ excitations

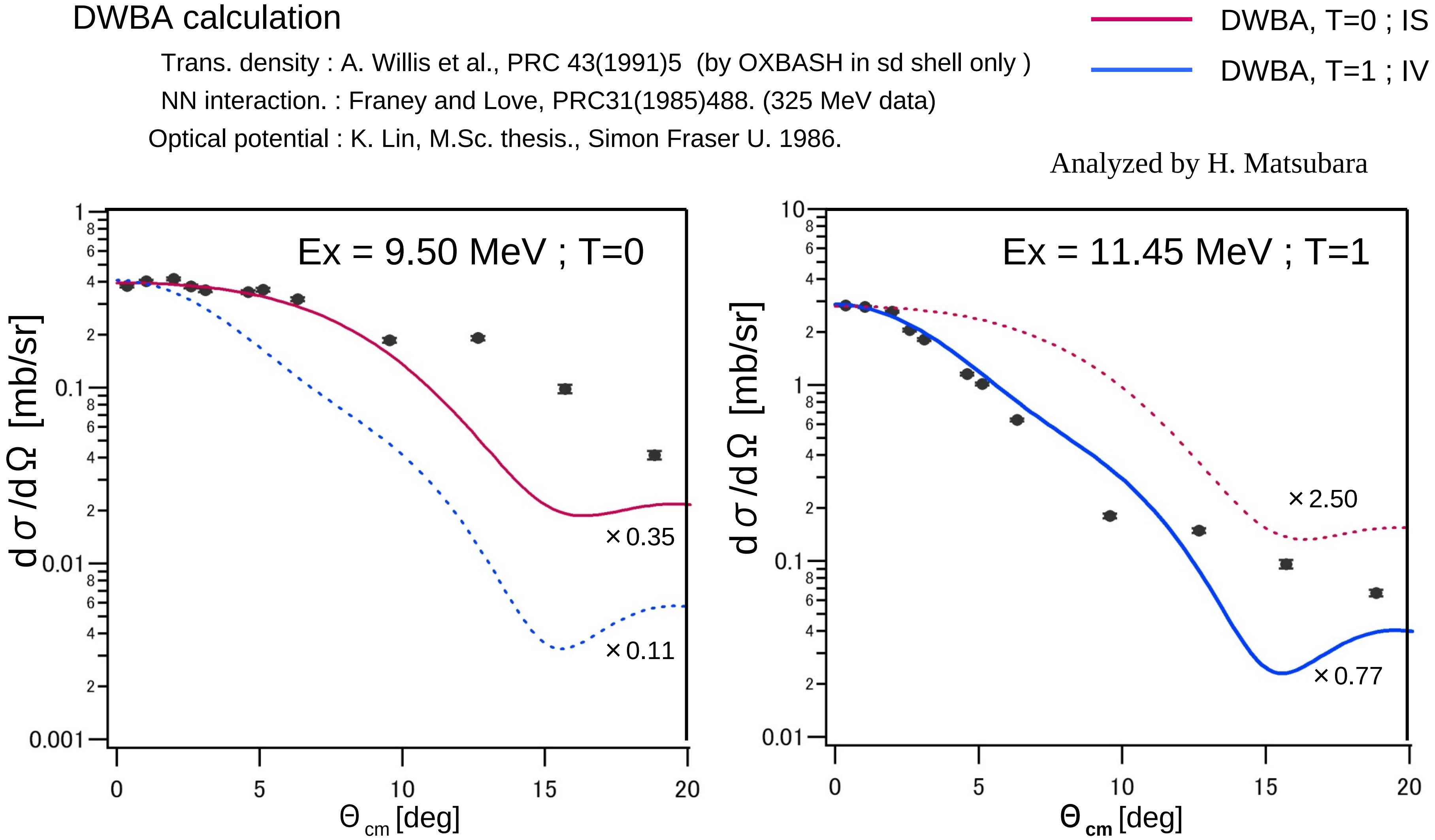
DWBA calculation

Trans. density : A. Willis et al., PRC 43(1991)5 (by OXBASH in sd shell only)

NN interaction. : Franey and Love, PRC31(1985)488. (325 MeV data)

Optical potential : K. Lin, M.Sc. thesis., Simon Fraser U. 1986.

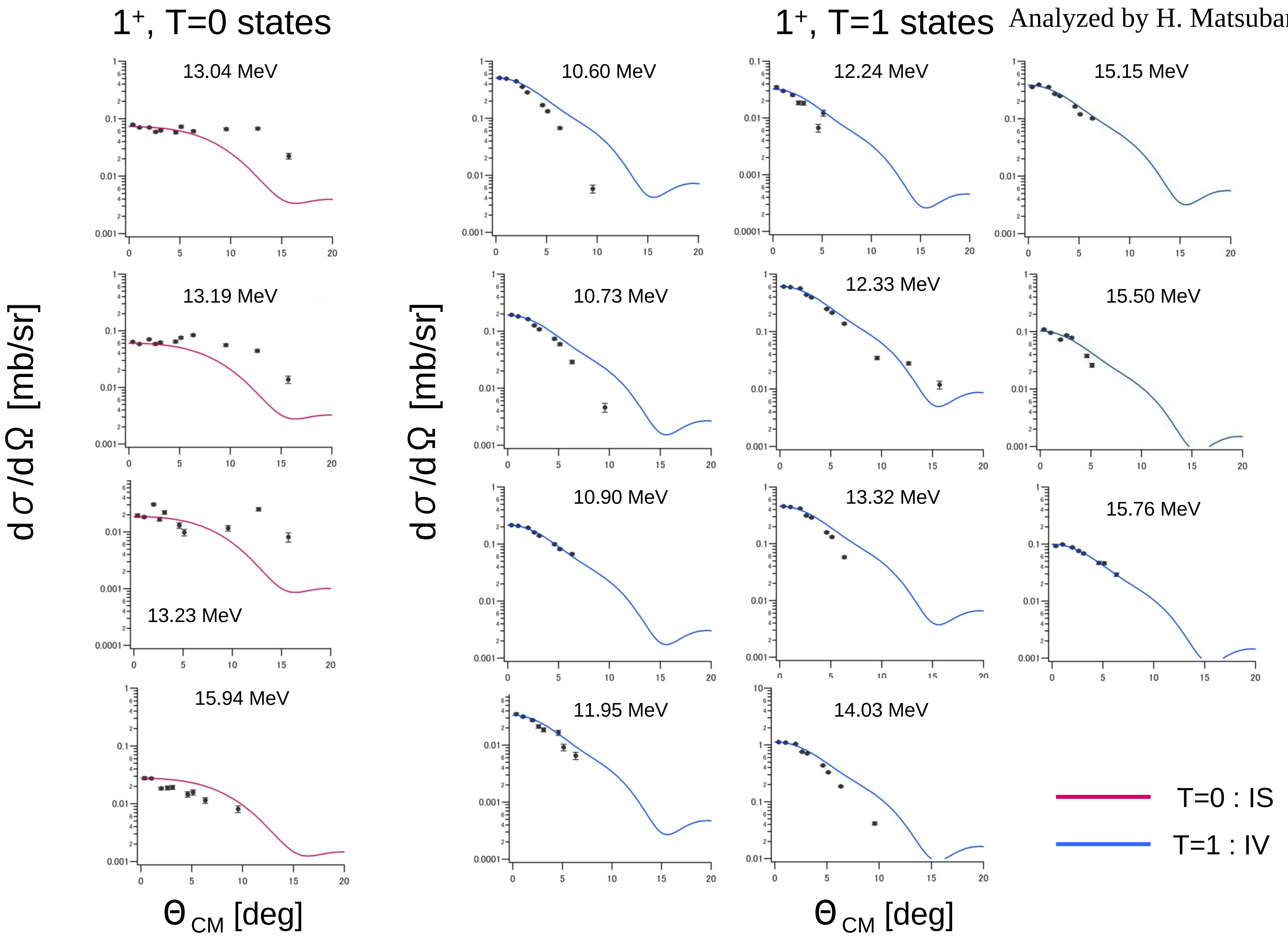
Analyzed by H. Matsubara



From angular distribution, isospin value is identified.

Other states identified as 1^+

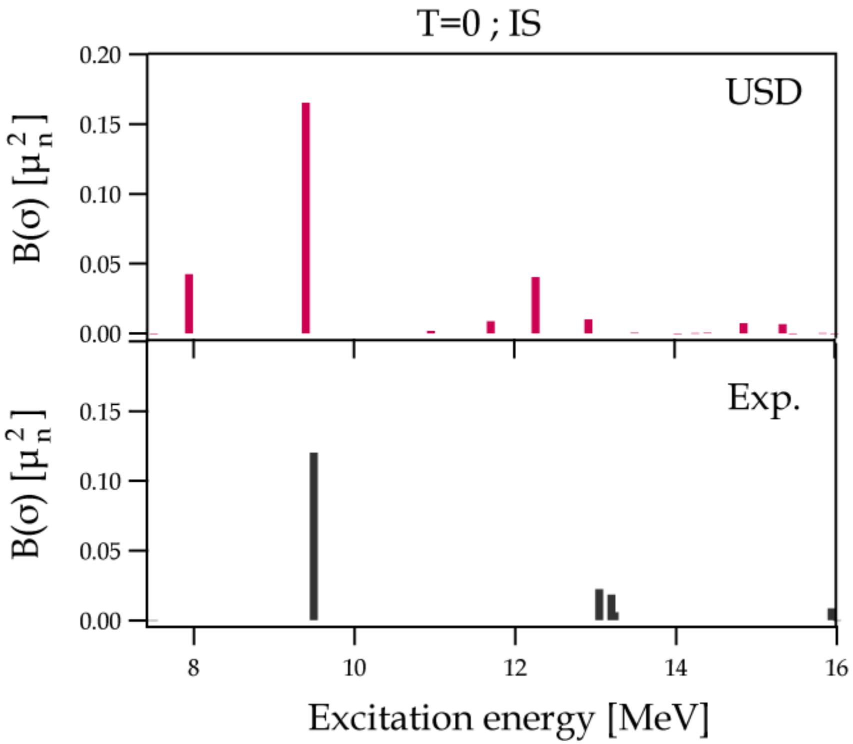
Analyzed by H. Matsubara

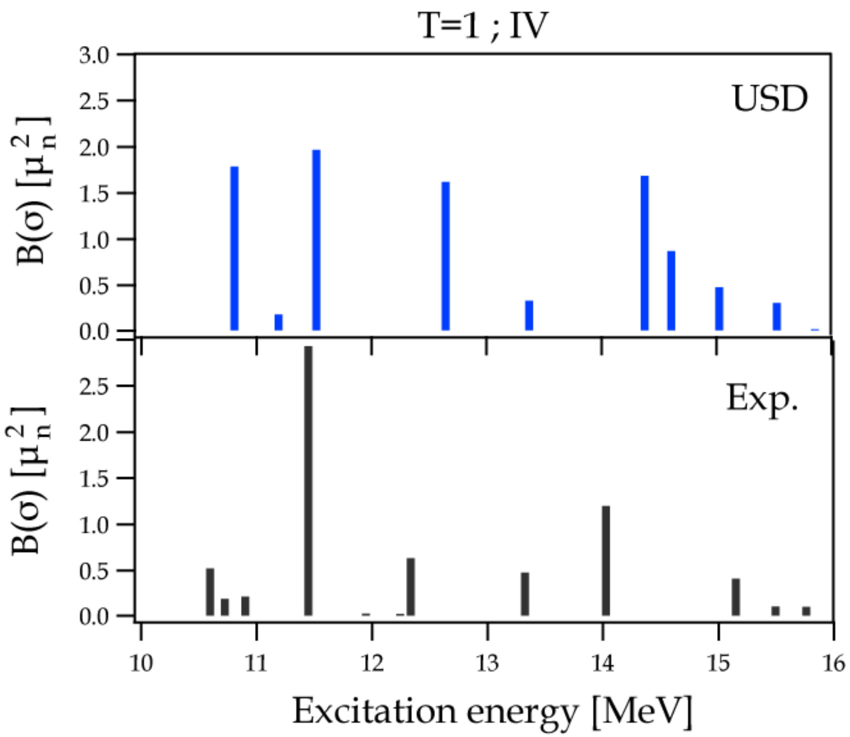


Strength distribution

preliminary

shell model calculation:
OXBASH + USD interaction





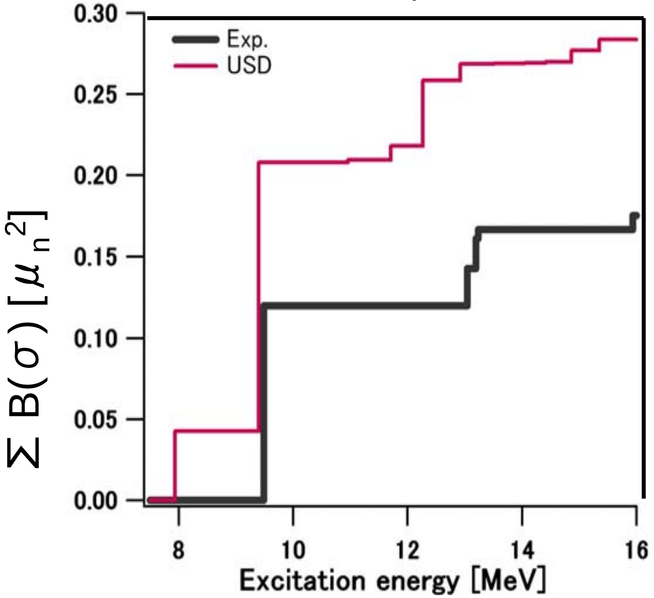
RCNP-E299: H. Matsubara et al.,
1^+ strength distributions will be measured for each IS and IV
for ^{16}O, ^{20}Ne, ^{24}Mg, ^{28}Si, ^{32}S, ^{36}Ar, ^{40}Ca

M1 strength in ^{28}Si

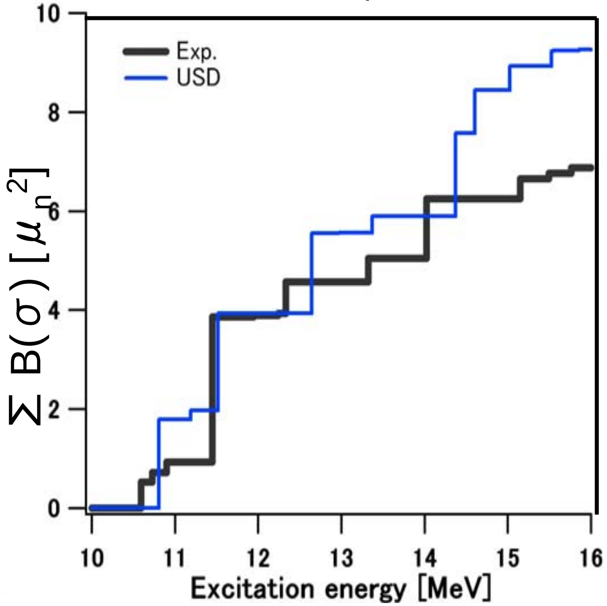
preliminary

Cumulative Sum

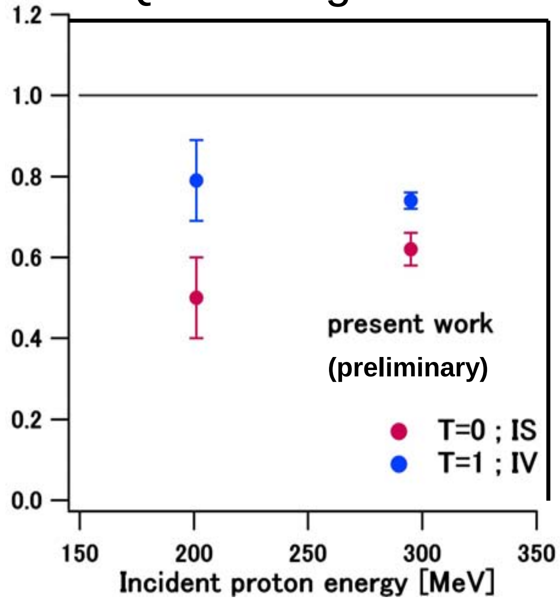
T=0 ; 1+



T=1 ; l+



Quenching factor



Followings should be checked more carefully.

- B(σ) is determined from dσ/dΩ(q=0) relying on the eff. interaction and DWIA calculation.

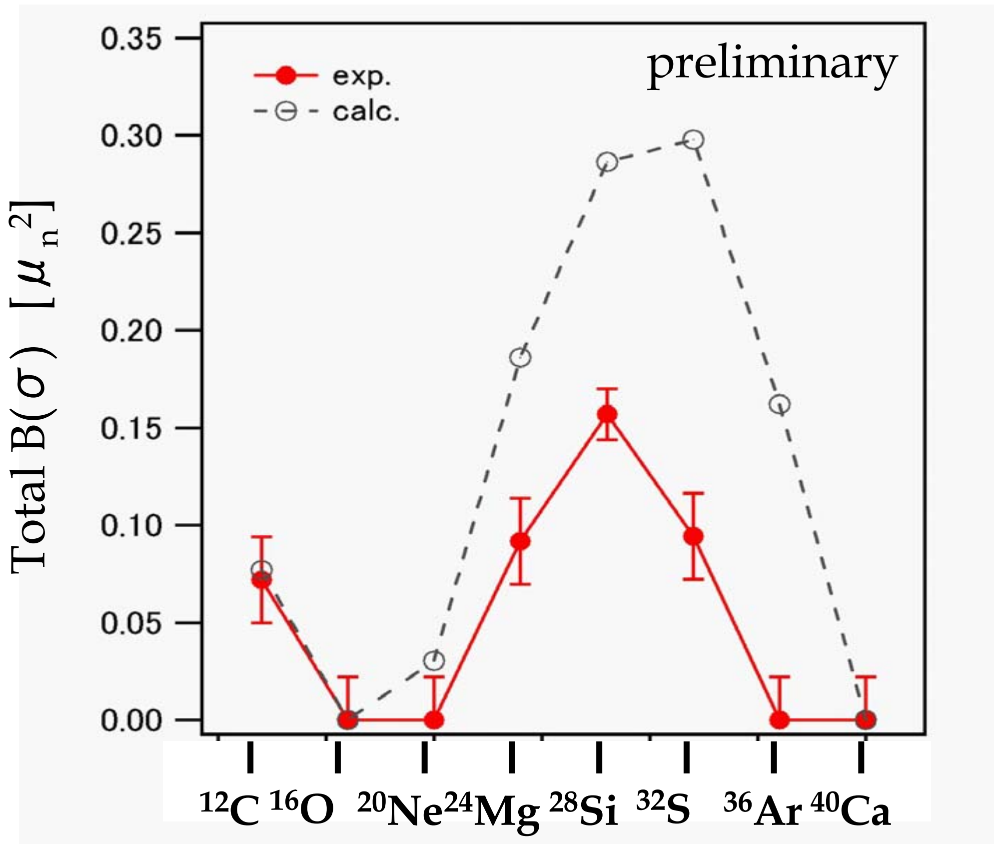
- Bare g-factor is used in the S.M. calculation.

$$Quenching\ Factor = \frac{\Sigma B(\sigma)_{\mathrm{exp}}}{\Sigma B(\sigma)_{shell-\mathrm{model}}}$$

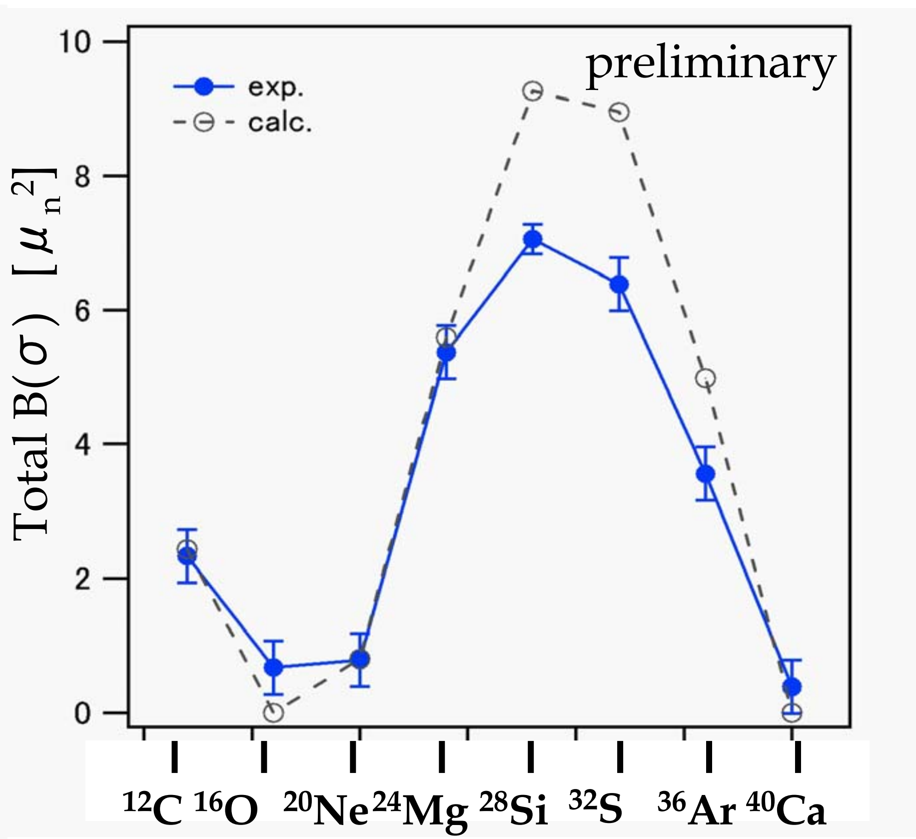
Total B(σ) strengths

very preliminary

IS



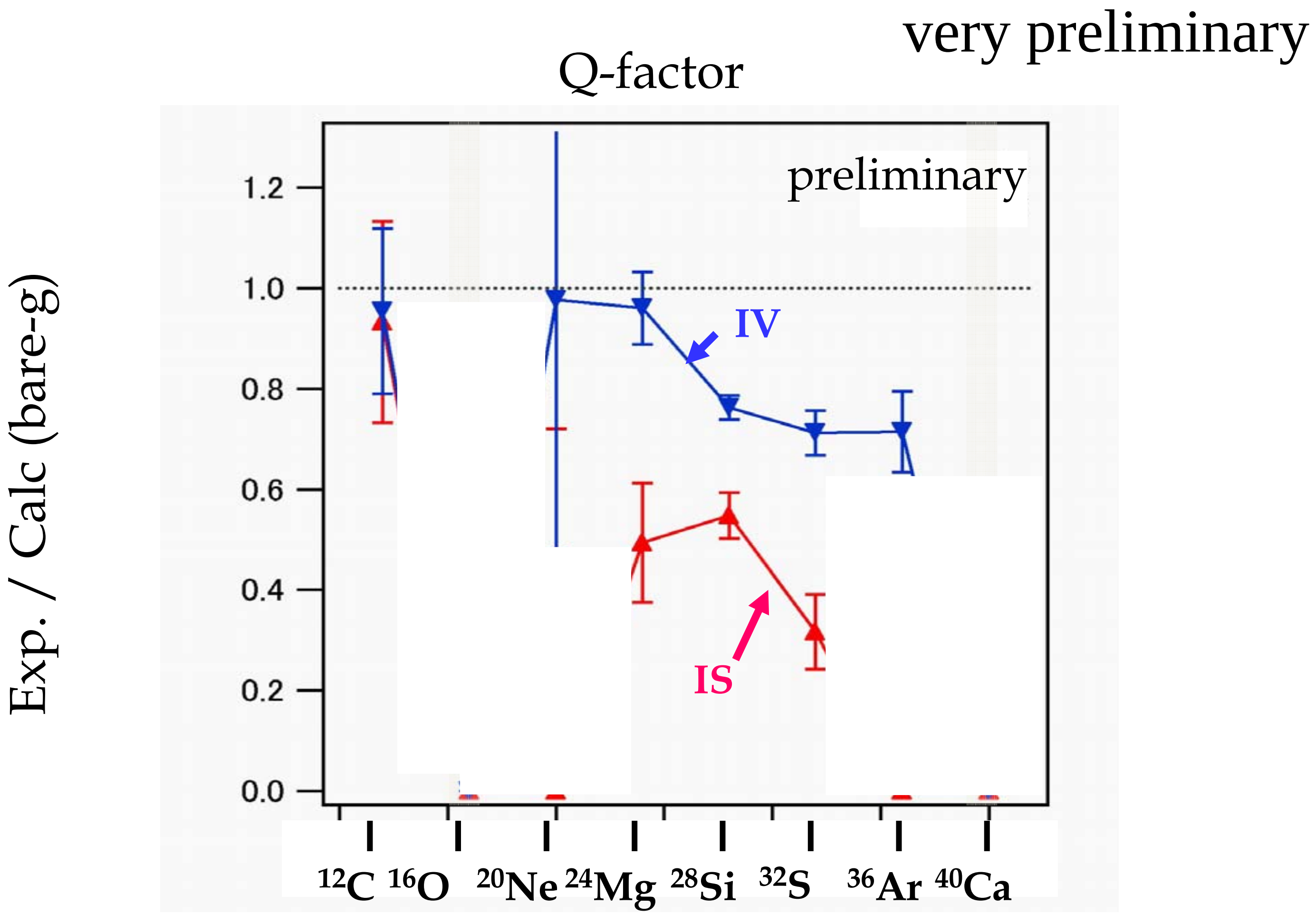
IV



Calc. = OXBASH shell model calculation (0 hw) with USD or CK int. and the free-g factors.

(∼10% ambiguities)

Comparison of Q-factors IS and IV



IS seems generally to be less than IV in the sd-shell.

M1 strength in ^{208}Pb

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E282

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Prediction of the M1 strengths in ^{208}Pb with 1*p*-1*h* basis

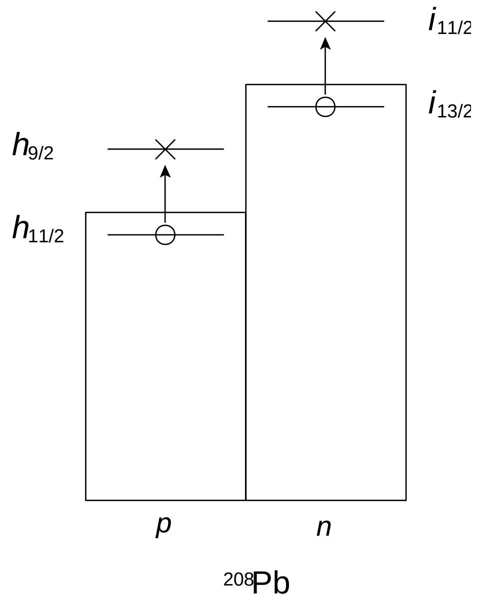
1*p*-1*h* excited states of protons $|\pi\{h_{9/2}\text{-}h_{11/2}^{-1}\}>$ and neutrons$|\nu\{i_{11/2}\text{-}i_{13/2}^{-1}\}>$ strongly couples to each other due to

- spin-orbit splittings of *p* and *n* orbits are similar
- orbital angular momentum l's are similar

and yield

- a lower-lying state at ~ 5.4 MeV with B(M1) ~ 1 μ_N^2
- a higher-lying state at ~ 7.5 MeV with B(M1) ~ 50 μ_N^2

in Tamm-Dancoff approximation.



see *e.g.*
J.D. Vergados, Phys. Lett. 36B (1971) 12.
Bohr and Mottelson, Nuclear Structure vol II (1975)636.

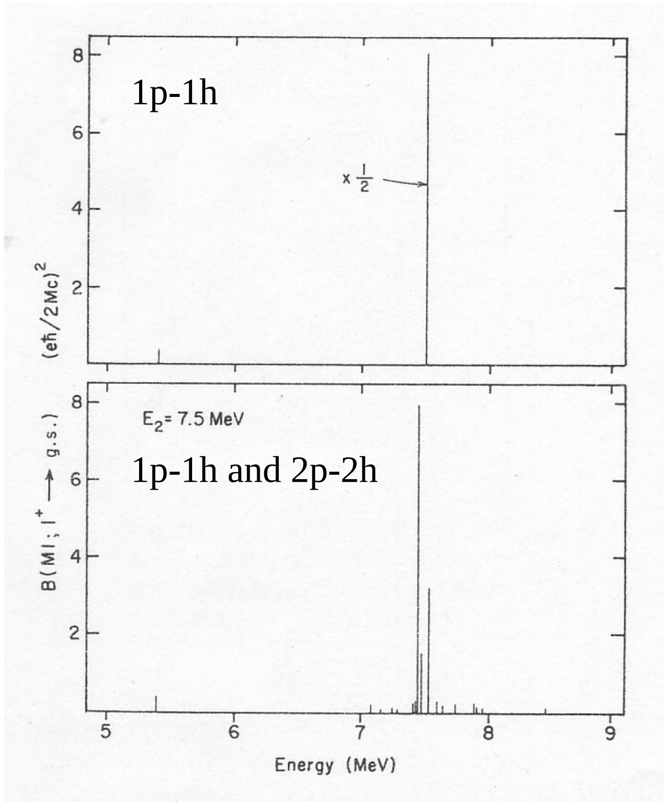
Fragmentation of the M1 strengths in ^{208}Pb

The low-lying strength is considered to be exhausted by a state located at 5.846 MeV.

observed by (*p*,*p*') S.I. Hayakawa *et al*., PRL49(1982)1624, (e,e'), and (d,d').

The higher-lying strength is fragmented into many tiny states by mechanisms:

- core-polarization or g.s. correlation
- coupling to 2p-2h states
- coupling to Δ-h states
- meson exchange current



calc. by Lee and Pittel PRC11(1975)607.

Experimentally, only a strength of ~10 μ_N^2 has been observed (until 1988) comparing with theoretical predictions of ~10 μ_N^2 .

→ "Missing M1 strength in ^{208}Pb"

Prediction of the M1 strengths in ^{208}Pb

Many theoretical works have been done for reproducing
the observed M1 strengths

- spreading by the coupling to 2p-2h states: 20% of reduction
- ground state correlation: 20% of reduction
- coupling to Δ-h states and MEC: 20% of reduction

If all these mechanisms additively contribute,
"the best that be expected from theoretical predictions is 20 μ_N^2"
I.S. Towner, Phys. Rep 155 (1987) 263.

Search for M1 strengths by experiments

Experimentally many reactions have been used to observe the M1 strengths:

^{208}Pb($\vec{\gamma}$,γ), ^{208}Pb(γ,$\vec{n}$), ^{207}Pb(*n*,*n*), ^{207}Pb(*n*,γ),

^{208}Pb(*e*,*e*'), and ^{208}Pb(*p*,*p*')

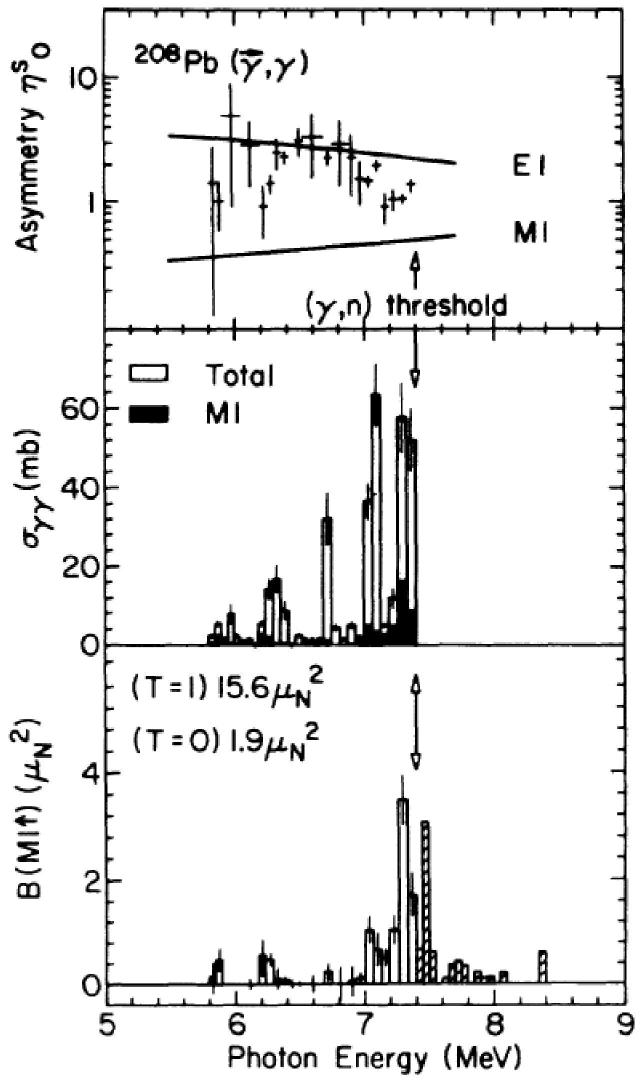
In 1988, R.M. Laszewsky et al. have identified

$8.8\mu_N^2$ below Sn by a ^{208}Pb($\vec{\gamma}$,γ) measurement.

In total the higher-lying strength became $15.6\mu_N^2$

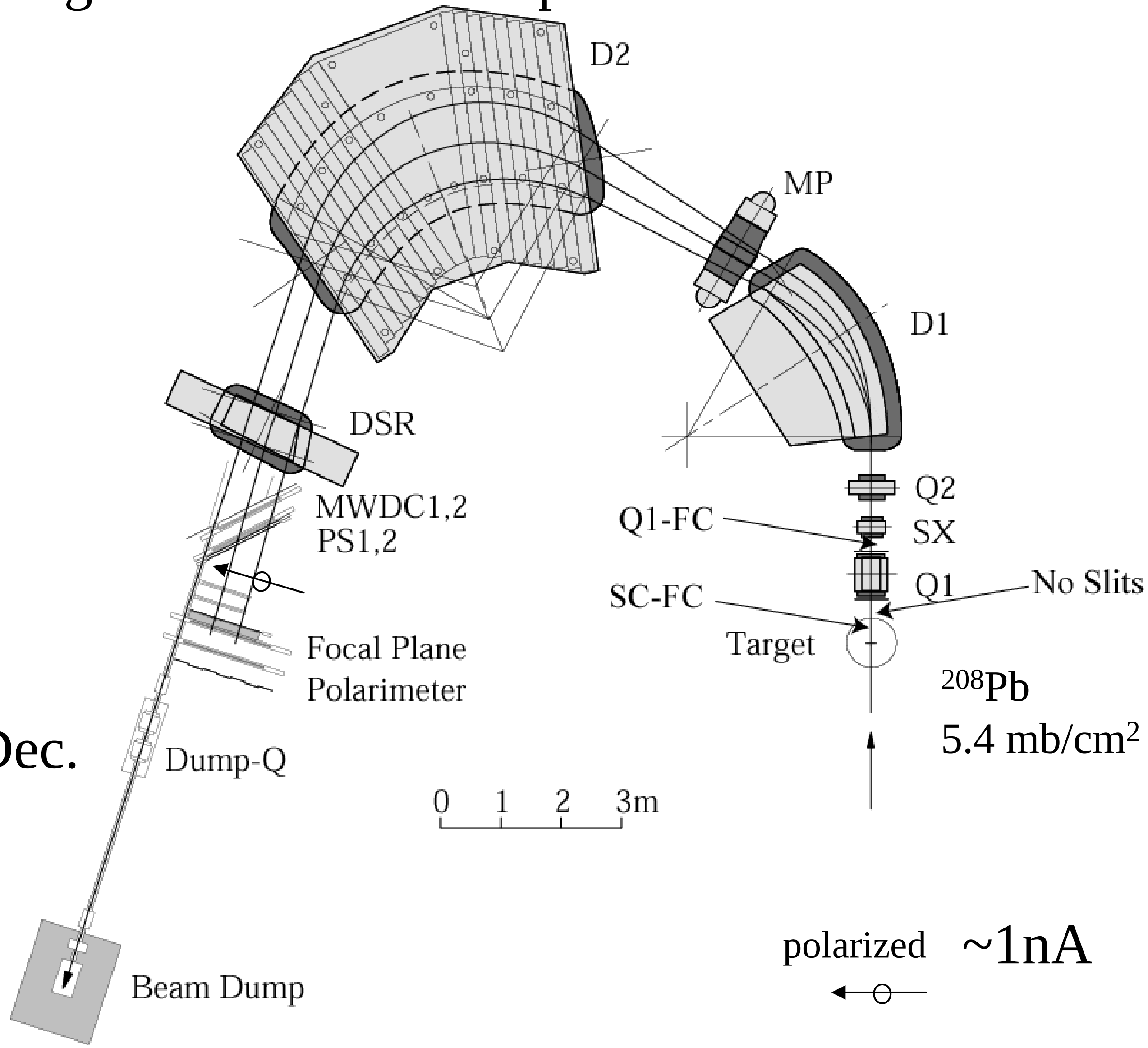
which came closer to the "best" (smallest) theoretical prediction of $20\mu_N^2$.

Determination of the M1 strength distribution in ^{208}Pb over a large Ex range is important to know the M1 quenching mechanism.



R.M. Laszewski et al, PRL61(1988)1710

Grand Raiden in the 0deg Measurement Setup



^{208}Pb
5.4 mb/cm^2

D_{LL} measurement is scheduled in Nov.-Dec. 2008.

polarized ~1nA

D_{NN} (=D_{SS}) Measurement

ΔS can be model-independently extracted by measuring polarization transfer coefficients at 0° (ΔS decomposition of the strengths)

T.Suzuki, PTP103(2000)859

$$2D_{NN} + D_{LL} = \begin{cases} -1 \text{ for } \Delta S = 1 & \text{M1} \\ 3 \text{ for } \Delta S = 0 & \text{E1 (Coulomb-Excitation)} \end{cases}$$

E1 and M1 strengths can be decomposed

The D_{NN} data were taken but D_{LL} were not.

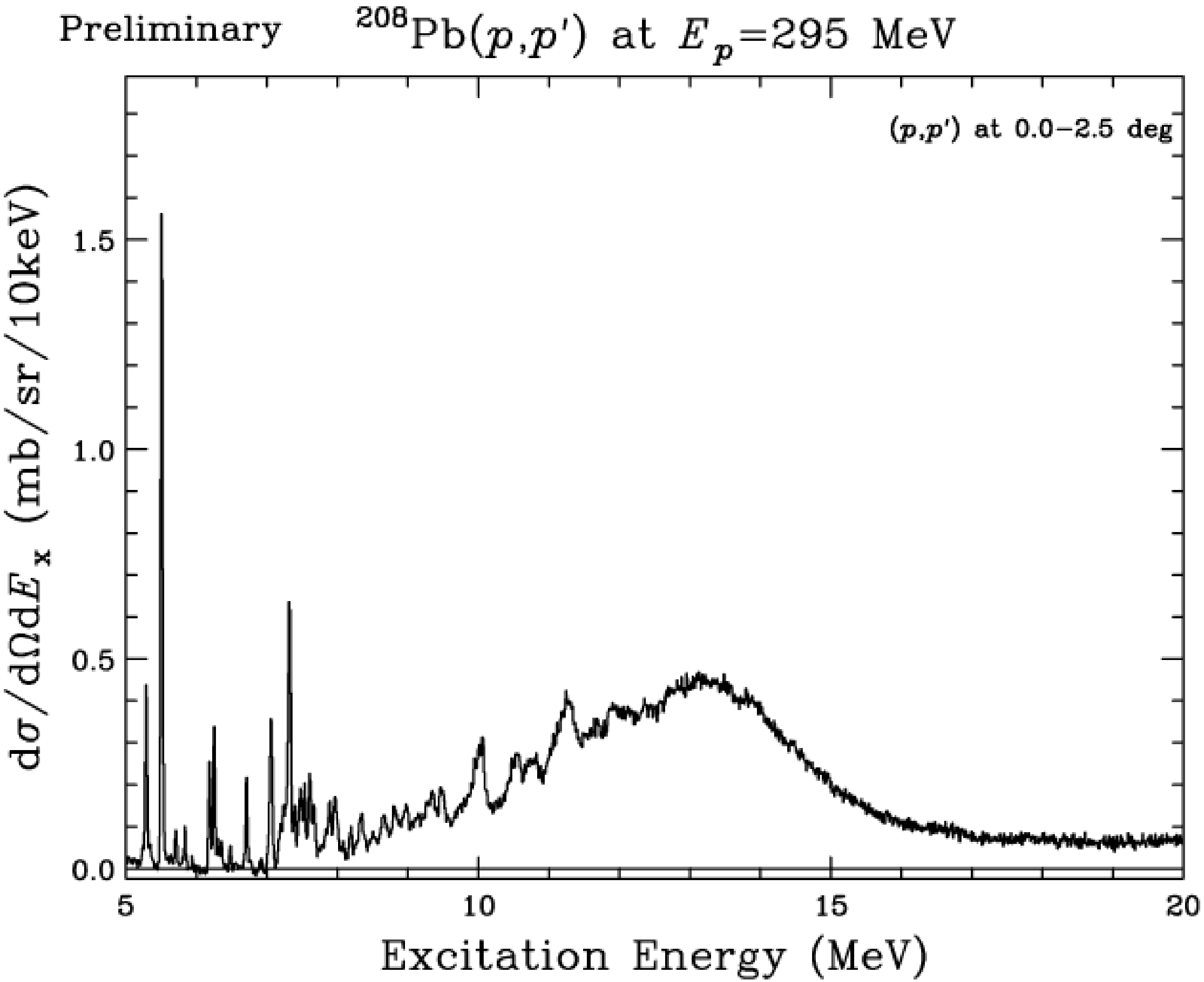
↓

Here, we play a <u>game</u> assuming a constant

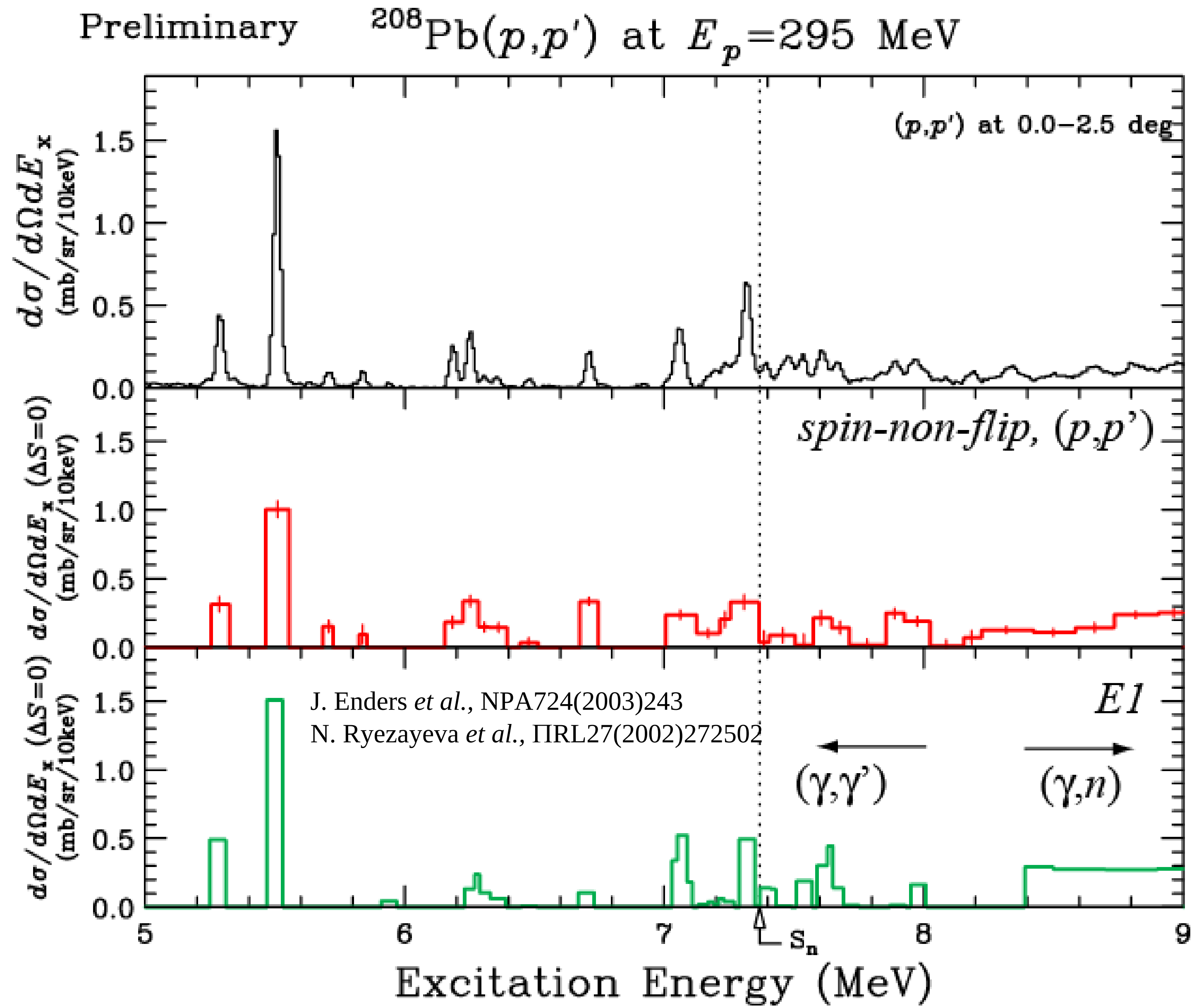
D_{NN} = -0.24 for M1 and +1 for E1 for the E1-M1 decomposition.

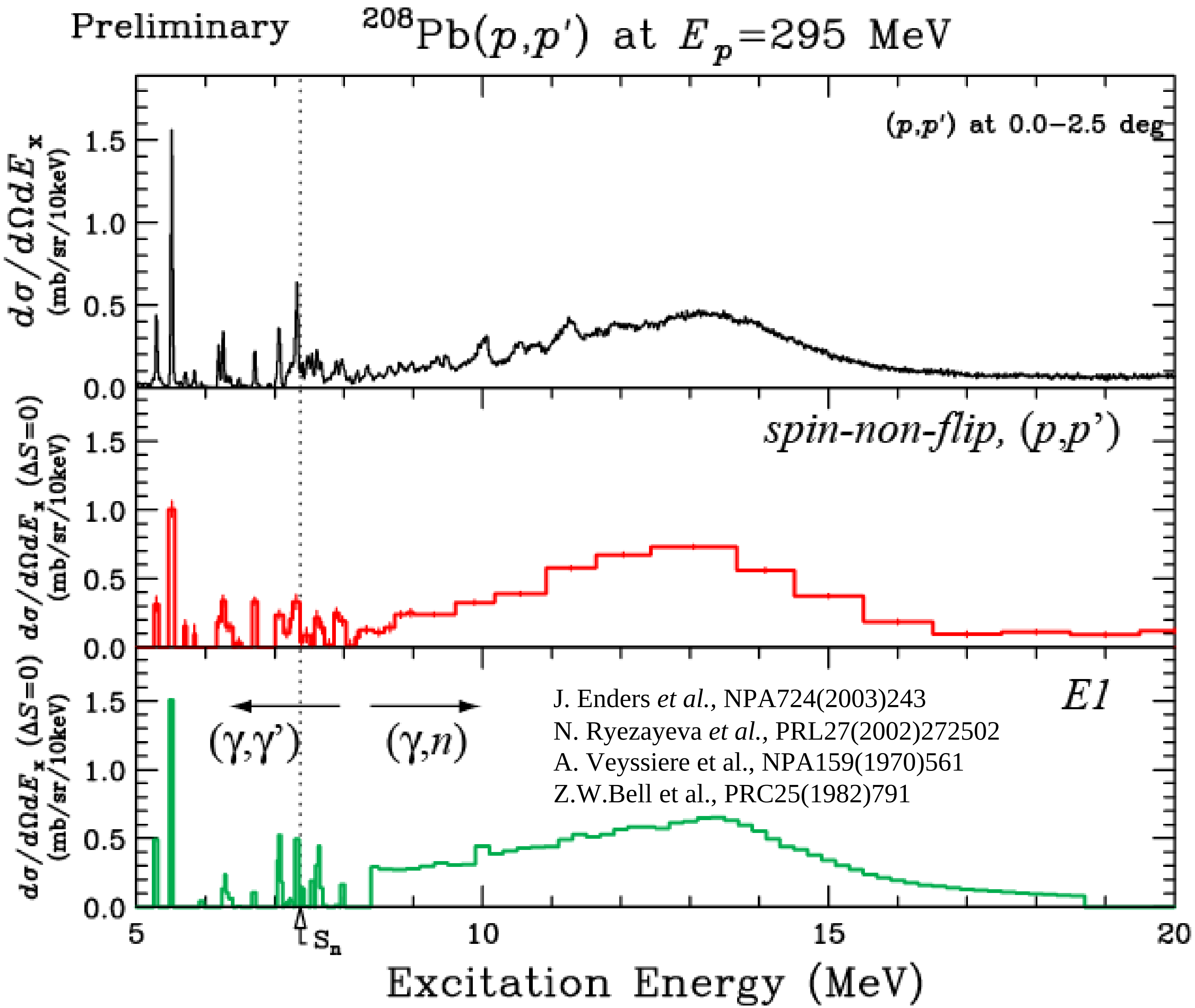
Normalization of B(σ) is not well determined

-0.24 is taken from T.Wakasa, M. Dozono *et al.*, for $^{12}C(p,n)^{12}N$(g.s) at 300 MeV at 0deg

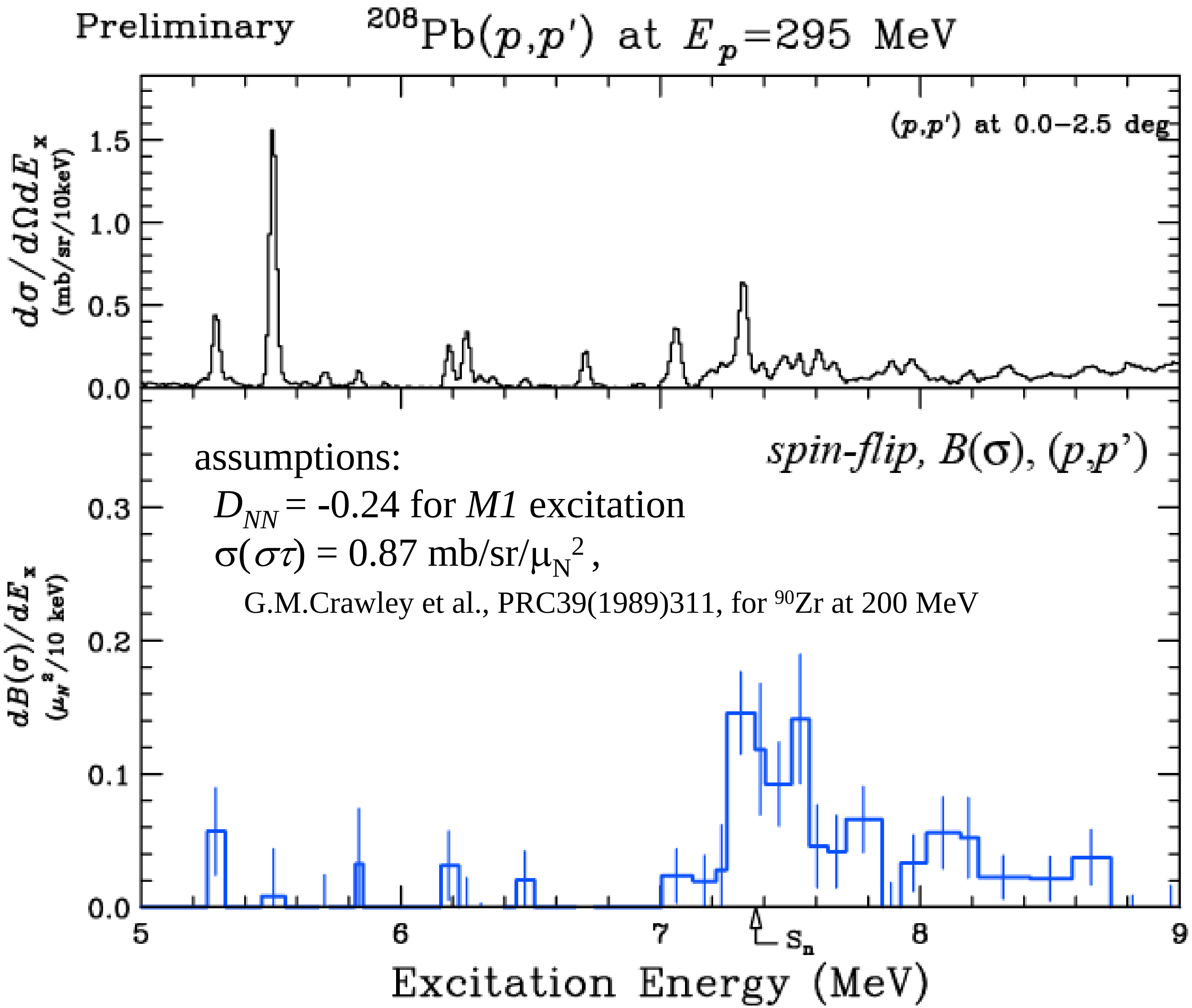


Preliminary
208Pb(p,p') at Ep=295 MeV
(p,p') at 0.0–2.5 deg
dσ/dΩdEx (mb/sr/10keV)
0.0
0.5
1.0
1.5
5
10
15
20
Excitation Energy (MeV)


Preliminary
208Pb(p,p') at Ep=295 MeV
(p,p') at 0.0−2.5 deg
spin-non-flip, (p,p')
E1
J. Enders et al., NPA724(2003)243
N. Ryezayeva et al., ΠRL27(2002)272502
(γ,γ')
(γ,n)
dσ/dΩdEx (mb/sr/10keV)
dσ/dΩdEx (ΔS=0) (mb/sr/10keV)
Sn
Excitation Energy (MeV)

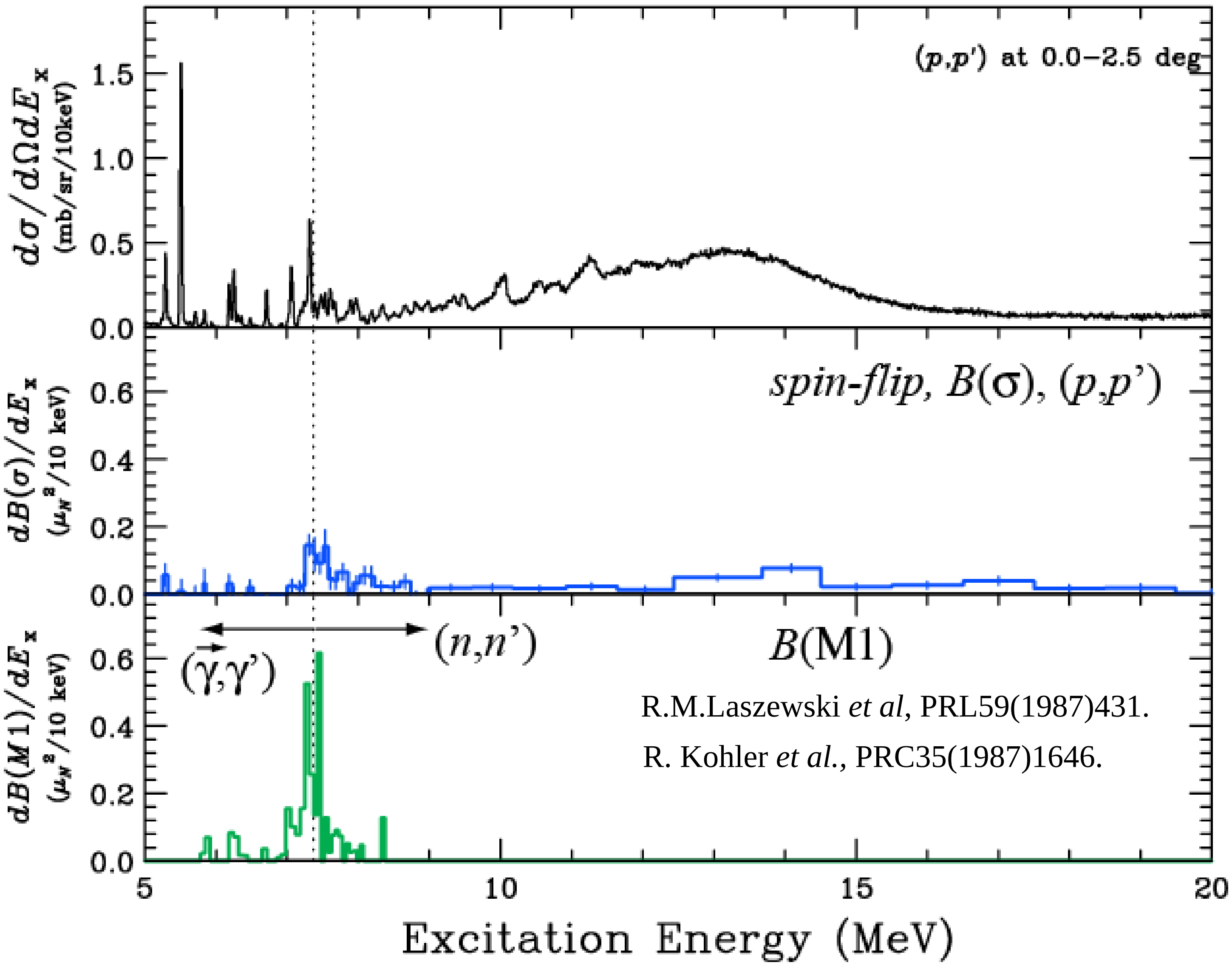


Preliminary
^{208}Pb(p,p') at E_p=295 MeV
(p,p') at 0.0–2.5 deg
$d\sigma/d\Omega dE_x$ (mb/sr/10keV)
spin-non-flip, (p,p')
$d\sigma/d\Omega dE_x$ (mb/sr/10keV) (ΔS=0)
E1
(γ,γ')
(γ,n)
J. Enders et al., NPA724(2003)243
N. Ryezayeva et al., PRL27(2002)272502
A. Veyssiere et al., NPA159(1970)561
Z.W.Bell et al., PRC25(1982)791
S_n
Excitation Energy (MeV)



Preliminary
208Pb(p,p') at Ep=295 MeV
(p,p') at 0.0−2.5 deg
dσ/dΩdEx (mb/sr/10keV)
1.5
1.0
0.5
0.0
spin-flip, B(σ), (p,p')
assumptions:
D_NN = -0.24 for M1 excitation
σ(στ) = 0.87 mb/sr/μN2,
G.M.Crawley et al., PRC39(1989)311, for 90Zr at 200 MeV
dB(σ)/dEx (μN2/10 keV)
0.3
0.2
0.1
0.0
5
6
7
8
9
Sn
Excitation Energy (MeV)

Preliminary ^{208}Pb(p,p') at E_p=295 MeV



Summary

0度を中心とする高分解能陽子非弾性散乱の測定手法をほぼ確立した。
　分解能 ~20 keV、 励起エネルギー 5-25 MeV
　E1およびM1の励起状態に感度が高い。

崩壊様式に依存しない測定であるため、閾値上下をまたいで測定ができる。
検出効率や分解能は励起エネルギーに依存せず、ほぼ一定。

208Pbの E1励起強度の実験値は(γ, γ’)の値とよく一致している。
M1の励起強度分離については解析中。

近々、解析方法について確立させ、データプロダクションのステージに入ることをめざしている。