



Compton Scattering at MAX-lab

EMIN 2009

L. Isaksson



Compton@MAXlab Collaboration

Duke University

University of Edinburgh

University of Glasgow

University of Göttingen

University of Illinois

University of Kentucky

Kharkov Institute of Physics and Technology

Lund University

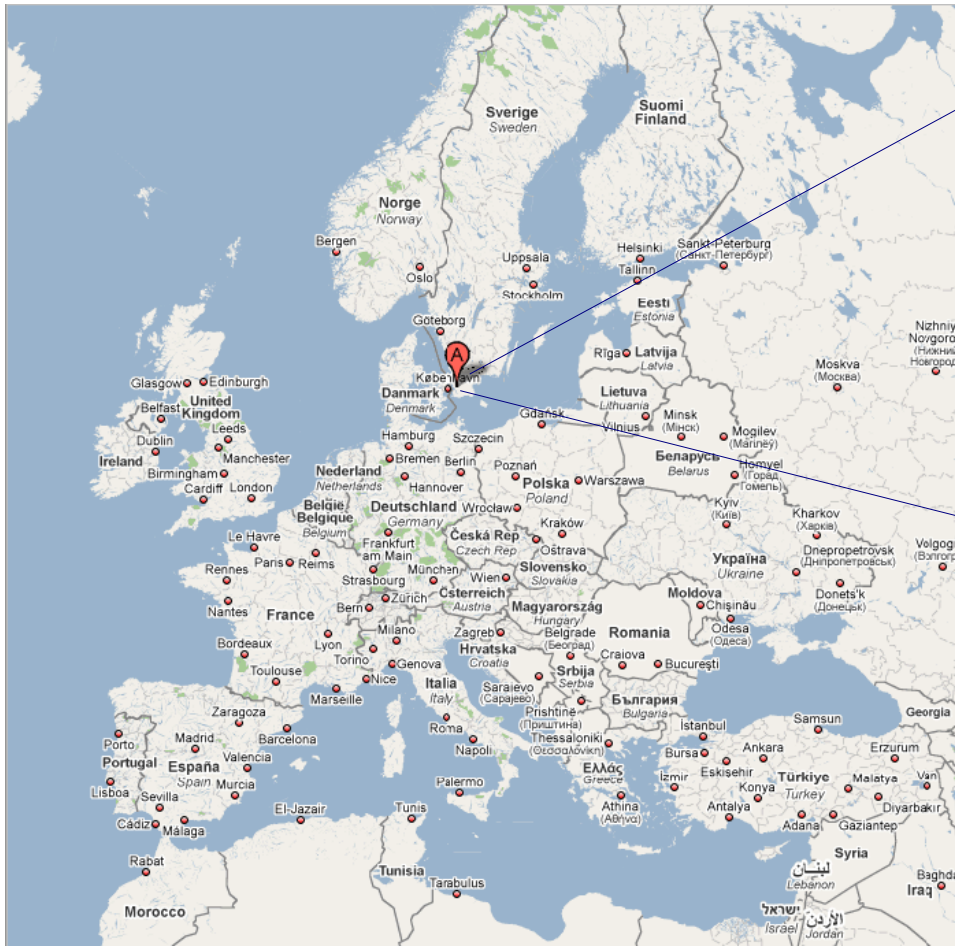
The Mount Allison University

University of Saskatchewan

University of Tübingen

The George Washington University

Where is MAX-lab?

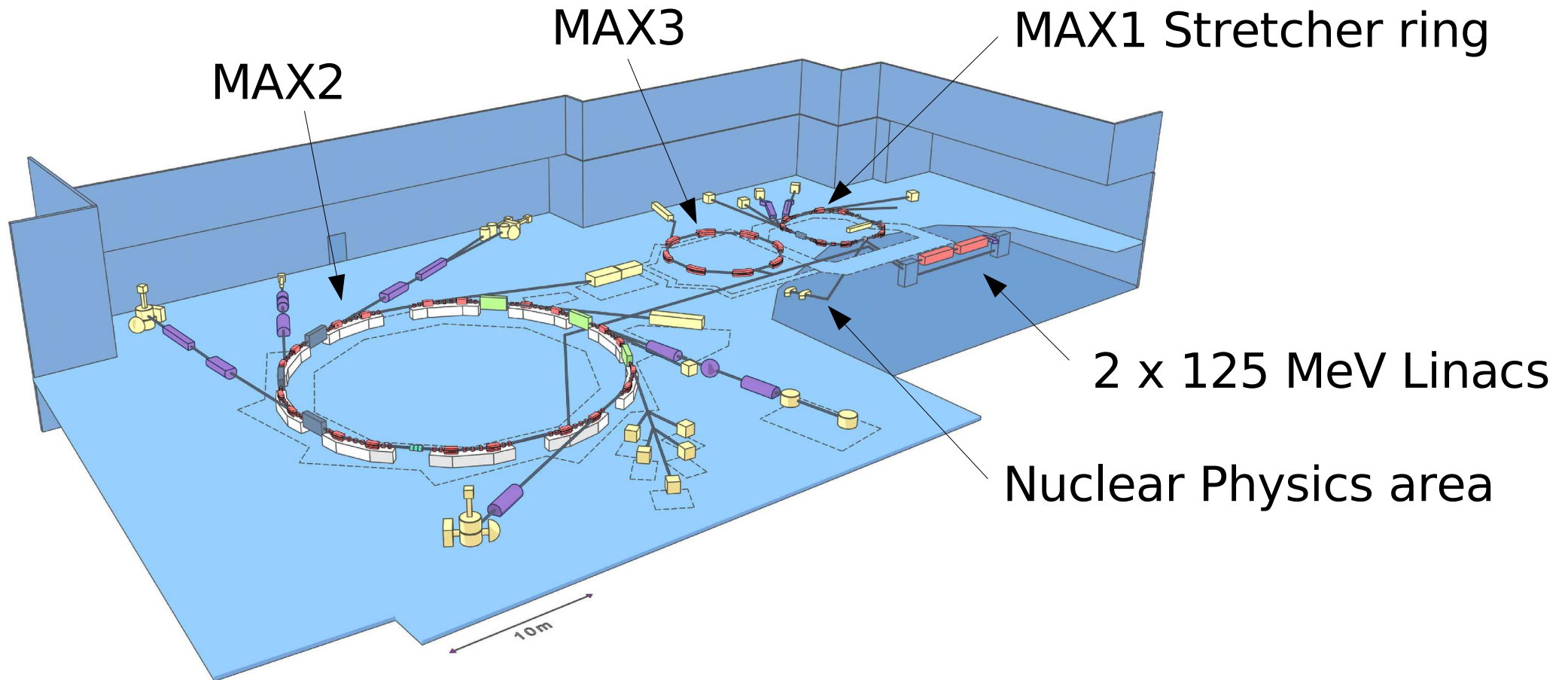


Lund, Sweden

Latitude: $55^{\circ} 42' N$

(Moscow: $55^{\circ} 45' N$)

MAX-lab accelerator system



Parallel operation of the three rings

Nuclear Physics: ~45% of beam-time at MAX1

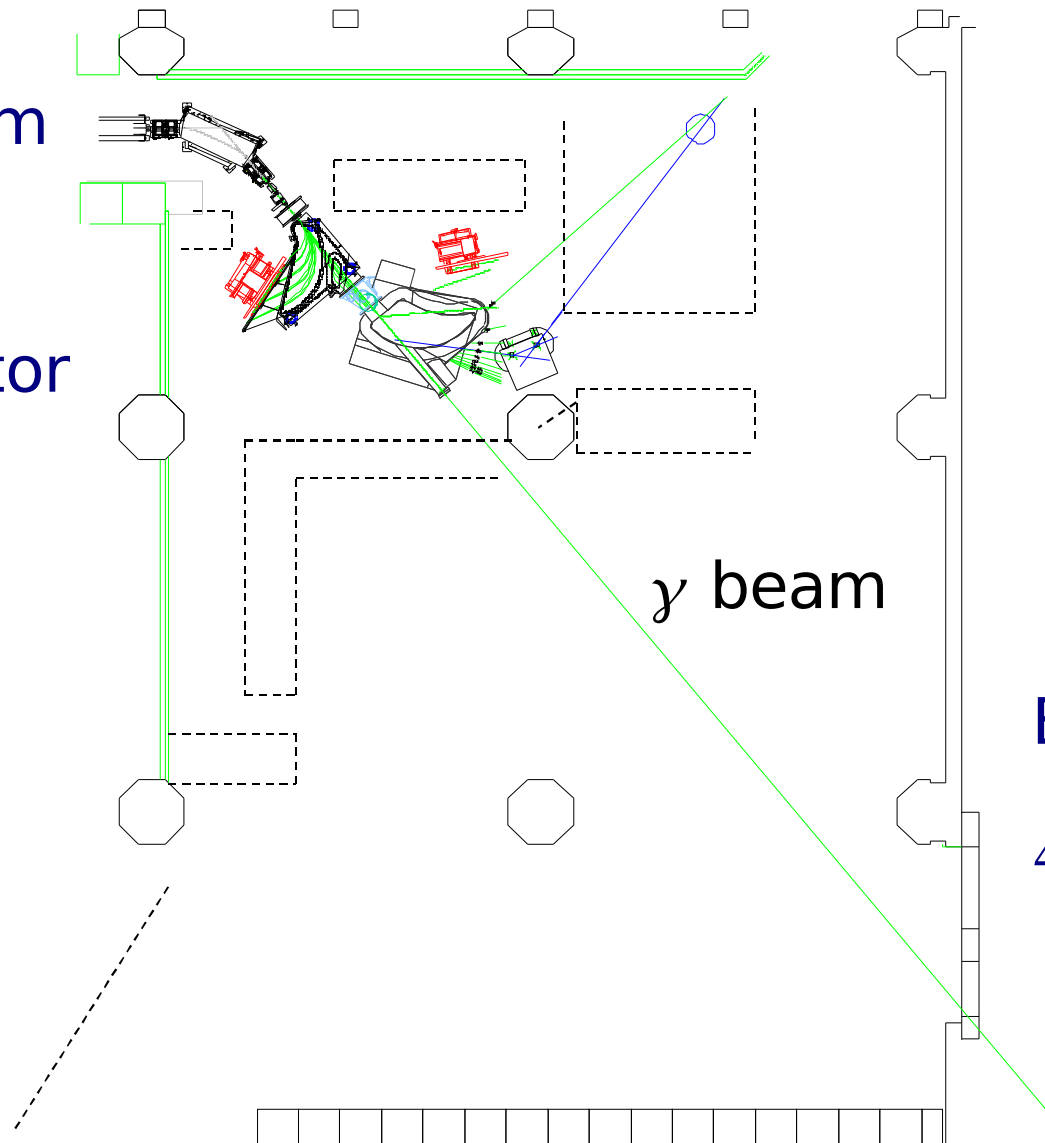
Upgraded beam in operation since September 2005

Tagged photon beam-line

Stretched e^- beam

~ 20 nA

$\sim 50\%$ duty factor



$E_\gamma = 15-180$ MeV

$\Delta E_\gamma = 0.5-1$ MeV

10^6 MeV $^{-1}$ s $^{-1}$

Compton Scattering programme

- Deuterium

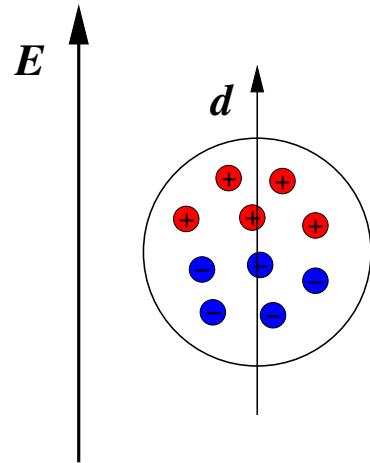
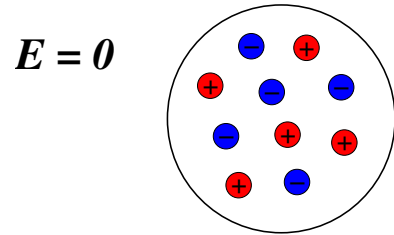
Extract neutron polarizabilities α_n and β_n

- ^4He , ^{12}C and ^{16}O

Extract polarizabilities of bound nucleons

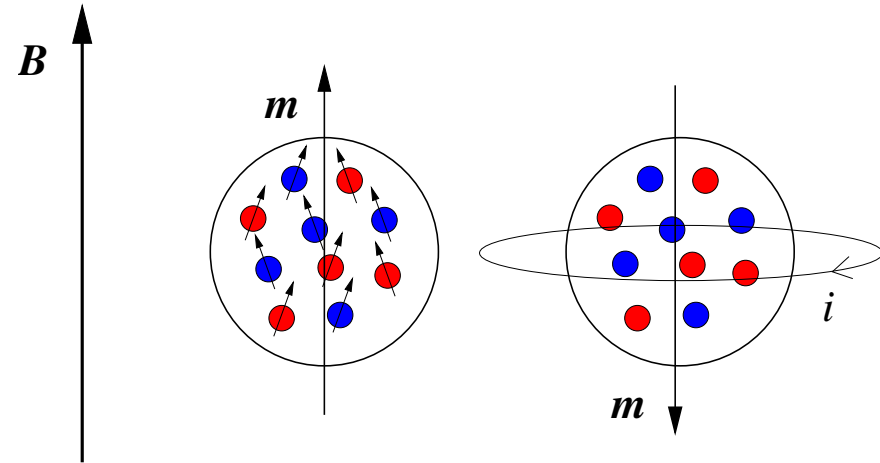
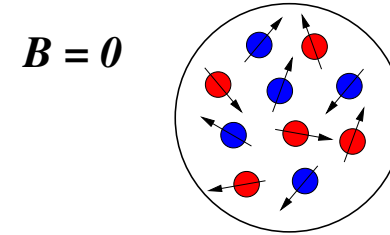
Polarizabilities

Electric (α)



$$d = \alpha E$$

Magnetic (β)



$$m = \beta B$$

α and β are intrinsic properties of the system

α_n and β_n from $D(\gamma,\gamma)$

α_p and β_p well known from $^1H(\gamma,\gamma)$ and

Baldin sum rule
$$\alpha_p + \beta_p = \frac{1}{2\pi^2} \int \frac{\sigma_{tot}(\omega)}{\omega^2} d\omega$$

$D(\gamma,\gamma)$:

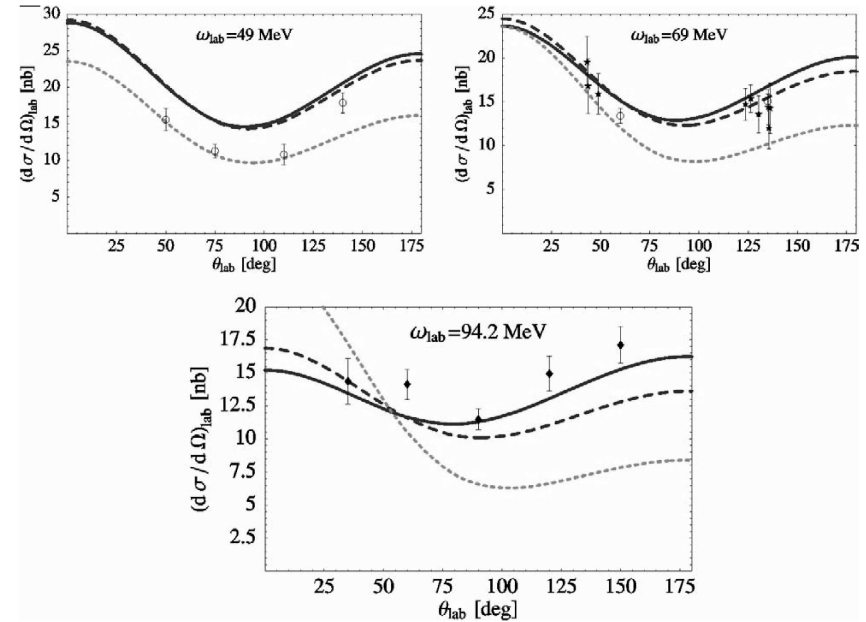
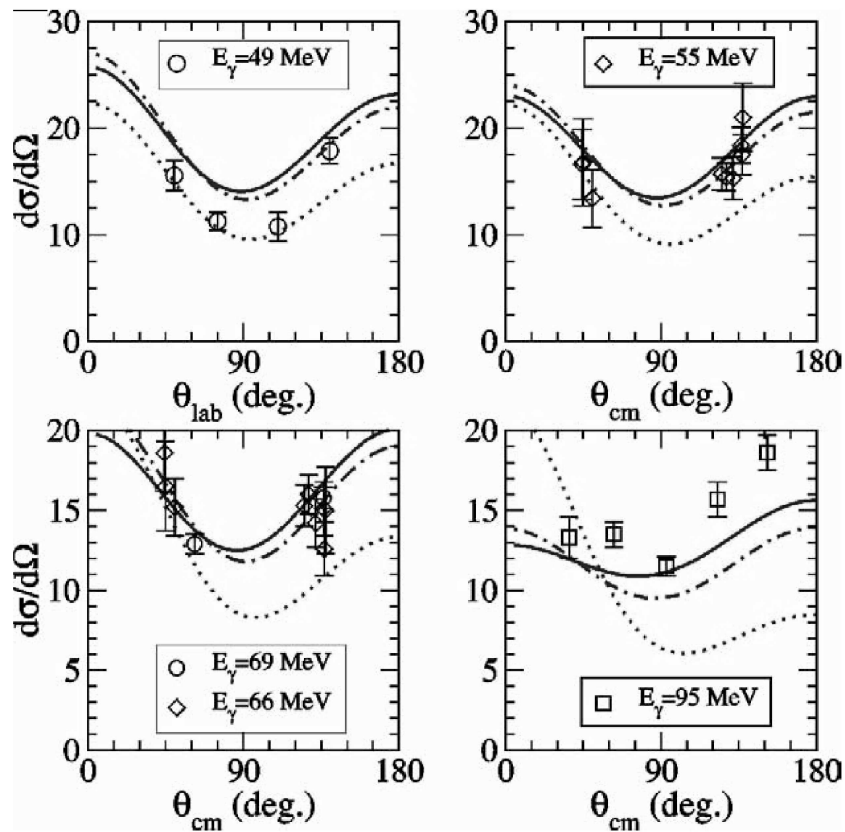
$\frac{d\sigma}{d\Omega}$ (backward direction) sensitive to α_N and β_N

\Rightarrow α_n and β_n can be extracted

Recent χ PT calculations

Beane *et al.*,
Nucl.Phys.A747(2005)311

Hildebrandt *et al.*,
Nucl.Phys.A748(2005)573



Δ -resonance
explicitly included

$$O(Q^4)$$

Need higher quality data

Goal of present $D(\gamma,\gamma)$ measurement

Significantly increase the world $D(\gamma,\gamma)$ data set:

- 40-110 MeV
- 30° - 150°
- Statistical errors $<5\%$

Set-up

Three of the largest
NaI-detectors worldwide:

CATS	(Mainz)
BUNI	(Boston)
DIANA	(Kentucky)



CATS

Standard electronics set-up

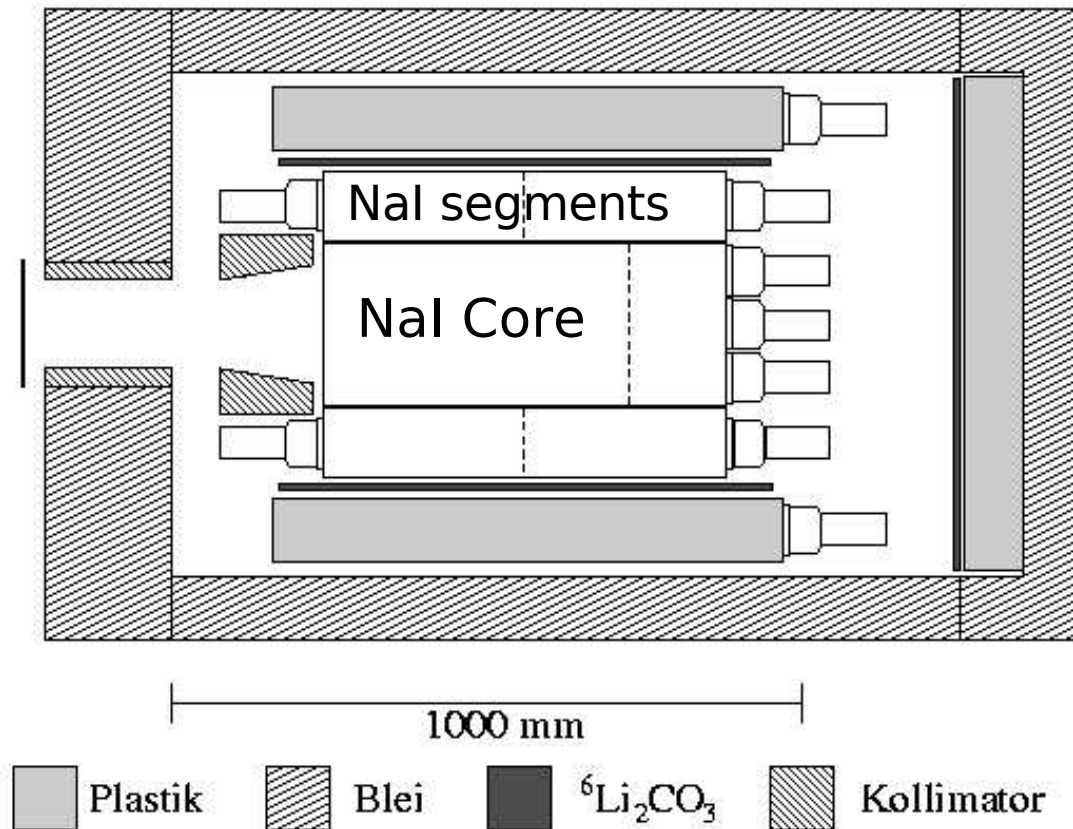
Trigger: single NaI-detector (scattered photon)

Incoming photon energy determined by tagger coincidences

Nal-detectors

The three detectors share a similar design:

CATS



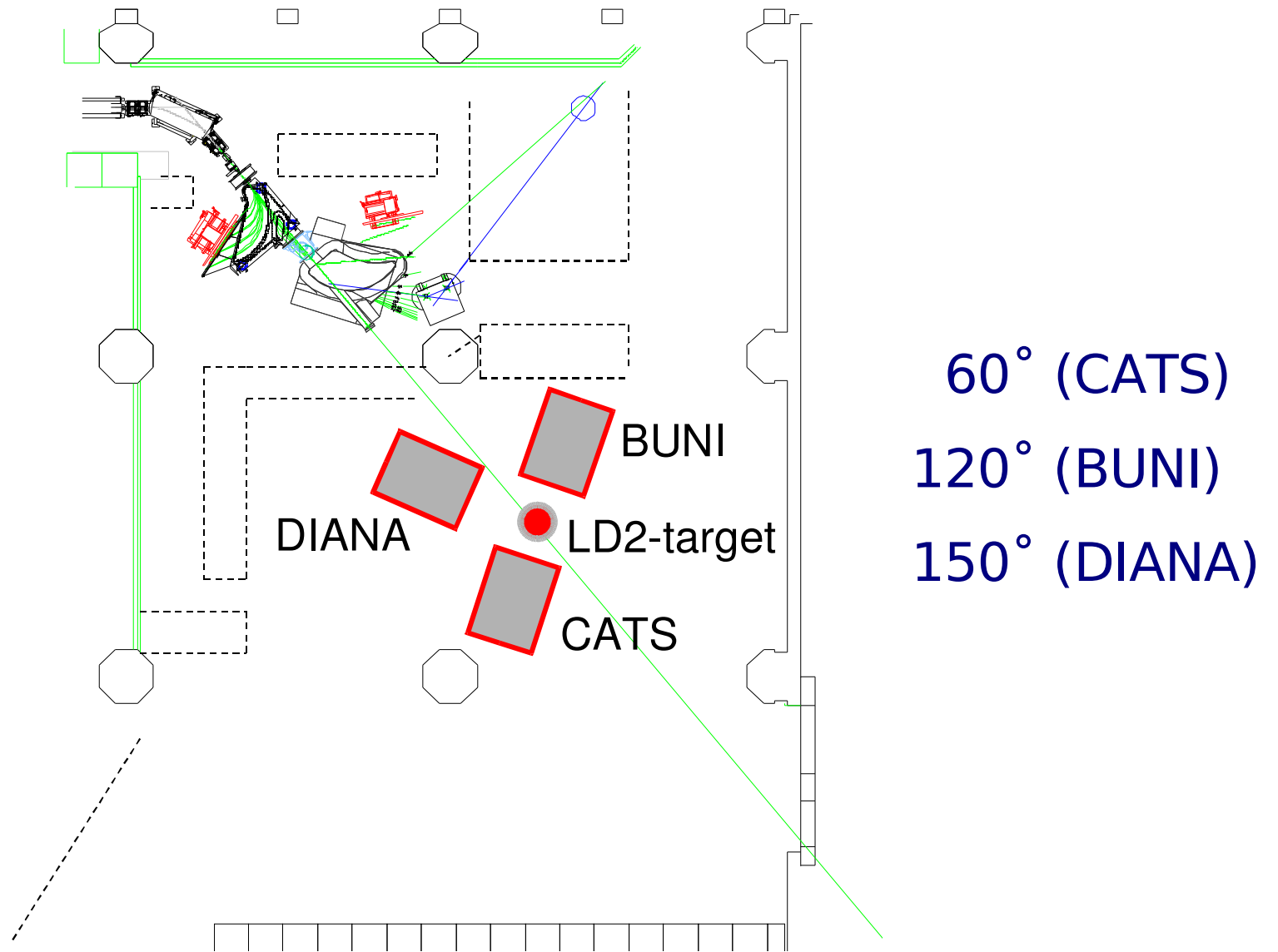
NaI Core: $\phi 27\text{cm} \times 64\text{cm}$

Six NaI segments

NaI total: $\phi 48\text{cm} \times 64\text{cm}$

(figure from O.Jahn, Diplomarbeit, Mainz)

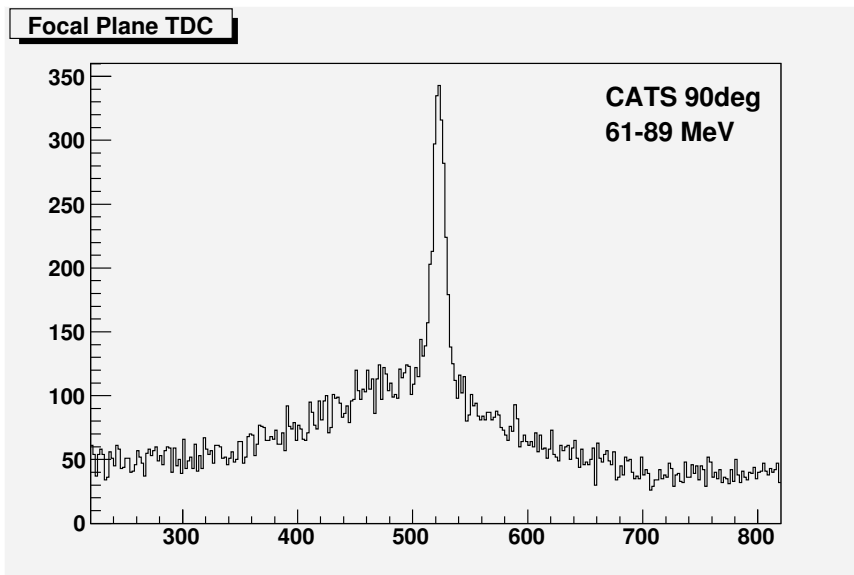
Detector configuration



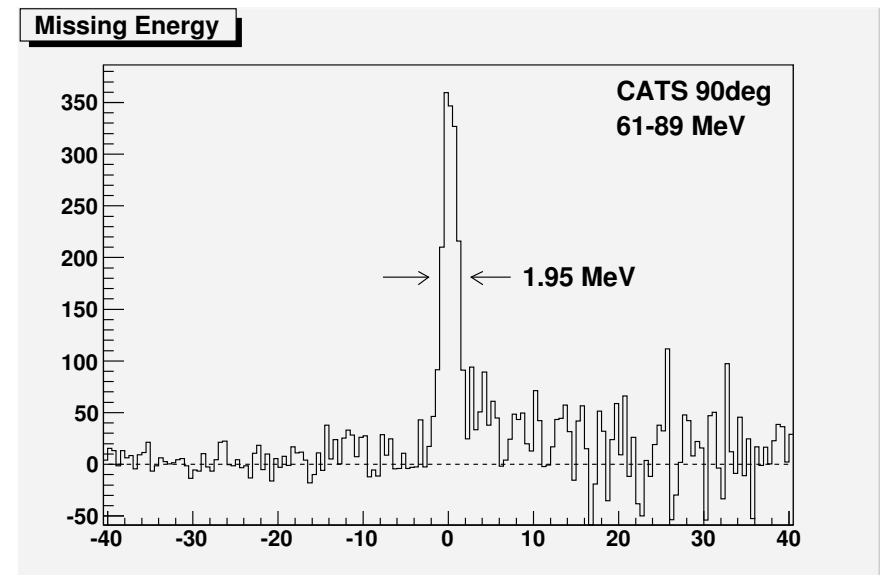
Carbon test measurement

Simpler target

20 times larger cross-section

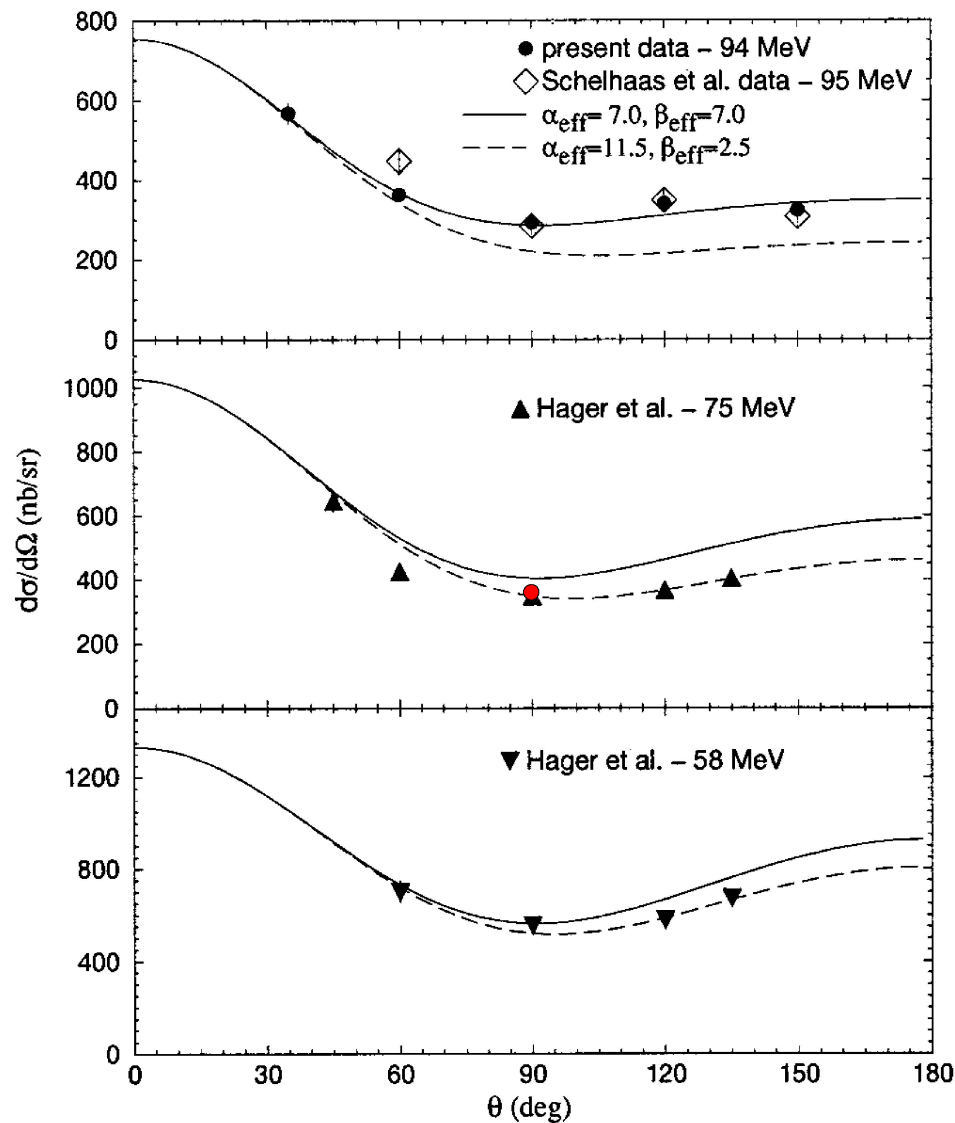


Tagger coincidences



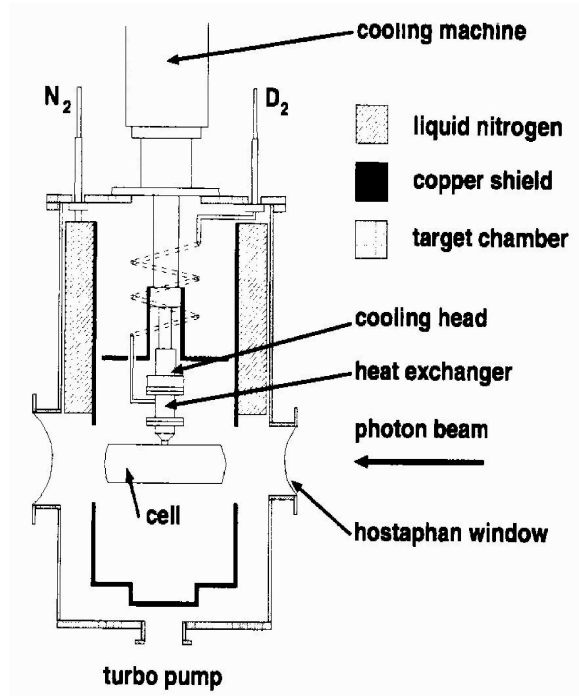
Missing energy

Carbon cross-section



- Warkentin *et al.*, SAL
94 MeV 292 ± 5 nb/sr
- ▲ Häger *et al.*, Lund
75 MeV 348 ± 11 nb/sr
- This measurement
75 MeV 367 ± 19 nb/sr
(preliminary)

Deuterium measurement



LD2-target



Target cell

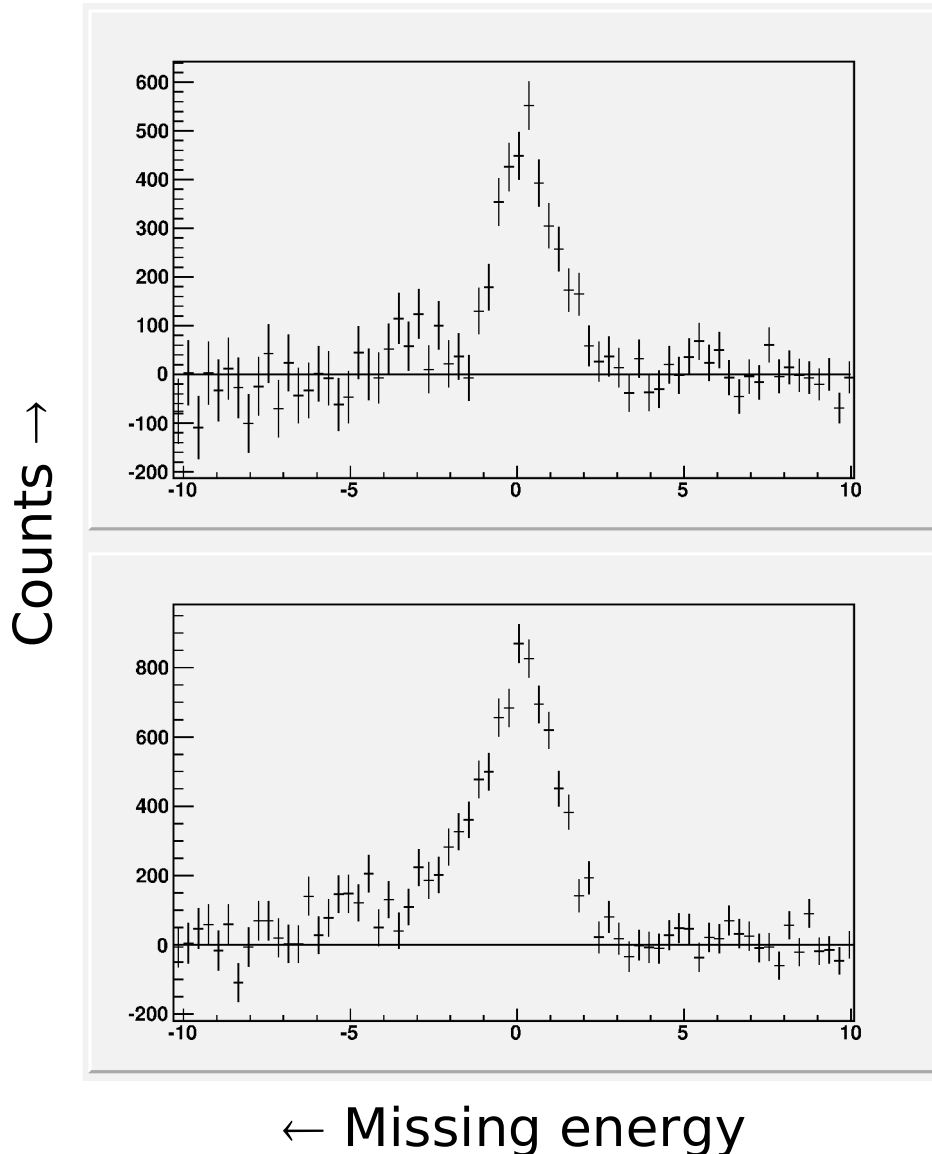
8 weeks of production runs to date

Analysis in progress

D(γ,γ) preliminary results

BUNI (120°)

Analysis results
courtesy L. Myers, Illinois



November 2007, 4 weeks

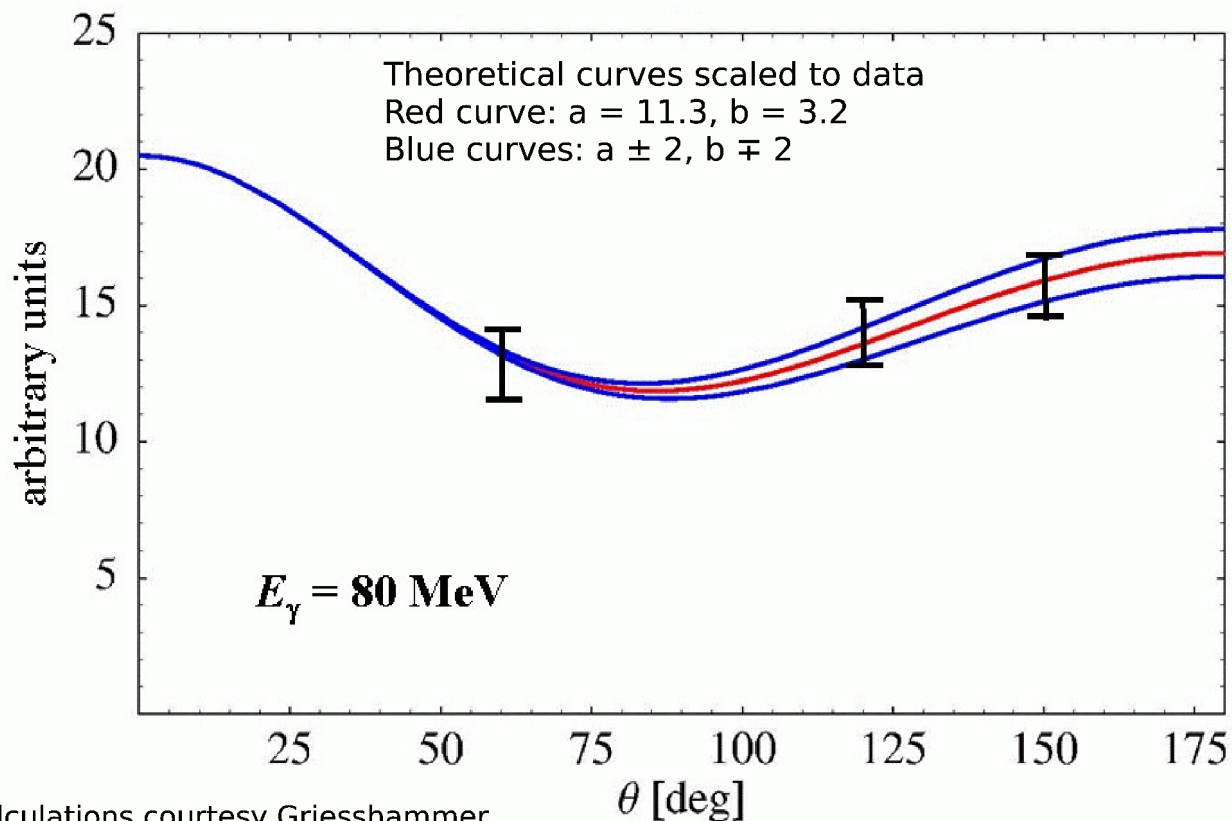
E_γ : 67-97 MeV

November 2008, 4 weeks

E_γ : 81-115 MeV

Similar spectra for
CATS (60°) and DIANA (150°)

$D(\gamma,\gamma)$ preliminary relative cross-sections



Calculations courtesy Griesshammer,
McGovern, Phillips and Shukla

November 2007
1/4 of tagged region

Data points: arbitrary units (corrections to be applied)

Theoretical curves: scaled

Need better statistics: 4 weeks in November 2009, ...

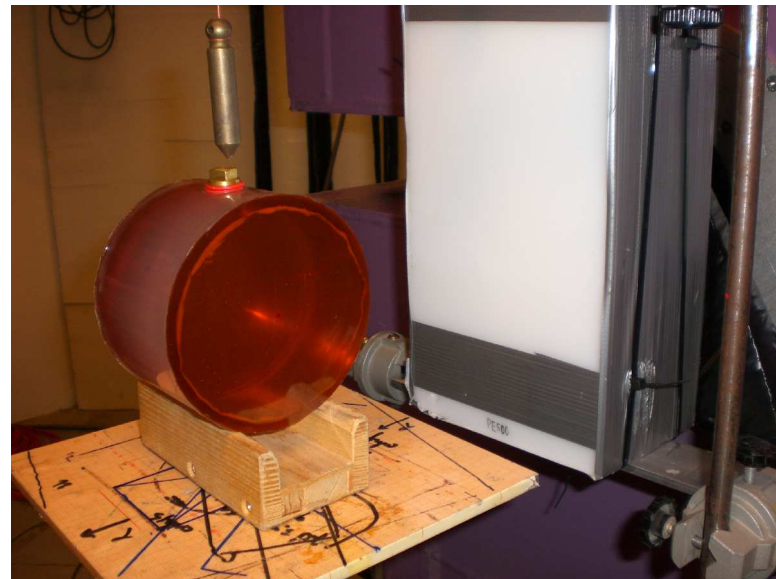
Oxygen measurement



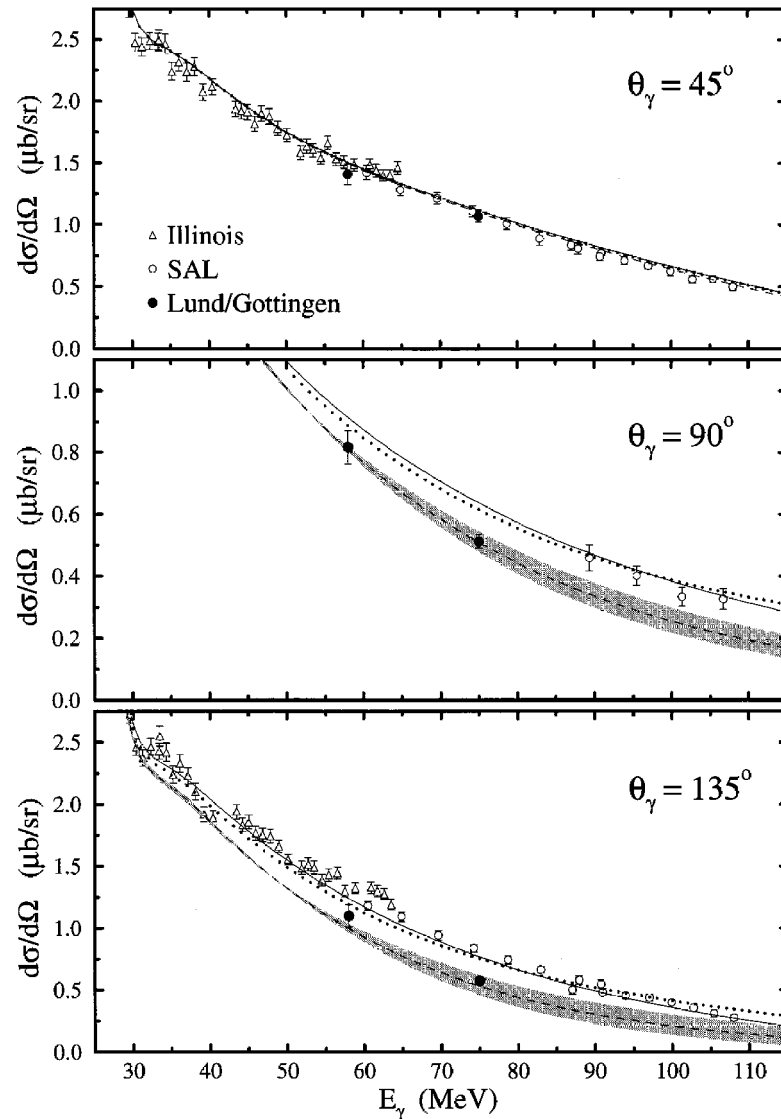
CATS and DIANA

E_γ : 65-96 MeV

θ : 45°, 90°, 135°, 150°



Previous $O(\gamma,\gamma)$ measurements



Illinois

SAL

Lund

Discrepancies \Rightarrow

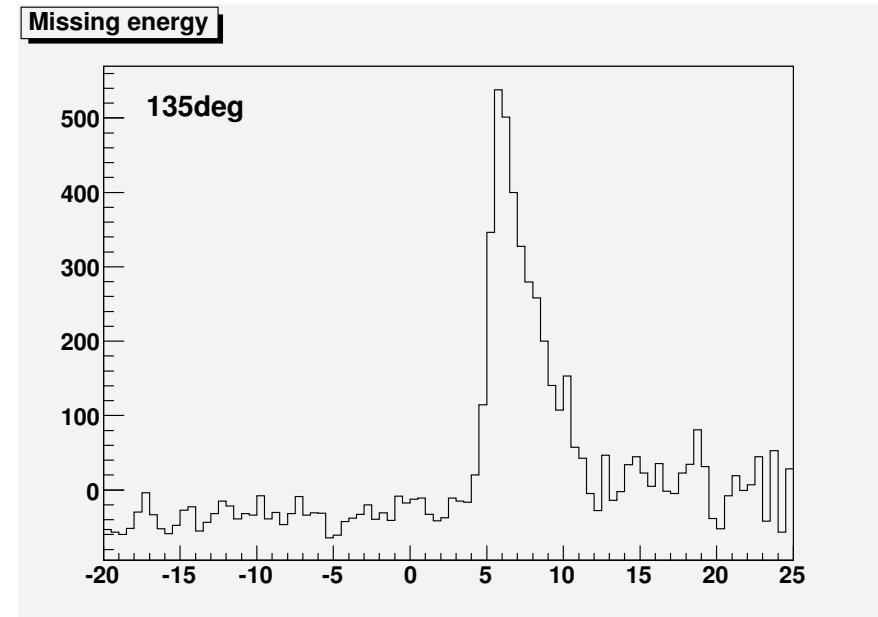
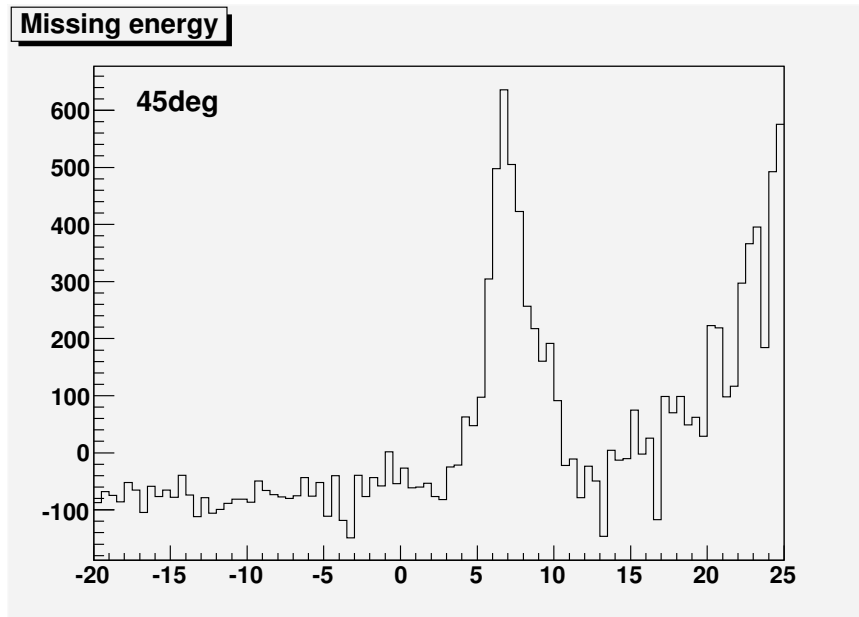
Large differences in
extracted polarizabilities

Feldman *et al.*, Phys.Rev.C54(1996)R2124

$O(\gamma,\gamma)$ very preliminary results

Offline analysis in progress

~Online spectra:

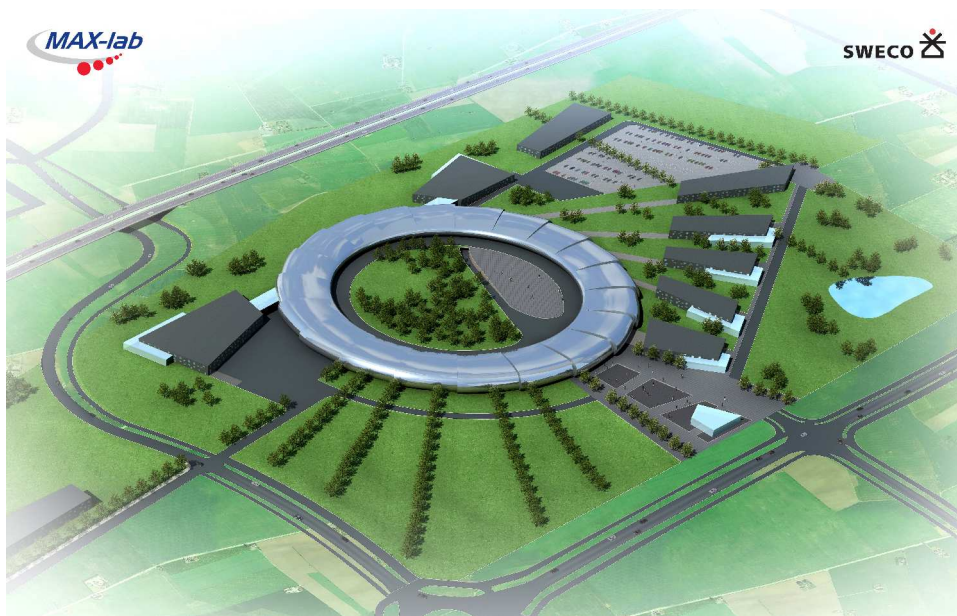


MAX IV

3 GeV linac and storage ring

Recently funded

First beamlines planned for 2015



Laser backscattering beamline

500 MeV

Feasibility investigations
have commenced

Funding applications
to be submitted

Summary

- Upgraded tagged photon beam at MAX-lab in routine operation
- Compton scattering experiments running on Deuterium, Carbon and Oxygen
- $^{12}\text{C}(\gamma,\gamma)$ cross-section agrees well with previous measurements
- $\text{D}(\gamma,\gamma)$ relative cross-sections show promise

Next step: 4 weeks of $\text{D}(\gamma,\gamma)$ in November 2009