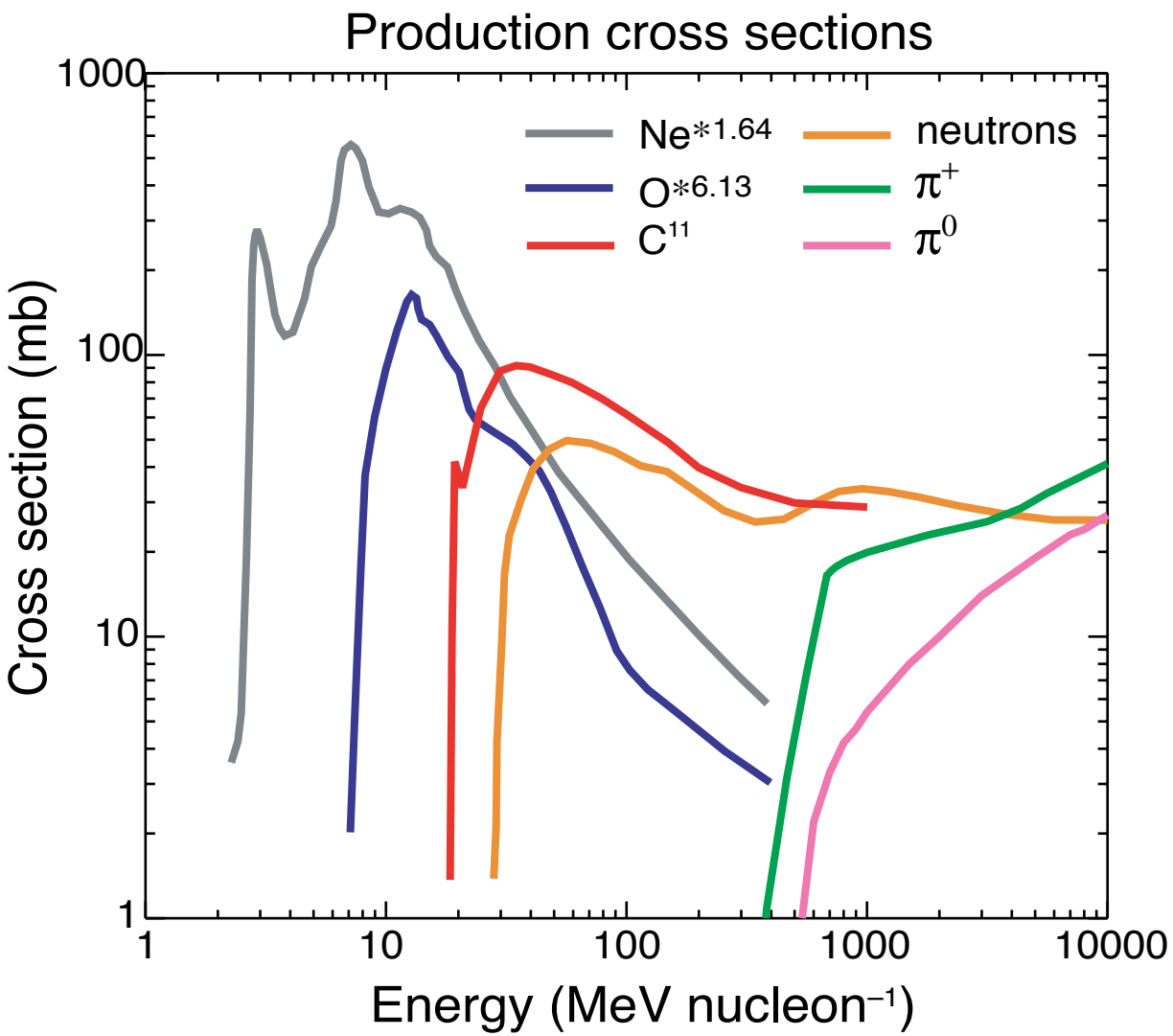
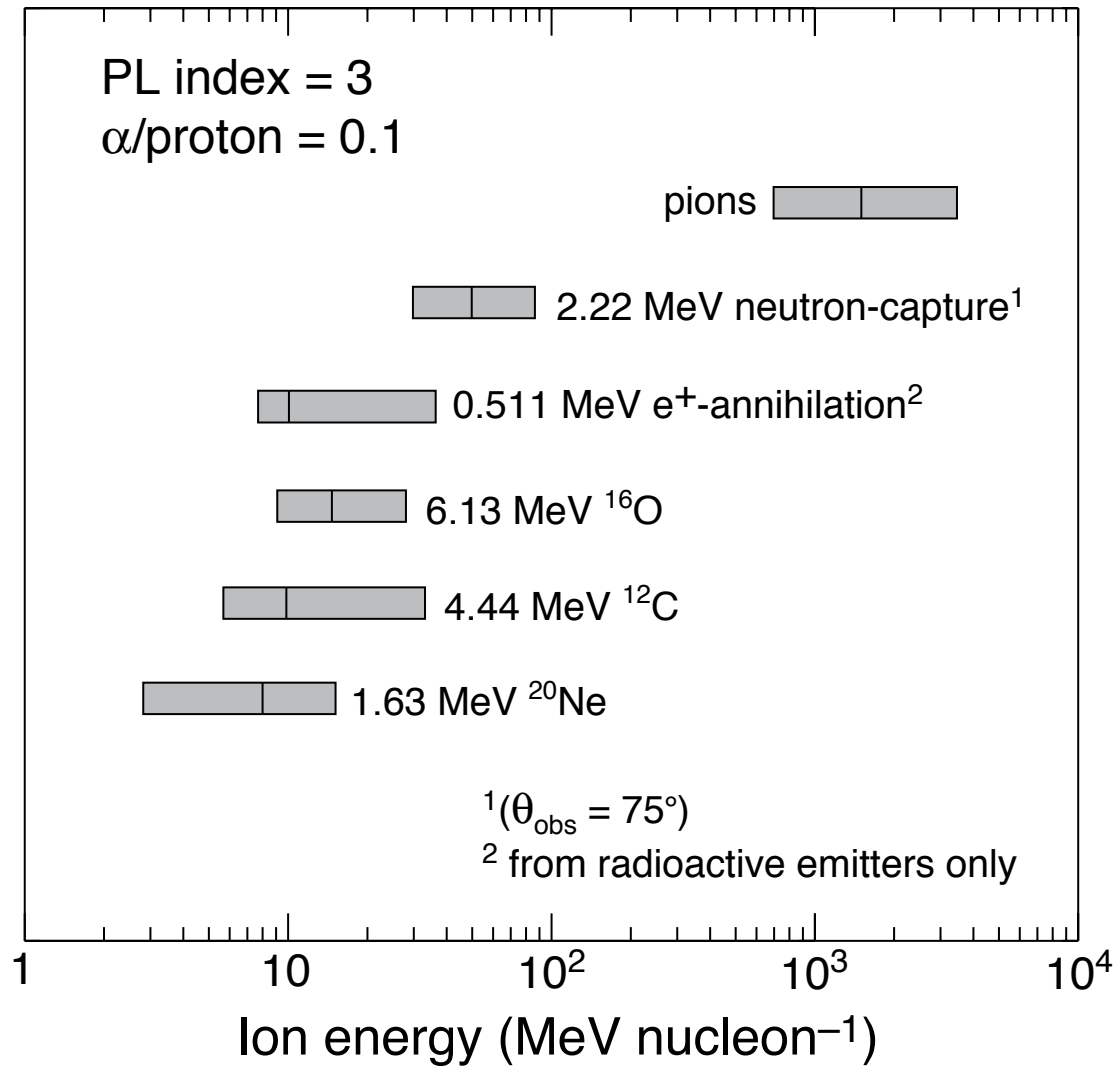
Accelerated Ion Parameters

composition:	broad-line ratios
α/proton ratio:	α–α line flux (if ^{4}He/H is known) narrow line ratios narrow line shapes
spectral index:	narrow-line ratios neutron-capture/narrow line ratio pion-decay/narrow or neutron-capture line
angular distribution:	narrow-line shape (α–α best) neutron capture/narrow-line ratio neutron/neutron-capture line ratio

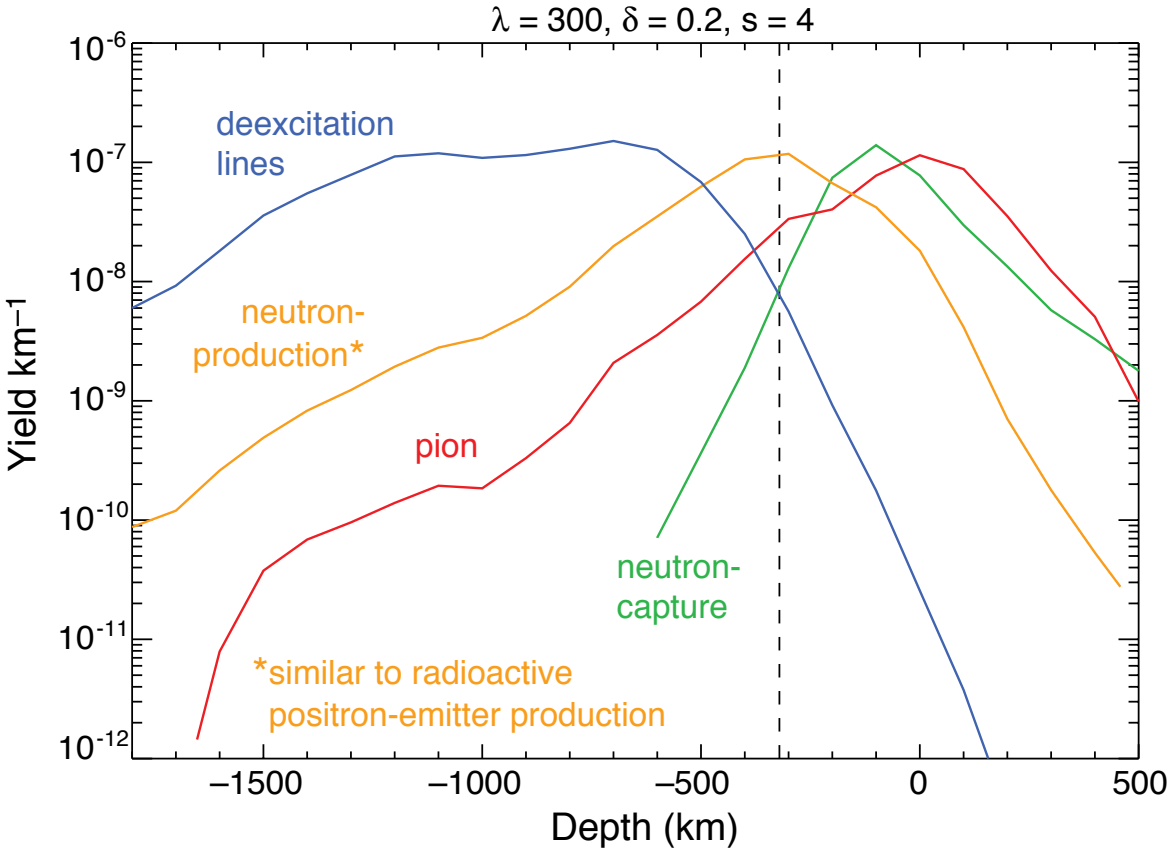
broad-line ratios:	composition spectral index
narrow line ratios:	spectral index ambient composition α/proton ratio
narrow line shapes:	angular distribution spectral index α/proton ratio
neutron-capture/narrow line ratio:	angular distribution spectral index


Production cross sections
Cross section (mb)
1000
100
10
1
1
10
100
1000
10000
Energy (MeV nucleon⁻¹)
Ne*1.64
O*6.13
C11
neutrons
π+
π0

Relevant Ion Energies



Photon Transmission



deexcitation lines: ~100%

positron annihilation: 30–90% (radio.)
0–50% (pion)

neutron-capture: 0–85%

pion-decay: 40–100%

Improvements to the Deexcitation Line Code

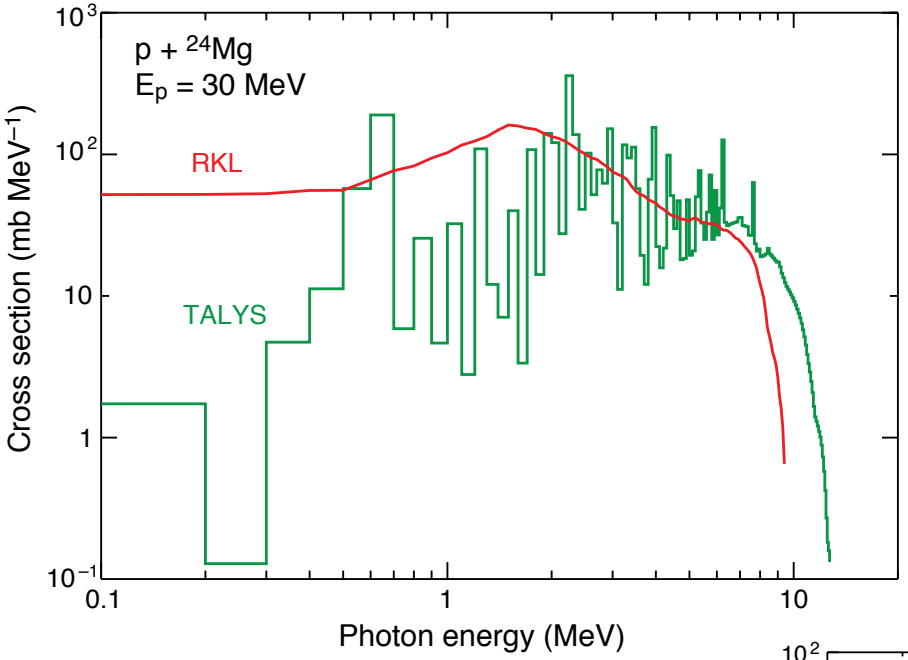
Significant emission arises from the numerous, relatively weak lines, especially from nuclei heavier than oxygen, not explicitly treated by the code, called the "unresolved-line continuum".

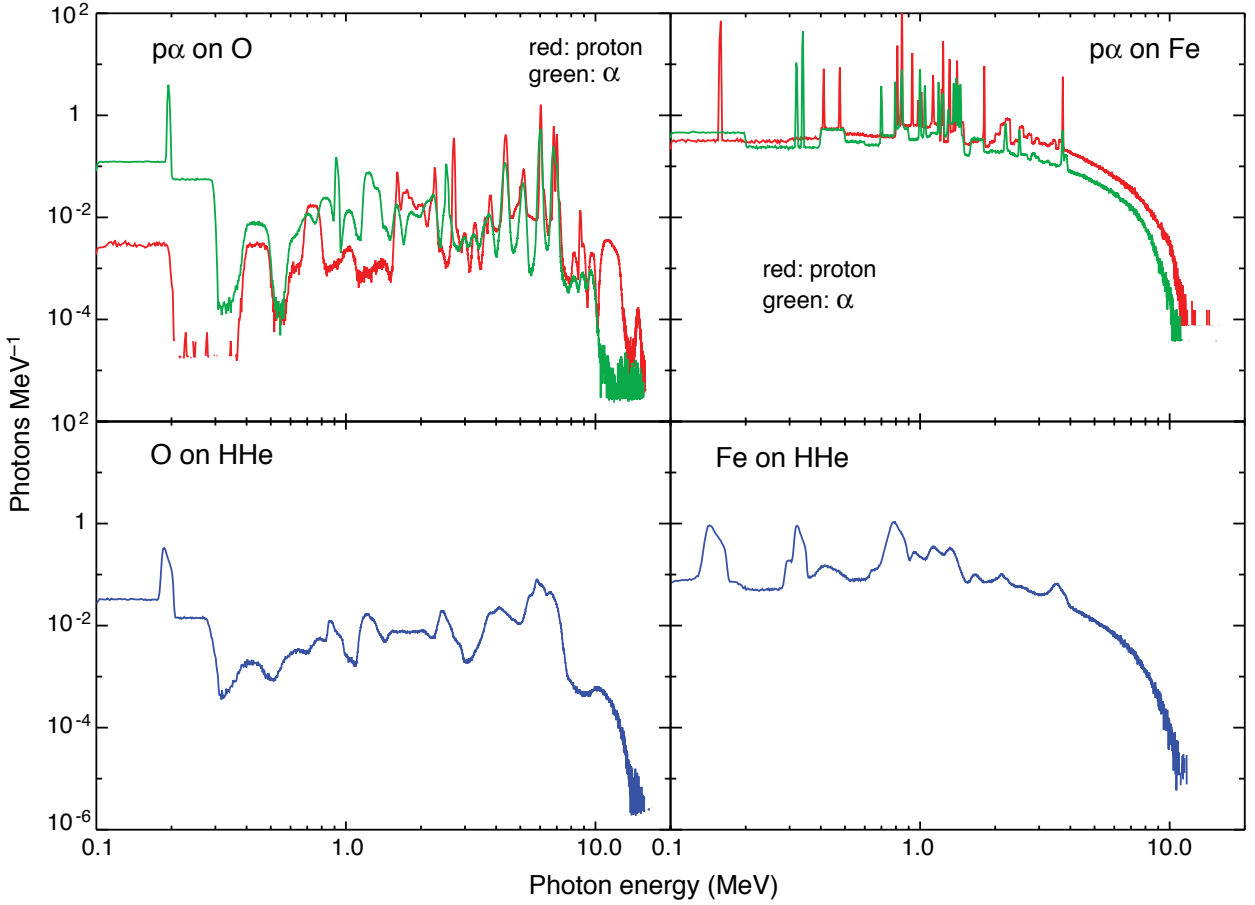
In the RKL gamma-ray line code, this component was estimated from low spectral-resolution laboratory measurements for only a few target nuclei at only a few projectile energies.

To provide this information about the unresolved-line continuum, we used the global-nuclear theoretical program TALYS. (Koning, Hilaire & Duijvestijn 2005; Koning & Duijvestijn 2006) **TALYS is software for the simulation of nuclear reactions using state-of-the-art nuclear models and comprehensive libraries of nuclear data, developed at NRG Petten, the Netherlands and CEA Bruyeres-le-Chatel, France.**

TALYS also allowed us to:

1. **check our assumptions about those explicit line cross sections in our code for which complete measurements are not available**
2. **include new moderate-strength lines for which no measurements are available.**


p + 24Mg
Ep = 30 MeV
RKL
TALYS
Cross section (mb MeV−1)
Photon energy (MeV)


pα on O
red: proton
green: α
pα on Fe
red: proton
green: α
O on HHe
Fe on HHe
Photons MeV−1
Photon energy (MeV)