Effect of the gas pressure in the X-ray intrinsic position resolution detection by noble gases

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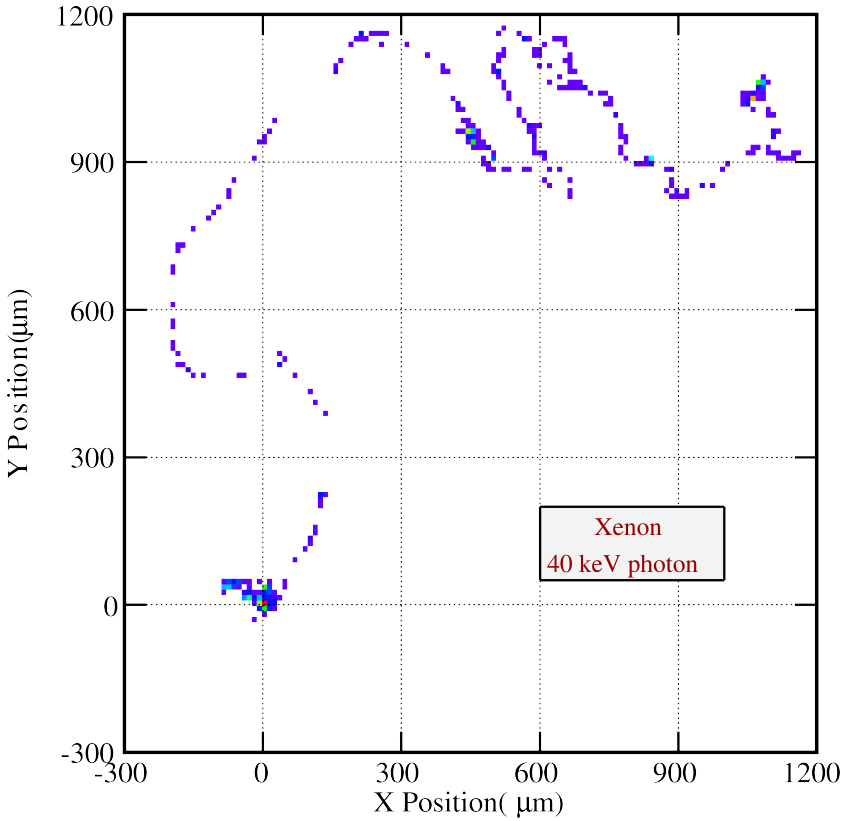
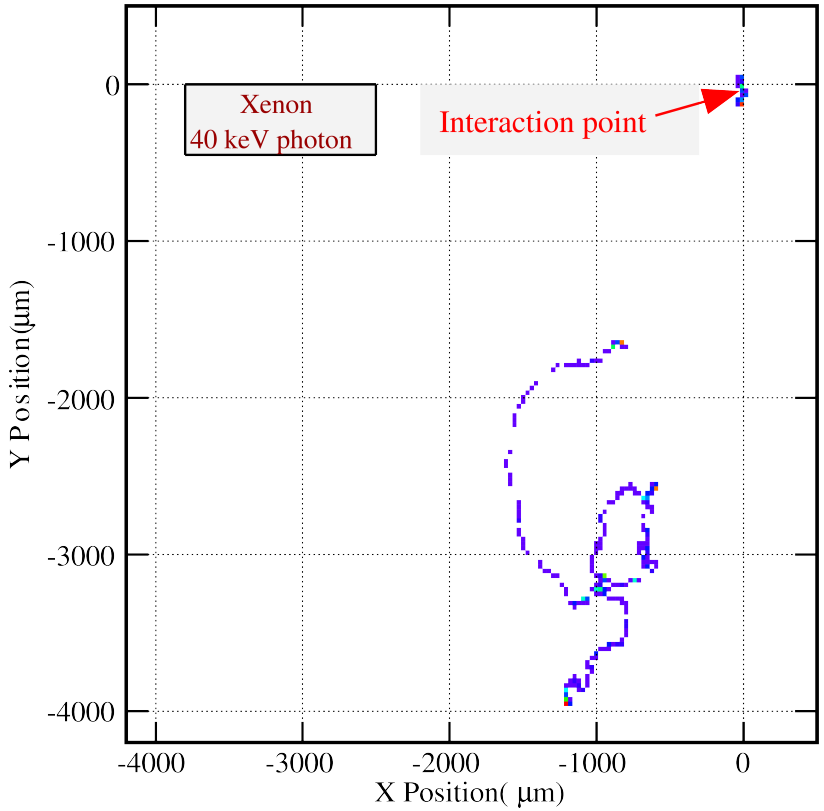
X-ray Position Resolution in gas

- Where is the problem?
  - Photoelectron range
    - Electron scattering
  - Fluorescence photons

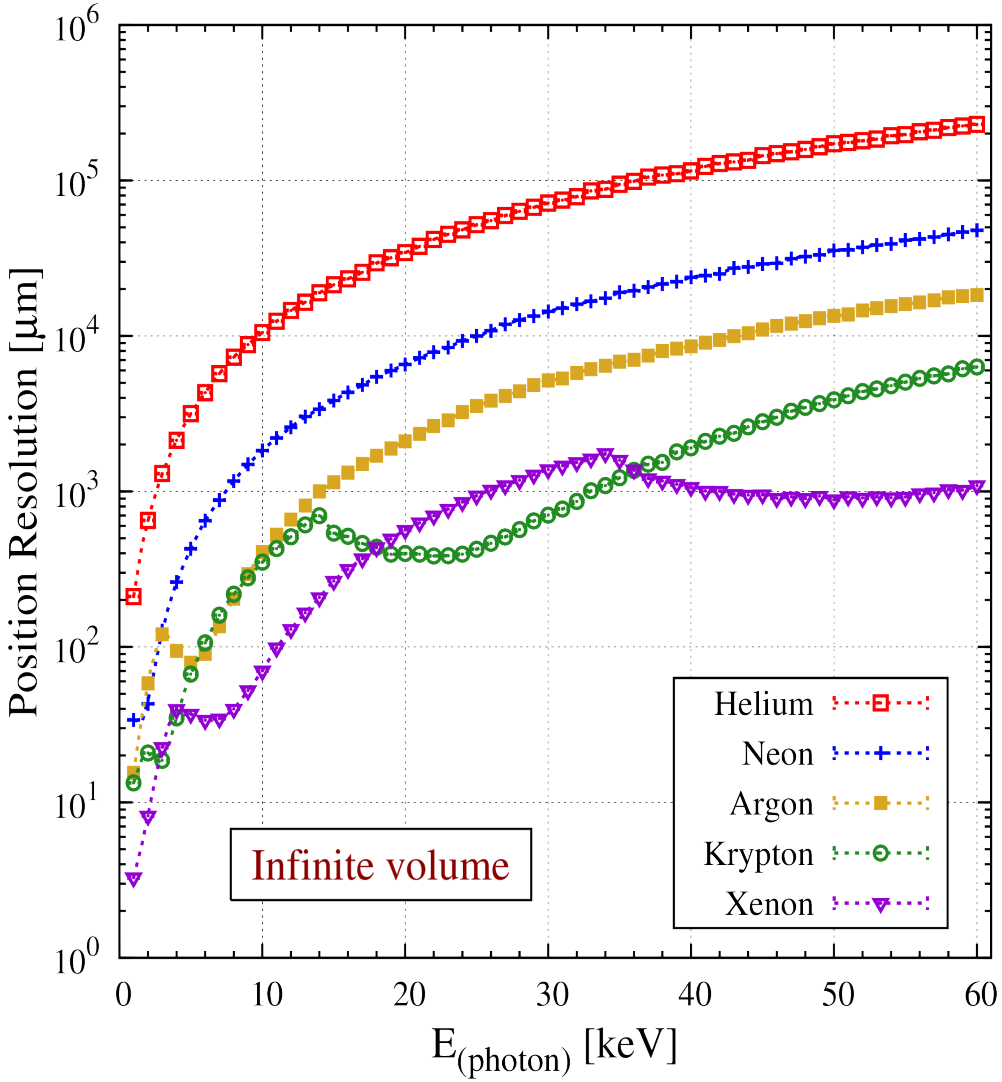
- **Photon energy dependence**
- **Gas dependence**

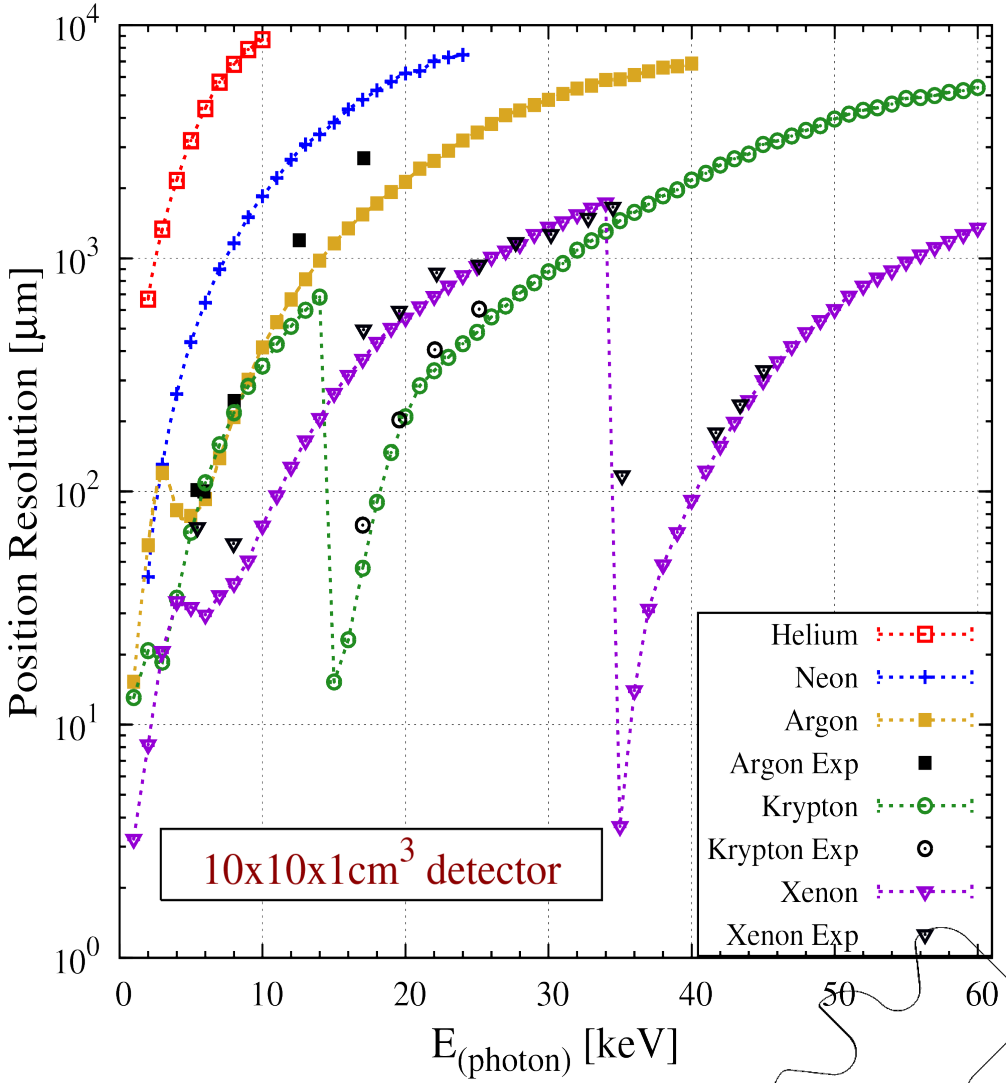




X-ray Position Resolution in gas

- PLB 741(2015)272–275





DEGRAD Calculations conditions

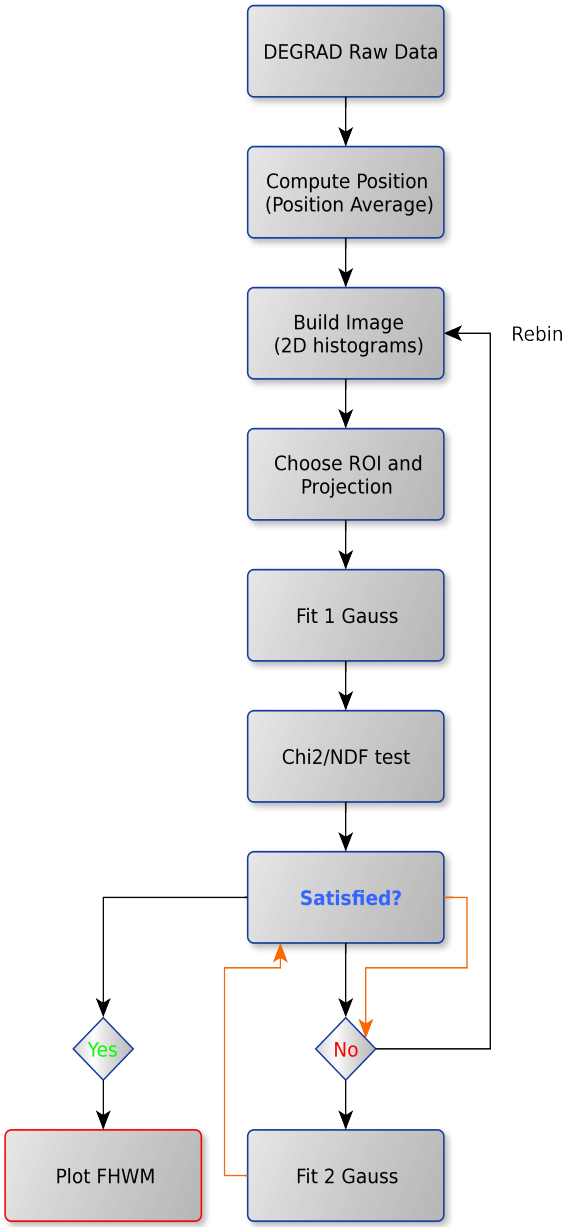
- Gas:
  - Pure Ar, pure Xe
  - Ar/10%CH_4, Ar 20%CO_2, Ar/30%CO_2, Xe/10%CO_2
  - 20 ºC, 1-10 bar
- 500k events
- Photon energy
  - 1-60 keV in 1 keV step
- No magnetic field
- E_{drift} = 300 V/cm.bar
  - Direction parallel to the photon incoming direction
- Stop energy
  - 1 eV below the lowest excitation energy*

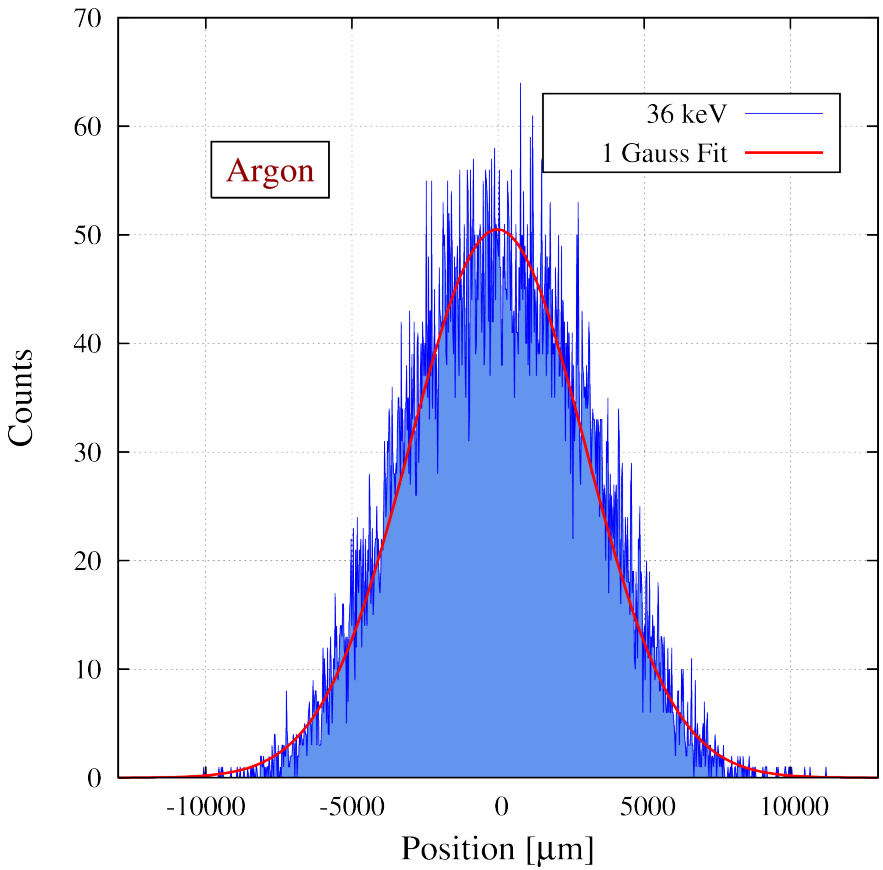
* Values from Magboltzl

Data analysis

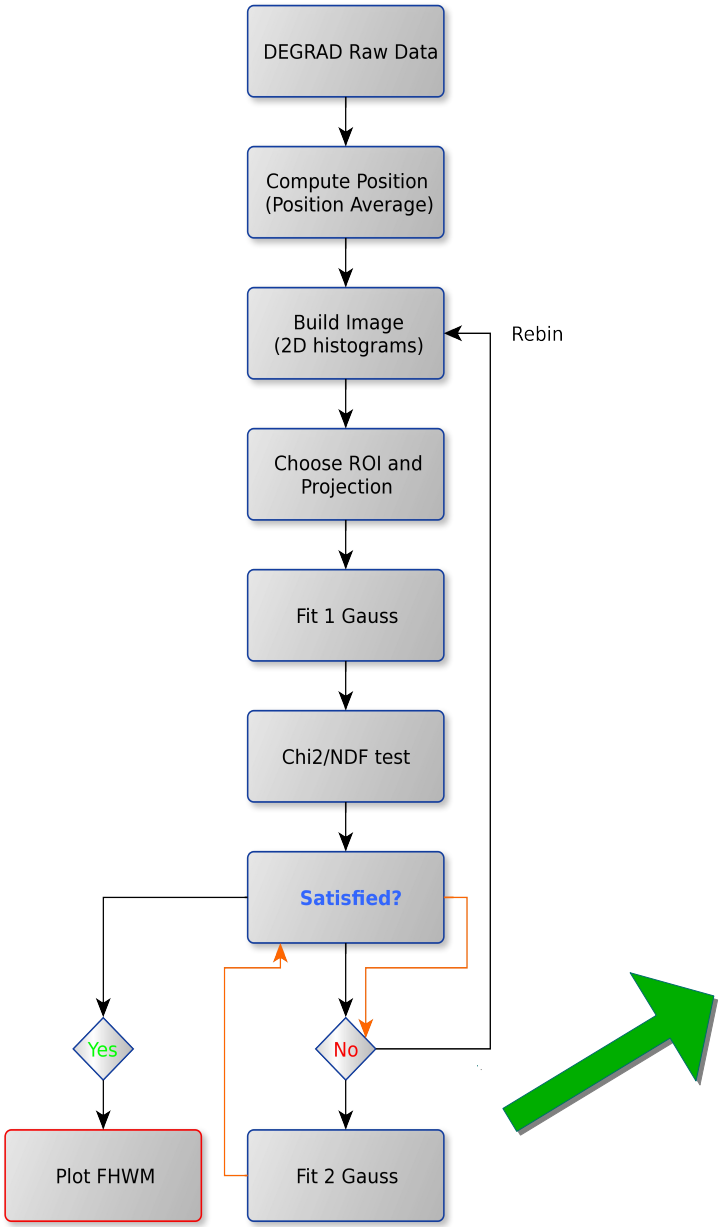
- Geometry
  - Infinite (photons interacting without distance restriction)
  - Detector
    - 10x10x1 cm^3
    - Photon interaction point in the center of the detector
- Each single event:
  - Primary electron position distribution
    - X and Y Position obtained from the averaged distribution
- Image
  - Reconstructed from the detected position distribution (2D histogram)
  - All energies considered (full spectrum), including fluorescence photons
  - Position resolution obtained from the FWHM of a Gaussian distribution

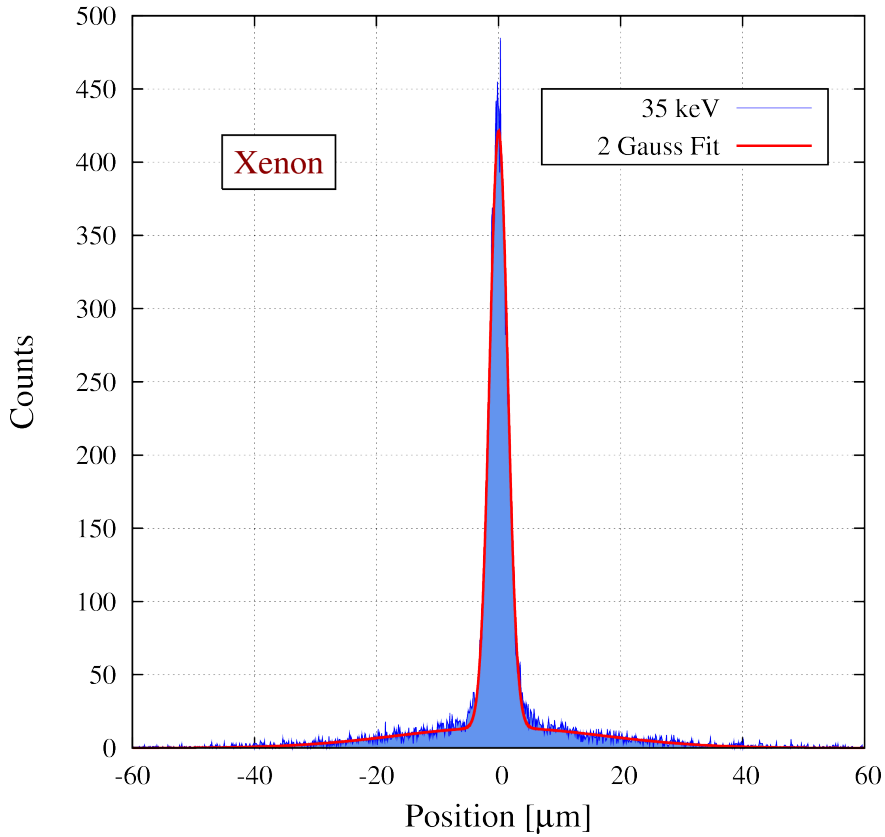
Data analysis



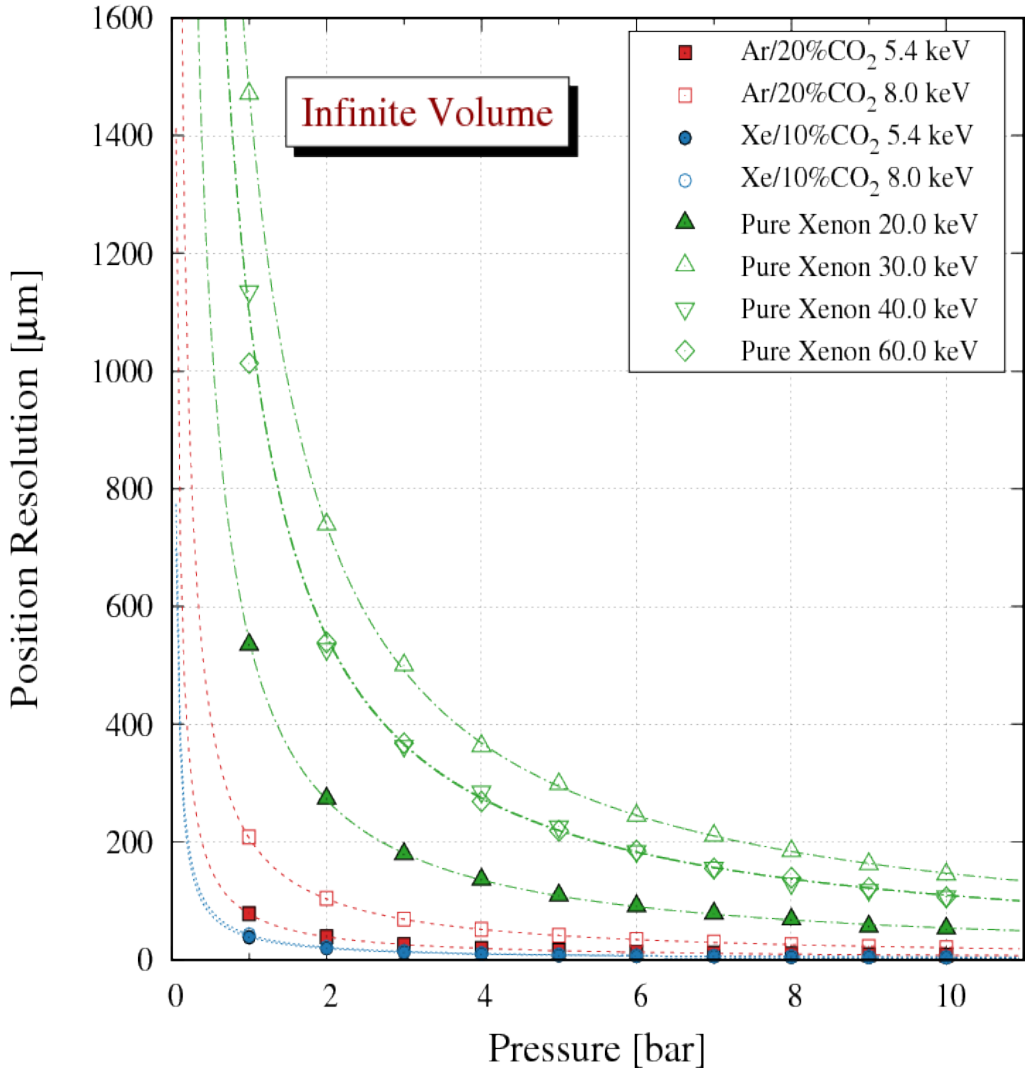


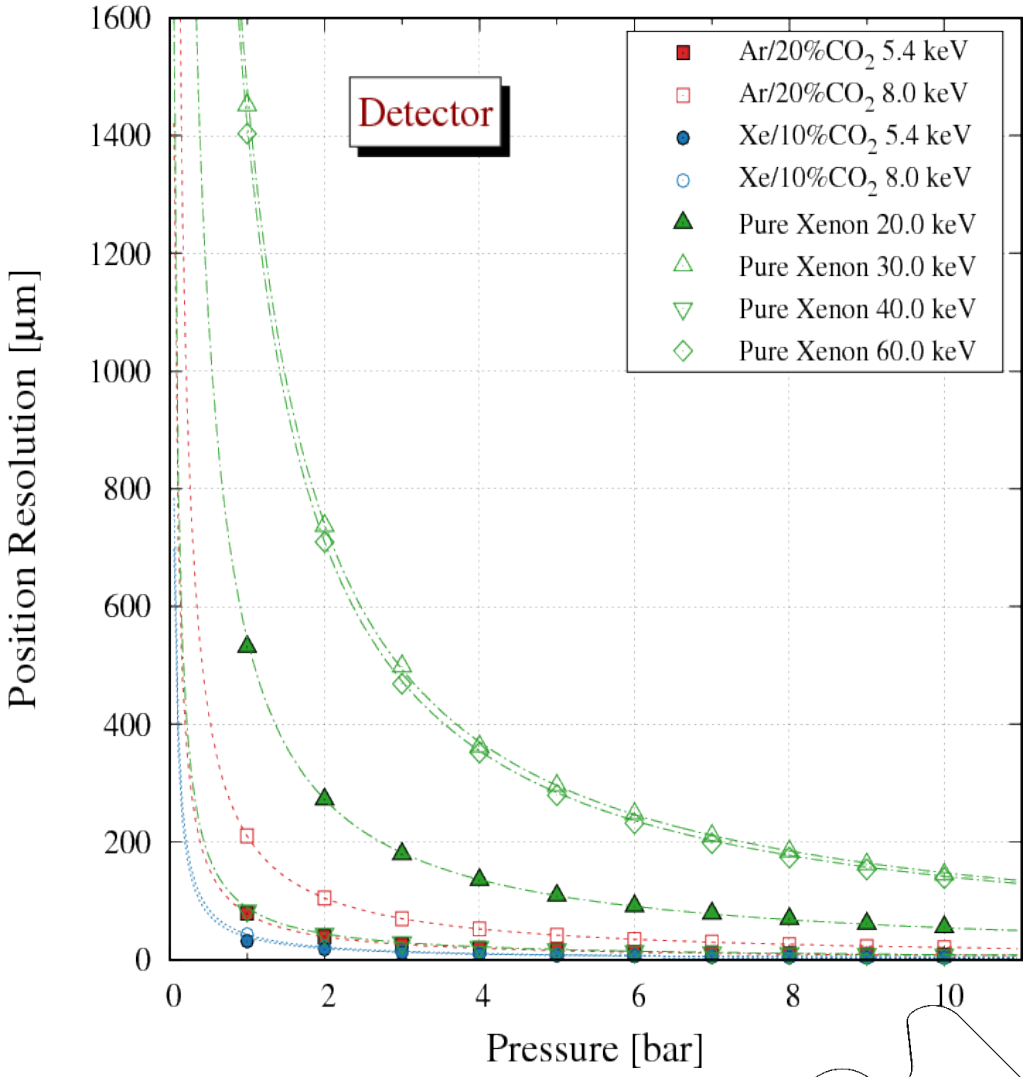
Data analysis



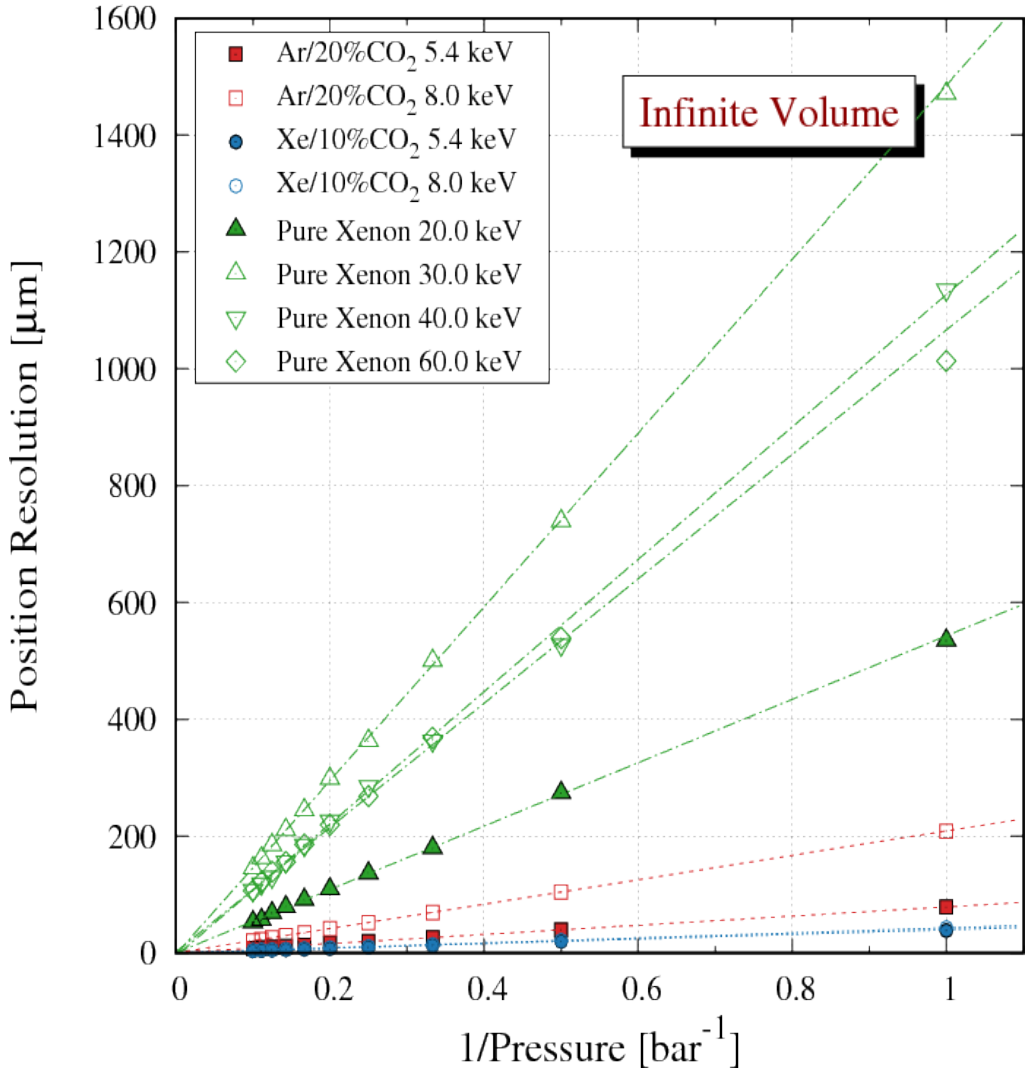


Results


Infinite Volume
Ar/20%CO2 5.4 keV
Ar/20%CO2 8.0 keV
Xe/10%CO2 5.4 keV
Xe/10%CO2 8.0 keV
Pure Xenon 20.0 keV
Pure Xenon 30.0 keV
Pure Xenon 40.0 keV
Pure Xenon 60.0 keV
Position Resolution [µm]
Pressure [bar]
0
200
400
600
800
1000
1200
1400
1600
0
2
4
6
8
10


Detector
Ar/20%CO2 5.4 keV
Ar/20%CO2 8.0 keV
Xe/10%CO2 5.4 keV
Xe/10%CO2 8.0 keV
Pure Xenon 20.0 keV
Pure Xenon 30.0 keV
Pure Xenon 40.0 keV
Pure Xenon 60.0 keV
Position Resolution [µm]
Pressure [bar]
0
200
400
600
800
1000
1200
1400
1600
0
2
4
6
8
10

Results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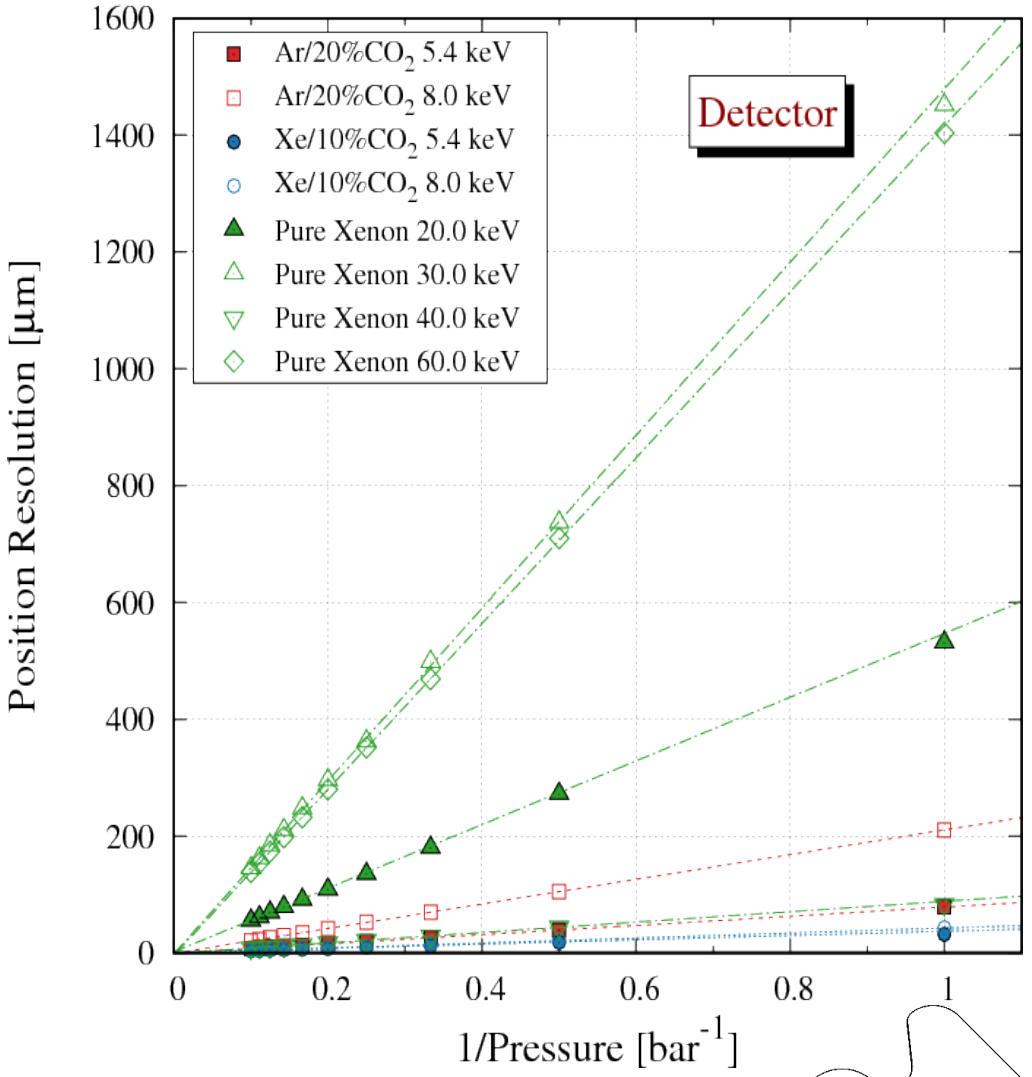
Xe/10%CO2 5.4 keV
Xe/10%CO2 8.0 keV
Pure Xenon 20.0 keV
Pure Xenon 30.0 keV
Pure Xenon 40.0 keV
Pure Xenon 60.0 keV
Position Resolution [µm]
1/Pressure [bar-1]
0
200
400
600
800
1000
1200
1400
1600
0.2
0.4
0.6
0.8
1


Detector
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Ar/20%CO2 8.0 keV
Xe/10%CO2 5.4 keV
Xe/10%CO2 8.0 keV
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Pure Xenon 30.0 keV
Pure Xenon 40.0 keV
Pure Xenon 60.0 keV
Position Resolution [µm]
1/Pressure [bar-1]
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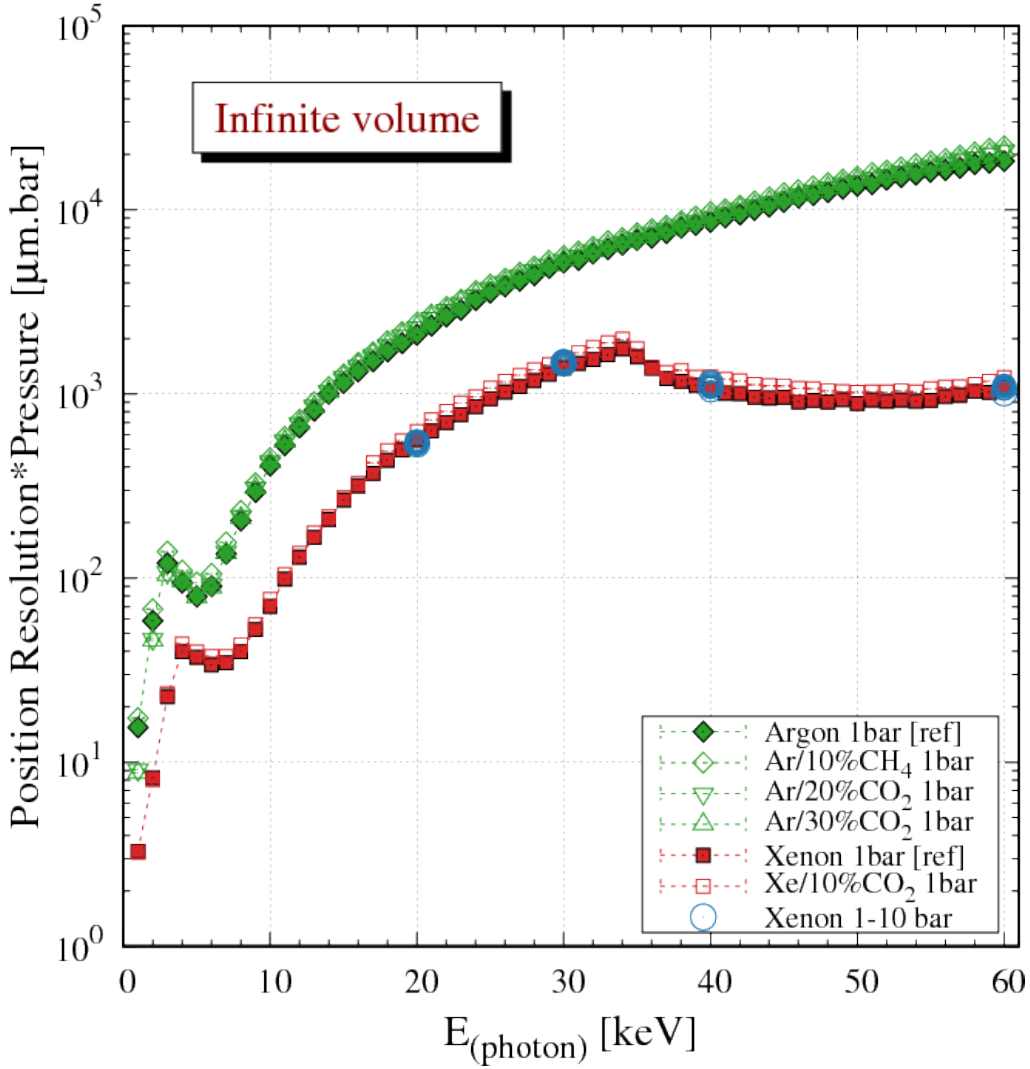
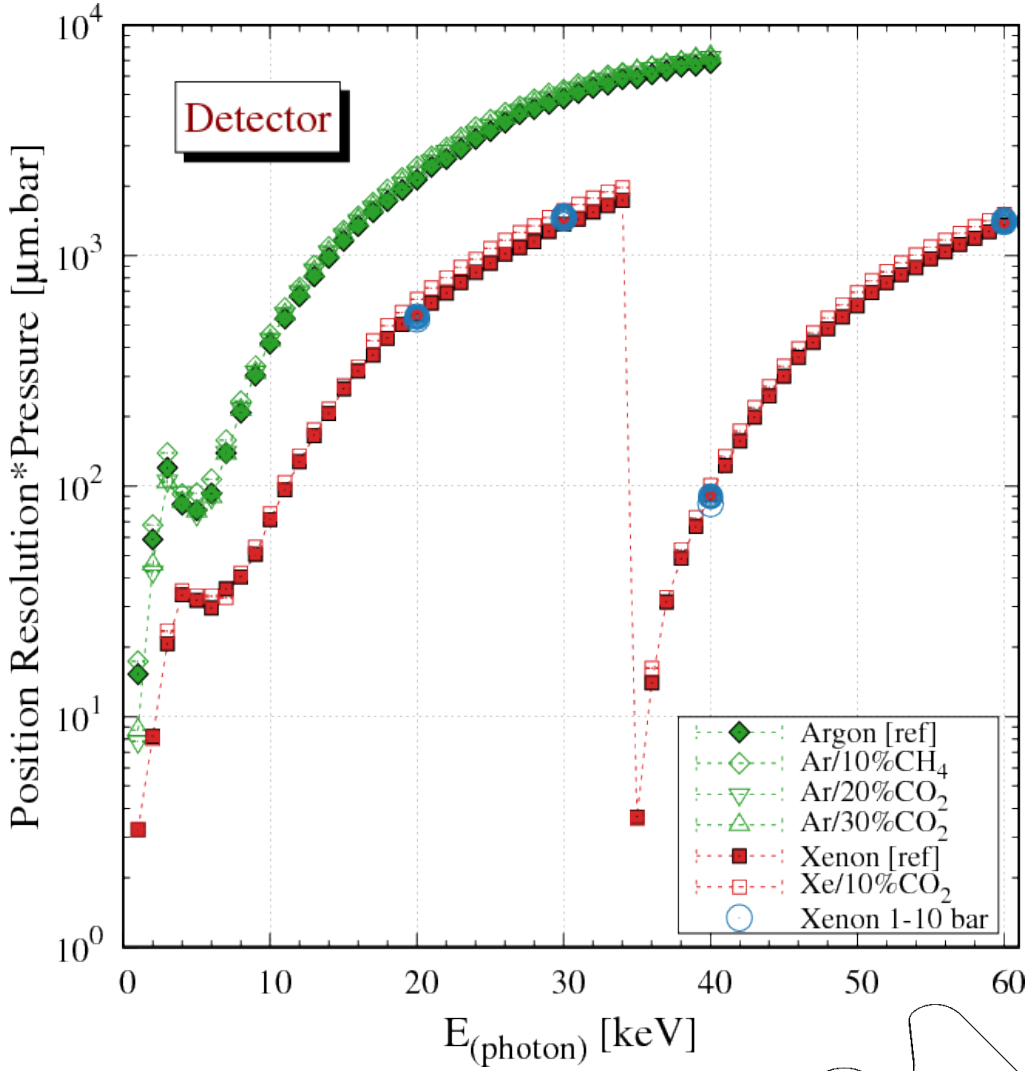
200
400
600
800
1000
1200
1400
1600
0.2
0.4
0.6
0.8
1

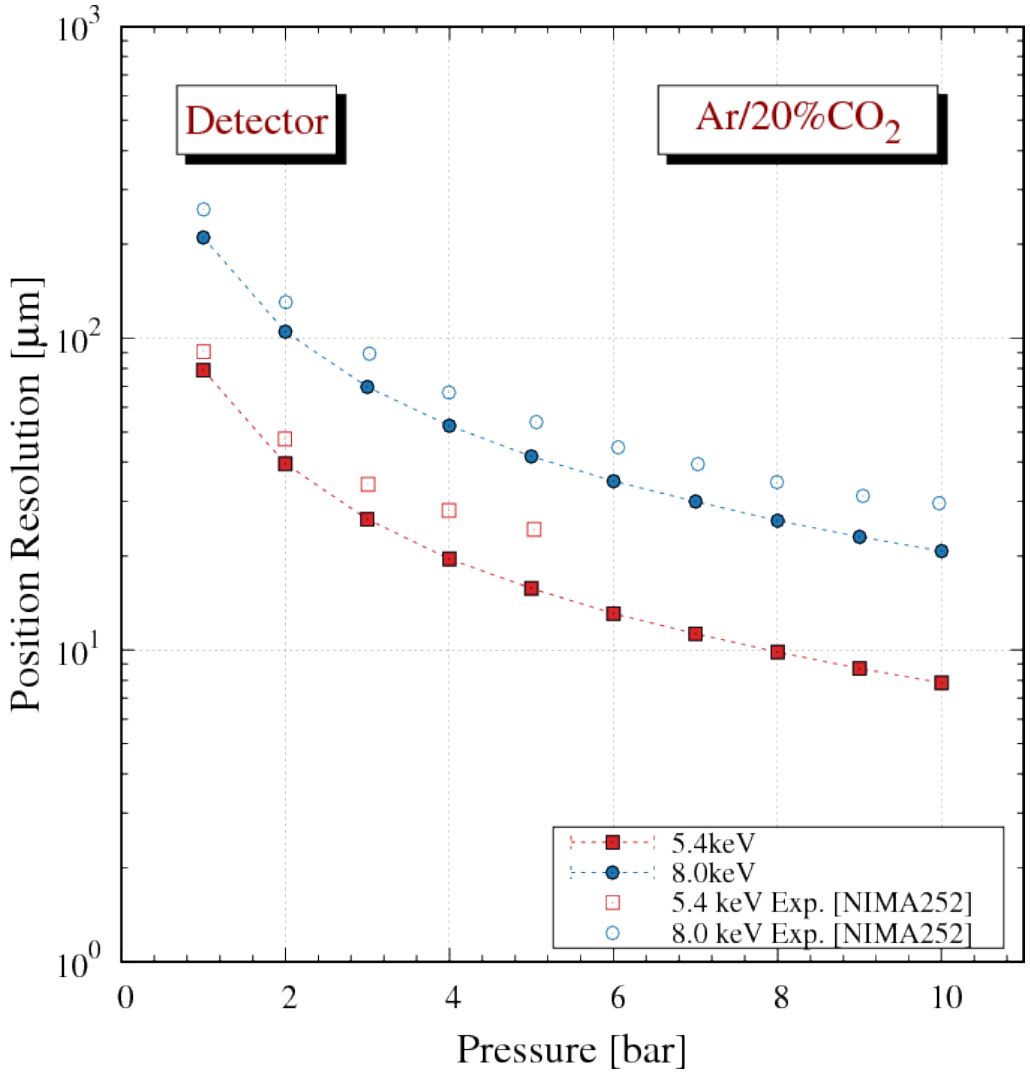
Results

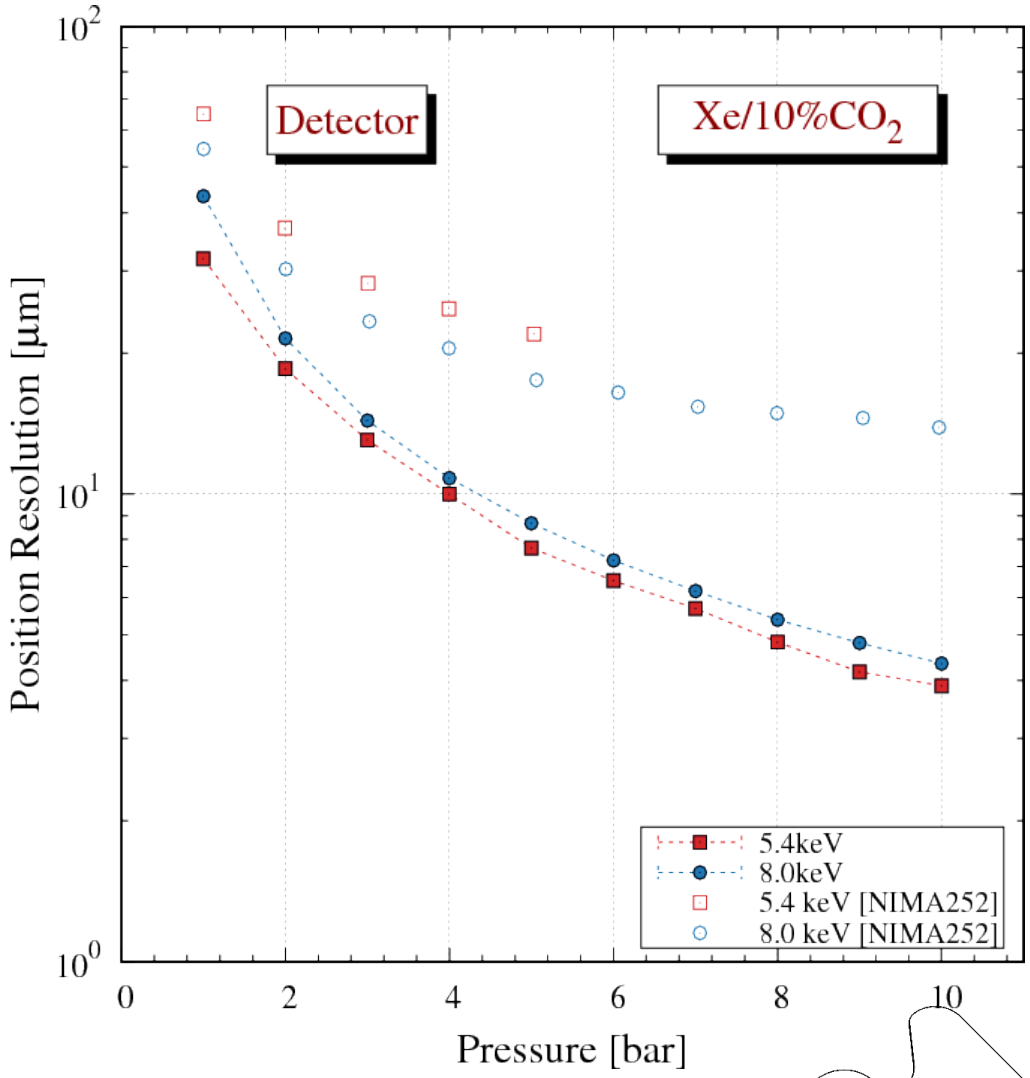




Refs for experimental data:
J. Fischer et al., NIM A 252 (1986) 239; G.C. Smith et al.,NIM A 350 (1994) 621; T.J. Shin et al., NIM A 587 (2008) 434.

Results





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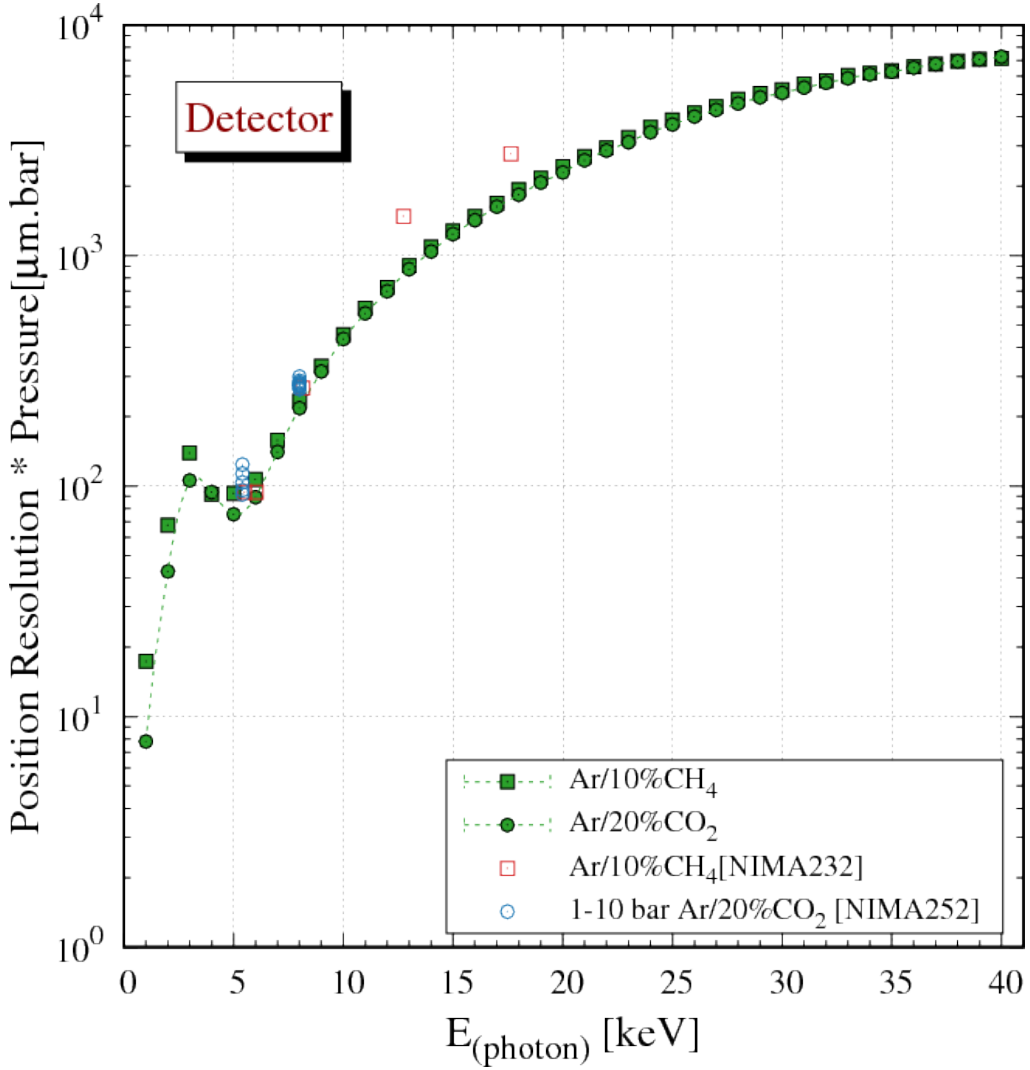
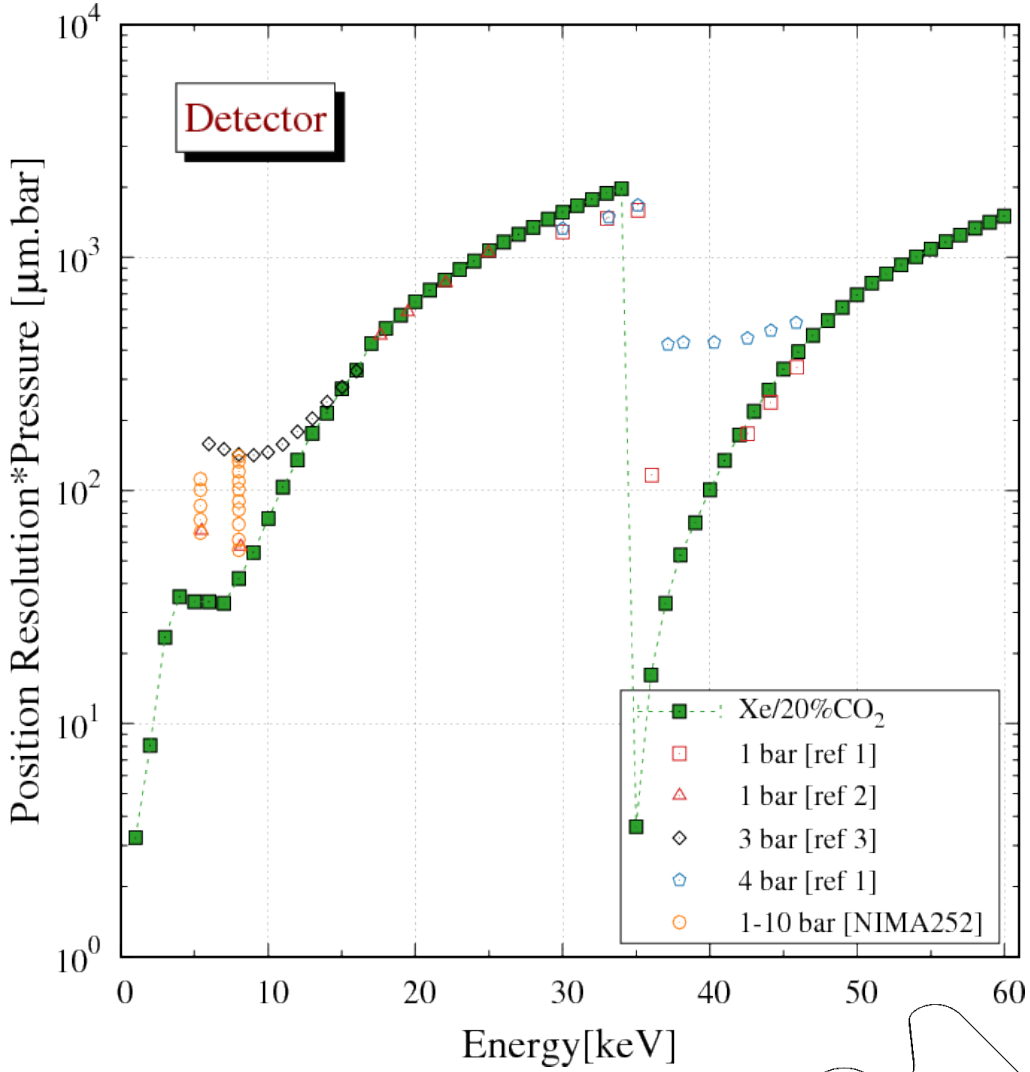
Results





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Conclusions and Future Work

- Preliminary results:
  - Energy resolution and position resolution degradation depending on the detectors geometry
  - Kr competes with Xe in the region 15-35 keV
    - BUT: image performance also depends on the statistics
      - Absorption probability should be included
- Experimental results needed
- Improve the position resolution by using clusterization algorithms (pixelated detectors).