

Erratum: Search for photons with energies above 10^{18} eV using the hybrid detector of the Pierre Auger Observatory

The Pierre Auger collaboration

E-mail: auger_spokespersons@fnal.gov

Received August 22, 2020

Accepted August 22, 2020

Published September 23, 2020

Erratum to: [JCAP04\(2017\)009](#)

ArXiv ePrint: [1612.01517](#)

1 Exposure calculation

Due to a mistake in the numerical integration following eq. (6.2) of the original article [1], the exposure shown in figure 5 of the original article was incorrect. The correct exposure is shown in figure 1.

2 Upper limits on the integral photon flux and fraction

The incorrect exposure affects the calculation of the upper limits on the integral photon flux following eq. (6.1) of the original article. The correct values for the upper limits are 0.038, 0.010, 0.009, 0.008 and $0.007 \text{ km}^{-2} \text{ sr}^{-1} \text{ yr}^{-1}$ for threshold energies of 1, 2, 3, 5 and 10 EeV. The correct values for the upper limits on the integral photon fraction subsequently derived are 0.14 %, 0.17 %, 0.42 %, 0.86 % and 2.9 % for the same threshold energies.

3 Author list

The author list of this erratum also corrects a mistake made in the original article, where F. Zuccarello was missing and Z. Zong was listed twice.



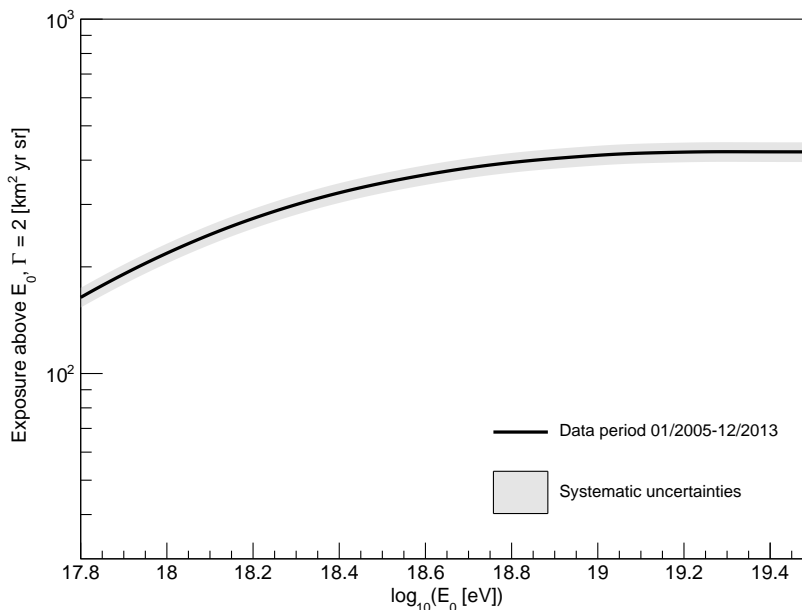


Figure 1. Hybrid exposure for primary photons in the time interval 1 January 2005–31 December 2013, assuming a power-law spectrum with $\Gamma = 2$. Systematic uncertainties due to the ontime and the trigger efficiency are shown as a gray band.

References

- [1] PIERRE AUGER collaboration, *Search for photons with energies above 10^{18} eV using the hybrid detector of the Pierre Auger Observatory*, *JCAP* **04** (2017) 009 [[arXiv:1612.01517](#)] [[INSPIRE](#)].

The Pierre Auger collaboration

A. Aab⁶³, P. Abreu⁷⁰, M. Aglietta^{48,47}, I. Al Samarai²⁹, I.F.M. Albuquerque¹⁶, I. Allekotte¹, A. Almela^{8,11}, J. Alvarez Castillo⁶², J. Alvarez-Muñiz⁷⁸, G.A. Anastasi³⁸, L. Anchordoqui⁸², B. Andrada⁸, S. Andringa⁷⁰, C. Aramo⁴⁵, F. Arqueros⁷⁶, N. Arsene⁹, H. Asorey^{1,24}, P. Assis⁷⁰, J. Aublin²⁹, G. Avila^{9,10}, A.M. Badescu⁷³, A. Balaceanu⁷¹, R.J. Barreira Luz⁷⁰, J.J. Beatty⁸⁷, K.H. Becker³¹, J.A. Bellido¹², C. Berat³⁰, M.E. Bertaina^{56,47}, X. Bertou¹, P.L. Biermann^b, P. Billoir²⁹, J. Biteau²⁸, S.G. Blaess¹², A. Blanco⁷⁰, J. Blazek²⁵, C. Bleve^{50,43}, M. Boháčová²⁵, D. Boncioli^{40,d}, C. Bonifazi²², N. Borodai⁶⁷, A.M. Botti^{8,33}, J. Brack⁸¹, I. Brancus⁷¹, T. Bretz³⁵, A. Bridgeman³³, F.L. Briechle³⁵, P. Buchholz³⁷, A. Bueno⁷⁷, S. Buitink⁶³, M. Buscemi^{52,42}, K.S. Caballero-Mora⁶⁰, L. Caccianiga⁵³, A. Cancio^{11,8}, F. Canfora⁶³, L. Caramete⁷², R. Caruso^{52,42}, A. Castellina^{48,47}, G. Cataldi⁴³, L. Cazon⁷⁰, A.G. Chavez⁶¹, J.A. Chinellato¹⁷, J. Chudoba²⁵, R.W. Clay¹², R. Colalillo^{54,45}, A. Coleman⁸⁸, L. Collica⁴⁷, M.R. Coluccia^{50,43}, R. Conceição⁷⁰, F. Contreras^{9,10}, M.J. Cooper¹², S. Coutu⁸⁸, C.E. Covault⁷⁹, J. Cronin⁸⁹, S. D’Amico^{49,43}, B. Daniel¹⁷, S. Dasso^{5,3}, K. Daumiller³³, B.R. Dawson¹², R.M. de Almeida²³, S.J. de Jong^{63,65}, G. De Mauro⁶³, J.R.T. de Mello Neto²², I. De Mitri^{50,43}, J. de Oliveira²³, V. de Souza¹⁵, J. Debatin³³, O. Deligny²⁸, C. Di Giulio^{55,46}, A. Di Matteo^{51,41}, M.L. Díaz Castro¹⁷, F. Diogo⁷⁰, C. Dobrigkeit¹⁷, J.C. D’Olivo⁶², Q. Dorosti³⁷, R.C. dos Anjos²¹, M.T. Dova⁴, A. Dundovic³⁶, J. Ebr²⁵, R. Engel³³, M. Erdmann³⁵, M. Erfani³⁷, C.O. Escobar^f, J. Espadanal⁷⁰, A. Etchegoyen^{8,11}, H. Falcke^{63,66,65}, G. Farrar⁸⁵, A.C. Fauth¹⁷, N. Fazzini^f, B. Fick⁸⁴, J.M. Figueira⁸, A. Filipčić^{74,75}, O. Fratu⁷³, M.M. Freire⁶, T. Fujii⁸⁹, A. Fuster^{8,11}, R. Gaior²⁹, B. García⁷, D. Garcia-Pinto⁷⁶, F. Gaté^e, H. Gemmeke³⁴, A. Gherghel-Lascu⁷¹, P.L. Ghia²⁸, U. Giaccari²², M. Giammarchi⁴⁴, M. Giller⁶⁸, D. Glas⁶⁹, C. Glaser³⁵, G. Golup¹, M. Gómez Berisso¹, P.F. Gómez Vitale^{9,10}, N. González^{8,33}, A. Gorgi^{48,47}, P. Gorham⁹⁰, A.F. Grillo⁴⁰, T.D. Grubb¹², F. Guarino^{54,45}, G.P. Guedes¹⁸, M.R. Hampel⁸, P. Hansen⁴, D. Harari¹,

T.A. Harrison¹², J.L. Harton⁸¹, A. Haungs³³, T. Hebbeker³⁵, D. Heck³³, P. Heimann³⁷,
A.E. Herve³², G.C. Hill¹², C. Hojvat^f, E. Holt^{33,8}, P. Homola⁶⁷, J.R. Hörandel^{63,65}, P. Horvath²⁶,
M. Hrabovský²⁶, T. Huege³³, J. Hulsman^{8,33}, A. Insolia^{52,42}, P.G. Isar⁷², I. Jandt³¹, S. Jansen^{63,65},
J.A. Johnsen⁸⁰, M. Josebachuili⁸, A. Kääpä³¹, O. Kambeitz³², K.H. Kampert³¹, I. Katkov³²,
B. Keilhauer³³, E. Kemp¹⁷, J. Kemp³⁵, R.M. Kieckhafer⁸⁴, H.O. Klages³³, M. Kleifges³⁴,
J. Kleinfeller⁹, R. Krause³⁵, N. Krohm³¹, D. Kuempel³⁵, G. Kukec Mezek⁷⁵, N. Kunka³⁴, A. Kuotb
Awad³³, D. LaHurd⁷⁹, M. Lauscher³⁵, R. Legumina⁶⁸, M.A. Leigui de Oliveira²⁰,
A. Letessier-Selvon²⁹, I. Lhenry-Yvon²⁸, K. Link³², L. Lopes⁷⁰, R. López⁵⁷, A. López Casado⁷⁸,
Q. Luce²⁸, A. Lucero^{8,11}, M. Malacari⁸⁹, M. Mallamaci^{53,44}, D. Mandat²⁵, P. Mantsch^f,
A.G. Mariazzi⁴, I.C. Mariş⁷⁷, G. Marsella^{50,43}, D. Martello^{50,43}, H. Martinez⁵⁸, O. Martínez
Bravo⁵⁷, J.J. Masías Meza³, H.J. Mathes³³, S. Mathys³¹, J. Matthews⁸³, J.A.J. Matthews⁹²,
G. Matthiae^{55,46}, E. Mayotte³¹, P.O. Mazur^f, C. Medina⁸⁰, G. Medina-Tanco⁶², D. Melo⁸,
A. Menshikov³⁴, M.I. Micheletti⁶, L. Middendorf³⁵, I.A. Minaya⁷⁶, L. Miramonti^{53,44}, B. Mitrica⁷¹,
D. Mockler³², S. Mollerach¹, F. Montanet³⁰, C. Morello^{48,47}, M. Mostafá⁸⁸, A.L. Müller^{8,33},
G. Müller³⁵, M.A. Muller^{17,19}, S. Müller^{33,8}, R. Mussa⁴⁷, I. Naranjo¹, L. Nellen⁶², P.H. Nguyen¹²,
M. Niculescu-Oglinzanu⁷¹, M. Niechciol³⁷, L. Niemietz³¹, T. Niggemann³⁵, D. Nitz⁸⁴, D. Nosek²⁷,
V. Novotny²⁷, H. Nožka²⁶, L.A. Núñez²⁴, L. Ochilo³⁷, F. Oikonomou⁸⁸, A. Olinto⁸⁹, M. Palatka²⁵,
J. Pallotta², P. Papenbreer³¹, G. Parente⁷⁸, A. Parra⁵⁷, T. Paul^{86,82}, M. Pech²⁵, F. Pedreira⁷⁸,
J. Pękala⁶⁷, R. Pelayo⁵⁹, J. Peña-Rodríguez²⁴, L. A. S. Pereira¹⁷, M. Perlín⁸, L. Perrone^{50,43},
C. Peters³⁵, S. Petrera^{51,38,41}, J. Phuntsok⁸⁸, R. Piegaiá³, T. Pierog³³, P. Pieroni³, M. Pimenta⁷⁰,
V. Pirronello^{52,42}, M. Platino⁸, M. Plum³⁵, C. Porowski⁶⁷, R.R. Prado¹⁵, P. Privitera⁸⁹,
M. Prouza²⁵, E.J. Quel², S. Querschfeld³¹, S. Quinn⁷⁹, R. Ramos-Pollan²⁴, J. Rautenberg³¹,
D. Ravignani⁸, B. Revenu^e, J. Ridky²⁵, M. Risse³⁷, P. Ristori², V. Rizi^{51,41}, W. Rodrigues de
Carvalho¹⁶, G. Rodriguez Fernandez^{55,46}, J. Rodriguez Rojo⁹, D. Rogozin³³, M.J. Roncoroni⁸,
M. Roth³³, E. Roulet¹, A.C. Rovero⁵, P. Ruehl³⁷, S.J. Saffi¹², A. Saftoiu⁷¹, F. Salamida^{51,41},
H. Salazar⁵⁷, A. Saleh⁷⁵, F. Salesa Greus⁸⁸, G. Salina⁴⁶, F. Sánchez⁸, P. Sanchez-Lucas⁷⁷,
E.M. Santos¹⁶, E. Santos⁸, F. Sarazin⁸⁰, R. Sarmento⁷⁰, C.A. Sarmiento⁸, R. Sato⁹, M. Schauer³¹,
V. Scherini⁴³, H. Schieler³³, M. Schimp³¹, D. Schmidt^{33,8}, O. Scholten^{64,c}, P. Schovánek²⁵,
F.G. Schröder³³, A. Schulz³², J. Schulz⁶³, J. Schumacher³⁵, S.J. Sciutto⁴, A. Segreto^{39,42},
M. Settimo²⁹, A. Shadkam⁸³, R.C. Shellard¹³, G. Sigl³⁶, G. Silli^{8,33}, O. Sima^g, A. Śmiałkowski⁶⁸,
R. Šmída³³, G.R. Snow⁹¹, P. Sommers⁸⁸, S. Sonntag³⁷, J. Sorokin¹², R. Squartini⁹, D. Stanca⁷¹,
S. Stanič⁷⁵, J. Stasielak⁶⁷, P. Stassi³⁰, F. Strafella^{50,43}, F. Suarez^{8,11}, M. Suarez Durán²⁴,
T. Sudholz¹², T. Suomijärvi²⁸, A.D. Supanitsky⁵, J. Swain⁸⁶, Z. Szadkowski⁶⁹, A. Taboada³²,
O.A. Taborda¹, A. Tapia⁸, V.M. Theodoro¹⁷, C. Timmermans^{65,63}, C.J. Todero Peixoto¹⁴,
L. Tomankova³³, B. Tomé⁷⁰, G. Torralba Elipse⁷⁸, P. Travnicek²⁵, M. Trini⁷⁵, R. Ulrich³³,
M. Unger³³, M. Urban³⁵, J.F. Valdés Galicia⁶², I. Valiño⁷⁸, L. Valore^{54,45}, G. van Aar⁶³, P. van
Bodegom¹², A.M. van den Berg⁶⁴, A. van Vliet⁶³, E. Varela⁵⁷, B. Vargas Cárdenas⁶², G. Varner⁹⁰,
J.R. Vázquez⁷⁶, R.A. Vázquez⁷⁸, D. Veberić³³, I.D. Vergara Quispe⁴, V. Verzi⁴⁶, J. Vicha²⁵,
L. Villaseñor⁶¹, S. Vorobiov⁷⁵, H. Wahlberg⁴, O. Wainberg^{8,11}, D. Walz³⁵, A.A. Watson^a,
M. Weber³⁴, A. Weindl³³, L. Wiencke⁸⁰, H. Wilczyński⁶⁷, T. Winchen³¹, M. Wirtz³⁵,
D. Wittkowski³¹, B. Wundheiler⁸, L. Yang⁷⁵, D. Yelos^{11,8}, A. Yushkov⁸, E. Zas⁷⁸, D. Zavrtnik^{75,74},
M. Zavrtnik^{74,75}, A. Zepeda⁵⁸, B. Zimmermann³⁴, M. Ziolkowski³⁷, Z. Zong²⁸
and F. Zuccarello^{42,52}

¹ *Centro Atómico Bariloche and Instituto Balseiro (CNEA-UNCuyo-CONICET), Argentina*

² *Centro de Investigaciones en Láseres y Aplicaciones, CITEDEF and CONICET, Argentina*

³ *Departamento de Física and Departamento de Ciencias de la Atmósfera y los Océanos, FCEyN, Universidad de Buenos Aires, Argentina*

⁴ *IFLP, Universidad Nacional de La Plata and CONICET, Argentina*

⁵ *Instituto de Astronomía y Física del Espacio (IAFE, CONICET-UBA), Argentina*

⁶ *Instituto de Física de Rosario (IFIR) — CONICET/U.N.R. and Facultad de Ciencias Bioquímicas y Farmacéuticas U.N.R., Argentina*

⁷ *Instituto de Tecnologías en Detección y Astropartículas (CNEA, CONICET, UNSAM) and Universidad Tecnológica Nacional — Facultad Regional Mendoza (CONICET/CNEA), Argentina*

- ⁸ *Instituto de Tecnologías en Detección y Astropartículas (CNEA, CONICET, UNSAM), Centro Atómico Constituyentes, Comisión Nacional de Energía Atómica, Argentina*
- ⁹ *Observatorio Pierre Auger, Argentina*
- ¹⁰ *Observatorio Pierre Auger and Comisión Nacional de Energía Atómica, Argentina*
- ¹¹ *Universidad Tecnológica Nacional — Facultad Regional Buenos Aires, Argentina*
- ¹² *University of Adelaide, Australia*
- ¹³ *Centro Brasileiro de Pesquisas Físicas (CBPF), Brazil*
- ¹⁴ *Universidade de São Paulo, Escola de Engenharia de Lorena, Brazil*
- ¹⁵ *Universidade de São Paulo, Inst. de Física de São Carlos, São Carlos, Brazil*
- ¹⁶ *Universidade de São Paulo, Inst. de Física, São Paulo, Brazil*
- ¹⁷ *Universidade Estadual de Campinas (UNICAMP), Brazil*
- ¹⁸ *Universidade Estadual de Feira de Santana (UEFS), Brazil*
- ¹⁹ *Universidade Federal de Pelotas, Brazil*
- ²⁰ *Universidade Federal do ABC (UFABC), Brazil*
- ²¹ *Universidade Federal do Paraná, Setor Palotina, Brazil*
- ²² *Universidade Federal do Rio de Janeiro (UFRJ), Instituto de Física, Brazil*
- ²³ *Universidade Federal Fluminense, Brazil*
- ²⁴ *Universidad Industrial de Santander, Colombia*
- ²⁵ *Institute of Physics (FZU) of the Academy of Sciences of the Czech Republic, Czech Republic*
- ²⁶ *Palacky University, RCPTM, Czech Republic*
- ²⁷ *University Prague, Institute of Particle and Nuclear Physics, Czech Republic*
- ²⁸ *Institut de Physique Nucléaire d'Orsay (IPNO), Université Paris-Sud, Univ. Paris/Saclay, CNRS-IN2P3, France, France*
- ²⁹ *Laboratoire de Physique Nucléaire et de Hautes Energies (LPNHE), Universités Paris 6 et Paris 7, CNRS-IN2P3, France*
- ³⁰ *Laboratoire de Physique Subatomique et de Cosmologie (LPSC), Université Grenoble-Alpes, CNRS/IN2P3, France*
- ³¹ *Bergische Universität Wuppertal, Department of Physics, Germany*
- ³² *Karlsruhe Institute of Technology, Institut für Experimentelle Kernphysik (IEKP), Germany*
- ³³ *Karlsruhe Institute of Technology, Institut für Kernphysik (IKP), Germany*
- ³⁴ *Karlsruhe Institute of Technology, Institut für Prozessdatenverarbeitung und Elektronik (IPE), Germany*
- ³⁵ *RWTH Aachen University, III. Physikalisches Institut A, Germany*
- ³⁶ *Universität Hamburg, II. Institut für Theoretische Physik, Germany*
- ³⁷ *Universität Siegen, Fachbereich 7 Physik — Experimentelle Teilchenphysik, Germany*
- ³⁸ *Gran Sasso Science Institute (INFN), L'Aquila, Italy*
- ³⁹ *INAF — Istituto di Astrofisica Spaziale e Fisica Cosmica di Palermo, Italy*
- ⁴⁰ *INFN Laboratori Nazionali del Gran Sasso, Italy*
- ⁴¹ *INFN, Gruppo Collegato dell'Aquila, Italy*
- ⁴² *INFN, Sezione di Catania, Italy*
- ⁴³ *INFN, Sezione di Lecce, Italy*
- ⁴⁴ *INFN, Sezione di Milano, Italy*
- ⁴⁵ *INFN, Sezione di Napoli, Italy*
- ⁴⁶ *INFN, Sezione di Roma "Tor Vergata", Italy*
- ⁴⁷ *INFN, Sezione di Torino, Italy*
- ⁴⁸ *Osservatorio Astrofisico di Torino (INAF), Torino, Italy*
- ⁴⁹ *Università del Salento, Dipartimento di Ingegneria, Italy*
- ⁵⁰ *Università del Salento, Dipartimento di Matematica e Fisica "E. De Giorgi", Italy*
- ⁵¹ *Università dell'Aquila, Dipartimento di Scienze Fisiche e Chimiche, Italy*
- ⁵² *Università di Catania, Dipartimento di Fisica e Astronomia, Italy*
- ⁵³ *Università di Milano, Dipartimento di Fisica, Italy*
- ⁵⁴ *Università di Napoli "Federico II", Dipartimento di Fisica "Ettore Pancini", Italy*
- ⁵⁵ *Università di Roma "Tor Vergata", Dipartimento di Fisica, Italy*
- ⁵⁶ *Università Torino, Dipartimento di Fisica, Italy*
- ⁵⁷ *Benemérita Universidad Autónoma de Puebla (BUAP), México*
- ⁵⁸ *Centro de Investigación y de Estudios Avanzados del IPN (CINVESTAV), México*
- ⁵⁹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas del Instituto Politécnico Nacional (UPIITA-IPN), México*
- ⁶⁰ *Universidad Autónoma de Chiapas, México*

- ⁶¹ *Universidad Michoacana de San Nicolás de Hidalgo, México*
- ⁶² *Universidad Nacional Autónoma de México, México*
- ⁶³ *Institute for Mathematics, Astrophysics and Particle Physics (IMAPP), Radboud Universiteit, Nijmegen, Netherlands*
- ⁶⁴ *KVI — Center for Advanced Radiation Technology, University of Groningen, Netherlands*
- ⁶⁵ *Nationaal Instituut voor Kernfysica en Hoge Energie Fysica (NIKHEF), Netherlands*
- ⁶⁶ *Stichting Astronomisch Onderzoek in Nederland (ASTRON), Dwingeloo, Netherlands*
- ⁶⁷ *Institute of Nuclear Physics PAN, Poland*
- ⁶⁸ *University of Łódź, Faculty of Astrophysics, Poland*
- ⁶⁹ *University of Łódź, Faculty of High-Energy Astrophysics, Poland*
- ⁷⁰ *Laboratório de Instrumentação e Física Experimental de Partículas — LIP and Instituto Superior Técnico — IST, Universidade de Lisboa — UL, Portugal*
- ⁷¹ *“Horia Hulubei” National Institute for Physics and Nuclear Engineering, Romania*
- ⁷² *Institute of Space Science, Romania*
- ⁷³ *University Politehnica of Bucharest, Romania*
- ⁷⁴ *Experimental Particle Physics Department, J. Stefan Institute, Slovenia*
- ⁷⁵ *Laboratory for Astroparticle Physics, University of Nova Gorica, Slovenia*
- ⁷⁶ *Universidad Complutense de Madrid, Spain*
- ⁷⁷ *Universidad de Granada and C.A.F.P.E., Spain*
- ⁷⁸ *Universidad de Santiago de Compostela, Spain*
- ⁷⁹ *Case Western Reserve University, U.S.A.*
- ⁸⁰ *Colorado School of Mines, U.S.A.*
- ⁸¹ *Colorado State University, U.S.A.*
- ⁸² *Department of Physics and Astronomy, Lehman College, City University of New York, U.S.A.*
- ⁸³ *Louisiana State University, U.S.A.*
- ⁸⁴ *Michigan Technological University, U.S.A.*
- ⁸⁵ *New York University, U.S.A.*
- ⁸⁶ *Northeastern University, U.S.A.*
- ⁸⁷ *Ohio State University, U.S.A.*
- ⁸⁸ *Pennsylvania State University, U.S.A.*
- ⁸⁹ *University of Chicago, U.S.A.*
- ⁹⁰ *University of Hawaii, U.S.A.*
- ⁹¹ *University of Nebraska, U.S.A.*
- ⁹² *University of New Mexico, U.S.A.*
- (a) *School of Physics and Astronomy, University of Leeds, Leeds, United Kingdom*
- (b) *Max-Planck-Institut für Radioastronomie, Bonn, Germany*
- (c) *also at Vrije Universiteit Brussels, Brussels, Belgium*
- (d) *now at Deutsches Elektronen-Synchrotron (DESY), Zeuthen, Germany*
- (e) *SUBATECH, École des Mines de Nantes, CNRS-IN2P3, Université de Nantes*
- (f) *Fermi National Accelerator Laboratory, U.S.A.*
- (g) *University of Bucharest, Physics Department, Bucharest*