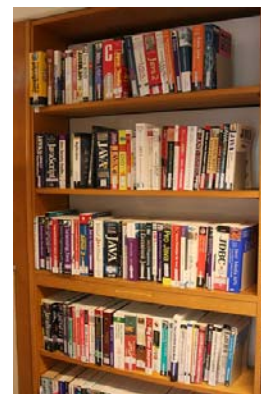
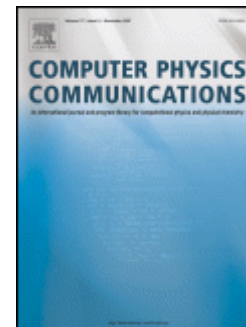


# The **impact** of **technological research** through an analysis of **literature**



Maria Grazia Pia  
INFN Genova, Italy

T. Basaglia (CERN), Z. Bell (ORNL),  
P. Dressendorfer (IEEE), J. Vigen (CERN)



IEEE Nuclear Science Symposium 2008  
Dresden, 18-25 October 2008





```

<!-- parameters for the shaping amp -->
<parameter name="StartDelayTime" type="double"> 42 </parameter>
<parameter name="StartDelayTime" type="double"> 42.3 </parameter>
<parameter name="StartDelayTime" type="double"> 9.9 </parameter>
<!-- parameters for the ASE -->
<parameter name="TimeOffset" type="double"> 1.0 </parameter>
<parameter name="TimeOffset" type="int"> 10 </parameter>
<!-- parameters of the geometry of the mount pads -->
<!-- PadLayoutID -->
<!-- Type -->
<!-- rSize -->
<!-- rMax -->
<!-- padAngle -->
<!-- rAngle -->
<!-- rMax -->
<!-- padAngle -->

```



```

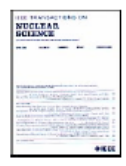
Program Mesh
use fj
implicit None
integer i, j, N
real z(36,30)
c Create data for plotting
do 100 i = 1, 30
  do 200 j = 1, 30
    z(i,j) = 3.0*asin(i+1)/
      + 4.0*cos(j+1)/4.0 + 2.0
    * sin(j)/4.0
  200 continue
  100 continue
c Convert Fortran variable z
c to ndarray using m2D, and
c call m2Mesh for Mesh plot
call m2Mesh(m(2))
c Pause to display the graph
call m2viewPause()
End Program Mesh

```

Writing software  
OR  
Writing scientific articles?

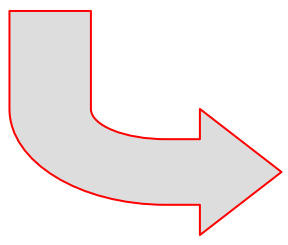
Maria Grazia Pia  
INFN Genova, Italy  
T. Basaglia (CERN), Z. Bell (ORNL),  
P. Dressendorfer (IEEE), A. Larkin (IEEE)  
IEEE Nuclear Science Symposium 2007  
Honolulu, HI, USA

Thanks to A. Howard, J. Knobloch, S. Mele, J. Yeomans (CERN)



S. Agostinelli et al.,  
"Geant4 – a simulation toolkit"  
NIM A 506 (3): 250-303, 2003  
Most cited in Nucl. Sci. Technol.  
663 citations Oct. 2007  
1226 citations Oct. 2008  
2<sup>nd</sup> most cited CERN & INFN

NSS 2007



NSS 2008

>130 software abstracts  
Largest track ever in  
NSS history

**1:** a: an impinging or striking especially of one body against another

b: a forceful contact or onset;

**2:** the force of impression of one thing on another: a significant or major effect

## Measuring impact: Impact Factor

Published in **Journal Citation Report (JCR)**,  
a product of Thomson ISI (Institute for Scientific Information)

**Impact Factor** = the average number of times published papers  
are cited up to two years after publication

$$I_{2008} = \text{Cited}_{2008} / \text{Published}_{2006-2007}$$

It is taken into account by funding agencies, academic institutions  
etc. to evaluate projects and research careers

Patterns concerning **Nuclear Science and Technology**  
in comparison to related categories

Wide and complex domain...  
Getting the flavour of it – more to follow

*2007 IF in most cases; average 2003-2007 otherwise*

# IEEE TNS

# IEEE TMI

227 journals in the category

10 journals w/o impact factor

lowest IF: **0.009**

*(still a rentable journal...)*

## ENGINEERING, ELECTRICAL & ELECTRONIC

1	P IEEE	3.820
2	IEEE T PATTERN ANAL	3.579
3	PROG ELECTROMAGN RES	3.320
<b>4</b>	<b>IEEE T MED IMAGING</b>	<b>3.275</b>
5	IEEE SIGNAL PROC MAG	2.907
6	IEEE T AUTOMAT CONTR	2.824
7	IEEE T NEURAL NETWOR	2.769
8	PROG QUANT ELECTRON	2.636
9	IEEE ELECTR DEVICE L	2.486
10	IEEE T IMAGE PROCESS	2.462
<b>75</b>	<b>IEEE T NUCL SCI</b>	<b>1.107</b>

Also in other categories:

### TNS

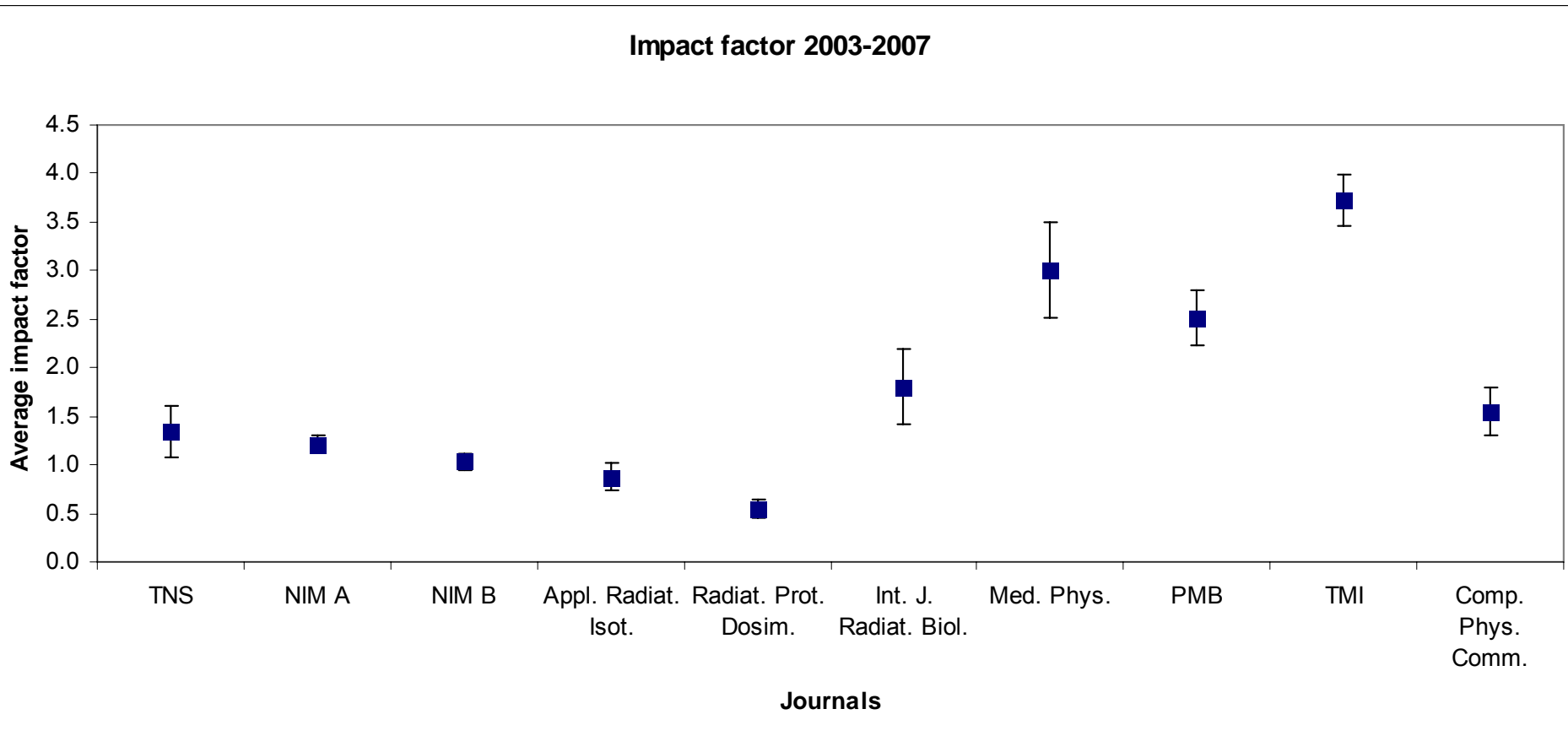
Nuclear Science and Technology

### TMI

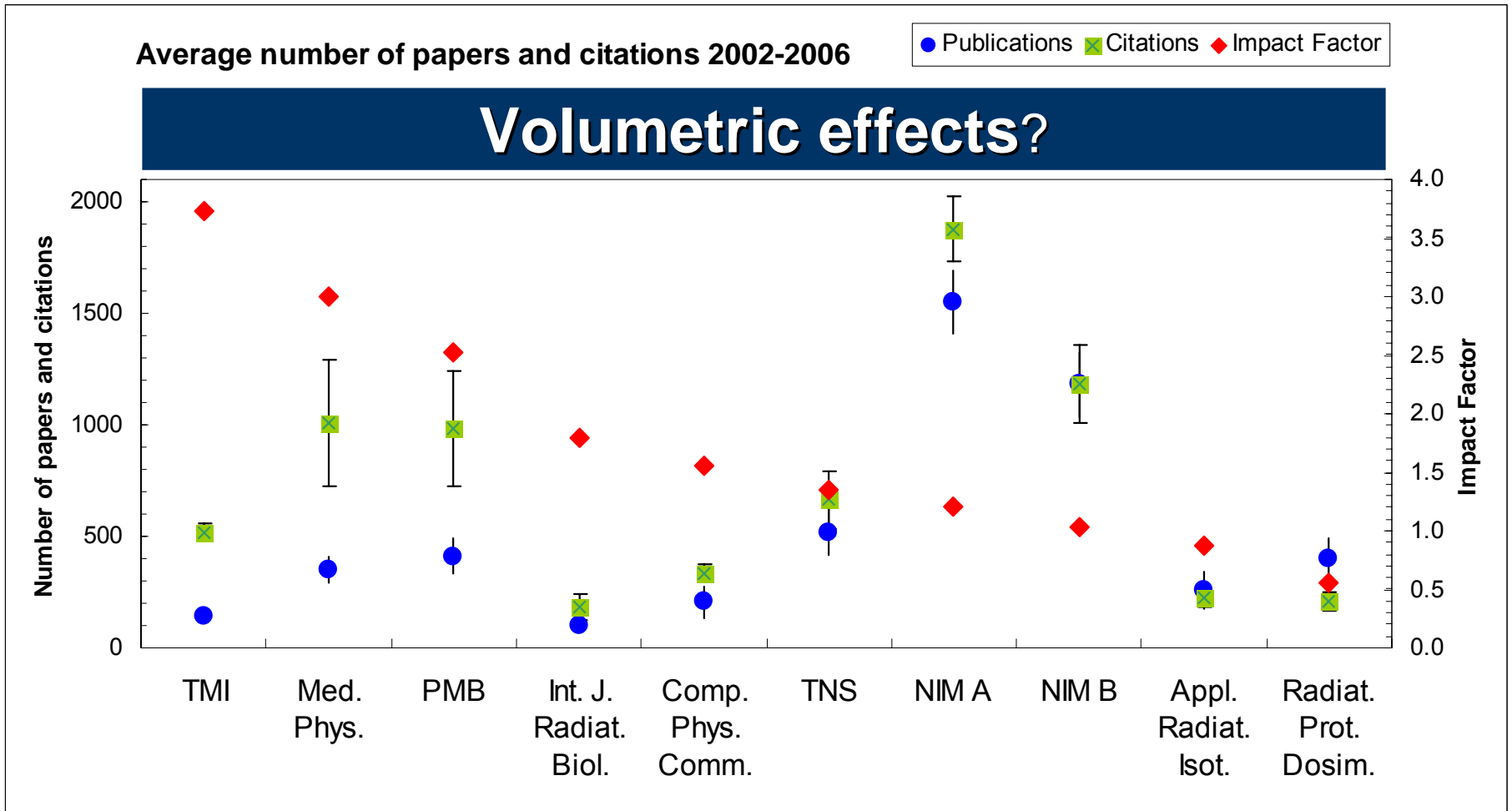
Radiology, Nuclear Medicine & Medical Imaging  
Engineering, Biomedical  
Imaging Science & Photographic Technology

# Technological journals

Representative sample from  
Nuclear Science and Technology  
Radiology, Nuclear Medicine and Medical Imaging



# Published papers and citations



Journals with higher impact factor (medical technology, CPC) tend to publish fewer papers than Nuclear Science and Technology ones

# So the last shall be first, and the first last ...

Matthew 20:16



Impact factor, JCR<sup>®</sup> 2007

## NUCLEAR SCIENCE & TECHNOLOGY

<b>1</b>	<b>J Nucl Mater</b>	<b>1.643</b>
2	Int J Radiat Biol	1.468
3	Radiochim Acta	1.210
4	NIM A	1.114
5	<i>IEEE TNS</i>	<i>1.107</i>
6	Fusion Eng Des	1.058
7	Radiat Meas	1.054
8	Appl Radiat Isotopes	1.008
9	NIM B	0.997
10	Fusion Sci Technol	0.945

## MATERIALS SCIENCE, MULTIDISCIPL.

1	PROG Mater SCI	20.846
2	Nat Mater	19.782
3	Nat Nanotechnol	14.917
4	Mat Sci Eng R	14.400
5	Nano Lett	9.627
6	Adv Mater	8.191
7	Adv Funct Mater	7.496
8	Small	6.408
9	MRS Bull	5.168
10	Chem Mater	4.883
<b>51</b>	<b>J Nucl Mater</b>	<b>1.643</b>

# ...also the second

NUCLEAR SCIENCE & TECHNOLOGY			BIOLOGY		
1	J Nucl Mater	1.643	1	Plos Biol	13.501
<b>2</b>	<b>Int J Radiat Biol</b>	<b>1.468</b>	2	Biol Rev	8.833
3	Radiochim Acta	1.210	3	Faseb J	6.791
4	NIM A	1.114	4	Philos T R Soc B	5.529
5	<i>IEEE TNS</i>	<i>1.107</i>	5	Bioessays	5.402
6	Fusion Eng Des	1.058	6	BMC Biol	5.059
7	Radiat Meas	1.054	7	P Roy Soc B-biol Sci	4.112
8	Appl Radiat Isotopes	1.008	8	Bioscience	4.083
9	NIM B	0.997	9	J Biol Rhythm	3.868
10	Fusion Sci Technol	0.945	10	Q Rev Biol	3.800
			<b>33</b>	<b>Int J Radiat Biol</b>	<b>1.468</b>



# ...and the third

## NUCLEAR SCIENCE & TECHNOLOGY

1	J Nucl Mater	1.643
2	Int J Radiat Biol	1.468
<b>3</b>	<b>Radiochim Acta</b>	<b>1.210</b>
4	NIM A	1.114
5	<i>IEEE TNS</i>	<i>1.107</i>
6	Fusion Eng Des	1.058
7	Radiat Meas	1.054
<b>8</b>	<b>Appl Radiat Isotopes</b>	<b>1.008</b>
9	NIM B	0.997
10	Fusion Sci Technol	0.945

## CHEMISTRY, INORGANIC & NUCLEAR

1	Coordin Chem Rev	8.568
2	Adv Inorg Chem	4.600
3	Adv Organomet Chem	4.176
4	Inorg Chem	4.123
5	Struct Bond	4.041
6	Organometallics	3.833
7	J Inorg Biochem	3.663
8	J Biol Inorg Chem	3.325
9	Dalton T	3.212
10	Tetrahedron-asymmetr	2.634
<b>24</b>	<b>Radiochim Acta</b>	<b>1.210</b>
<b>25</b>	<b>Appl Radiat Isotopes</b>	<b>1.008</b>

# ...and the fourth

## NUCLEAR SCIENCE & TECHNOLOGY

1	J Nucl Mater	1.643
2	Int J Radiat Biol	1.468
3	Radiochim Acta	1.210
<b>4</b>	<b>NIM A</b>	<b>1.114</b>
5	IEEE TNS	1.107
6	Fusion Eng Des	1.058
7	Radiat Meas	1.054
8	Appl Radiat Isotopes	1.008
9	<b>NIM B</b>	0.997
10	Fusion Sci Technol	0.945

## SPECTROSCOPY

1	Mass Spectrom Rev	10.896
2	Prog Nucl Mag Res Sp	5.205
3	Appl Spectrosc Rev	4.250
4	J Am Soc Mass Spectr	3.664
5	J Raman Spectrosc	3.514
6	J Anal Atom Spectrom	3.269
7	NMR Biomed	3.063
8	J Mass Spectrom	3.062
9	Rapid Commun Mass Sp	2.971
10	Spectrochim Acta B	2.957
<b>25</b>	<b>NIM A</b>	<b>1.114</b>

## PHYSICS, PARTICLES & FIELDS

1	Annu Rev Nucl Part S	12.885
2	J Cosmol Astropart P	6.067
3	J High Energy Phys	5.659
4	Phys Rev D	4.696
5	Nucl Phys B	4.645
6	Prog Part Nucl Phys	4.101
7	J Phys G Nucl Partic	3.485
8	Astropart Phys	3.483
9	Eur Phys J C	3.255
10	Adv Theor Math Phys	2.980
<b>18</b>	<b>NIM A</b>	<b>1.114</b>

## INSTRUMENTS & INSTRUMENTATION

1	Appl Spectrosc Rev	4.250
2	J Synchrotron Radiat	2.978
3	Sensor Actuat B-chem	2.934
4	Microfluid Nanofluid	2.241
5	IEEE T Ind Electron	2.216
6	Chemometr Intell Lab	2.063
7	J Micromech Microeng	1.930
8	Laser Phys Lett	1.918
9	Appl Spectrosc	1.902
10	Metrologia	1.667
<b>23</b>	<b>NIM A</b>	<b>1.114</b>
<b>25</b>	<b>NIM B</b>	<b>0.997</b>

# TMI follows the same trend

## IMAGING SCIENCE & PHOTOGRAPHIC TECHNOL.

1	<b>IEEE T Med Imaging</b>	<b>3.275</b>
2	Remote Sens Environ	3.013
3	ISPRS J Photogramm	1.116
4	Photogramm Eng Rem S	1.103
5	Int J Remote Sens	0.987
6	Photogramm Rec	0.889
7	J Visual-japan	0.867
8	J Imaging Sci Techn	0.707
9	J Electron Imaging	0.455
10	Imaging Sci J	0.220

## RADIOLOGY, NUCL. MED. & MED. IMAGING

1	Hum Brain Mapp	6.151
2	J Nucl Med	5.915
3	Radiology	5.561
4	Neuroimage	5.457
5	Semin Nucl Med	5.250
6	Int J Radiat Oncol	4.290
7	Invest Radiol	4.234
8	Eur J Nucl Med Mol I	4.101
9	Radiother Oncol	4.074
10	Semin Radiat Oncol	3.788
<b>14</b>	<b>IEEE T Med Imaging</b>	<b>3.275</b>
<b>16</b>	<b>Med Phys</b>	<b>3.198</b>
<b>25</b>	<b>Phys Med Biol</b>	<b>2.528</b>
<b>49</b>	<b>Int J Radiat Biol</b>	<b>1.468</b>
<b>65</b>	<b>Appl Radiat Isotopes</b>	<b>1.008</b>
<b>85</b>	<b>Radiat Prot Dosim</b>	<b>0.528</b>

# Stars and galaxies vs. oil...

Which field has greater societal impact?

Astronomy or Energy and Fuels?

## ENERGY & FUELS

1	Prog Energ Combust	5.269
2	Renew Sust Energ Rev	3.774
3	Fuel Cells	3.273
4	Bioresource Technol	3.103
5	J Power Sources	2.809
6	Int J Hydrogen Energ	2.725
7	P Combust Inst	2.647
8	Combust Flame	2.184
9	Prog Photovoltaics	2.179
10	Sol Energ Mat Sol C	2.002

## ASTRONOMY & ASTROPHYSICS

1	Annu Rev Astron Astr	20.290
2	Astrophys J Suppl S	7.898
3	Annu Rev Earth PI Sc	7.732
4	Astrophys J	6.405
5	J Cosmol Astropart P	6.067
6	Astron Astrophys Rev	6.000
7	Mon Not R Astron Soc	5.249
8	Astron J	5.019
9	Phys Rev D	4.696
10	Astron Astrophys	4.259

# The Higgs boson vs. business

## PHYSICS, PARTICLES & FIELDS

1	Annu Rev Nucl Part S	12.885
2	J Cosmol Astropart P	6.067
3	J High Energy Phys	5.659
4	Phys Rev D	4.696
5	Nucl Phys B	4.645
6	Prog Part Nucl Phys	4.101
7	J Phys G Nucl Partic	3.485
8	Astropart Phys	3.483
9	Eur Phys J C	3.255
10	Adv Theor Math Phys	2.980

## ECONOMICS

1	J Polit Econ	4.190
2	J Econ Lit	3.973
3	Q J Econ	3.688
4	J Account Econ	3.034
5	J Financ Econ	2.988
6	Econometrica	2.972
7	J Econ Perspect	2.831
8	J Econ Geogr	2.679
9	Rev Econ Stud	2.539
10	J Econ Growth	2.292

## BUSINESS

1	Acad Manage J	5.017
2	Acad Manage Rev	4.372
3	Market Sci	3.964
4	J Marketing	3.750
5	Admin Sci Quart	2.912
6	Strategic Manage J	2.829
7	J Int Bus Stud	2.283
8	J Retailing	2.054
9	J Manage	2.000
10	J Manage Stud	1.926

CELL BIOLOGY		
1	Nat Rev Mol Cell Bio	31.921
2	Cell	29.887
3	Nat Med	26.382
4	Annu Rev Cell Dev Bi	23.545
5	Nat Cell Biol	17.623
6	Cell Metab	17.148
7	Gene Dev	14.795
8	Trends Cell Biol	13.527
9	Curr Opin Cell Biol	13.444
10	Mol Cell	13.156

BIOCHEMISTRY & MOLEC. BIOL.		
1	Annu Rev Biochem	31.190
2	Cell	29.887
3	Nat Med	26.382
4	Annu Rev Bioph Biom	17.757
5	Trends Biochem Sci	14.994
6	Nat Chem Biol	13.683
7	Plos Biol	13.501
8	Mol Cell	13.156
9	Cytokine Growth F R	11.816
10	Genome Res	11.224

On another scale

MEDICINE, GENERAL & INTERNAL		
1	New Engl J Med	52.589
2	Lancet	28.638
3	Jama-j Am Med Assoc	25.547
4	Ann Intern Med	15.516
5	Annu Rev Med	13.415
6	Plos Med	12.601
7	Brit Med J	9.723
8	Arch Intern Med	8.391
9	Can Med Assoc J	7.067
10	Ann Med	5.779

ONCOLOGY		
1	Ca-cancer J Clin	69.026
2	Nat Rev Cancer	29.190
3	Cancer Cell	23.858
4	J Natl Cancer I	15.678
5	J Clin Oncol	15.484
6	Lancet Oncol	12.247
7	Nat Clin Pract Oncol	8.217
8	Cancer Res	7.672
9	Stem Cells	7.531
10	Adv Cancer Res	7.524

# A magic word?

COMPUTER SCIENCE, INTERDISCIPL. APPL.		
1	BIOINFORMATICS	5.039
2	NEUROINFORMATICS	3.750
3	MED IMAGE ANAL	3.505
<b>4</b>	<b>IEEE T MED IMAGING</b>	<b>3.275</b>
5	J AM MED INFORM ASSN	3.094
6	J CHEM INF MODEL	2.986
7	MATCH-COMMUN MATH CO	2.580
8	J COMPUT PHYS	2.372
9	COMPUT LINGUIST	2.367
10	QSAR COMB SCI	2.117
<b>16</b>	<b>COMPUT PHYS COMMUN</b>	<b>1.842</b>

# HEP journals IF

PHYSICS, PARTICLES & FIELDS		
1	<b>Annu Rev Nucl Part Sci.</b>	12.885
2	J Cosmol Astropart Phys	6.067
3	<b>J High Energy Phys</b> (JHEP)	5.659
4	<b>Phys Rev D</b> (PRD)	4.696
5	<b>Nucl Phys B</b> (NPB)	4.645
6	Prog Part Nucl Phys	4.101
7	<b>J Phys G</b> Nucl Partic	3.485
8	Astropart Phys	3.483
9	<b>Eur Phys J C</b> (EPJC)	3.255
10	Adv Theor Math Phys	2.980

PHYSICS, MULTIDISCIPLINARY		
5	<b>Phys Rev Lett</b>	6.944
8	<b>Phys Lett B</b>	4.189



# A family business

	<i>IF</i>	JHEP	PRD	NPB	JPG	EPJC	PLB	PRL	Sum
Ann. Rev. Nucl. Part. Sci.	12.885	21.7	14.6	3.7	3.7	3.4	10.1	2.6	59.8
JHEP	5.659	46.0	28.9	0.8	0.9	1.0	0.9	2.9	81.4
PRD	4.696	12.2	29.7	2.4	1.4	2.8	7.1	3.8	59.4
NPB	4.645	26.5	20.4	8.6	0.8	2.7	6.9	2.3	68.2
JPG*	3.485	5.6	25.3	1.4	5.2	4.0	8.4	6.4	56.3
EPJC	3.255	9.7	21.4	2.6	5.1	11.9	6.6	4.4	61.7

\* Review of Particle Physics 2006

# Multidisciplinary impact

	NIM A	TNS	TMI	PRD	PRL	NIM B	PMB	Med. Phys.
NIM A	33.4	2.4		3.8	3.7	3.1	1.0	0.3
TNS	25.7	28.8	0.4	0.3	0.3	2.7	4.4	1.4
TMI	0.6	1.9	9.9				8.6	6.0

Mostly medical-oriented for TMI

Largely multidisciplinary for TNS and NIM

Different mutual citation pattern between NIM A and TNS

Tech journals have lower impact factor than HEP journals,  
but cited by larger set of journal

Nuclear Science & Technology category ↔ Women Studies

# What contributes to the impact factor?

	NIM A	TNS	TMI	J Rad Biol	JHEP	PRD	Correlation
Avg IF	1.212	1.344	3.730	1.801	5.659	4.696	
Publ. 2005-06	2922	<b>1126</b>	<b>303</b>	189	1862	4920	
Avg Cited/yr	1878	663	521	183	5042	13866	
0 citations %	34.3	<b>34.2</b>	<b>8.6</b>	16.9	9.5	6.4	<b>-0.86</b>
Top cited	96	<b>130</b>	<b>50</b>	<b>26</b>	179	285	
%	5.1	19.6	6.0	14.2	3.7	2.0	<b>-0.68</b>
Top 10 cited	474	<b>388</b>	<b>401</b>	148	1313	1707	
%	<b>25.2</b>	<b>58.5</b>	77.0	80.9	26.0	12.3	<b>-0.71</b> w/o NIM A
≥10 citations	119	39	53	10	657	1900	
%	4.1	3.5	17.5	5.3	35.3	38.6	<b>0.96</b>

Lower IF correlated to many papers never being cited

Top cited paper in TNS has higher impact than TMI equivalent

Top 10 cited papers contribute largely in TMI/TNS, more spread in PRD/JHEP

# Impact: research or research digest?

Category	Rank	Journal	IF
Physics, multidisciplinary	1	Rev. Mod.Phys.	38.403
	2	Phys. Rep.	20.263
Physics, Particle and fields, Physics, Nuclear	1	Annu. Rev. Nucl. Part. Sci.	12.885
Astronomy and astrophysics	1	Annu. Rev. Astron. Astr.	20.290
Instruments and instrumentation	1	Appl. Spectrosc. Rev.	4.25
Engineering, biomedical	1	Annu. Rev. Biomed. Eng.	11.567
Public, Env. & Occupational Health	1	Annu. Rev. Publ. Health	8.978

**Review journals have by far higher impact factor than journals publishing direct research results**

What we call the beginning is often the end  
And to make an end is to make a beginning.

*T.S. Eliot, Four Quartets*

## What we have learned so far

Patterns, trends and peculiarities  
in nuclear/particle physics and technology literature  
beyond the arithmetic definition of impact factor

- Impact: somebody else **uses** what is published
  - In the family / in a wider community
- Impact: **related to the volume?**
  - Journals publishing few papers
- Impact: journal or **paper?**
  - Papers with few citations in high impact factor journals
  - Papers with large number of citations in low impact factor journals
- Impact: of **research** or of **digest?**
  - Review journals
- The impact of this study: **action?**