

**Fact and figures
for Denmark
General & HEP**

**RECFA visit to
DK
May 2013**



Outline

- Economy, education and physics in DK
- HEP places and people. DK@CERN.
- Funding of HEP. Present and future.

Economy and research



- Population: 5.6M
- Area: 43,094 km³
- No. 15 in OECD by GDP/capita: 35,757 (2005)\$.
- The world's highest level of income equality.
- Frequently ranked as "happiest people".
- High job frequency: 72.8% (78.7% in 2008!).
- R&D expenditure of GDP: 3.1% (1% public).
- R&D FTEs: 35200 (private), 20000 (public).
- No. 2 in publication frequency (Finland higher)
- Universities with physics 6

Education

- Everybody spends **9-10** years in primary school.
- **90%** attend secondary school or similar.
- **46%** pursue further education. **Sharply up** from 2007. Females/males=**1.22**.
- **1525** got a PhD degree in 2011.
- Public education is **free of charge** and students get a public support of **771€ monthly**. PhD students cost **5500€ monthly**.
- **Highest public education expense** (7.5% of GDP).
- Highest participation in adult learning (31.8%)

Physics

- ~300 enroll each year, up ~50% from 2008.
- ~half complete this education.
- ~100 PhDs/year
- doubled since 2007, about half are foreign.
- Bachelor+Master 3y+2y. PhD duration 3y.
- Zero unemployment among physics graduates.
- Physics=cosmo+geo+nano+particle.
- Nano is largest by far. Particle physics is about 10%.



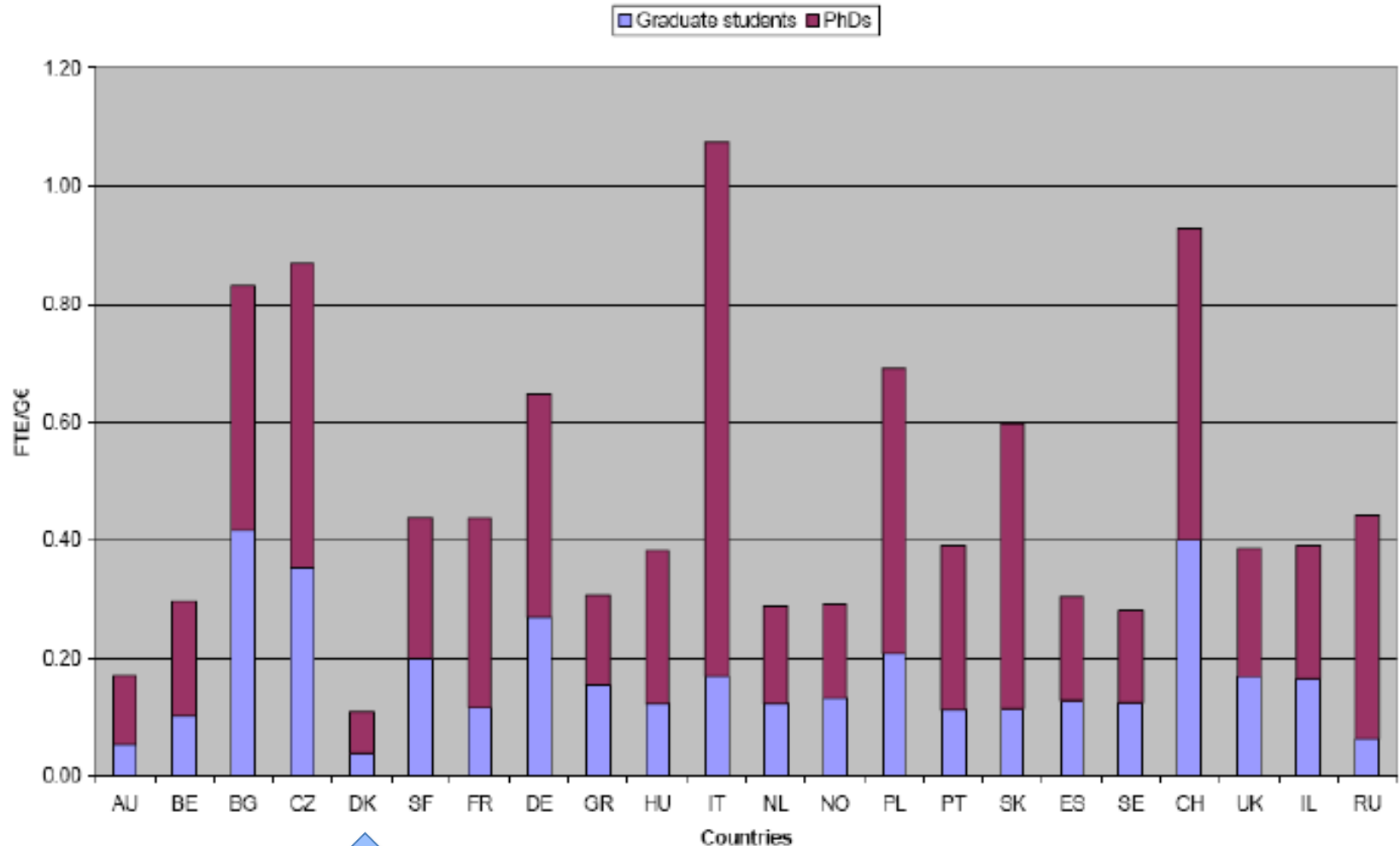
HEP places

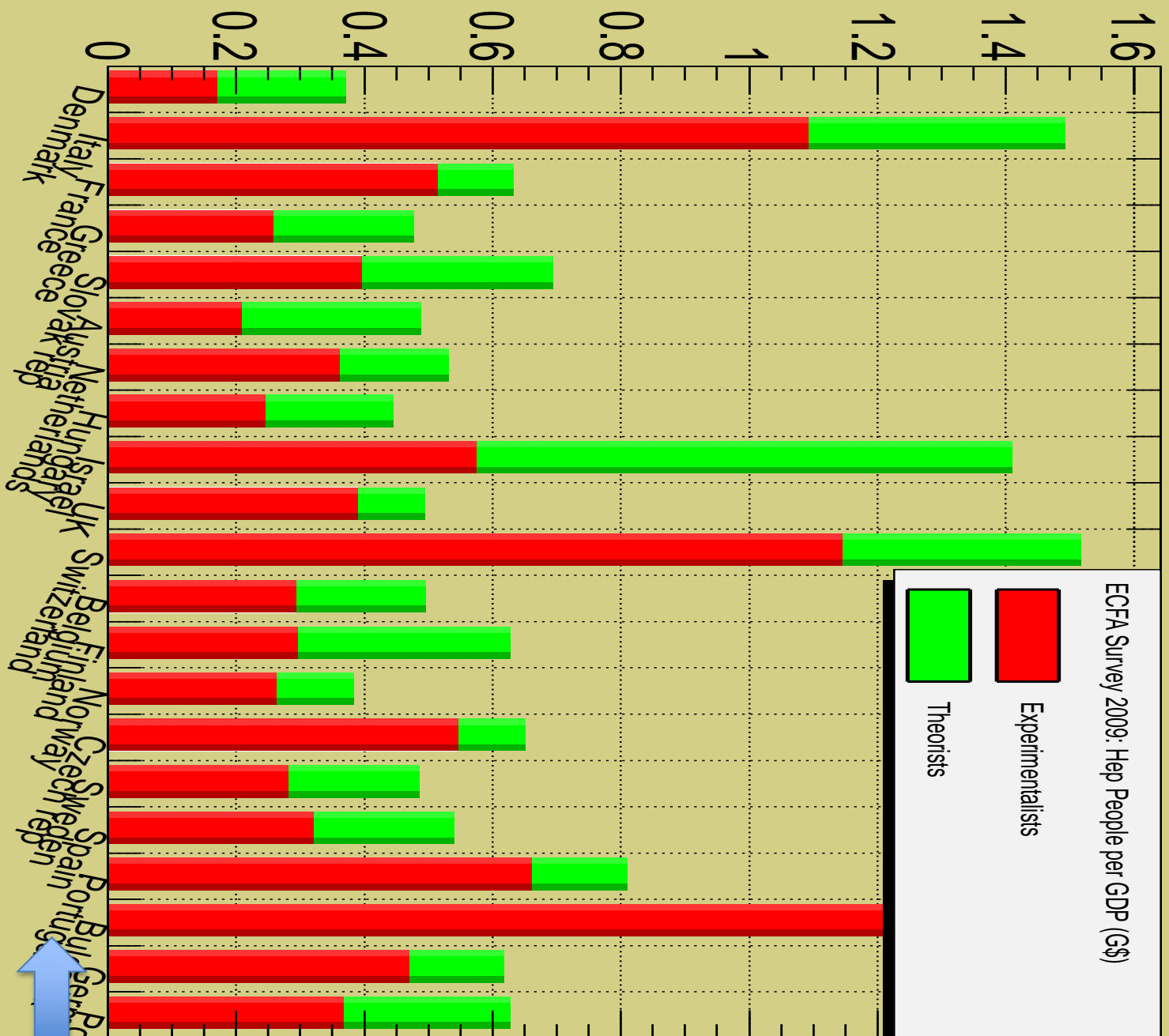
- **KU: Copenhagen**
theory,
LHC experiments, Planck
- **AU: Aarhus**
CERN non-LHC experiments,
cosmology
- **SDU: Odense**
phenomenology, cosmology

The Technical University (Copenhagen) is now also knocking at the door (OSCAR)

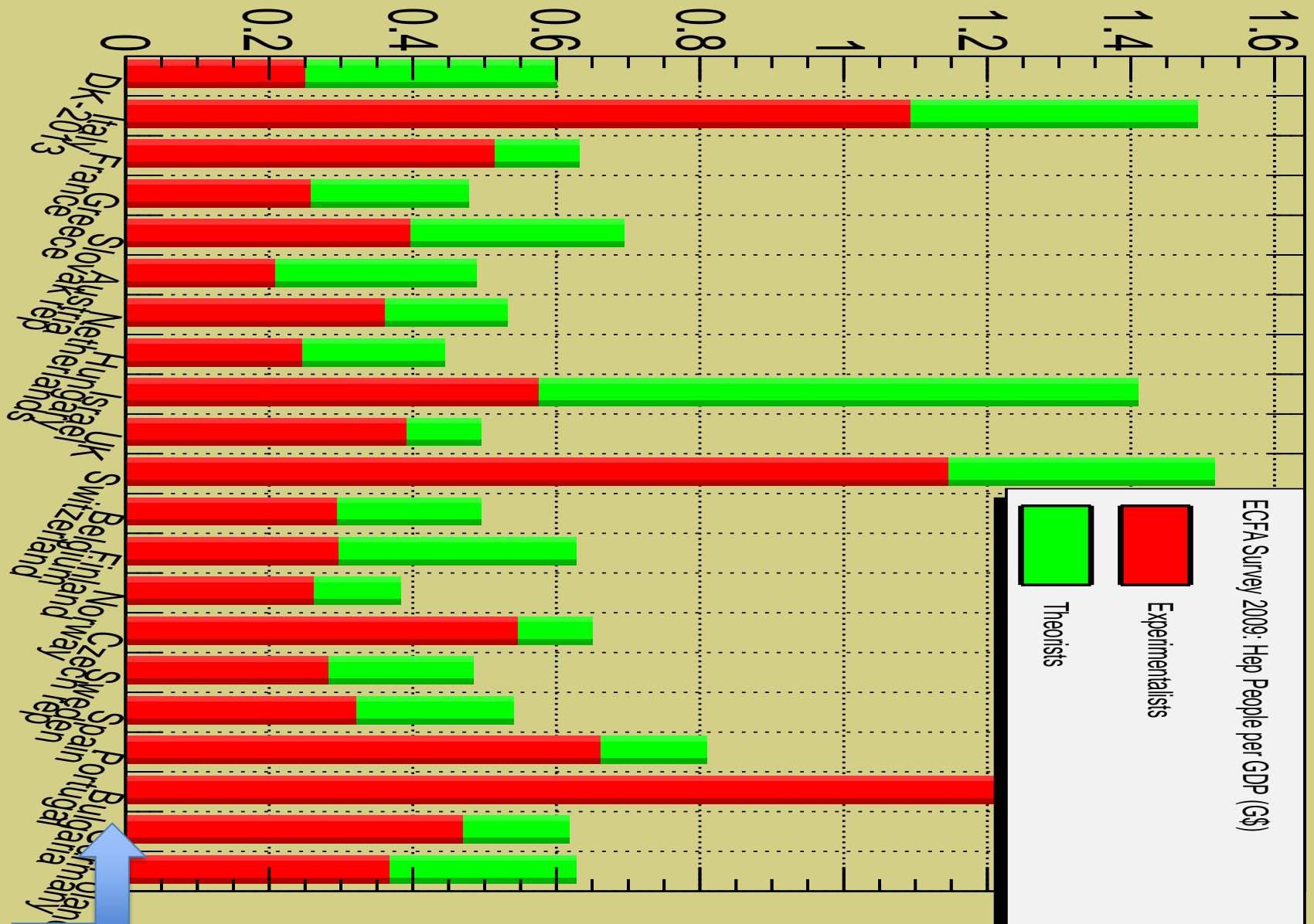
DK HEP people (2005)

Researchers and graduate students normalized with the GDP of the countries





DK HEP people (2013)



HEP people

	Permanent	Post Doc	PhD	Master
LHC Exp	8	11	9	9
CERN non-LHC	8	1	9	5
Theory	15	31	23	10
Total	31	43	41	24

- Currently, ~4 new positions, in phenomenology and astro-particle physics, are being filled.
- Theory is ~40% phenomenology, ~30% QFT/string and ~30% astroparticle and cosmology.
- Currently, about **3 technician/engineer FTEs** are provided by universities

DK @ CERN

- Contribution to CERN budget: 1.8% (almost 16M€)
- CERN member state since 1954
- Using all CERNs accelerators

Numbers (2012):

users 71 – including many theorists

Tech students 3

staff 20 (including 2 non-permanent physicists)



Niels Bohr,
PS inauguration, 5.2.1960

DK in CERN experiments

- ATLAS (KU) (TRT, HLT, ALFA, μ MEGAS, phys)
- ALICE (KU) (FMD, TPC, physics)
- ISOLDE (AU) (Nucl. physics and biochemistry)
- AD-ALPHA (AU) (anti-hydrogen spectroscopy)
- AD-ACE (AU) (antiproton cancer therapy)
- AD-ASACUSA (AU) (atomic physics)
- NA63 (AU) (QED in strong fields)
- CLIC (AU) (beamstrahlung)

National Collaboration

- NICE (National Instrument center for CERN Experiments) coordinates M&O, new equipment, travels, a few Postdoc and PhD salaries, summer students, CERN schools, CERN events, cars at CERN etc.
- Cooperation on equipment (ISOLDE), detector R&D (Mimosa), astro-particle research, outreach and education between KU, AU and SDU.

NBI Colliderscope



<http://colliderscope.nbi.ku.dk/english/video1/>

HEP Funding 2013

Foundation	Main beneficiary	Yearly amount
Research Council	NICE (CERN operations)	1.4 M€
DC Scientific Computing	Tier1 contribution	0.1 M€
Danish National Research Foundation	CP3-Origins (Odense)	1.1 M€
	Discovery (Copenhagen)	1.1 M€
	Astro-particle (Cph)	0.8 M€ (start sept 13)
Research Council/NBIA	Various post doc grants	1.3 M€
ERC	ALPHA, ISOLDE	0.7 M€
Sum public funding		6.5M€
Lundbeck	2 theory, 1 ATLAS (young)	0.8M€
Villum	1 theory	0.2M€
Various	Various post doc grants	0.3M€
Sum private funding		1.3 M€

All numbers include 44% overhead

Expensive equipment come on top. CERN activities have received about 3.7M€ since 1998.

HEP centers

- **NICE** : *DK CERN operations* (P.H.Hansen, **KU**). 1.4M€/y (Funded by the Natural Science Research Council. Now this changes).
- **CP3-Origins**: *Particle physics phenomenology and cosmology* (F. Saninno, **SDU**). 1.1M€/y (DNRF, 2009-14).
- **Discovery**: *Data analysis in ATLAS, ALICE and PLANCK and particle physics phenomenology* (P.H.Hansen, **KU**). 1.1M€/y (DNRF, 2010-14).

This year strengthened:

- **Niels Bohr Professor:** Astro-particle phenomenology and experiment (IceCube). S. Sarkar, Ox+**KU**. DNRF 3.9M€. 2013-18.
- **ERC senior grant:** ALPHA experiment, J. Hangst, **AU**, 2.1M€ plus hardware from Carlsberg 0.5M€.
- **ERC junior grant:** ISOLDE astro-nuclear physics, H. Fynbo, **AU**, 1.4M€.

Future plans:

- The two DNRF centers are presently up for an review for extension into 2015-19. Hope for the best.
- Copenhagen will push for full DK membership of IceCube from 2015. This requires extra funding.
- The CERN experiments will apply for various upgrades. Already contributing from running budgets.

Times are a-changing:

- A cornerstone is the NICE center providing for the basic CERN operations.
- The funding of NICE will be taken over by a new committee, **NUFI**, that is composed by all the universities and research councils. Its charge is to fund all large “Research Infrastructure”.
- A second pillar, DCSC(DeIC) providing High Performance Computing, including the Danish contribution to the Nordic Tier1, is about to terminate. Future uncertain.

-and a problem arises:

- In a draft budget, the new **NUFI** will cut the funding of NICE in half of the present budget. To 0.7M€. This follows a downwards slide from 2007 where the budget was 1.9M€ in present value.
- Already the slow downslide has precluded any *new* DK initiatives at CERN. The new cut will reduce *current* activities to near zero.
- Similar cuts hit the activities at ESO, ESRF etc
- This is a potential disaster that we have about a week to defuse. May we succeed!

Summary:

- Denmark is doing very well in general research and education.
- Particle physics has on average been in a positive development since 2009. This includes a first push into experimental astro-particle physics.
- Particle physics is threatened by a structural change in CERN experiment funding and is also depending on the outcome of an ongoing review of two phenomenology/analysis centers.