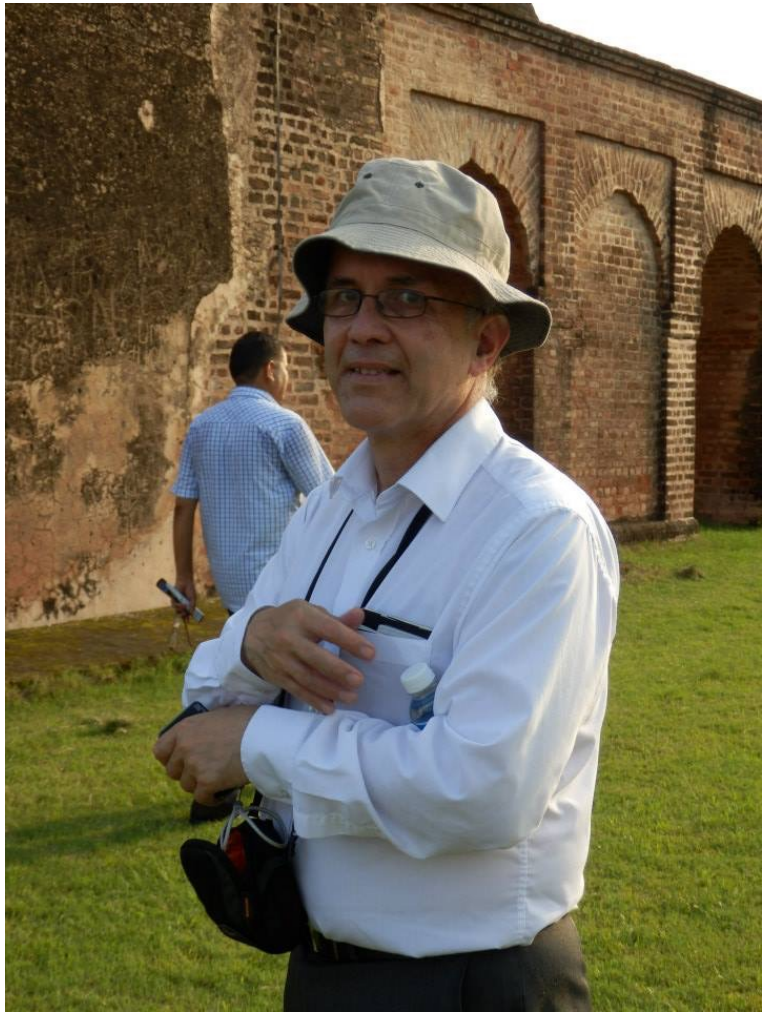
Orlando and Physics in Birmingham

Paul Newman
(University of Birmingham)

Orlando-fest
Thurs 16 Feb 2023



Early years

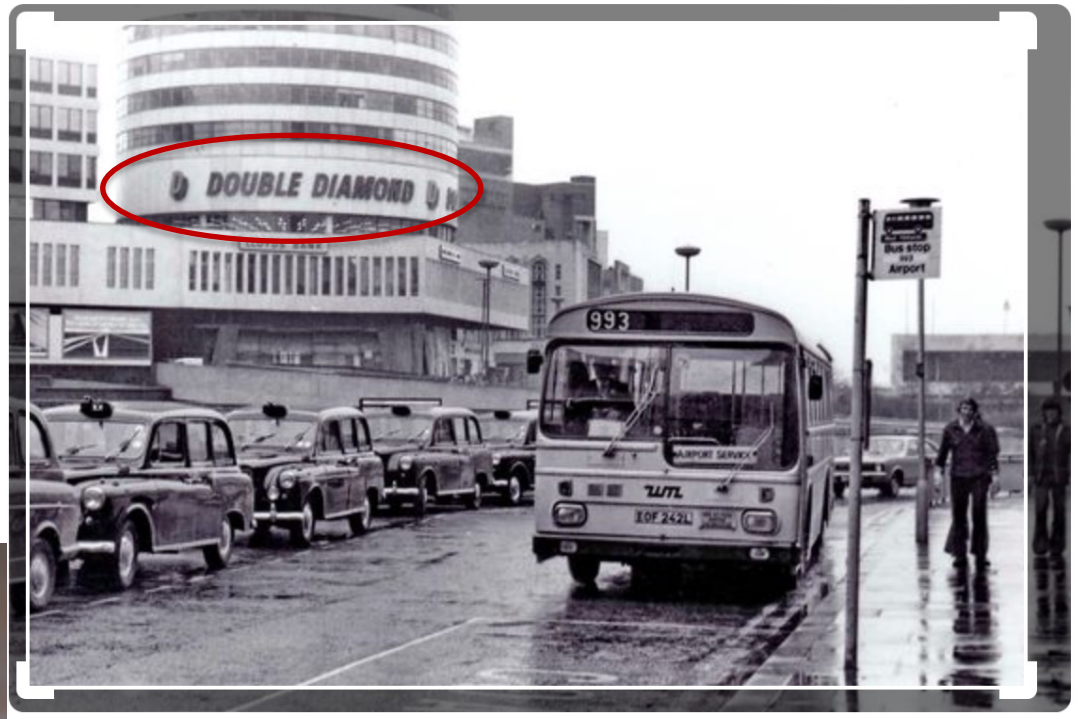
1972-75: BA Physics & Philosophy, Merton College, Oxford

Early years

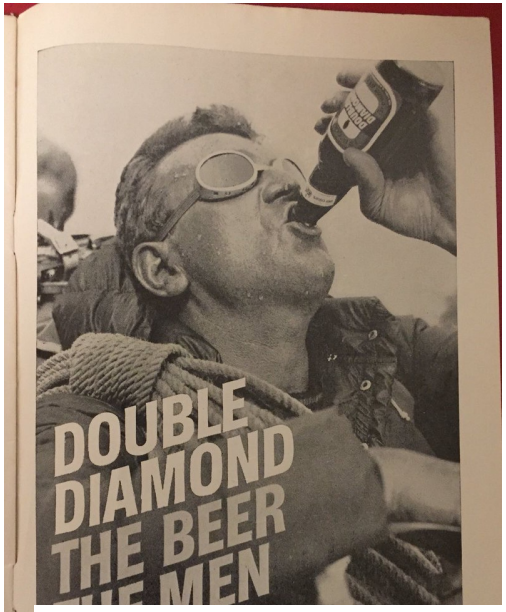
1975-8: MSc Birmingham:
K^0bar interactions in
K^-p at 8.25 GeV

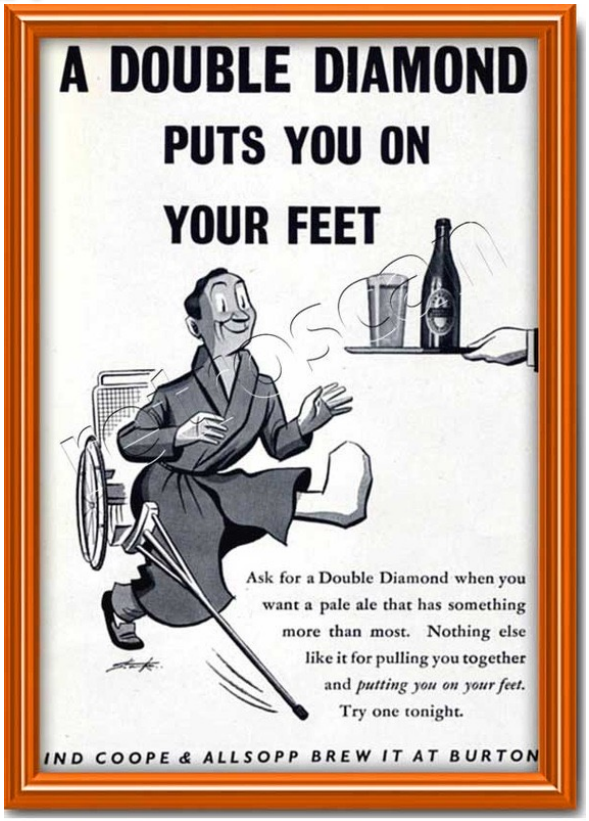
1978-80: Return to Venezuela
(Puerto Ordaz)

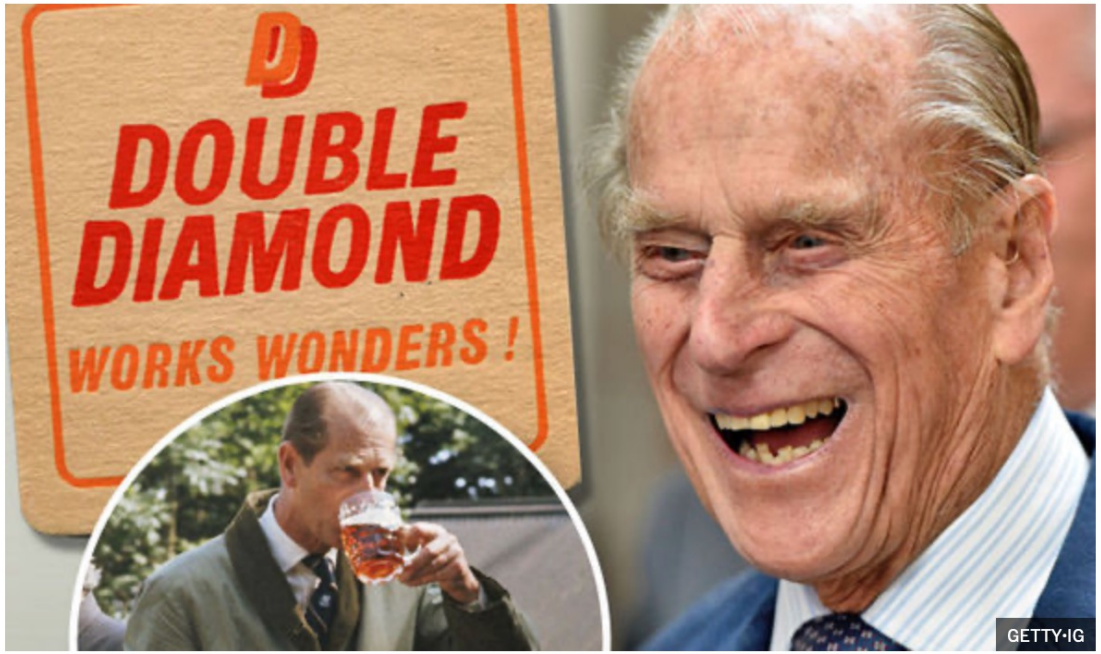
1980-82: PhD Birmingham:
Strangeonium production and Ξ^*
production in K^-p at 8.25 GeV



Double Diamond?







Double Diamond ale is the preferred tipple for Prince Philip

"Double Diamond is the preferred tipple for Prince Philip" [Daily Express]

An early sighting in Birmingham (1981)

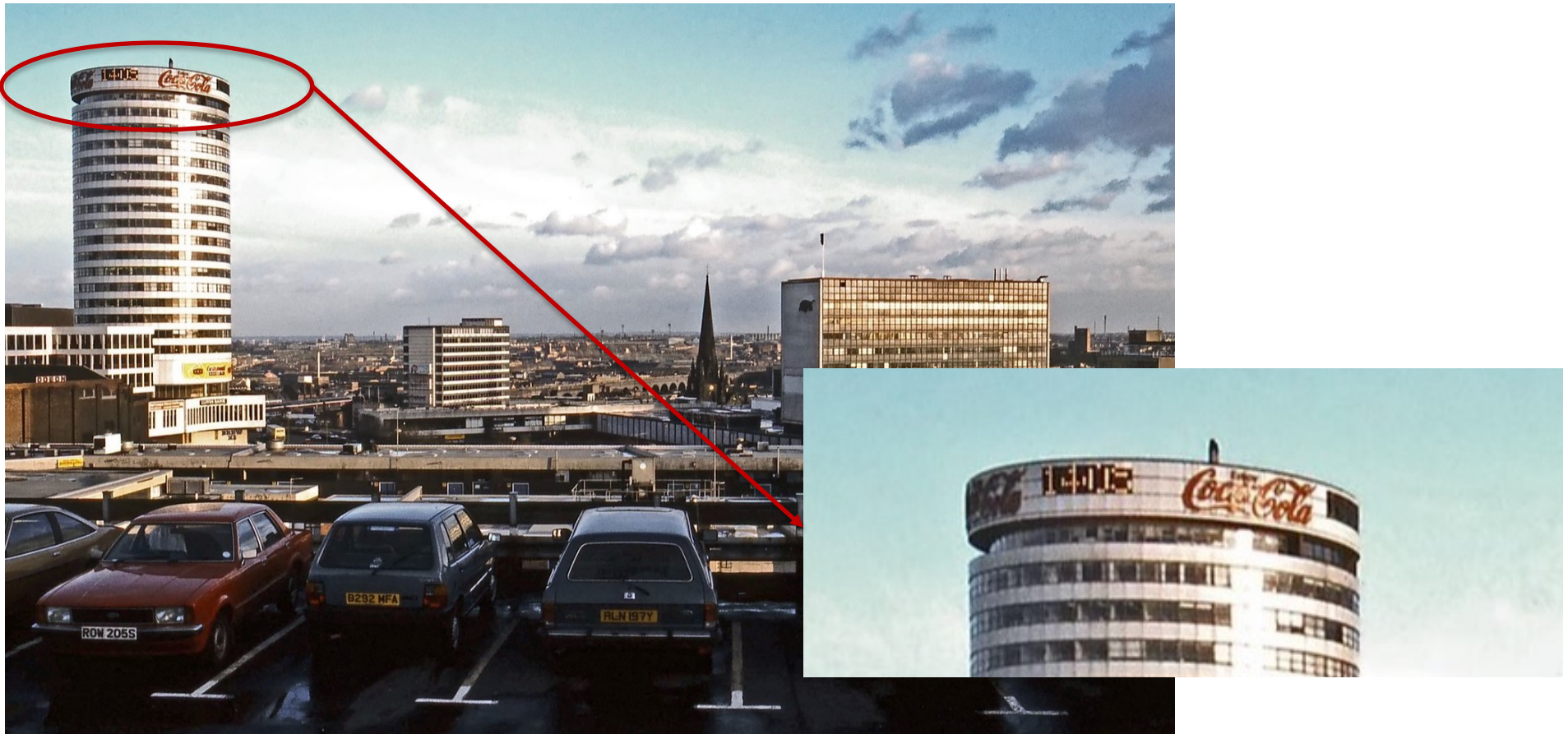
An early sighting in Birmingham (1981)

An early sighting in Birmingham (1981)

Departure and Return to Birmingham

1982-84: PDRA, Imperial College London

1984: Research Fellow, Birmingham



Departure and Return to Birmingham

1982-84: PDRA, Imperial College London

1984: Research Fellow, Birmingham

38 Years Later …

- Apart from 2 CERN associateships, Orlando has been here ever since

- Last-standing heavy ion physicist on particle physics corridor

- West 319 will never be the same again!

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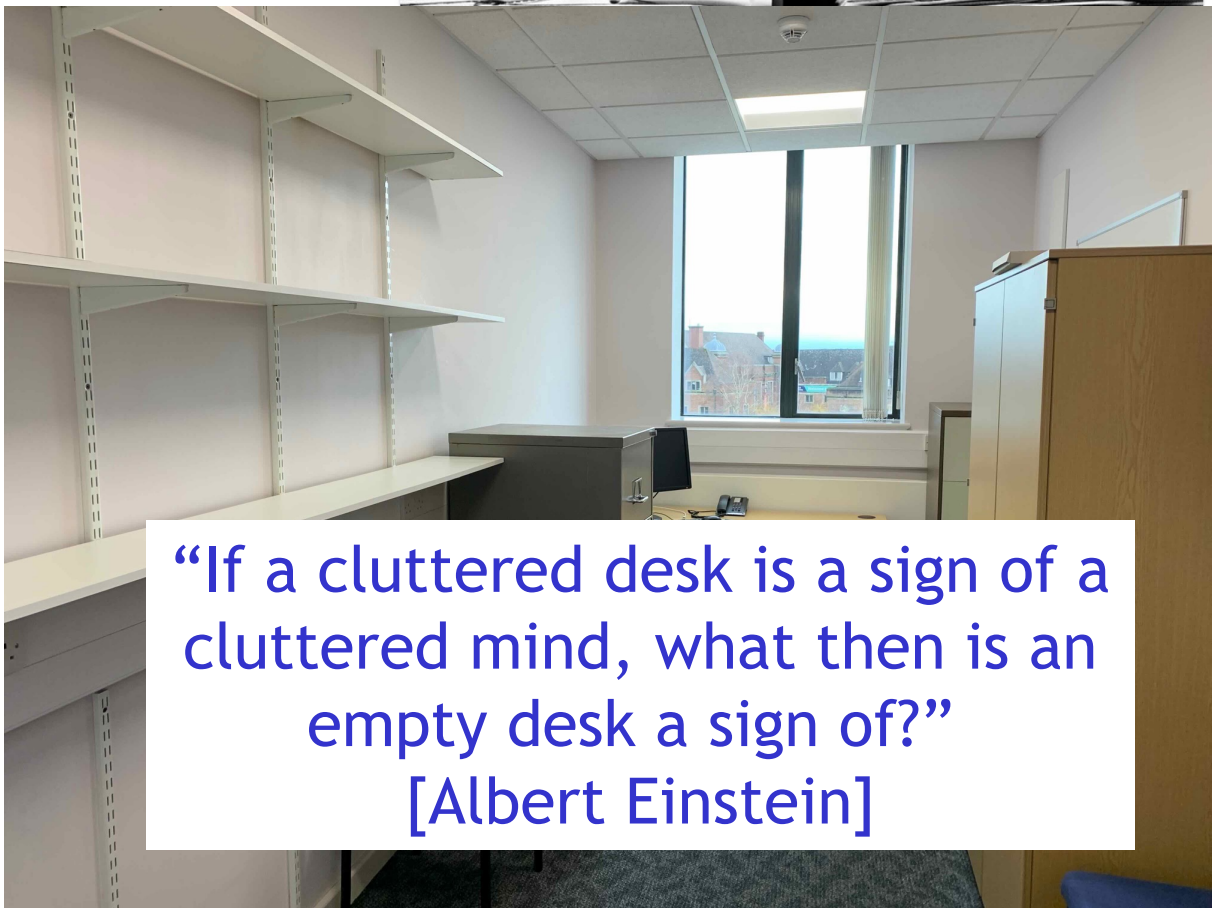
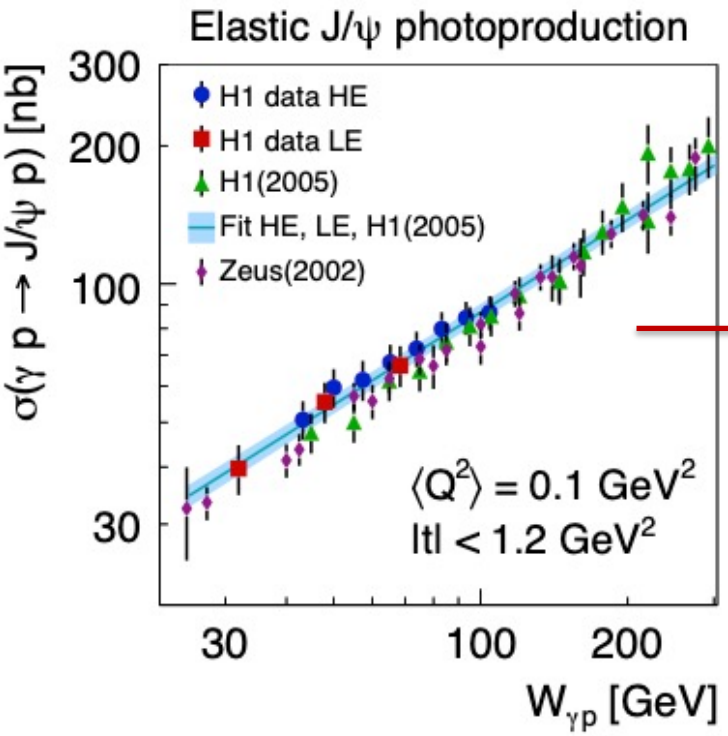


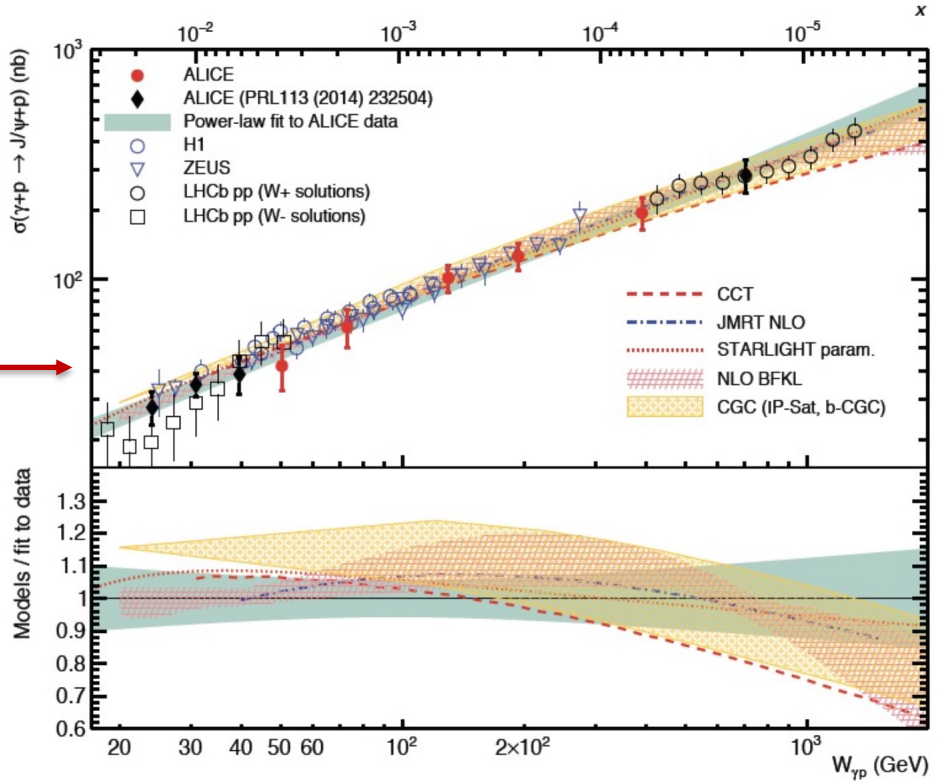
"If a cluttered desk is a sign of a cluttered mind, what then is an empty desk a sign of?"
[Albert Einstein]

Major contribution 1: Science Outputs

Described elsewhere this afternoon, but at a personal level …

Many excellent conversations about diffraction and more, including increasingly searching questions on background treatments





Major contribution 1: Science Outputs

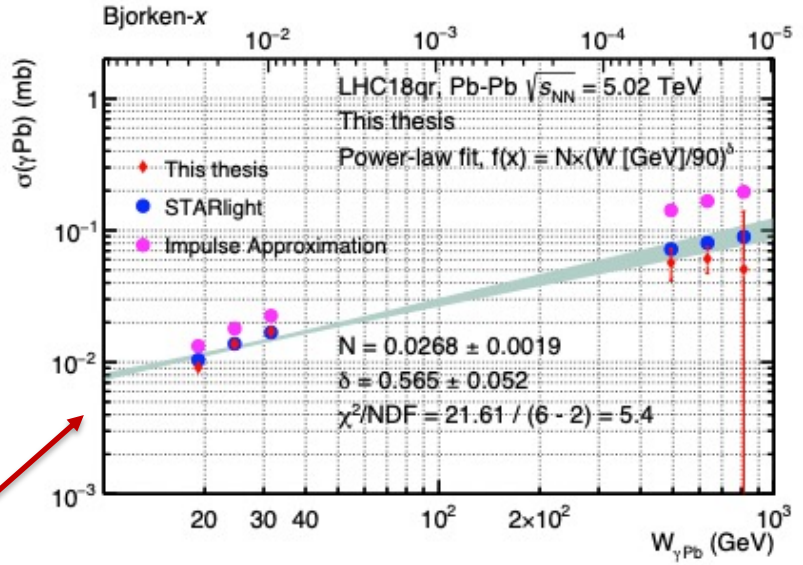
… pushing back the boundaries as far as the data allow …

Forward J/ψ in Ultraperipheral Collisions with the ALICE detector during LHC Run 2

Simone Ragoni

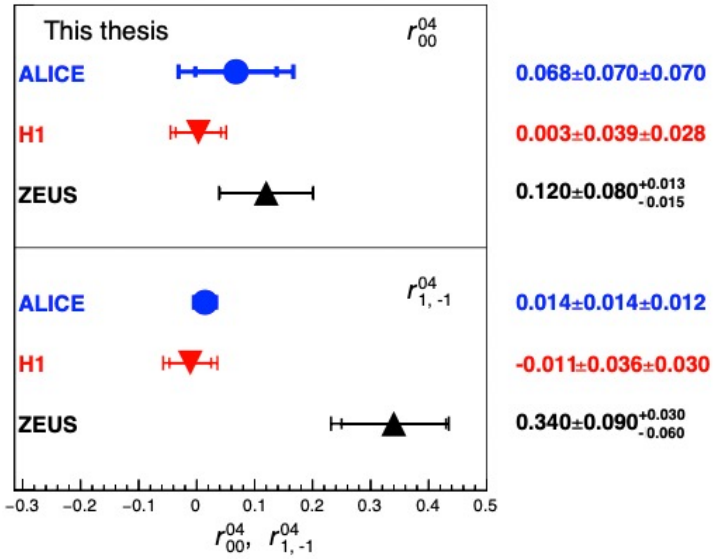
A thesis presented for the degree of

Doctor of Philosophy



Using forward neutrons to resolve ambiguities in coherent J/Ψ production in PbPb

Using angular distributions to extract spin density matrix elements



Major contribution 1: Science Outputs

LHC Working Group on Forward Physics and Diffraction

- Convening could sometimes be a thankless organisational task in a world of increasingly ageing theorists discussing Regge poles etc …

- Orlando could always be relied upon to ensure ALICE was represented and to say something new and interesting…

ALICE

Central Diffraction in ALICE in Run 3

O. Villalobos Baillie for the ALICE collaboration
University of Birmingham

LHC Forward Physics and Diffraction Meeting
CERN 17th December 2019

ALICE

…and now for something completely different…

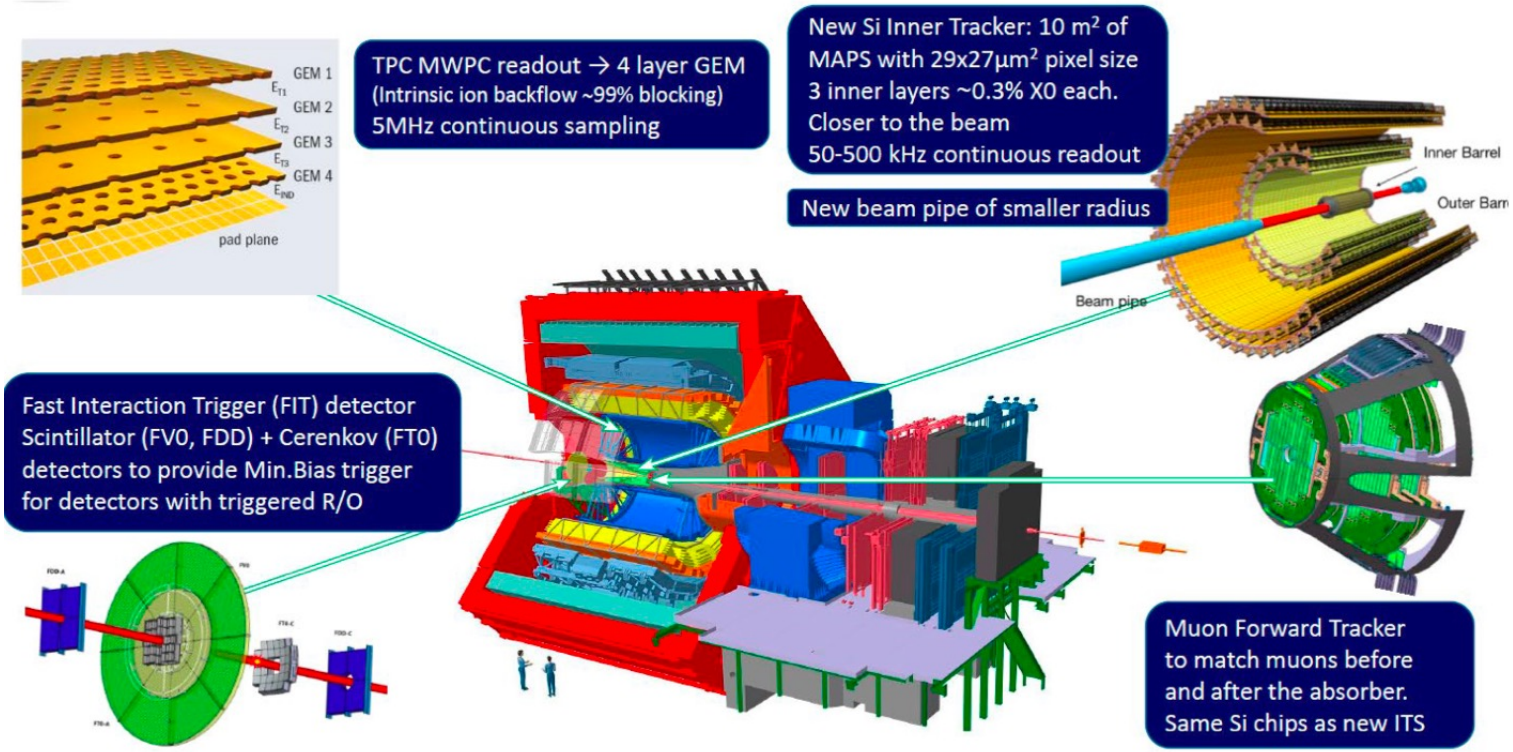
Major contribution 1: Science Outputs

LHC Working Group on Forward Physics and Diffraction

ALICE

Run 3 hardware upgrade

https://indico.cern.ch/event/773049/contributions/3581368



Major contribution 2: Conferences

- Orlando had a long-standing involvement with the ‘Strangeness in Quark Matter’ Conference series

- Member of International Organising Committee several times.

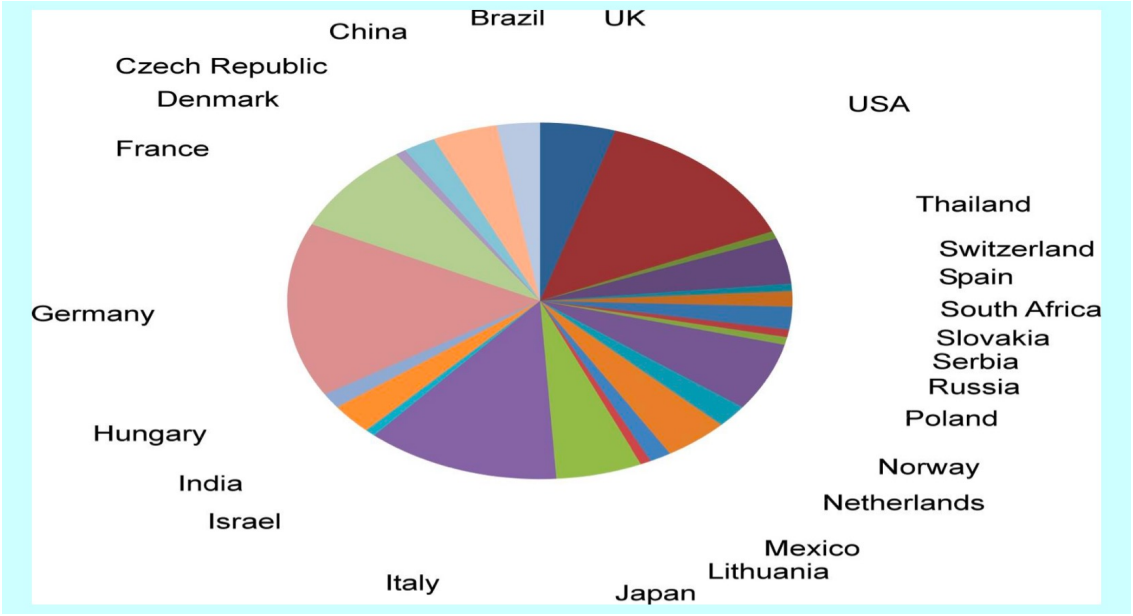
- Had to host it in B’ham eventually … July 2013 (OVB as chair)

Strangeness in Quark Matter
SQM 2013

Local Organising Committee

O. Villalobos Baillie *University of Birmingham*
L. Barnby *University of Birmingham*
D. Evans *University of Birmingham*
S. Hands *University of Swansea*
P. G. Jones *University of Birmingham*
R. Lemmon STFC *Daresbury Laboratory*
R. Lietava *University of Birmingham*
R. Romita *University of Liverpool*
A. Starinets *University of Oxford*

SQM 2013 (Birmingham)



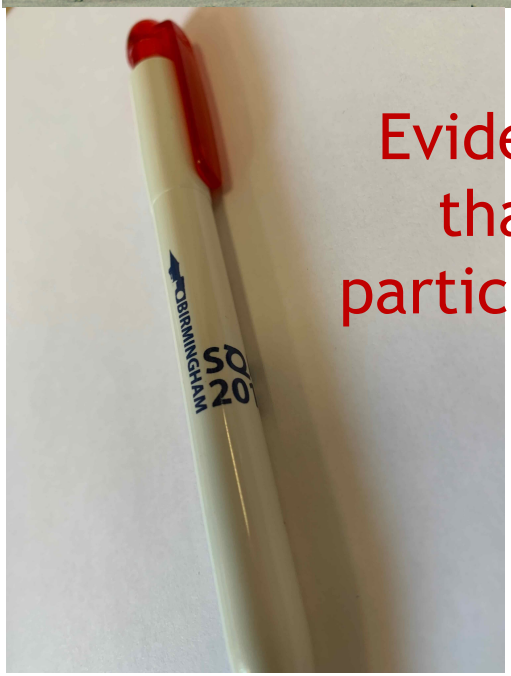
Huge contribution to growth of a major conference series

1994: Crete, 40 (incl OVB)

2013: Birmingham,
170 from 25 countries

2022: South Korea, 372

SQM 2013 (Birmingham)



Evidence
that I
participated

3 months later, (despite some health issues)

9–14 Sept 2013
Department of Physics and Electronics, University of Jammu
Asia/Kolkata timezone

17 Birmingham colleagues visited Anju et al in Jammu for conference and summer school

Jammu 2013

Opening session from the summer school component

Fri 13/09

09:00

Stuff: What is it? - Introduction to Particle Physics and Accelerators *Paul Newman*

10:00

Seminar Hall, The Buisness School 09:30 - 10:30

Principles of triggering *Orlando Villalobos Baillie*

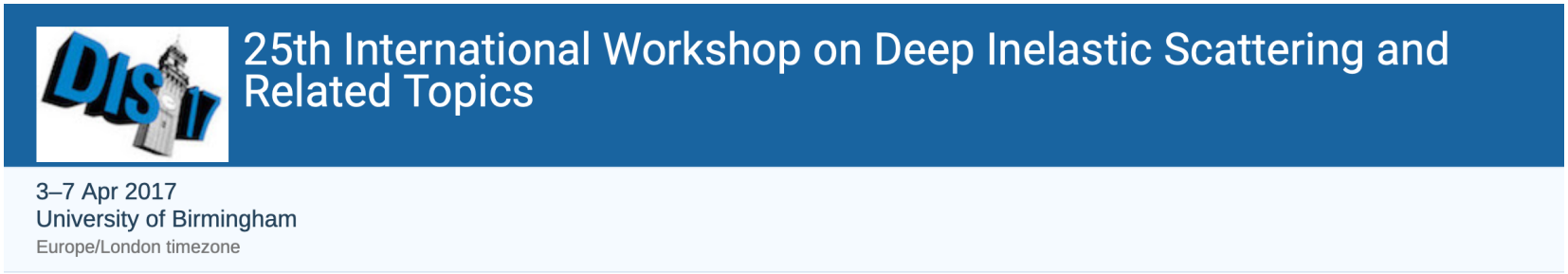
11:00

Seminar Hall, The Buisness School 10:30 - 11:30

TEA/COFFEE

Orlando, please upload your slides

Orlando's input to DIS'17

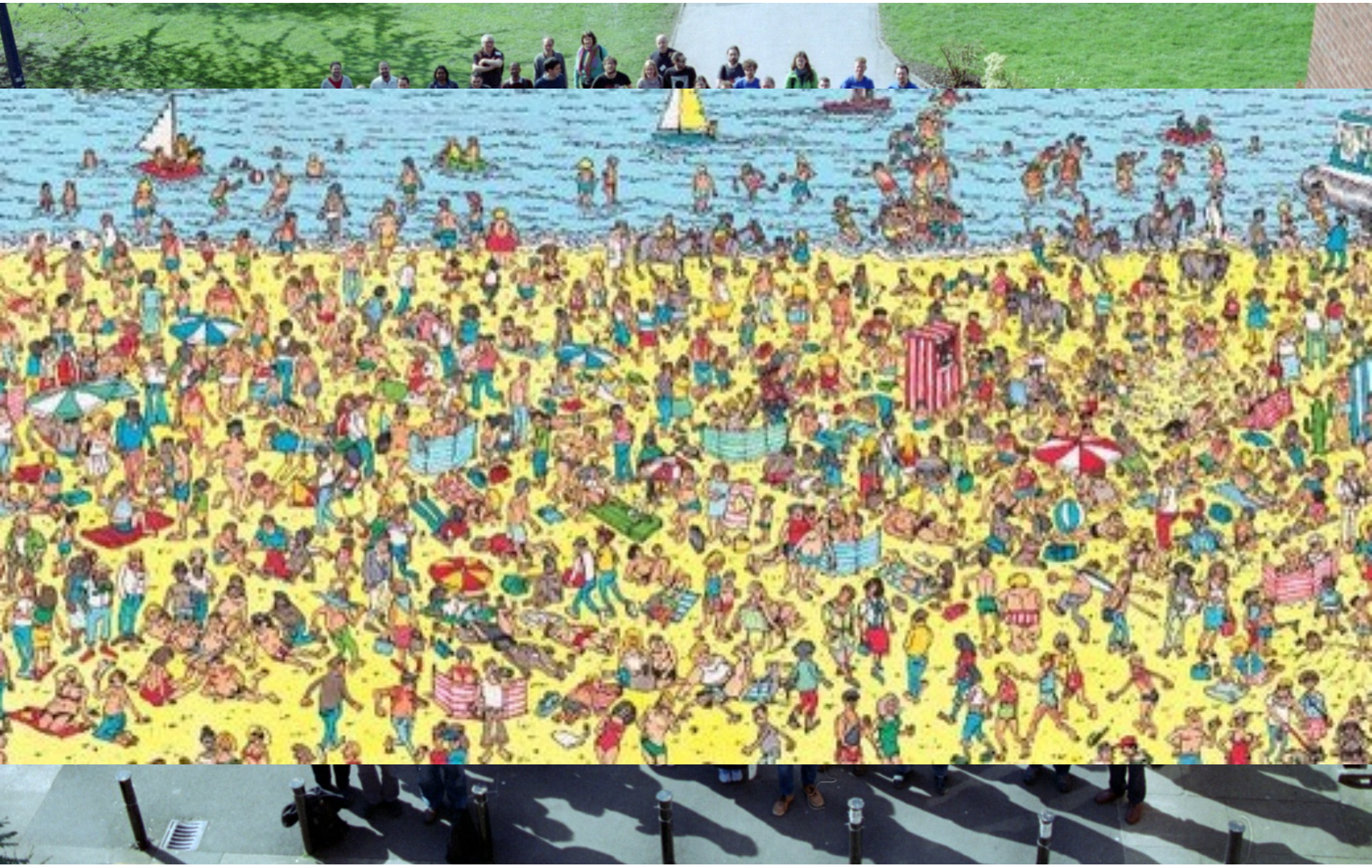


Originally named 'Program and Local Organisation Panel' (PLOP)

Orlando told me everything I needed to know to host a big conference in Birmingham, how to advertise, where to get money etc …

DIS'17: Where's Orlando?

DIS'17: Where's Orlando?



DIS'17: Where's Orlando?

Also missing from the ~400 'official' conference photos?!?

… except for one …

… except for one …

Major contribution 3: PhD supervision

On WA/NA Experiments

1983: Roger Jones
1984: Mary Trainor
1988: David Evans
1989: Richard Barnes
1990: Chris Doddenhoff
1990: Steve Clewer
1991: Andy Bayes
1992: Paul Davies
1995: Keith Norman
1996: Mark Venables
1995: Brian Earl
1996: Mike Thompson
2000: Rory Clarke
2002: Richard Platt

On ALICE

2004: Daniel Tapia Takaki
2007: Zoe Matthews
2009: Plamen Petrov
2011: Graham Lee
2014: Kay Graham
2017: Oliver Jevons
2018: Simone Ragoni

Not to mention lots of informal supervision of many others

Incredibly patient and endlessly helpful

… Orlando the supervision machine!

Orlando's students: where are they now?

1983: Roger Jones	→ Head of Physics, University of Lancaster
1984: Mary Trainor	→ CERN → Scientific Civil Service
1988: David Evans	→ CERN → Academic, Birmingham
1989: Richard Barnes	→ Tessella
1990: Chris Doddenhoff	
1990: Steve Clewer	
1991: Andy Bayes	
1992: Paul Davies	→ Tessella → Morgan Stanley
1995: Keith Norman	→ Tessella → Quantum Computing, Oxford
1996: Mark Venables	
1995: Brian Earl	
1996: Mike Thompson	
2000: Rory Clarke	→ Uni Texas → Daresbury (Clara)
2002: Richard Platt	
2004: Daniel Tapia Takaki	→ Academic, Kansas University
2007: Zoe Matthews	→ Teaching physics, Abingdon
2009: Plamen Petrov	→ FPGA prog'ing (Omnivision, Brussels)
2011: Graham Lee	→ PDRA, Rutherford Lab
2014: Kay Graham	→ Volunteering
2017: Oliver Jevons	→ PDRA, Glasgow
2018: Simone Ragoni	→ PDRA, Creighton, USA

(Work in progress)

Major Contribution 4: PG Teaching

Orlando's lectures to PG students began in 1993.
The audience that year contained:

Ian Brawn
Paul Davies
Mark Pearce
… and Paul Newman.

2 sets of lectures … Each 10 hours (though initially somewhat shorter)
1) Particle Physics II: Global symmetries, groups …
2) Deep inelastic scattering
and later …
3) Triggers for Particle Physics

Number of students increased in later years due to remote connections from Warwick, Nottingham, Leicester, Bristol - MPAGS

Orlando continues to teach 1)
Roman took over 3) in 2022
I took over 2) in 2022 … in principle … though I could not attract students quite as well as Orlando …

Teaching Deep Inelastic Scattering 1993

POSTGRADUATE PARTICLE PHYSICS

1992–93

II DEEP INELASTIC SCATTERING

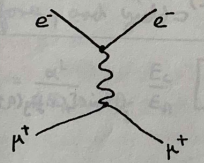
II/93

DEEP INELASTIC SCATTERING

1. Introduction.

The use of the relativistic wave equations for spin 0 and spin ½ particles, and in particular their application in perturbation theory (i.e. calculations using the Feynman rules), provide powerful tools for calculating the amplitudes for two body scattering processes.

The usefulness of these calculations can be greatly extended by realizing that they specify the functional dependence for scattering between particles of any kind with spin ½ (or spin 0). For example the calculation of the cross section for the reaction $e^- \mu^+ \to e^- \mu^+$ via one photon exchange

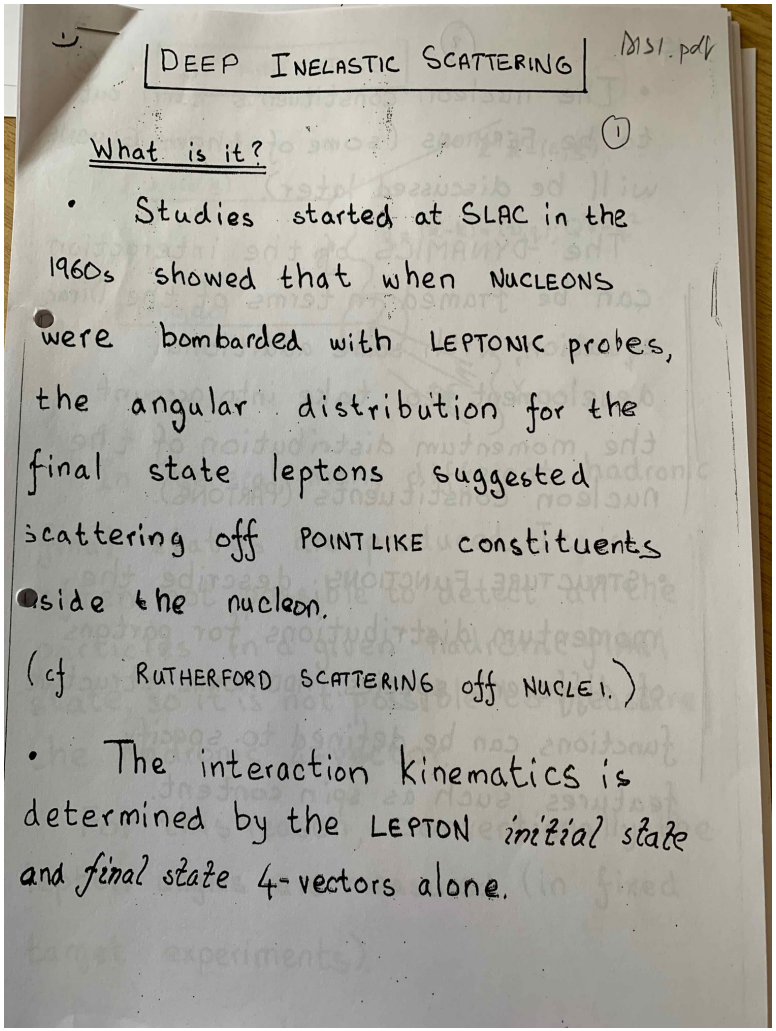


can be readily extended to other ½ ½ → ½ ½ processes. The differential cross section can be written in the form

$$d\sigma = \frac{1}{F} |\mathcal{M}|^2 \, dQ \qquad [HM(4.29)_p 90]$$

$$= \frac{1}{|\underline{v}_A - \underline{v}_B| \, 2E_A E_B} |\mathcal{M}|^2 \left\{ \frac{d^3p_c}{(2\pi)^3 2E_c} \frac{d^3p_D}{(2\pi)^3 2E_D} \right\} \qquad [CI(9.1)_p 172]$$

Teaching Deep Inelastic Scattering 2021



DEEP INELASTIC SCATTERING

DISI.pdf

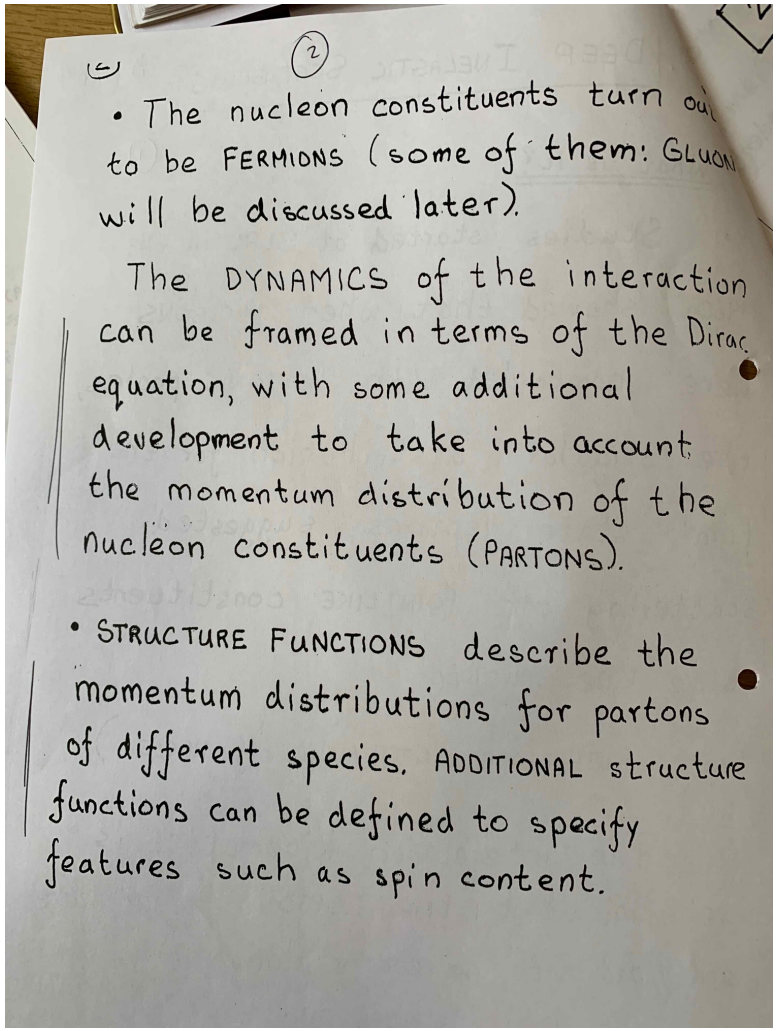
What is it?

(1)

- Studies started at SLAC in the 1960s showed that when NUCLEONS were bombarded with LEPTONIC probes, the angular distribution for the final state leptons suggested scattering off POINTLIKE constituents inside the nucleon.

(cf RUTHERFORD SCATTERING off NUCLEI.)

- The interaction kinematics is determined by the LEPTON *initial state* and *final state* 4-vectors alone.



(2)

- The nucleon constituents turn out to be FERMIONS (some of them: GLUONS will be discussed later).

The DYNAMICS of the interaction can be framed in terms of the Dirac equation, with some additional development to take into account the momentum distribution of the nucleon constituents (PARTONS).

- STRUCTURE FUNCTIONS describe the momentum distributions for partons of different species. ADDITIONAL structure functions can be defined to specify features such as spin content.

Observation 1: Pressure to digitize successfully resisted

Observation 2: Handwriting improved

Observation 3: Expectations of the students decreased

Teaching Group Theory in 2022

Convenor: Dr O. Villalobos Baillie (Birmingham)

Module Code: PP5

Duration (Hours): 10 hourly sessions

Start Date and Commitments

Start: 7/11/2022 - 10 lectures on Mo 12-13, Tue 12-13

Module Details

Review properties of groups and how they can be applied in particle physics

Get overview of relevant concepts in Lie groups and Lie algebra;

Get introduction to the application of these groups to the static Quark Model;

Study structure of SU(3) multiplets and their coupling.

Resources

Lecture notes

Symmetry Lectures Contents

Teaching Group Theory in 2022: Lecture 1

Symmetries in Particle Physics

O. Villalobos Baillie
University of Birmingham

Introduction

- In this course, we shall examine how certain types of symmetry can be expressed and applied in Particle Physics.
- Aim is to provide an intuitive approach, without going into rigorous proofs of the results we shall require.

Digitised!

Teaching Group Theory 2022: Most of the rest

1.

SYMMETRIES IN PARTICLE PHYSICS

LECTURE 1

The application of SYMMETRY PRINCIPLES has been a powerful tool in the development of particle physics.

When formulating physical laws, the requirement that they display symmetry (sometimes to very high order) has been fruitful.

HOW?

There is a connection between symmetries and conserved quantities

- Especially useful in particle physics, where only FINAL STATES (after all interactions have ceased) are measurable.

2.

The *totally antisymmetric* state is

$$\Lambda_1^0 = \frac{1}{\sqrt{6}}(sdu - sud + usd - dsu + dus - uds)$$

The mixed symmetry states can be built up from the u and d states.

	M, S	M, A	
p	$\frac{1}{\sqrt{6}}[(ud+du)u-2uud]$	$\frac{1}{\sqrt{2}}(ud-du)u$	
n	$-\frac{1}{\sqrt{6}}[(ud+du)d-2ddu]$	$\frac{1}{\sqrt{2}}(ud-du)d$	
Σ^+	$\frac{1}{\sqrt{6}}[(us+su)u-2uus]$	$\frac{1}{\sqrt{2}}(us-su)u$	$u_-\|d\rangle \Rightarrow \|s\rangle$ on p
Σ^-	$\frac{1}{\sqrt{6}}[(ds+sd)d-2dds]$	$\frac{1}{\sqrt{2}}(ds-sd)d$	τ_- on Σ^0
Ξ^-	$-\frac{1}{\sqrt{6}}[(ds+sd)s-2ssd]$	$\frac{1}{\sqrt{2}}(ds-sd)s$	τ_- on Ξ^0
Ξ^0	$-\frac{1}{\sqrt{6}}[(us+su)s-2ssu]$	$\frac{1}{\sqrt{2}}(us-su)s$	u_- on Σ^0
Σ^0	$\frac{1}{\sqrt{12}}[s(du+ud)+(dsu+usd)-2(dus+uds)]$	$\frac{1}{2}[(dsu+usd)-s(ud+du)]$	τ_- on Σ^+
Λ^0	$\frac{1}{\sqrt{2}}\left[\frac{dsu-usd}{\sqrt{2}}+\frac{s(du-ud)}{\sqrt{2}}\right]$	$\frac{1}{\sqrt{12}}[s(du-ud)+(usd-dsu)-2(dus-uds)]$	orthog. Σ^0

Not so digitised!

Teaching Group Theory 2022: Most of the rest

1.

SYMMETRIES IN PARTICLE PHYSICS

LECTURE 1

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$$\Lambda_1^\circ = \frac{1}{\sqrt{6}}(sdu - sud + usd - dsu + dus - uds)$$

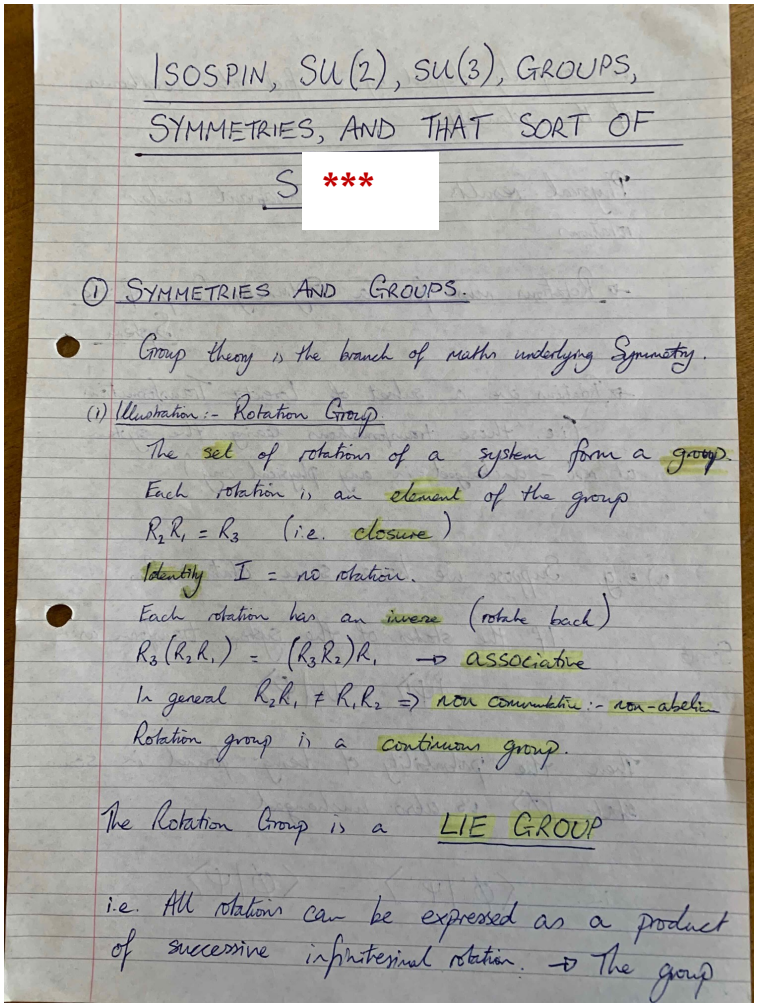
The mixed symmetry states can be built up from the u and d states.

	M, S	M, A	
p	$\frac{1}{\sqrt{6}}[(ud+du)u-2uud]$	$\frac{1}{\sqrt{2}}(ud-du)u$	
n	$-\frac{1}{\sqrt{6}}[(ud+du)d-2ddu]$	$\frac{1}{\sqrt{2}}(ud-du)d$	
Σ^+	$\frac{1}{\sqrt{6}}[(us+su)u-2uus]$	$\frac{1}{\sqrt{2}}(us-su)u$	$I_-\|d\rangle \Rightarrow \|s\rangle$ on p
Σ^-	$\frac{1}{\sqrt{6}}[(ds+sd)d-2ddu]$	$\frac{1}{\sqrt{2}}(ds-sd)d$	I_- on Σ°
Ξ^-	$-\frac{1}{\sqrt{6}}[(ds+sd)s-2ssd]$	$\frac{1}{\sqrt{2}}(ds-sd)s$	I_- on Ξ°
Ξ°	$-\frac{1}{\sqrt{6}}[(us+su)s-2ssu]$	$\frac{1}{\sqrt{2}}(us-su)s$	U_- on Σ°
Σ°	$\frac{1}{\sqrt{12}}[s(du+ud)+(dsu+usd)-2(dus+uds)]$	$\frac{1}{2}[(dsu+usd)-s(ud+du)]$	I_- on Σ^+
Λ°	$\frac{1}{\sqrt{2}}\left[\frac{dsu-usd}{\sqrt{2}}+\frac{s(du-ud)}{\sqrt{2}}\right]$	$\frac{1}{\sqrt{12}}[s(du-ud)+(usd-dsu)-2(dus-uds)]$	orthog. Σ°

- Reams of meticulously researched, carefully written, notes
- A subject Orlando clearly enjoys enormously
- Good luck with the continuation (and the book???)

Some of my notes from Group Theory (1993)

First page



ISOSPIN, SU(2), SU(3), GROUPS, SYMMETRIES, AND THAT SORT OF S ***

① SYMMETRIES AND GROUPS.

Group theory is the branch of maths underlying Symmetry.

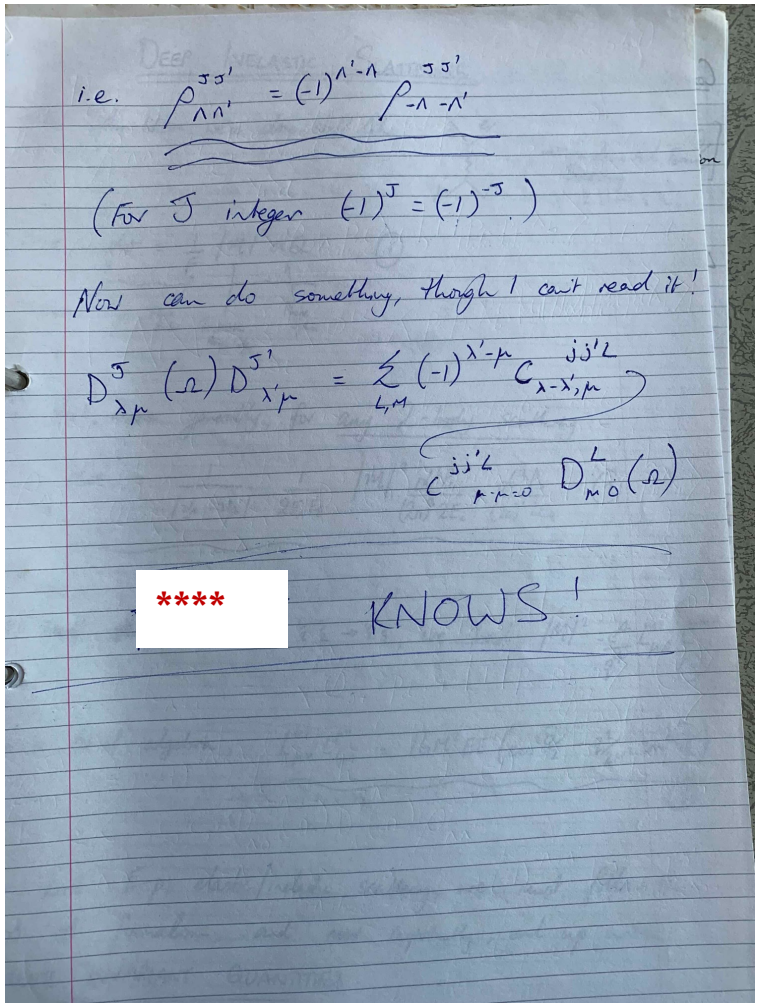
(i) Illustration :- Rotation Group

The set of rotations of a system form a group.
Each rotation is an element of the group
$R_2 R_1 = R_3$ (i.e. closure)
Identity I = no rotation.
Each rotation has an inverse (rotate back)
$R_3(R_2 R_1) = (R_3 R_2) R_1$ → associative
In general $R_2 R_1 \neq R_1 R_2$ ⇒ non commutative :- non-abelian
Rotation group is a continuous group.

The Rotation Group is a LIE GROUP

i.e. All rotations can be expressed as a product of successive infinitesimal rotation. → The group

Last page



i.e. $\rho^{JJ'}_{\Lambda\Lambda'} = (-1)^{\Lambda'-\Lambda} \rho^{JJ'}_{-\Lambda-\Lambda'}$

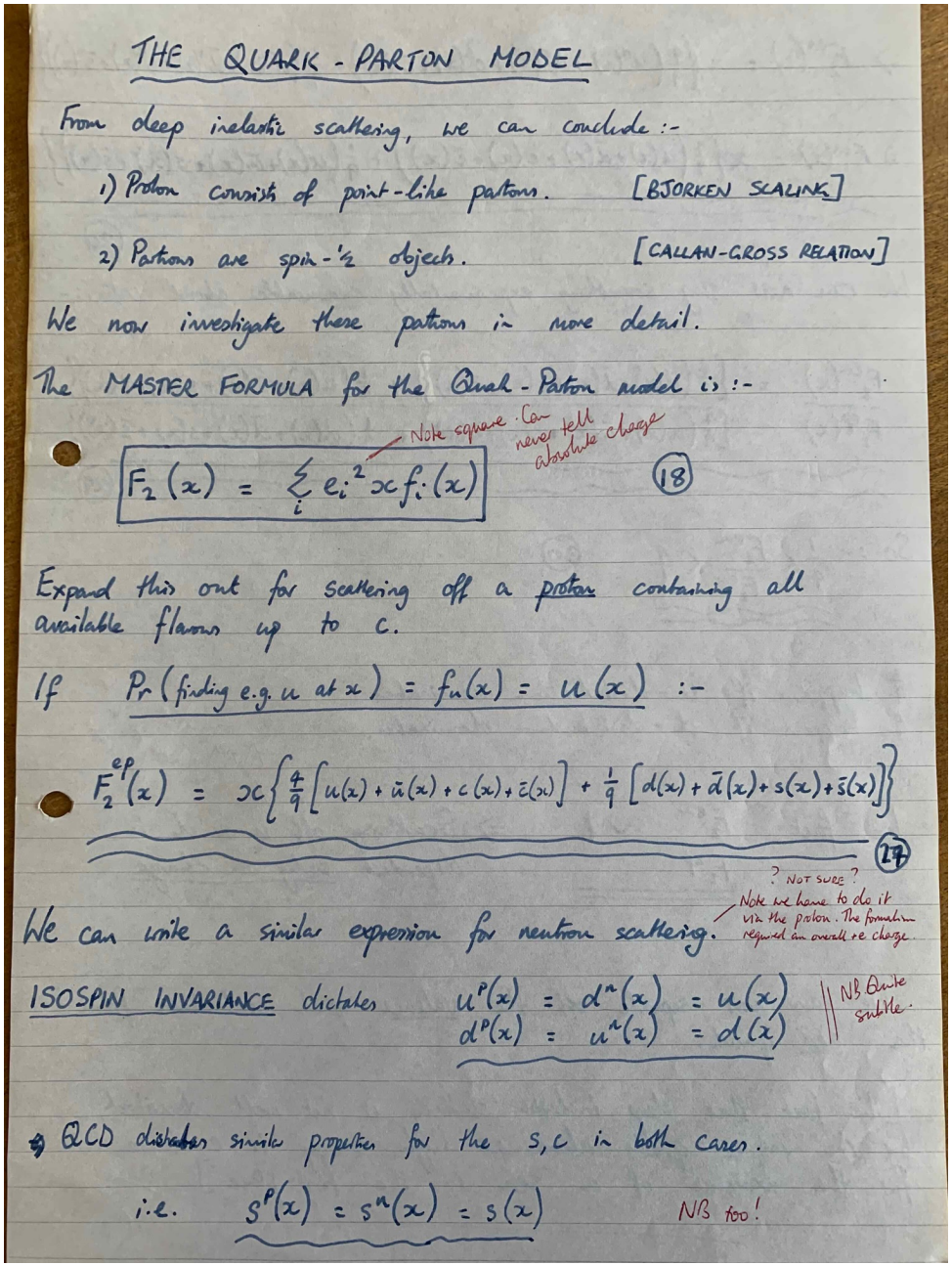
(For J integer $(-1)^J = (-1)^{-J}$.)

Now can do something, though I can't read it!

$$D^J_{\lambda\mu}(\Omega) D^{J'}_{\lambda'\mu} = \sum_{L,M} (-1)^{\lambda'-\mu} C^{jj'L}_{\lambda-\lambda',\mu} C^{jj'L}_{\mu-\mu=0} D^L_{M0}(\Omega)$$

**** KNOWS!

Some of my notes from the DIS course (1993)



THE QUARK-PARTON MODEL

From deep inelastic scattering, we can conclude :-

1) Proton consists of point-like partons. [BJORKEN SCALING]

2) Partons are spin-½ objects. [CALLAN-GROSS RELATION]

We now investigate these partons in more detail.

The MASTER FORMULA for the Quark-Parton model is :-

Note square. Can never tell absolute charge

$$F_2(x) = \sum_i e_i^2 x f_i(x) \qquad (18)$$

Expand this out for scattering off a proton containing all available flavours up to c.

If $P_r(\text{finding e.g. } u \text{ at } x) = f_u(x) = u(x)$:-

$$F_2^{ep}(x) = x\left\{\frac{4}{9}\left[u(x)+\bar{u}(x)+c(x)+\bar{c}(x)\right] + \frac{1}{9}\left[d(x)+\bar{d}(x)+s(x)+\bar{s}(x)\right]\right\} \qquad (17)$$

We can write a similar expression for neutron scattering.

? NOT SURE ?

Note we have to do it via the proton. The formalism required an overall +e charge.

ISOSPIN INVARIANCE dictates $u^p(x) = d^n(x) = u(x)$, $d^p(x) = u^n(x) = d(x)$ || NB Quite subtle.

QCD dictates similar properties for the s, c in both cases.

i.e. $s^p(x) = s^n(x) = s(x)$ NB too!

- Surprisingly neat!

- Orlando clearly taught me everything I know on the subject.

- Little did either of us know that I would still be doing this stuff 30 years later.

… generations of students are grateful for Orlando's unique insights and thoughtfulness in how to convey them

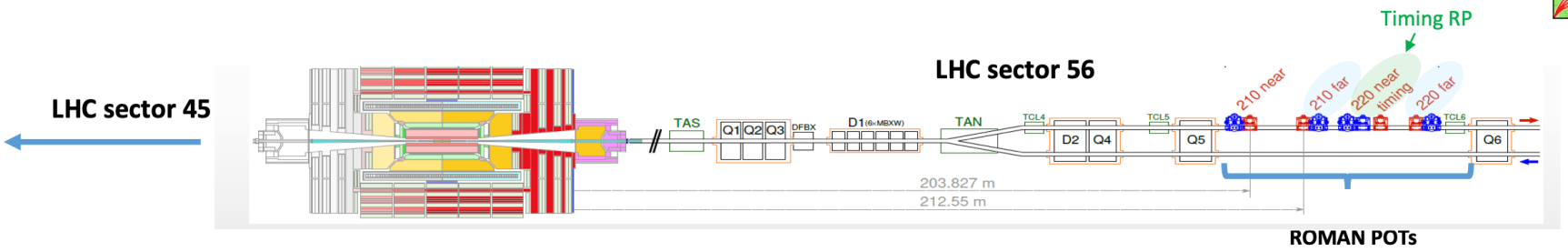
But what became of Double Diamond?

But what became of Double Diamond?

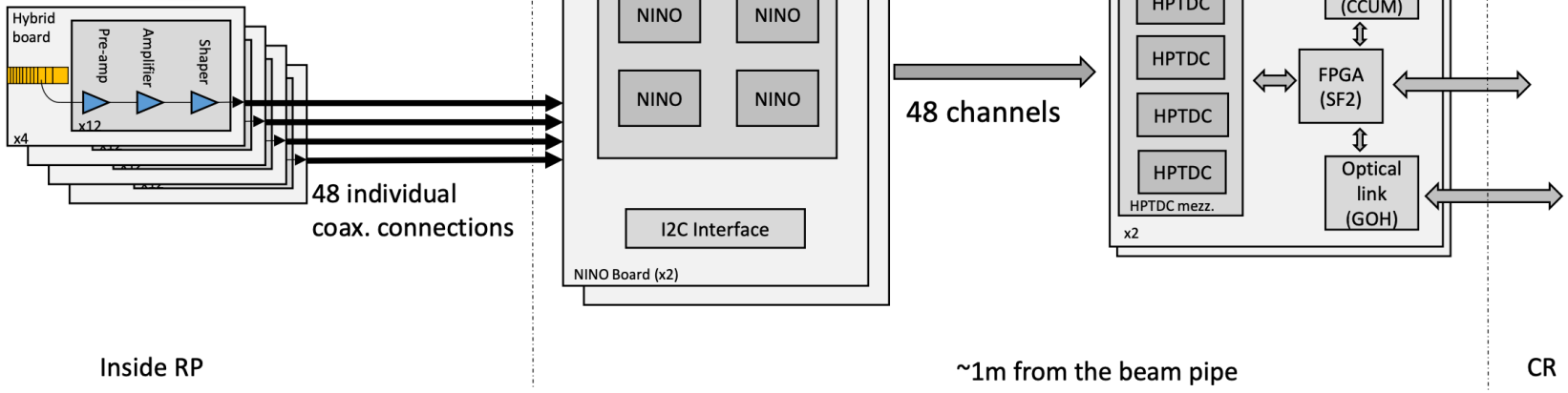
Last brewed in 2003

2022: CMS PPS Roman pot Cerenkov radiator timing detectors

PPS timing system



Plane 0: Single diamond (SD)
Plane 1: Single diamond
Plane 2: Double diamond (DD)
Plane 3: Double diamond



Thank you Orlando!

Congratulations on getting to this point
Enjoy your retirement (and please don't stop!)