

The BGOOD experiment at ELSA



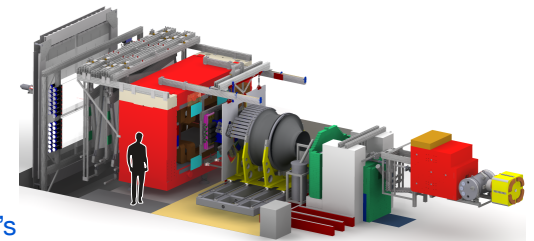
Hartmut Schmieden
Physikalisches Institut
Universität Bonn



supported by DFG
PN 50165297 and
PN 405882627



This project has received funding from the European Union's
Horizon 2020 research and innovation programme under grant
agreement No 824093



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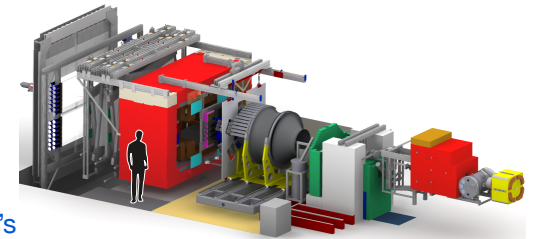
Why a second experiment at ELSA ?



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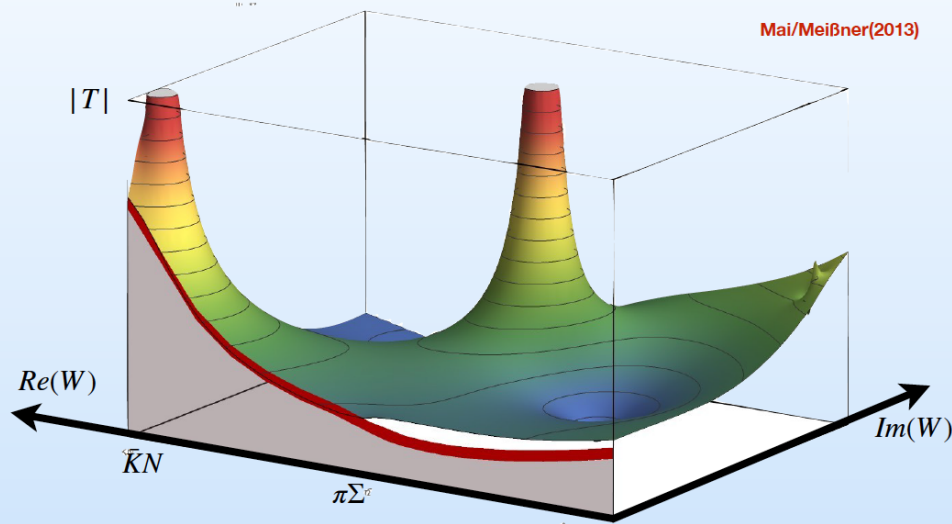
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$\Lambda(1405)$

Narrow pole (1410 MeV) & broad pole (~1350 MeV)

Mai/Meißner(2013)



taken from Maxim Mai's
talk at NSTAR 2019
(Baryon ChPT)

Oller/Meißner (2001)

- Relativistic re-summation of chiral potential
- Two-poles on II Riemann Sheet → Now part of PDG

Kaiser/Siegel/Weise (1995) Oset/Ramos (1998)

- Lippmann-Schwinger equation for $K-p, \Sigma\pi, \Lambda\pi$
- Potential from Chiral Lagrangian

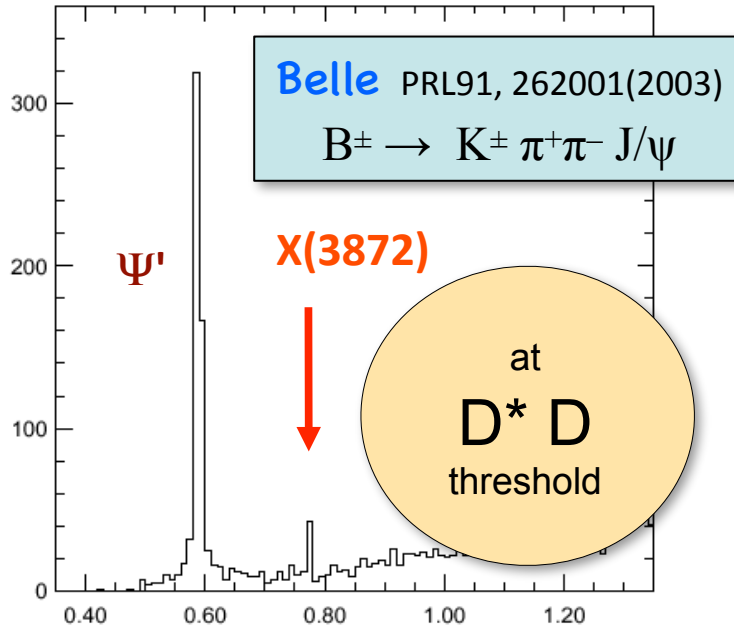
“Thus, a potential derived from chiral dynamics with interaction ranges commensurate with the meson-baryon system necessarily produces a quasi-bound state or resonance below or near the K - p threshold”

context c-quark sector

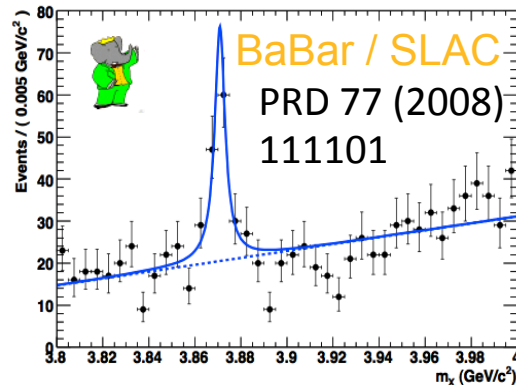
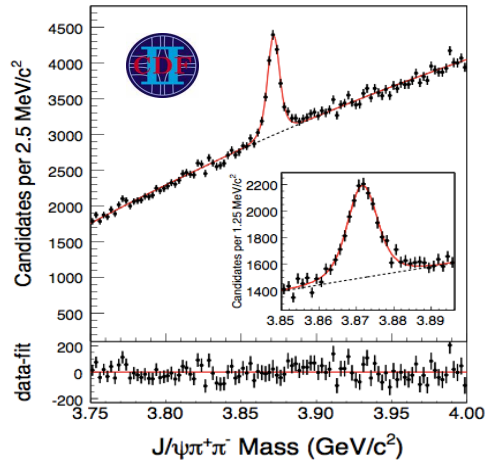
nature



$X(3872)$



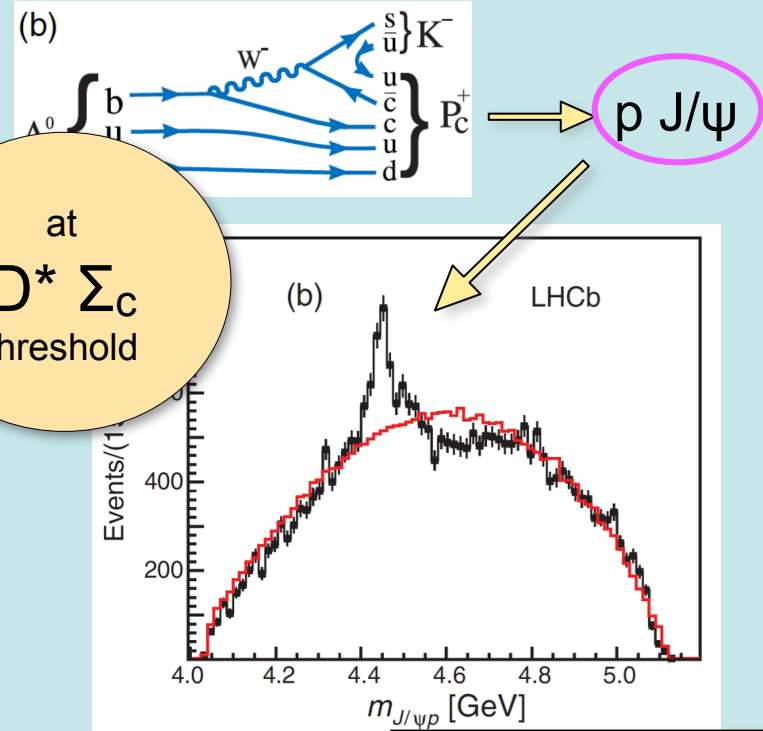
$$M(\pi^+ \pi^- 1^+ 1^-) - M(1^+ 1^-)$$



$P_c^+(4380, 4450)$

Forsaken pentaquark

R. Aaij et al., PRL 115 (2015) 072001



PB / VB hidden c predicted from meson-baryon interactions:
 Oset, Zou et al., PRL 105 (2010)

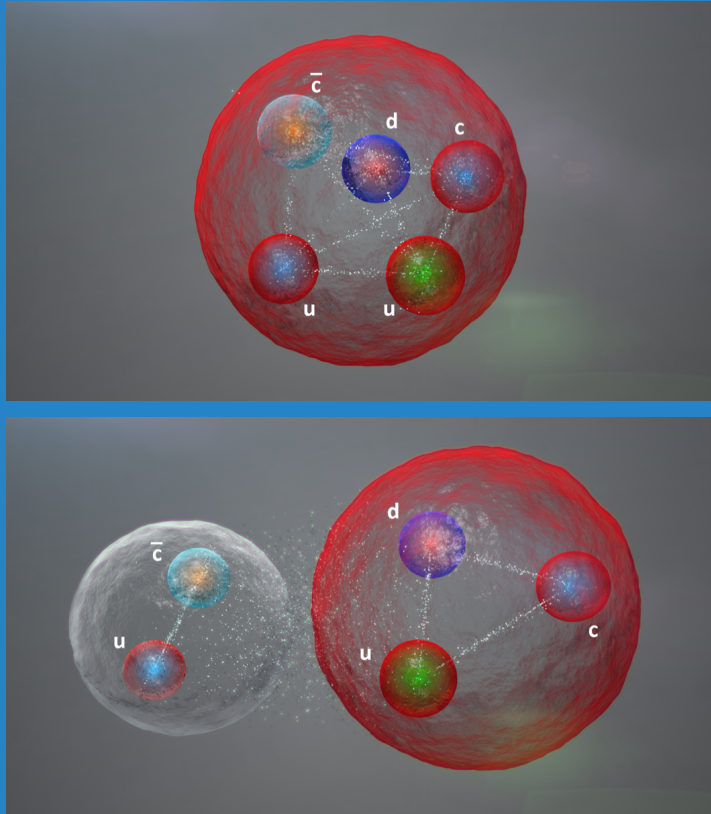
"new N_{cc}^* states are simply brothers or sisters of the well known $N^*(1535)$ and $\Lambda^*(1405)$... and many other dynamically generated states ..."

context c-quark sector

$X(3872)$

$P_c^+(4380, 4450)$

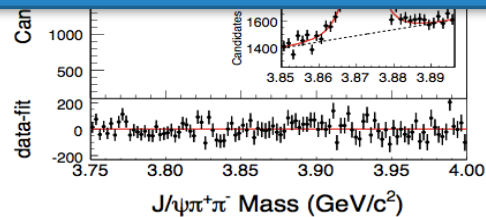
Forsaken pentaquark



- 5-quark structures definitely observed
- (hidden) c-quark sector
- similar 4-quark states in meson sector
- structure/binding mechanism under debate

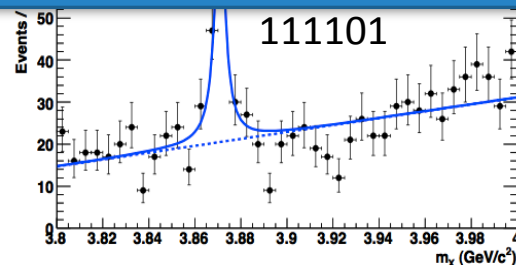
➡ paradigm change in hadron physics
 ➡ general feature of structure formation in QCD ?
 ➡ similar structures in (hidden) s-quark sector ??

but: — mass pattern $D - D^* / K - K^*$ and
 — widths $D^* - K^*$ different



CDF / Tevatron

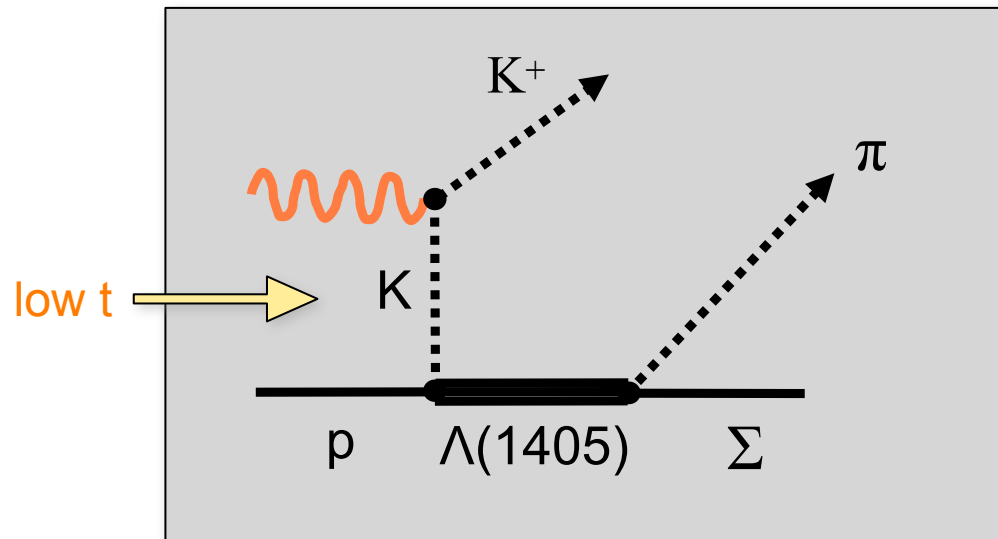
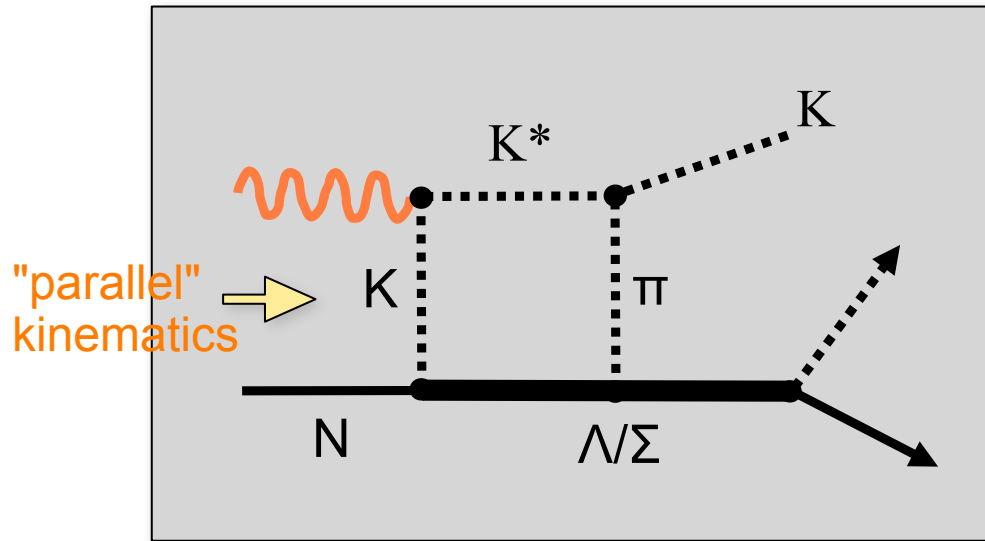
PRL 103 (2009) 152001



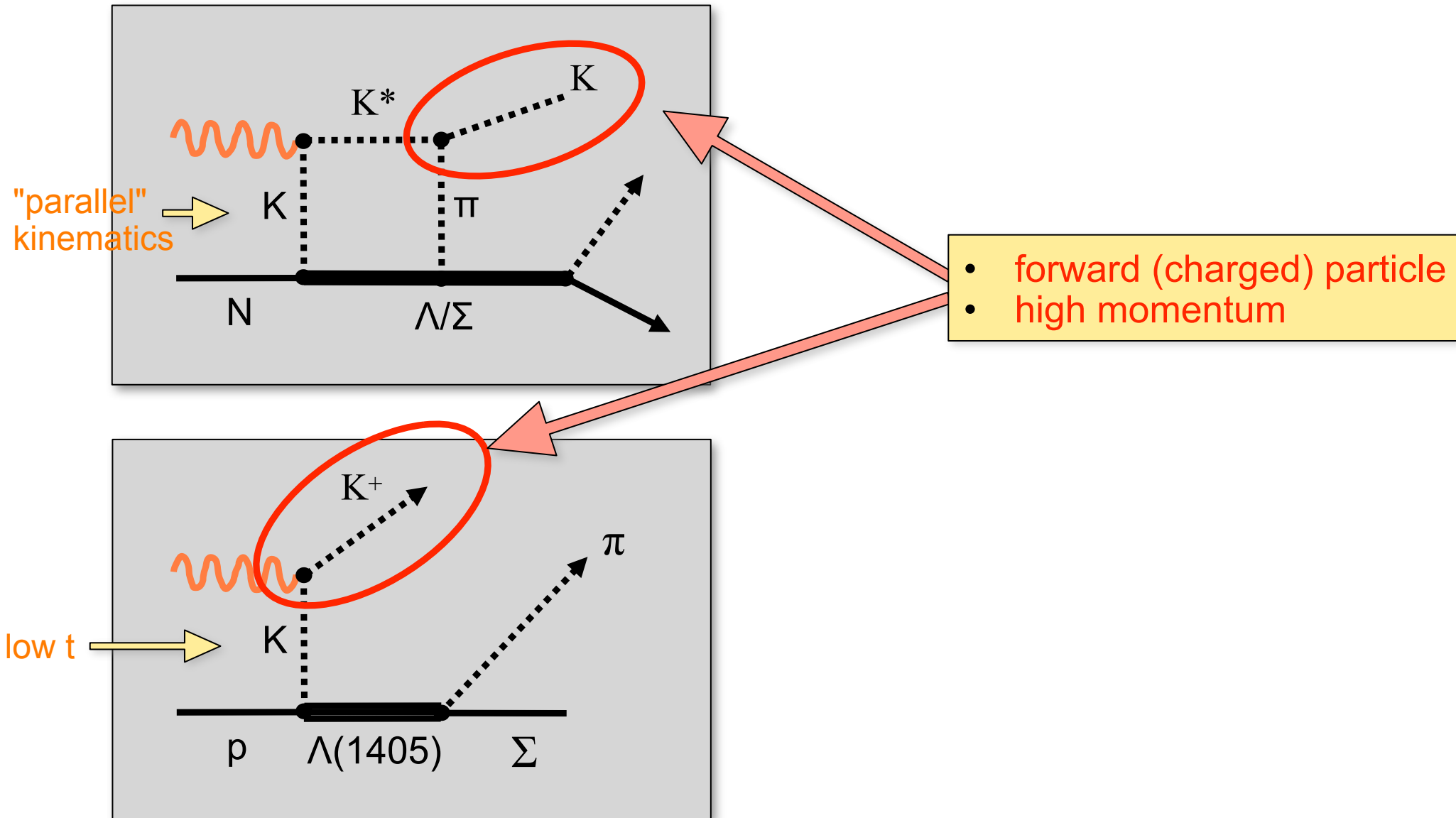
meson-baryon interactions:
 Oset, Zou et al., PRL 105 (2010)

"new N_{cc}^* states are simply
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 known $N^*(1535)$ and $\Lambda^*(1405)$
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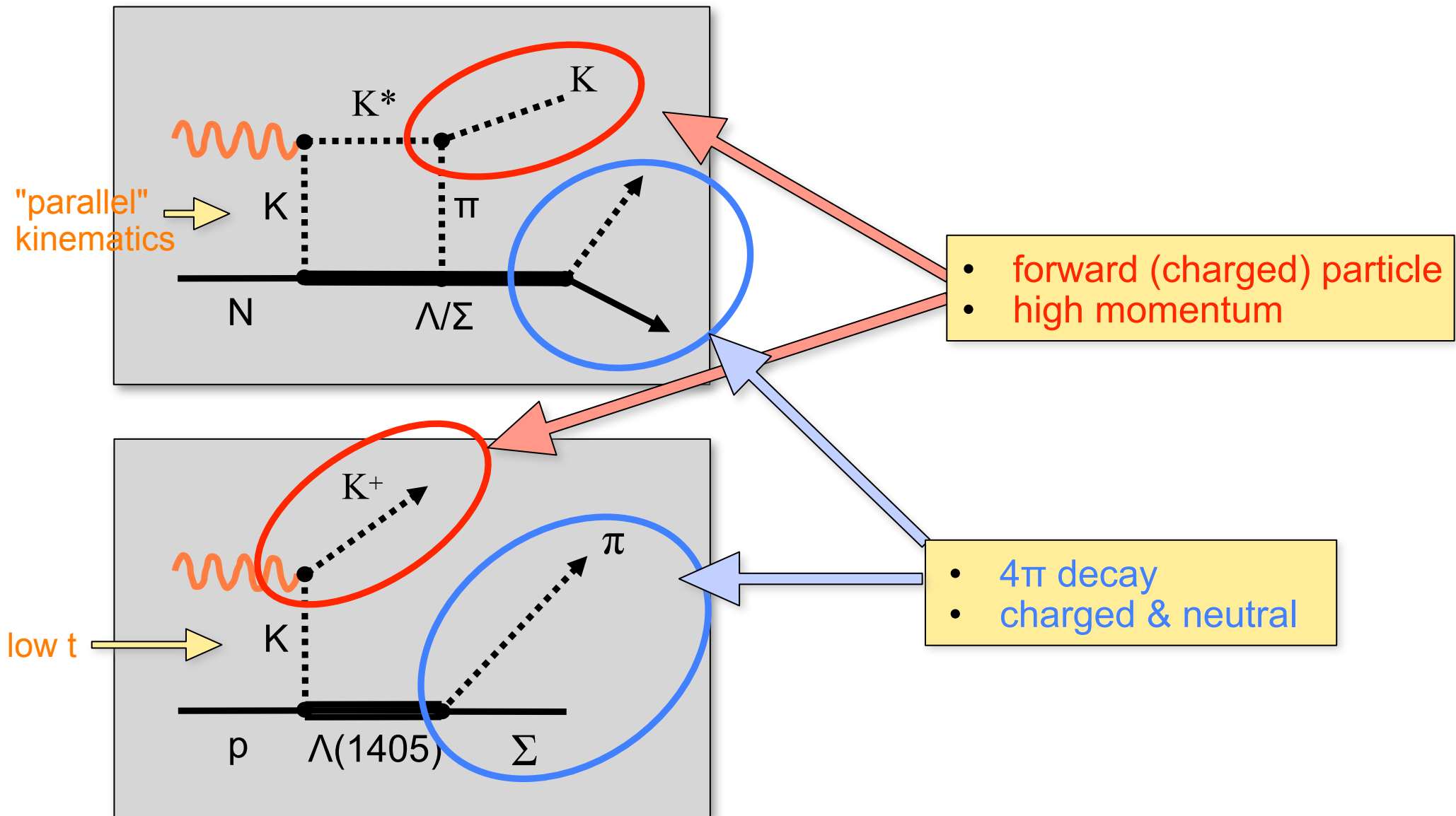
essential motivation: t-channel Kinematics



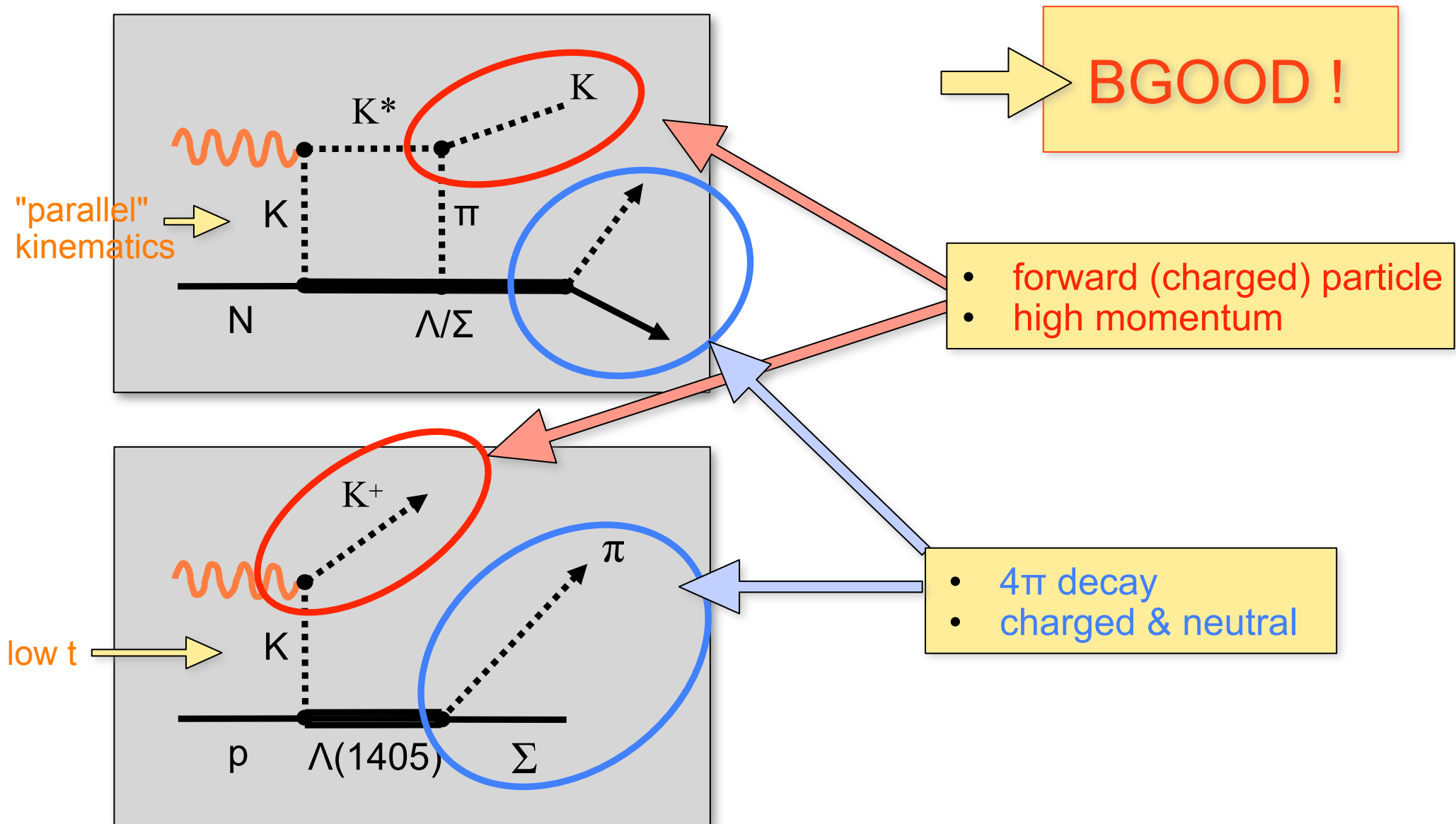
essential motivation: t-channel Kinematics



essential motivation: t-channel Kinematics



essential motivation: t-channel Kinematics

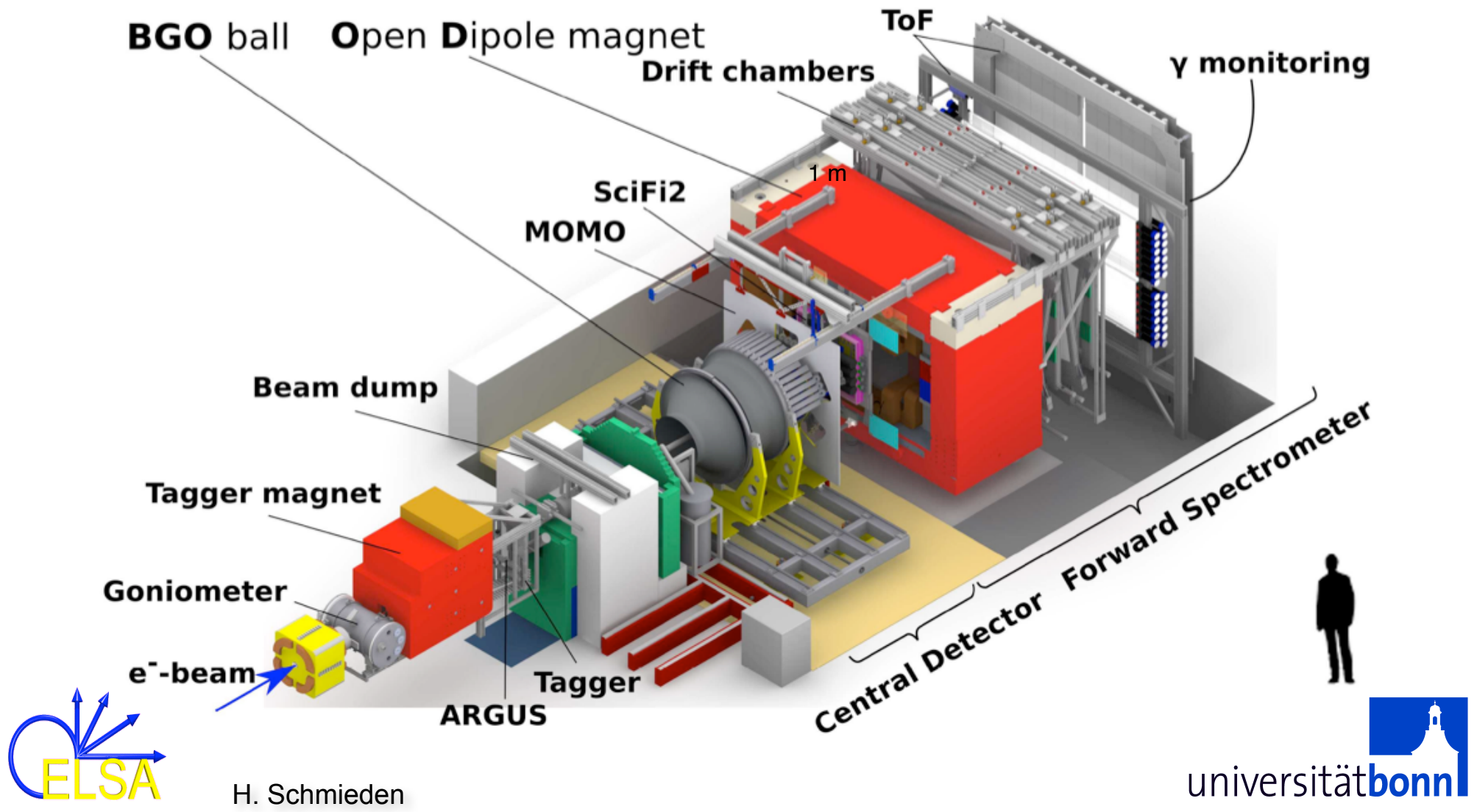


BGOOD experiment

S. Alef et al. [BGOOD collab.], EPJ A 56 (2020) 104

spokespersons: P. Levi Sandri (Frascati) & H. Schmieden (Bonn)

- combination of BGO central calorimeter & forward spectrometer
- high momentum resolution, excellent neutral & charged particle id



H. Schmieden

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BGOOD experiment

S. Alef et al. [BGOOD collab.], EPJ A 56 (2020) 104

Levi Sandri (Frascati) &
H. Schmieden (Bonn)

rometer
particle id

γ monitoring

ard Spectrometer



- combination
- high moment

BGO ball

Beam

Tagger magnet

Goniometer

e^- -beam



H. Schmi

The European Physical Journal

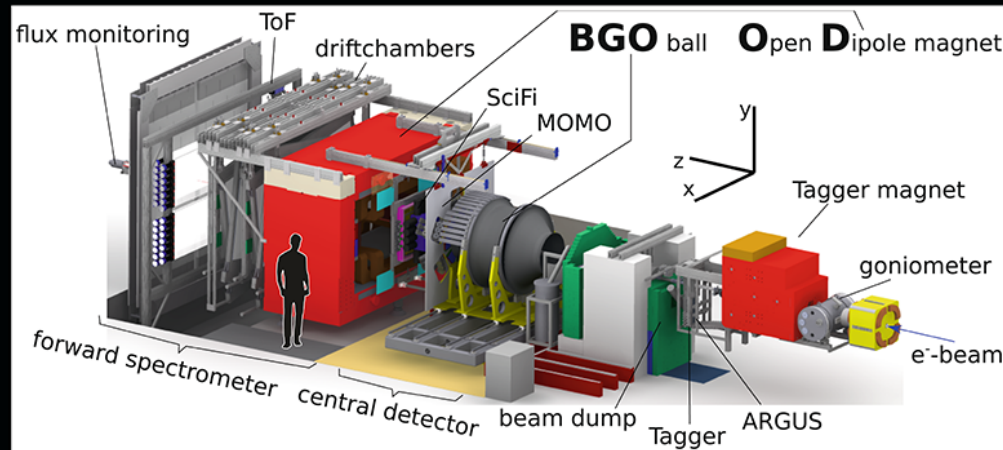
volume 56 · number 4 · april · 2020

EPJ A



Recognized by European Physical Society

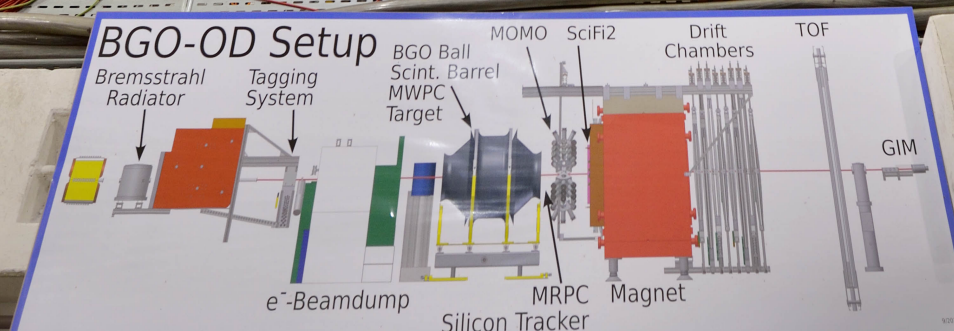
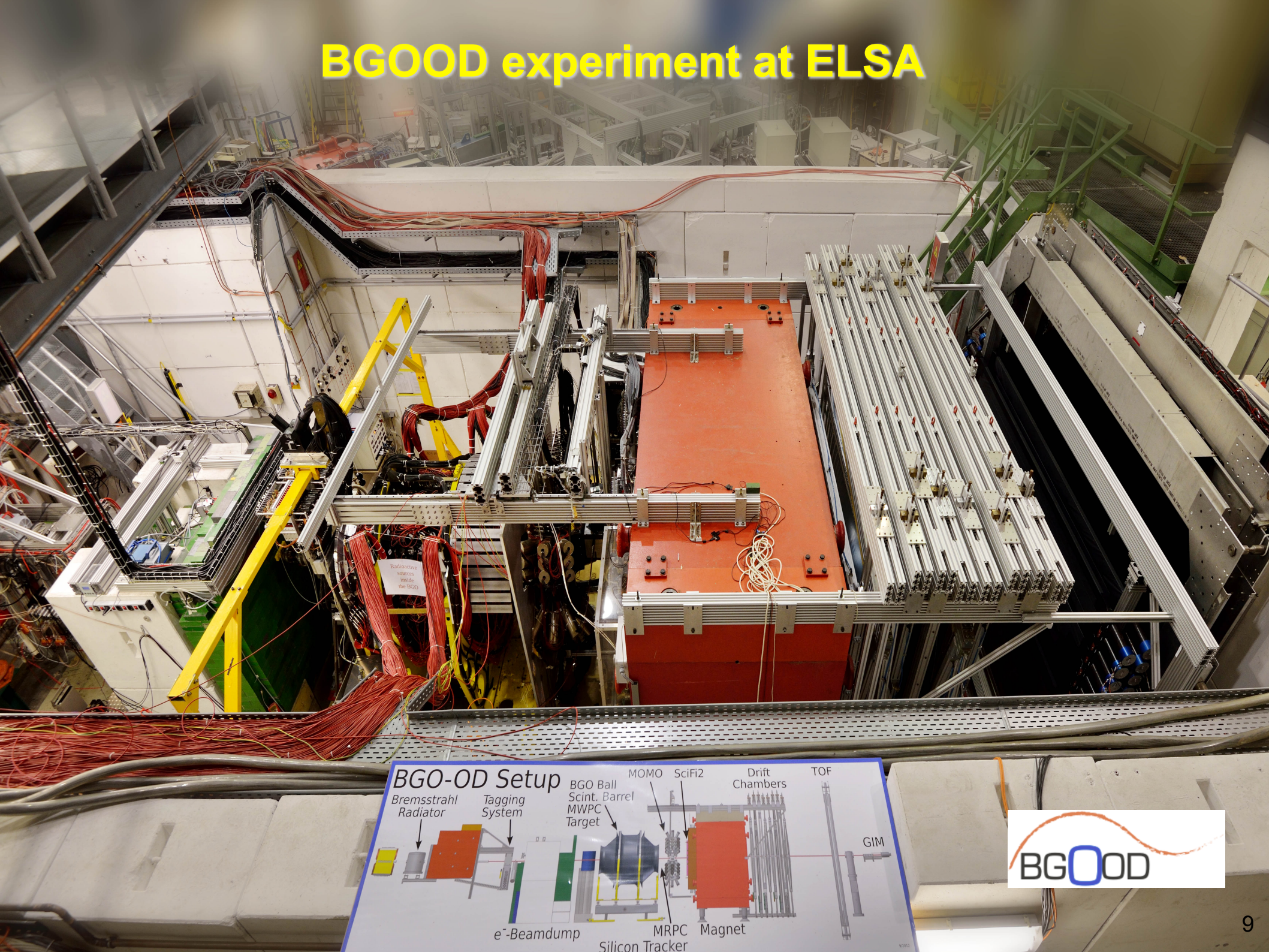
Hadrons and Nuclei



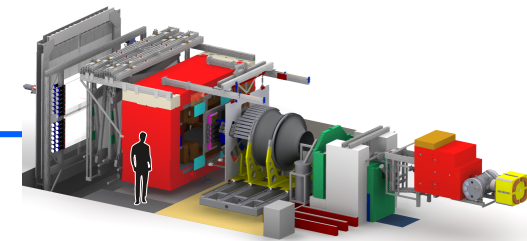
Overview of the BGOOD (BGOball Open Dipole magnet) experiment at the ELSA Facility dedicated to study meson photo-production

From: T. C. Jude and P. Levi Sandri et al. on "The BGOOD experimental setup at ELSA"

BGOOD experiment at ELSA



BGOOD collaboration



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¹⁴ Russian Academy of Sciences Institute for Nuclear Research, Prospekt 60-letiya Oktyabrya 7a, Moscow 117312, Russia

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¹⁷ Dipartimento MIFT, Università degli Studi di Messina, Via F. S. D'Alcontres 31, 98166 Messina, Italy

¹⁸ Institute for Nuclear Research of NASU, 03028 Kiev, Ukraine

¹⁹ *Present Address:* DESY Research Centre, Hamburg, Germany

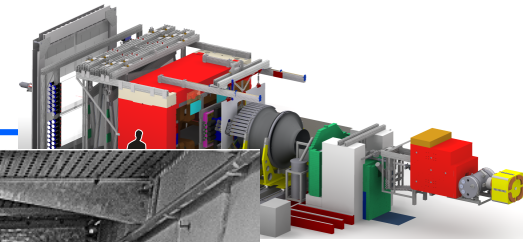
²⁰ *Present Address:* Forschungszentrum Jülich, Jülich, Germany

²¹ *Present Address:* University of Rijeka, Rijeka, Croatia

²² *Present Address:* Lund University & ESS, Lund, Sweden



BGOOD collaboration



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O. Jahn¹,
K. Koop²,
M. Manga
P. Pedroni
A. Stugele

¹ Rheinische
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³ Petersburg
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⁵ Justus-Lie
⁶ Departme
⁷ INFN Ron
⁸ Dipartime
⁹ INFN sez
¹⁰ Dipartime
¹¹ INFN sez
¹² Istituto Su
¹³ Institut für
¹⁴ Russian A
¹⁵ INFN - La
¹⁶ INFN sez
¹⁷ Dipartime
¹⁸ Institute fo
¹⁹ Present Ac
²⁰ Present Ac
²¹ Present Ac
²² Present Ac



hsag on 9.12.14 – just after first “data run”

Important Steps

- forward spectrometer construction
- Gatchina connection
- The Italians → BGO
- long-term co-spokesman: Paolo Levi Sandri
- CRC 16
- INFN
- later DFG individual & Horizon2020
- significant PI support
- reliable & flexible ELSA operation

strong interaction

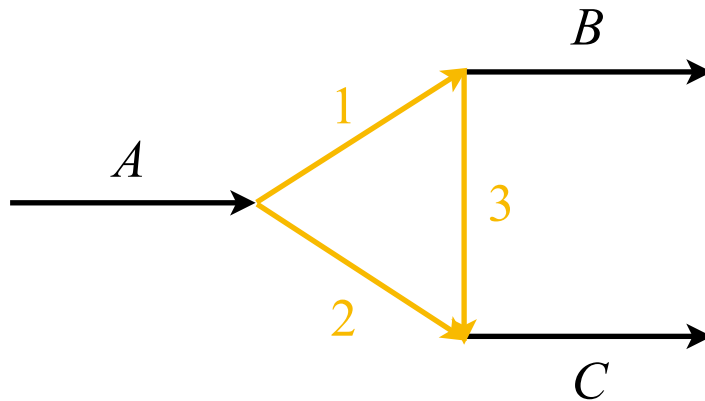


H. Schmieden

strong interaction → **Theory / Eulogio**

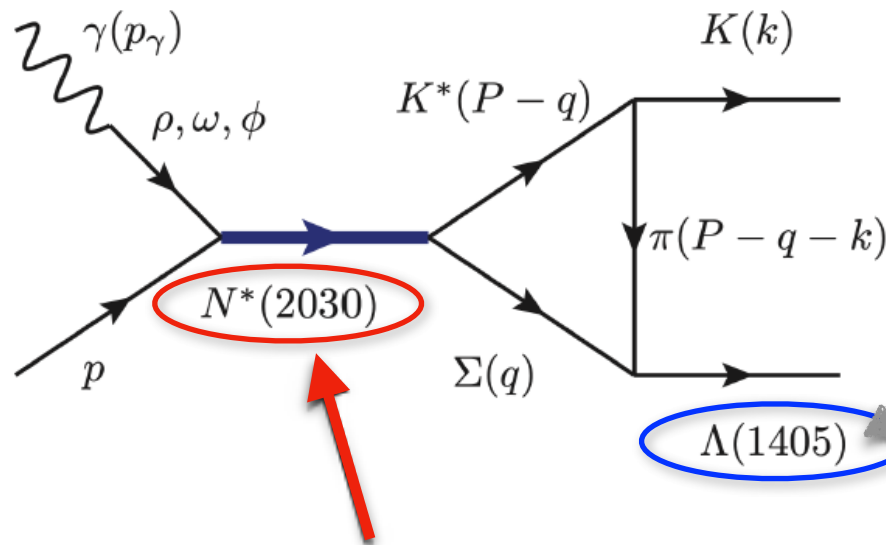


H. Schmieden



Coleman-Norton theorem,
Il Nuovo Cimento 38 (1965) 438:
1, 2, 3 must be nearly on mass shell

can mimic resonance



or drive (dynamically generated) resonance

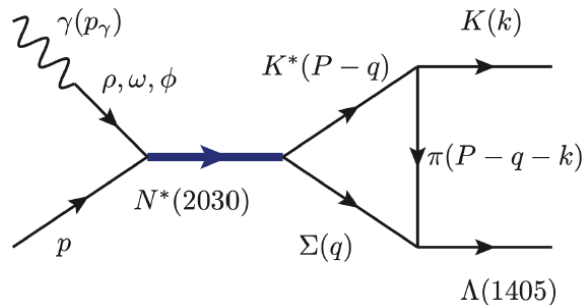
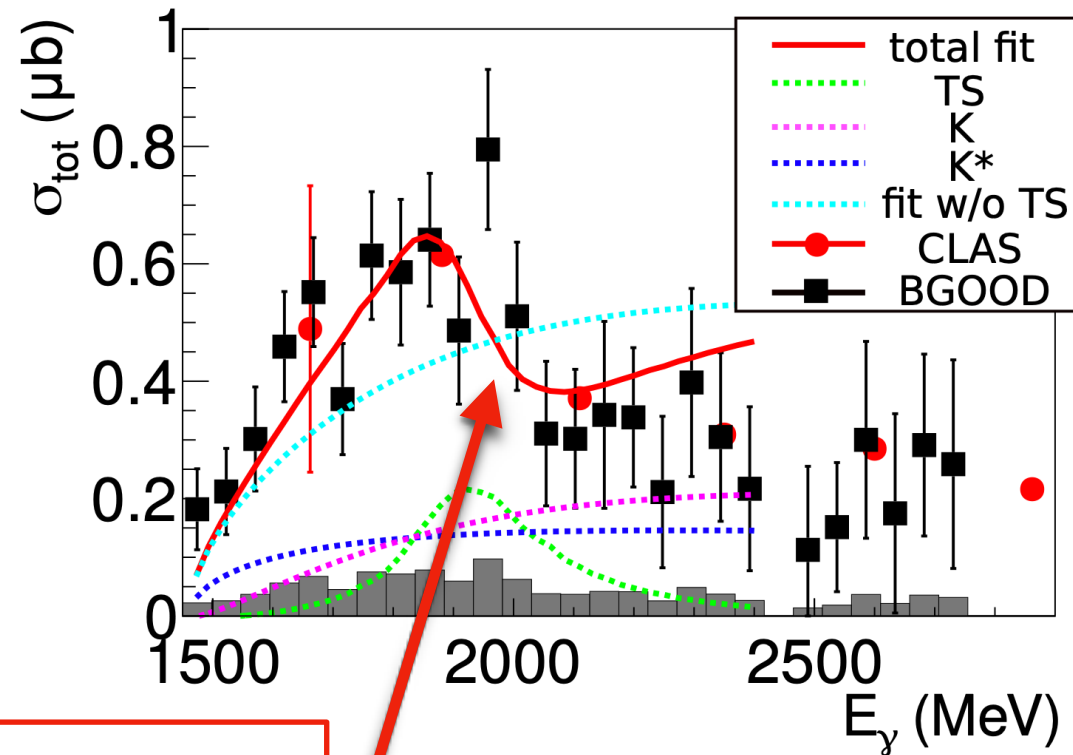
E. Wang, J. Xie, W. Liang, F. Guo, E. Oset,
PR C 95 (2017) 015205

$K^*\Sigma$ suspect in $K^0\Sigma^0$ channel

K⁺ Λ(1405)

K⁺ Λ(1405) photoproduction – total x-sec

G. Scheluchin *et al.* [BGOOD collab.]
Phys. Lett. B 833 (2022)



E. Wang, J. Xie, W. Liang, F. Guo, E. Oset,
PR C 95 (2017) 015205

cusp: triangle mechanism significant

How did things work out ?

- Diploma, Bachelor & Master students
- PhD "students"
- Postdocs, Katrin Kohl
- Technical Coordinators:
Hartmut Kalinowsky, Daniel Elsner, Jürgen Hannappel,
Georg Scheluchin, Johannes Groß
- MC / Analysis Coordinators:
Vera Kleber, Tom Jude → habilitation degree & s.p.
- Covid-19 pandemic
- Russia's war
- Ukrainian support: Mariia & Kharkov team

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→ It was an is the dedication and enthusiasm of all of you which made BGOOD fly and the big success it is.

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THANKS

→ It was an is the dedication and enthusiasm of all of you which made BGOOD fly and the big success it is. I'm very proud: good basis for CmF / Insight