

Physics beyond models i.e. experimental aspects of working together with Peter Braun-Munzinger

**potpourri of best memories
from E877, CERES, and ALICE**



I got my PhD with KaoS data in 1992. What next?

April 9, 1993

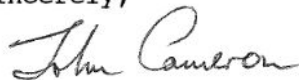
Dr. Dariusz Miskowiec
Gesellschaft für
Schwerionenforschung
Planckstr. 1
D-6100 Darmstadt
GERMANY

Dear Dr. Miskowiec:

Recently a faculty committee has evaluated and indicated considerable interest in your application for a research associate position at the Indiana University Cyclotron Facility. We would like to have the opportunity of talking with you and having you present a seminar at IUCF.

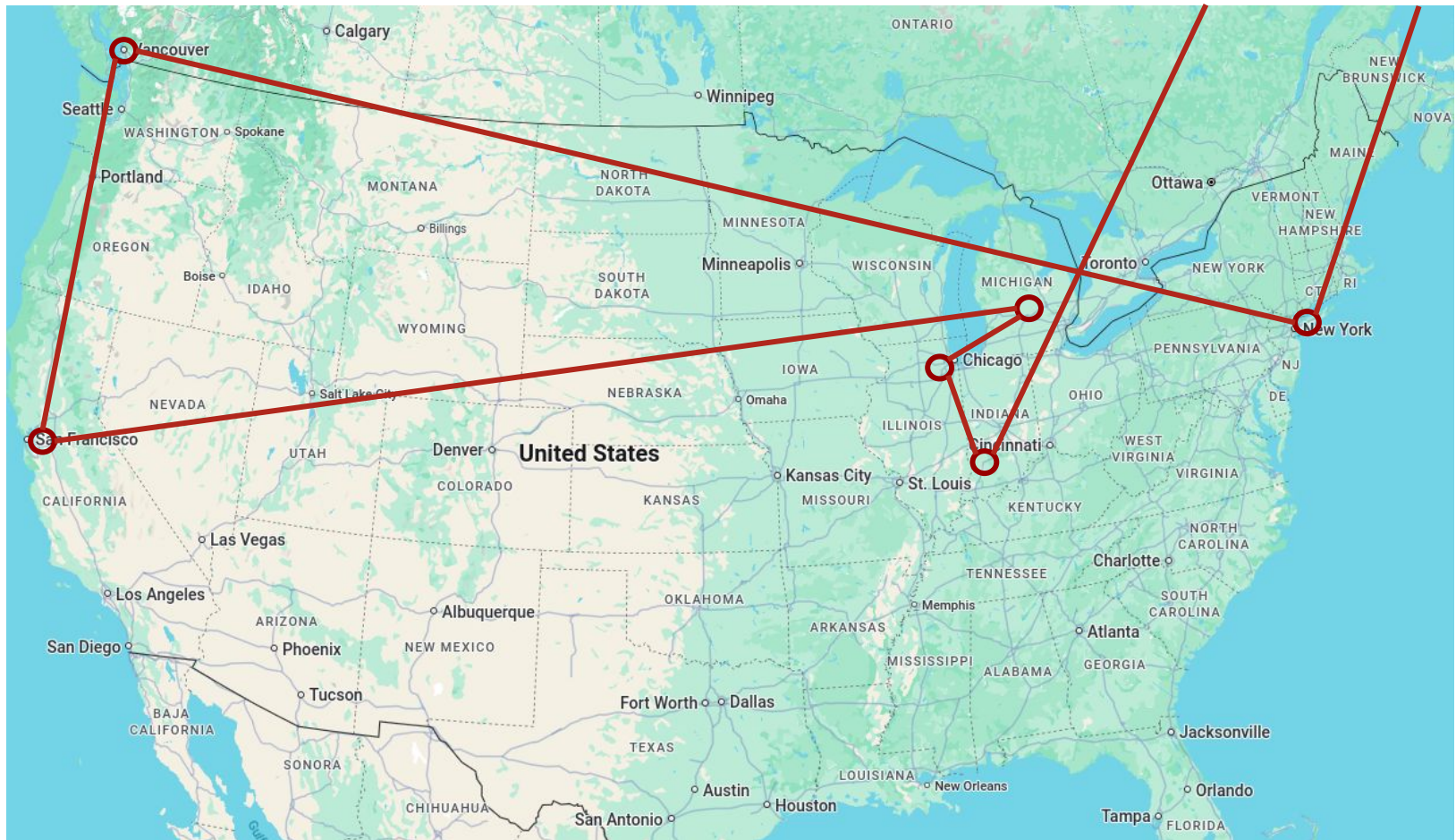
Do you have any plans to visit the U.S. We would be able to pay partial cost but unfortunately funding constraints would not allow us to cover the entire cost of a trip. Perhaps your trip could be combined with one to other research facilities. Please let us know if this seems feasible.

Sincerely,



John M. Cameron
Director, IUCF

my U.S. tour in summer 1993



September 27, 1993

Dr. Dariusz Miśkowiec
KP2
GSI
Postfach 110552
64220 Darmstadt
Germany

Dear Dr. Miśkowiec:

I am very pleased to be able to offer you a position as research associate in our relativistic heavy ion group at Stony Brook. The position is initially for one year, renewable to two years, and carries an annual salary of \$33,000. Since our new grant starts on Feb. 1, 1994, I would like to propose a starting date of Feb. 1, 1994. As a member of our group you will be employed by the Research Foundation of the State of New York, with significant health and fringe benefits.

This is a particularly exciting time for the field of ultrarelativistic nuclear collisions, with the first Au-Au collisions taking place right at this writing, and with plans for upgrades and new detectors for AGS and RHIC experiments underway. Your talents would fit very well into our group and I look forward to hearing from you soon.

Sincerely,

A handwritten signature in dark ink, appearing to read 'Peter Braun-Munzinger', with a long horizontal flourish extending to the right.

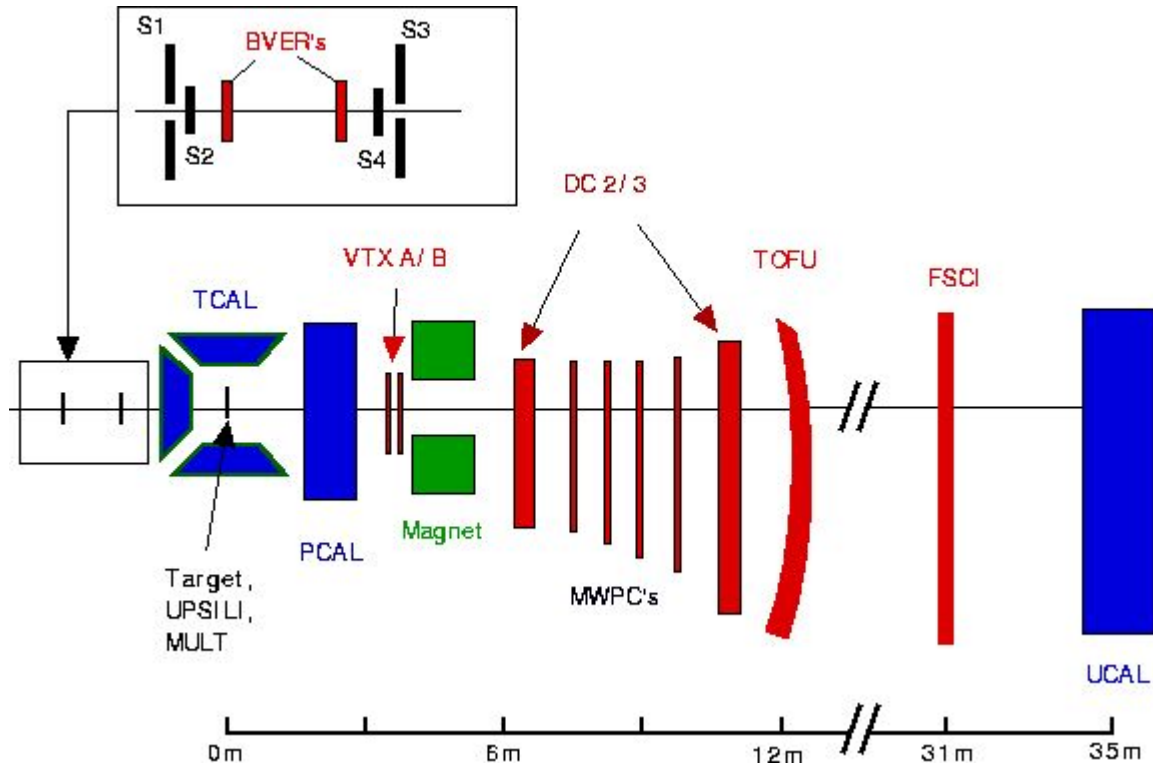
Peter Braun-Munzinger
Professor of Physics

E877

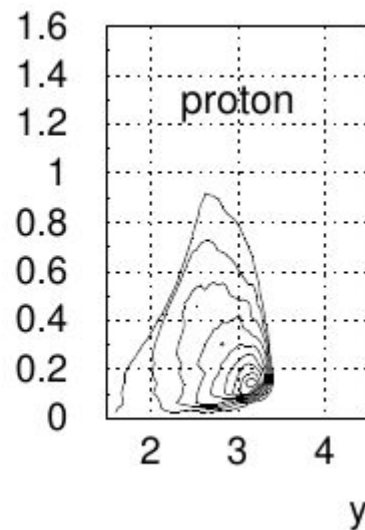
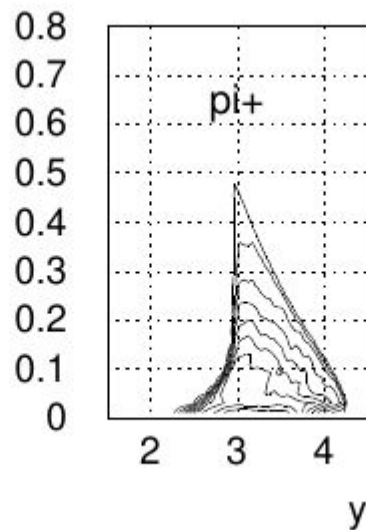
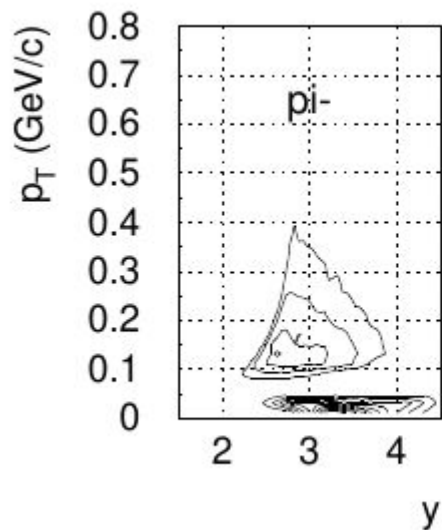
E877 collaboration 1993



E877 experiment 1994-1996: Au-Au at 10.8 GeV/c



E877 charged-particle acceptance



E877 running 1994

I have put a new shift schedule on the public area on skipper. It is in e877/pub/shifts_94/shifts_94.txt
Please copy it from there. I will also put a copy of this on the info system.

Concerning the shifts, I would like to reiterate that:

1. The first name on the shift is the shift supervisor.
2. His/her responsibility include:
 - a) keeping careful notes on everything happening during the shift.
 - b) informing the next supervisor on the status and further plans.
 - c) tapes can only be written after informing the shift supervisor
 - d) all tapes need to be labelled and catalogued
 - e) one floor check per shift, use last years version until we update it.
 - f) keep tape log, run sheet, and logbook up-to-date
 - g) assign one member of the shift crew to supervise the beam
 - h) assign one member of the shift crew to supervise the monitor and spectra and later in the experiment, to do tape copying.
 - i) keep me or my substitute informed as to what is going on in the experiment when I am not in the counting house.
3. For the time of Sep. 5-11, I will be out-of-town (at the Corinne meeting in France). Johanna Stachel will take over the role of run coordinator during my absence.

Peter Braun-Munzinger
Physics Dept.,
SUNY, Stony Brook, NY 11794-3800

Tel.: (516)632-8111
Fax : (516)632-8573

pbm

Reply

Reply All

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More

To

cleland@vms.cis.pitt.edu

,

pbm

,

clemen@vms.cis.pitt.edu

MORE

25/10/1994, 02.01

monitor

Dear Colleagues,
I think our monitor has been abused with excessive noises and inappropriate background pictures. The monitor programs are there to monitor the experiment and nothing else. Please follow these rules at all times.

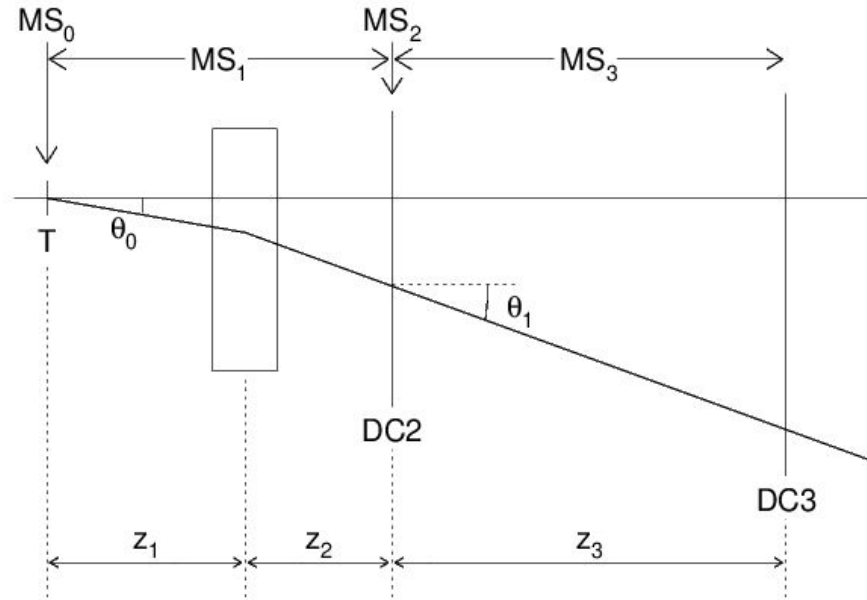
pbm

Peter Braun-Munzinger
Physics Dept.,
SUNY, Stony Brook, NY 11794-3800

Tel.: (516)632-8111
Fax : (516)632-8573



data analysis: momentum-dependent proton mass?



- $DC2$ and $DC3 \Rightarrow$ deflection $\Rightarrow$ momentum
- according to survey, $z_{DC2} = 2400.00$ mm
- proton mass can be made constant by changing z_{DC2}
- HW and DM remeasured the distances in early 1995 - next slide

Conclusions

=====

1. Target position is $z = -0.74$ cm in the coordinate system defined by the floor marks (from measurements 3. and 4.)
2. Measurement 2. is probably wrong because it is inconsistent with previous measurements:
 - a) JPW in prehistory 615.8 cm
 - a) JPW + DM on June 17, 1994 615.8 $\pm$ 0.4 cm
 - b) SP on July 28, 1994 615.9 $\pm$ 0.2 cm
3. Measurement 1. is approximately consistent with the previously measured DC2 position $z = 538.8 \pm 0.2$ cm using the floor marks, and the present observation that the floor marks are 0.74 cm off:
 $538.8 \pm 0.2 + 0.74 = 539.54 \pm 0.2$ to be compared with 539.8 ± 0.3

Thus the proposed corrections in the QUANAH files would be:

=====

1. Shift DC2 by 1.2 cm upstream
2. Shift target by 0.74 upstream, or if this is not possible,
Shift everything except target by 0.74 downstream.

D.M. 03/20/1995

February 1, 1995

Dr. Dariusz Miskowiec
Physics Department
SUNY
Stony Brook, NY 11794-3800

Dear Dariusz:

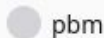
Herewith I would like to reappoint you as postdoctoral fellow in our group for another year, *i.e.* from April 1, 1995 to March 31, 1996. In recognition of your strong contributions to our research, your salary is increased to \$ 34,500, starting from April 1, 1995. I look forward to another year of continued exciting research results from your activities.

Regards,



Peter Braun-Munzinger
Professor of Physics

E877 running in 1995



pbm



Reply



Reply All



Forward



Attachments

To cleland@vms.cis.pitt.edu @, pbm, snoopy, martin, thongbay **MORE**

result of run plan mtg at BNL

Summary of Run 95 Discussion with BNL Management

1. The AGS official start-up is now Oct. 1. Startup with Au at 11.6 A GeV/c will be around the 15th of October. The run with 11.6 A GeV/c Au will be 8 weeks until about Dec. 15. There is a slight chance (maybe 20% in my own estimate) that the planned Nasa run will be shifted to the end, in which case the Au run would start around Oct. 5.
2. The AGS Intensity will be 2×10^{11} per spill. Spill length will be up to 1.6 s depending on whether or not the experiments can use it. The AGS cycle time will be spill time + 1.8 s
3. RHIC studies will be interspersed with AGS normal running, and should for the most time be "invisible" to the users.
4. The AGS schedule can be looked up by anybody on WWW. Go to the BNL home page and select AGS (<http://www.bnl.gov>).

```
=====
|| Peter Braun-Munzinger          Tel.: (516)632-8111 ||
|| Physics Dept.,                Fax : (516)632-8573 ||
|| SUNY, Stony Brook, NY 11794-3800 ||
=====
```



pbm



Reply



Rep

To cleland@vms.cis.pitt.edu @, pbm, pantuev, snoopy, martin,

=====

E877 Shift Schedule
Oct. 18, 1995 - Dec. 13, 1995
update: Oct. 17, 1995

Wed., Oct. 18
02:00-09:00 -----
09:00-18:00 -----
18:00-02:00 Wessels, PBM

Thu., Oct. 19
02:00-09:00 Panitkin, Xu
09:00-18:00 Miskowiec, Stachel
18:00-02:00 Drigert, O'Brien

Fri., Oct. 20
02:00-09:00 Hong, French
09:00-18:00 PBM, Xu
18:00-02:00 Hemmick, Drigert

Sat., Oct. 21
02:00-09:00 Hong, Filimonov
09:00-18:00 Woody, Dietzsch
18:00-02:00 Voloshin, Piazza

Sun., Oct. 22
02:00-09:00 Rosati, Johnson
09:00-18:00 Hong, Miskowiec, Paul
18:00-02:00 Voloshin, Lacasse, French

Mon Oct 23

E877 best-shift contest



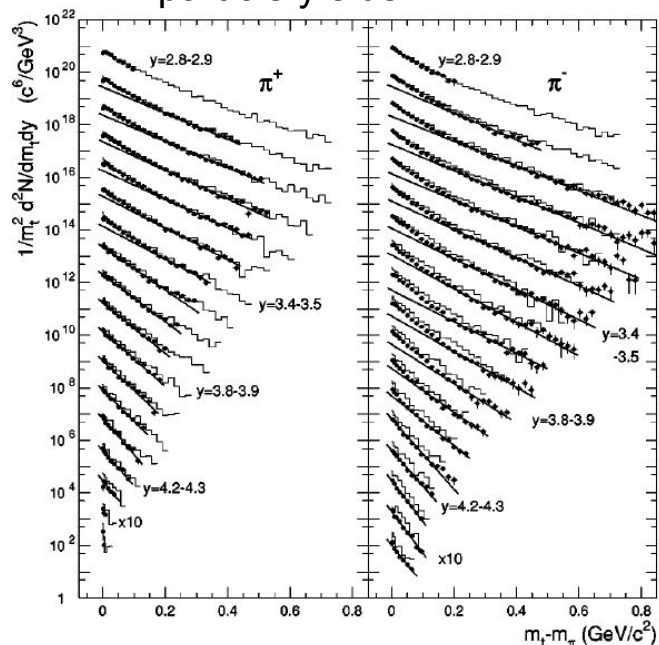
best shift := highest data volume

prize = bottle of genuine Champagne per shifter

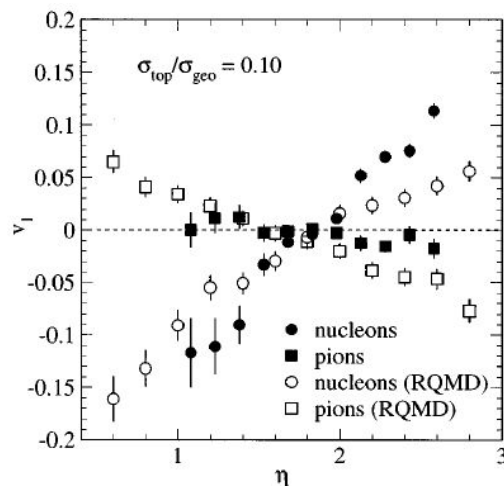


main types of E877 results

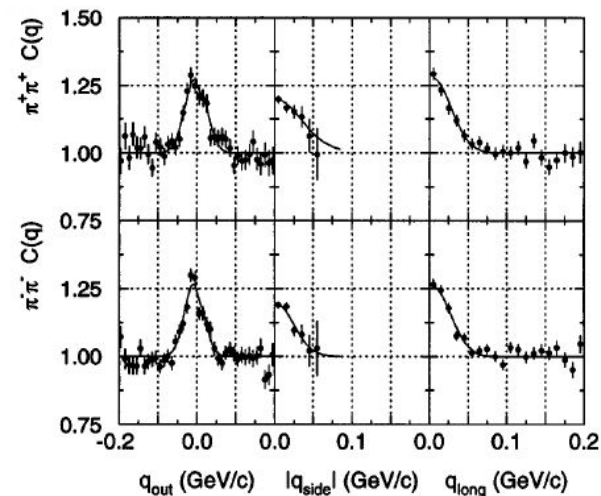
particle yields



flow



two-particle correlations



lasting impact E877

particle yields

- thermal model

flow analysis

- flow parametrization by Fourier coefficients $v_1, v_2, \dots$
- basic features of their p_T dependence

HBT analysis

- finite-size Coulomb correction
- simultaneous analysis of several species combinations
- boosted Gaussian analysis
- direct determination of phase-space density

phase-space density from Bose-Einstein correlations

following G. Bertsch, [PRL 72\(1994\)2349](#) and [PRL 77\(1996\)789](#)

see also [D. Miskowiec, Proceedings of Hirschegg 1997](#)

pion phase-space density $f(\mathbf{r}, \mathbf{p})$ = number of pions per h^3 volume

pion source function $g(\mathbf{r}, t, \mathbf{p})$ = number of pions with their last interaction
in an $\hbar^3$ volume per unit time

here, "pion" means one particular pion species, e.g. π^+

At freeze-out t_0 of pions with momentum $\mathbf{p}$

$$g(\vec{r}, t, \vec{p}) = \delta(t - t_0) f(\vec{r}, \vec{p}) / (2\pi)^3$$

Define the average phase-space density as

$$\langle f \rangle_{\vec{p}} := \frac{\int d^3r [f(\vec{r}, \vec{p})]^2}{\int d^3r f(\vec{r}, \vec{p})}$$

denominator: $\int d^3r \ f(\vec{r}, \vec{p}) = (2\pi)^3 \frac{d^3n}{d^3p}$

numerator: first notice that

$$\begin{aligned} & (2\pi)^3 \int d^3q \int d^4r_1 \int d^4r_2 \ g(\vec{r}_1, t_1, \vec{p}_1) \ g(\vec{r}_2, t_2, \vec{p}_2) \ \cos(q\Delta r) \\ &= (2\pi)^{-3} \int d^3r_1 \int d^3r_2 \ f(\vec{r}_1, \vec{p}_1) \ f(\vec{r}_2, \vec{p}_2) \int d^3q \cos(q\Delta r) \\ &= \int d^3r [f(\vec{r}, \vec{p})]^2 . \end{aligned}$$

Thus

$$\langle f \rangle_{\vec{p}} = \left(\frac{d^3n}{d^3p} \right)^{-1} \int d^3q \int d^4r_1 \int d^4r_2 \ g(\vec{r}_1, t_1, \vec{p}_1) \ g(\vec{r}_2, t_2, \vec{p}_2) \cos(q\Delta r)$$

But from Pratt's formula

$$\int d^4r_1 d^4r_2 g(\vec{r}_1, t_1, \vec{p}_1) g(\vec{r}_2, t_2, \vec{p}_2) \cos(q\Delta r) = \frac{d^6 n}{d^3 p_1 d^3 p_2} - \frac{d^3 n}{d^3 p_1} \frac{d^3 n}{d^3 p_2}$$

and thus

$$\begin{aligned} \langle f \rangle_{\vec{p}} &= \left(\frac{d^3 n}{d^3 p} \right)^{-1} \int d^3 q \left[\frac{d^6 n}{d^3 p_1 d^3 p_2} - \frac{d^3 n}{d^3 p_1} \frac{d^3 n}{d^3 p_2} \right] \\ &= \frac{d^3 n}{d^3 p} \int d^3 q [C(\vec{q}) - 1] \\ &= \frac{d^3 n}{d^3 p} \frac{\sqrt{\pi}^3 \lambda}{R_o R_s R_l} \end{aligned}$$

We are interested in the phase-space density within the source core, without the halo. Then

$$\langle f \rangle_{\vec{p}}^{core} = \frac{d^3 n}{d^3 p} \frac{\sqrt{\pi}^3 \sqrt{\lambda}}{R_o R_s R_l}$$

- its value quantifies how close we are to the **pion-laser** scenario
- its slope is closer related to the **actual temperature T** than the slope of $\frac{d^3 n}{d^3 p}$:

	$d^3 n / d^3 p$ slope	$\langle f \rangle^{core}$ slope
no expansion	T	T
only longitudinal	< T	T
longitudinal and transverse	> T	> T

Little girls are like identical bosons.





potential application for thermal fits of yields

Thermal models fitting the yields of particle species use volume V .
For a continuous distribution of particles in space, V is not well defined.
The average phase space density is. And can be measured.

Caveat: $\langle f \rangle_{\vec{p}}^{core}$ is determined at kinetic freezeout, while it is the chemical freezeout that matters for the yields.



CERES

upgrade of CERES by addition of a TPC

- 1996-1997 design
- 1997-1998 construction and commissioning
- 1999-2000 data taking

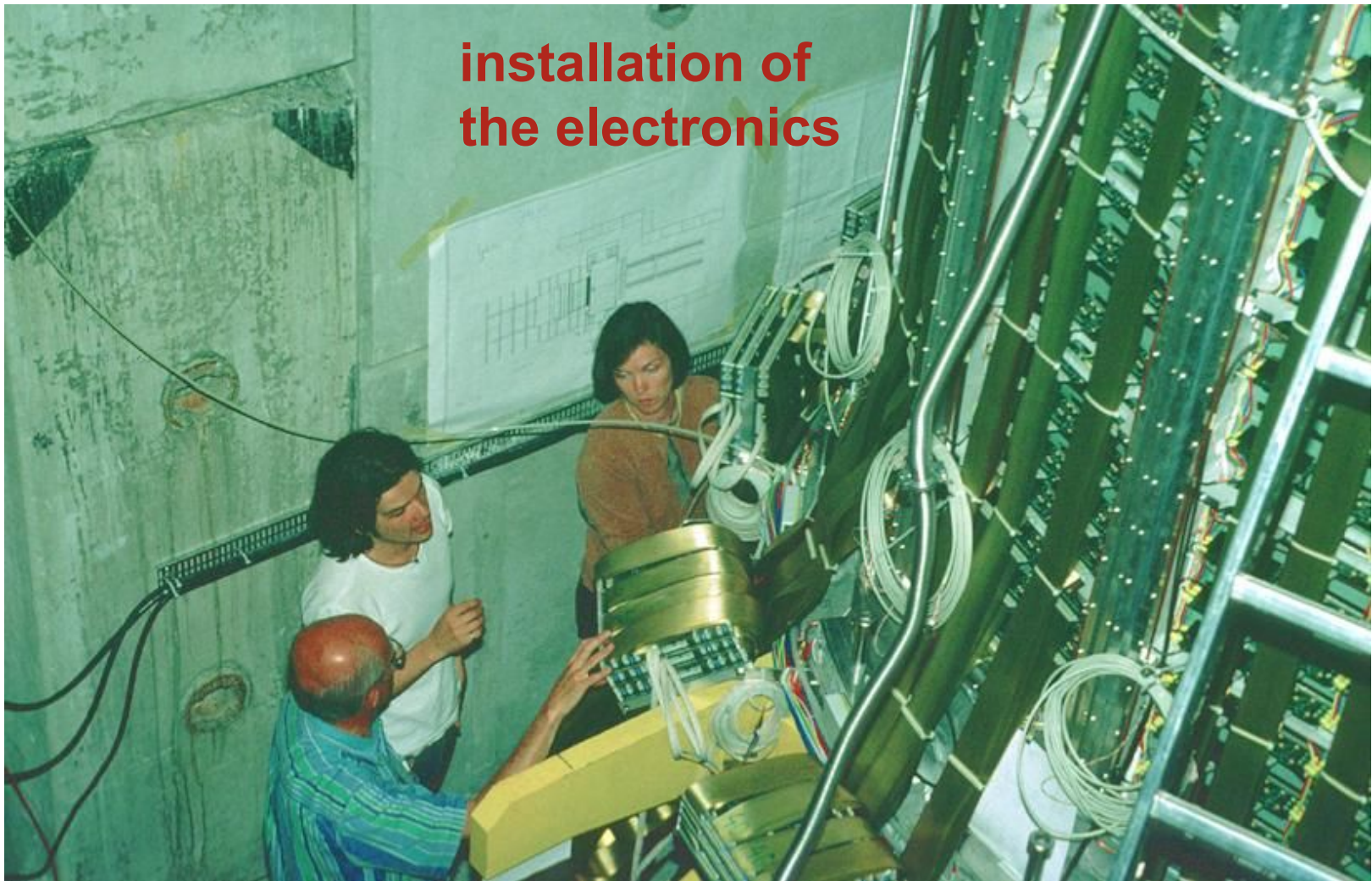
CERES TPC

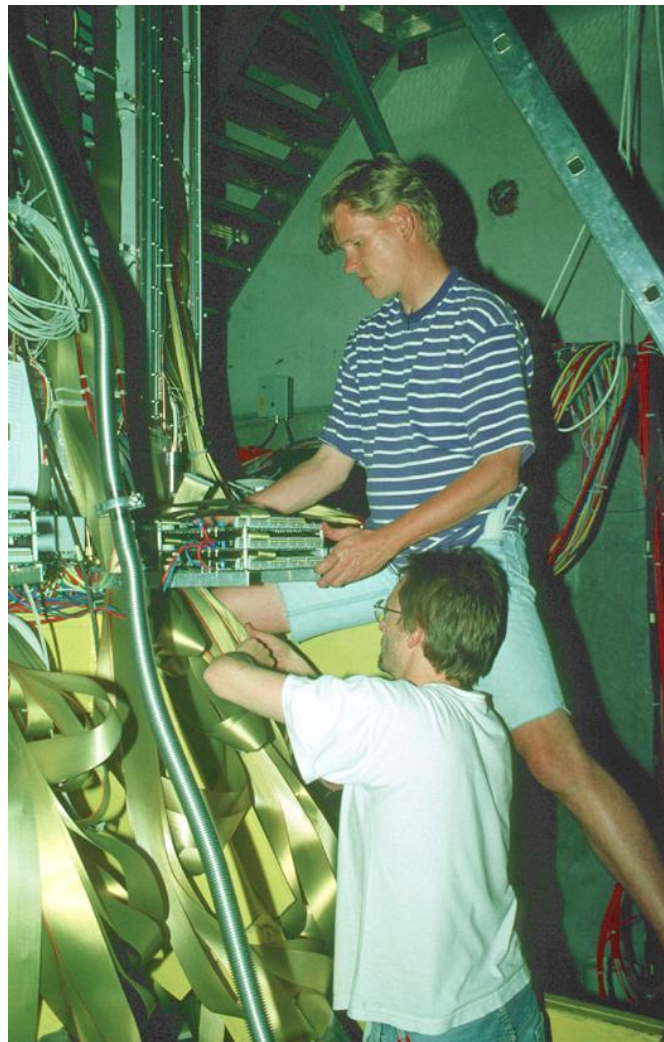


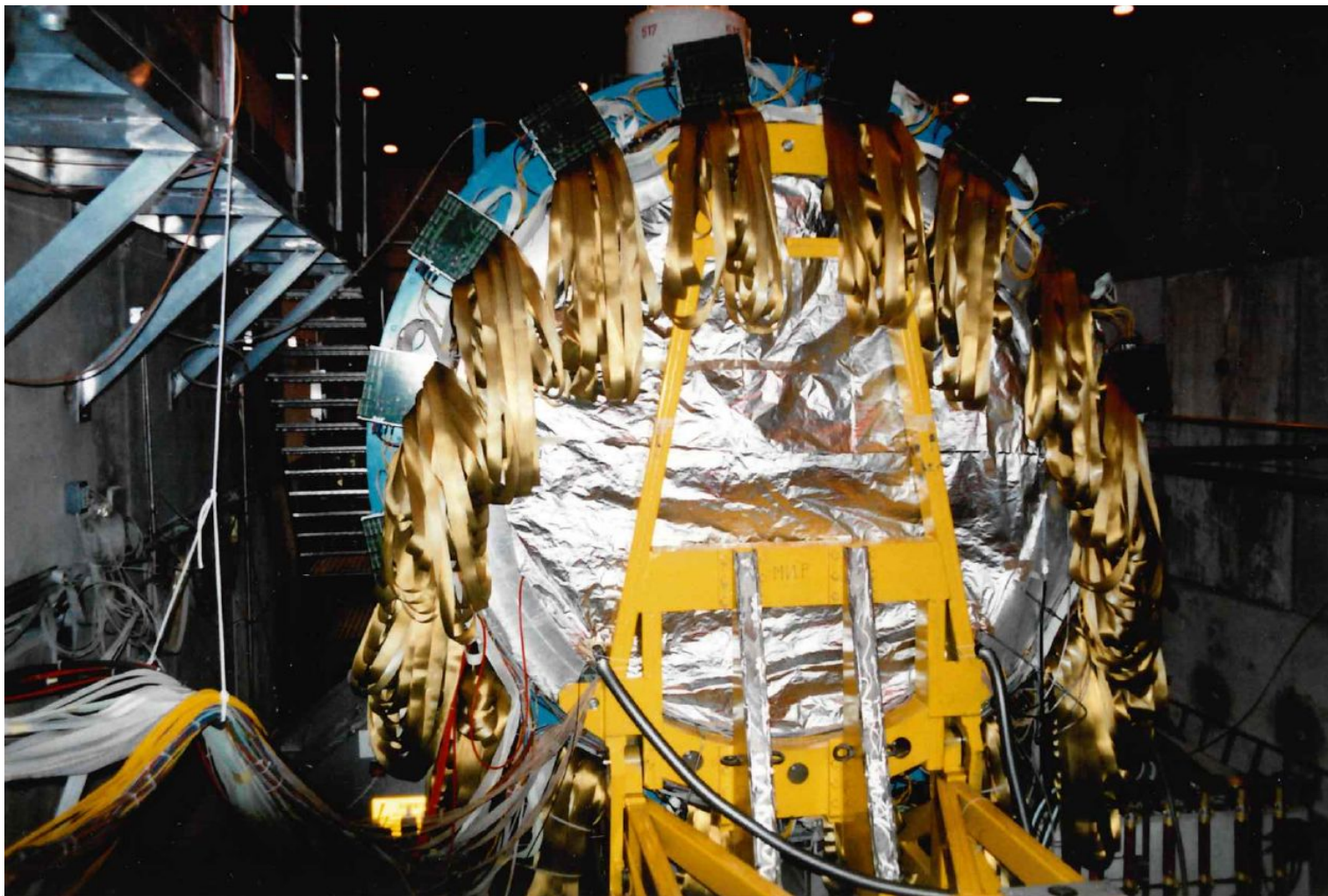
CERES TPC insertion 22-Jun-1998



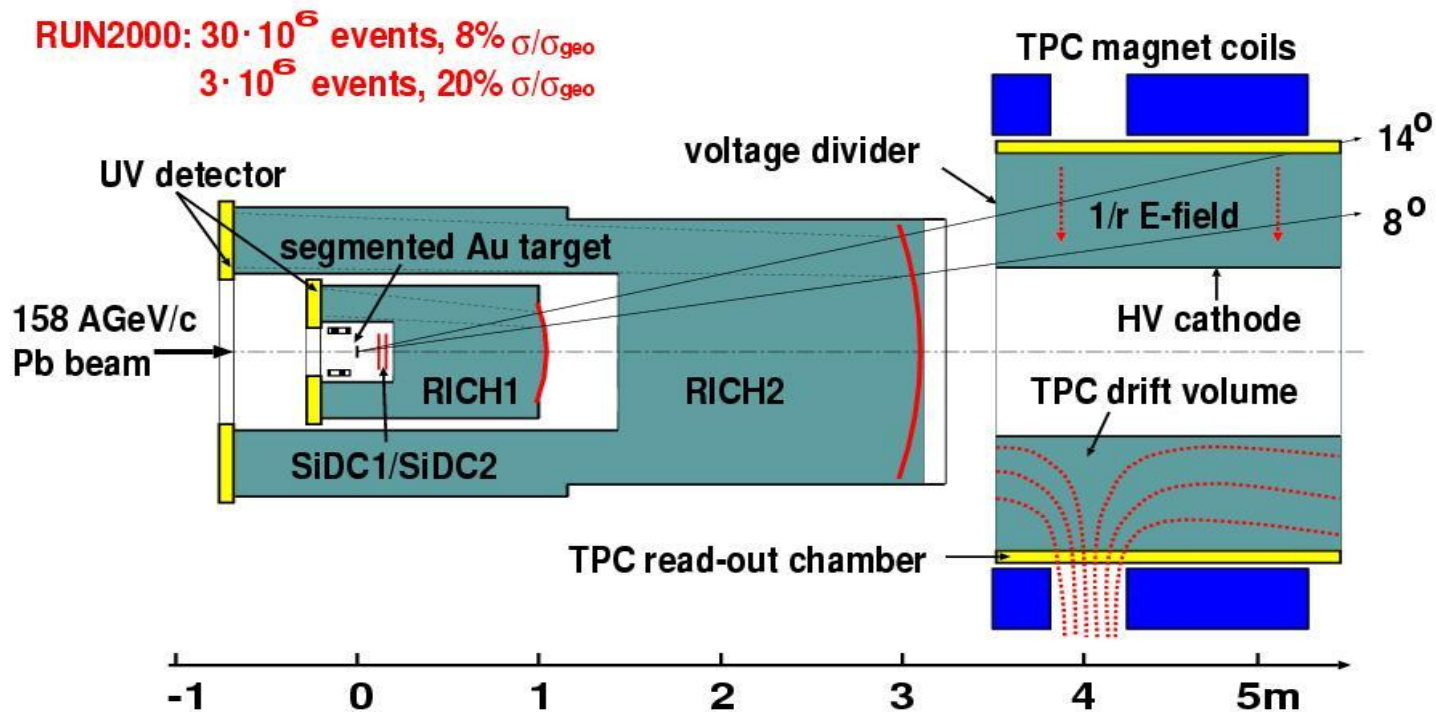
installation of the electronics



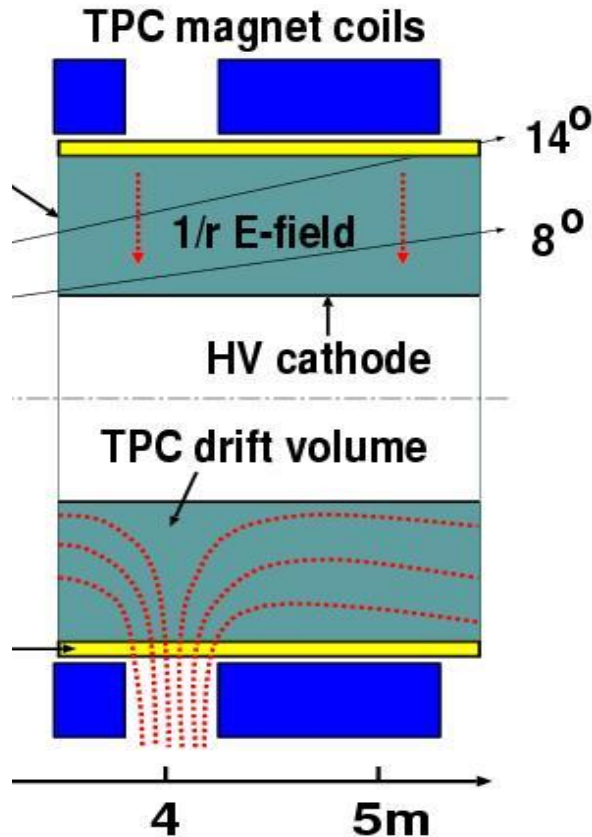




upgraded CERES 1998-2000



stray magnetic field of CERES TPC



no return yoke! And thus:

- displays changing shape and color when crane passing
- first ramping: chips pulled out of their sockets
- no relays, motorized holders nor actuators
- B trying to rip tools from one's hand
- broken credit cards
- but no problem with watches!



my responsibilities during the CERES runs

- 1996 - fixed a broken shelf
- 1997 - no run
- 1998 - laser
- 1999 - laser
- 2000 - laser

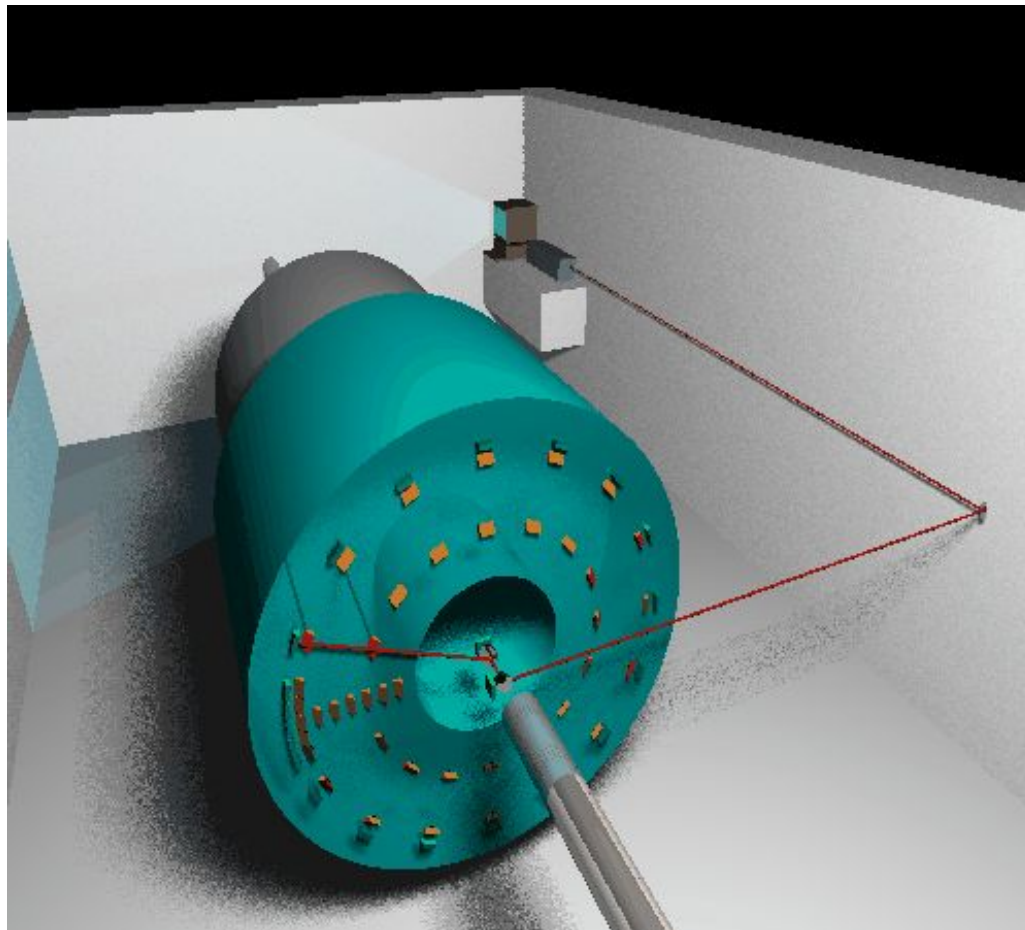
my responsibilities during the CERES runs

- 1996 - fixed a broken shelf
- 1997 - no run
- 1998 - laser
- 1999 - laser, trigger
- 2000 - laser, trigger

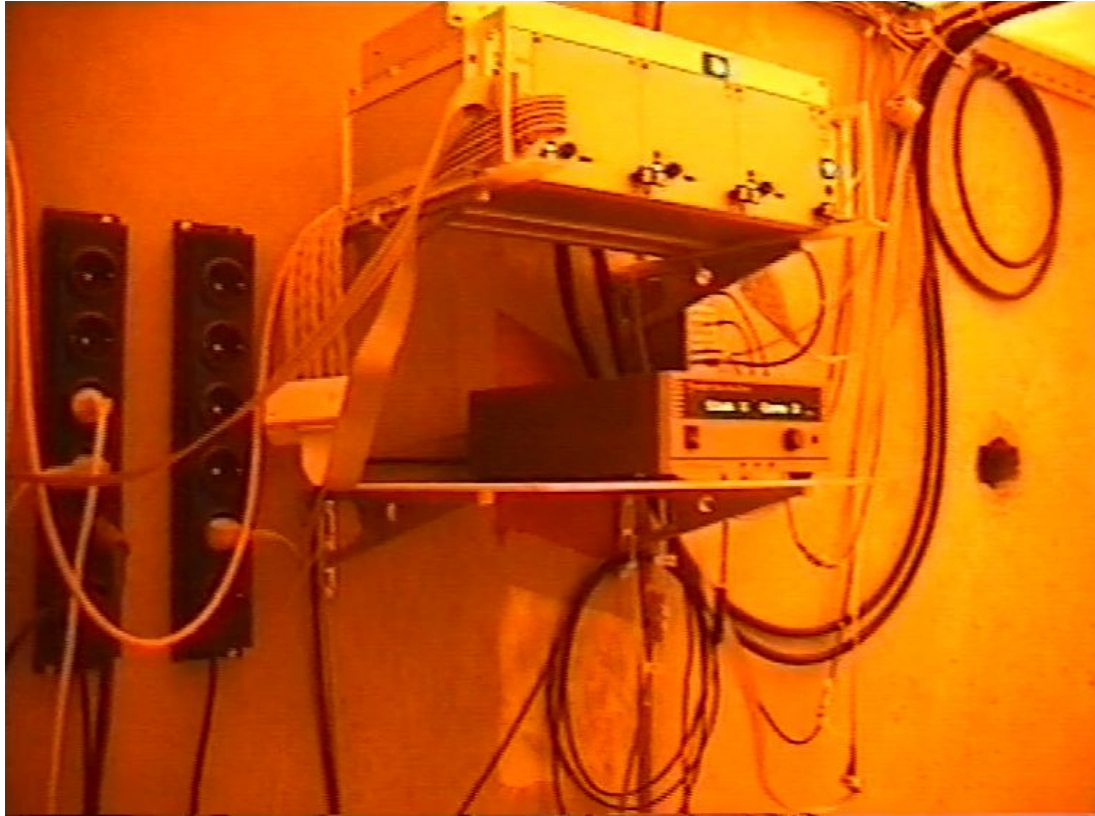
my responsibilities during the CERES runs

- 1996 - fixed a broken shelf
- 1997 - no run
- 1998 - laser
- 1999 - laser, trigger
- 2000 - laser, trigger, DAQ

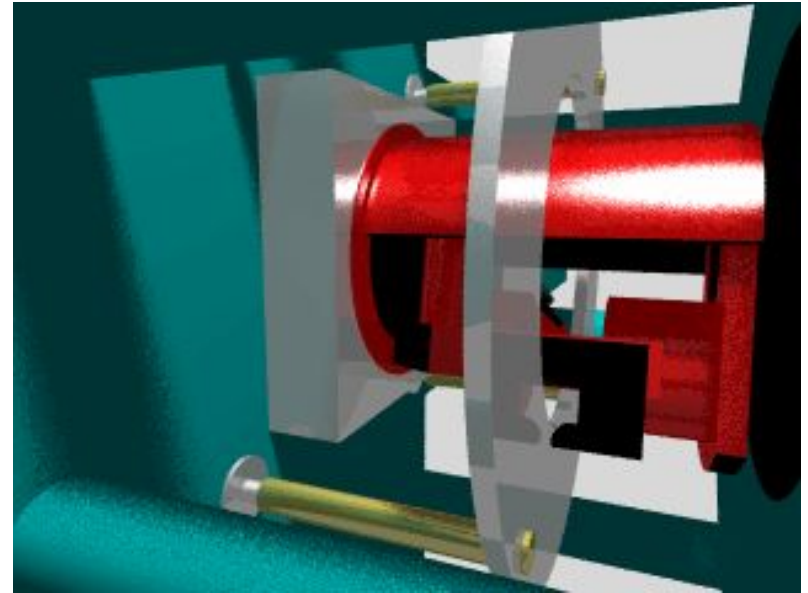
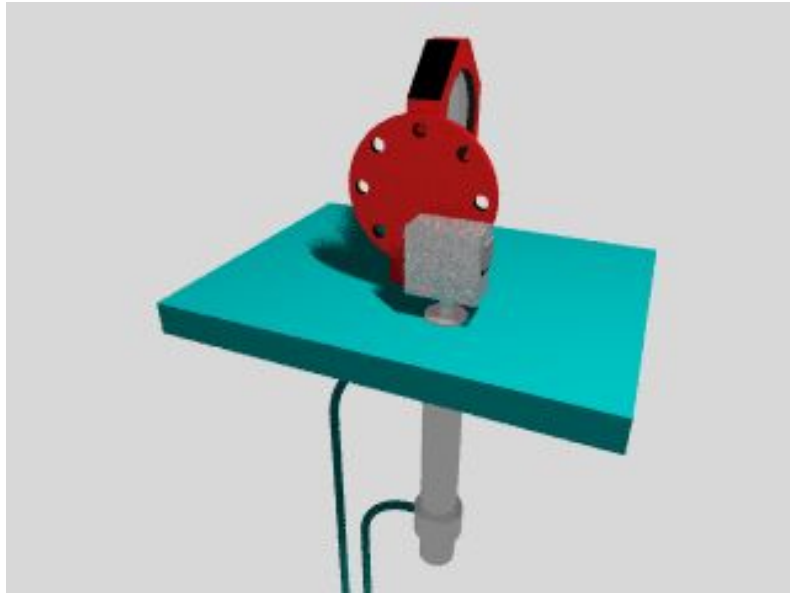
laser system for CERES TPC



laser system for CERES TPC

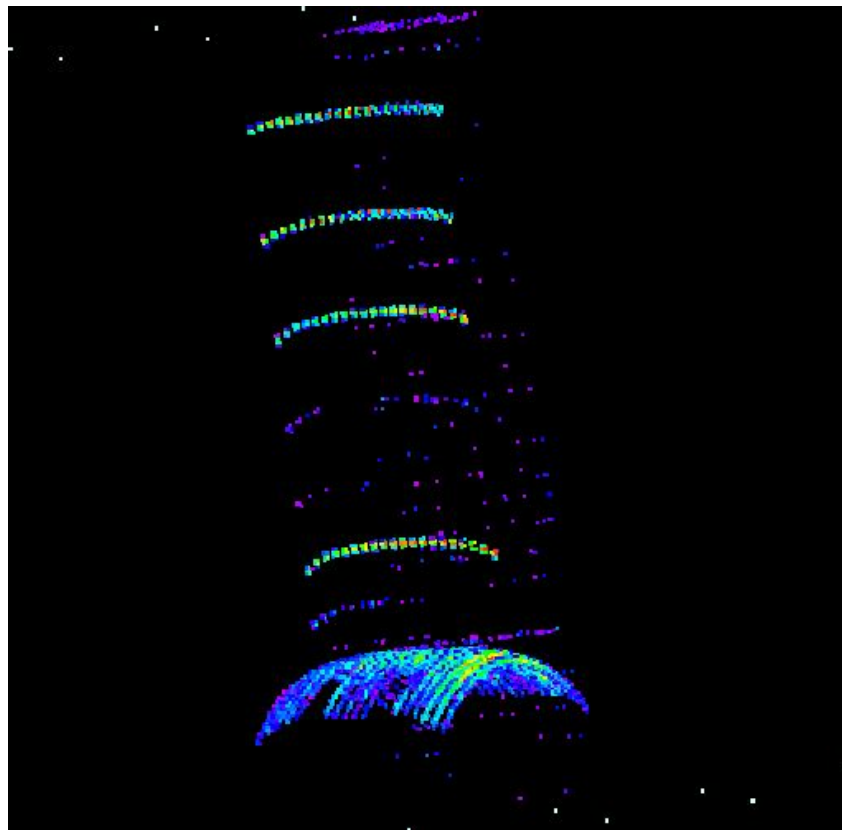


mirror actuators - pneumatic!



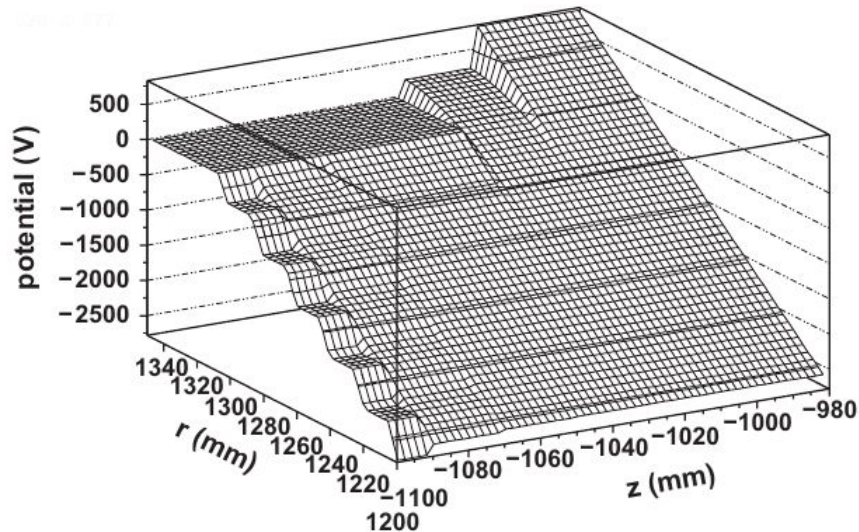


first laser shots in CERES TPC 23-May-1998

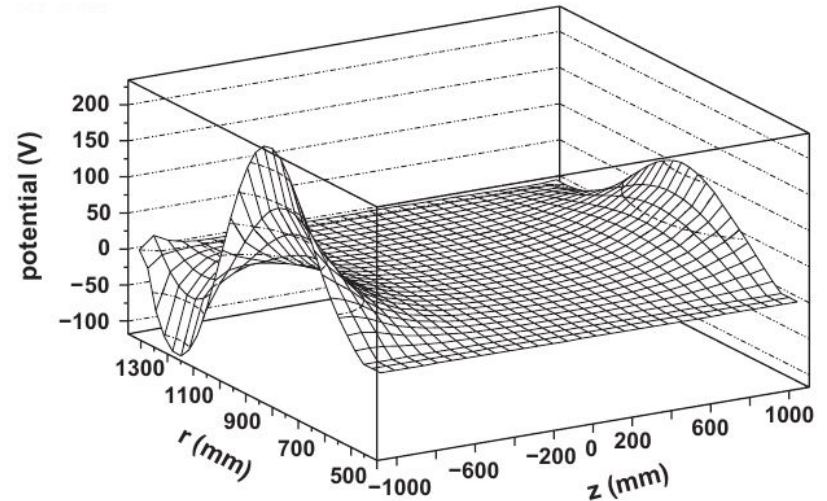


electric field

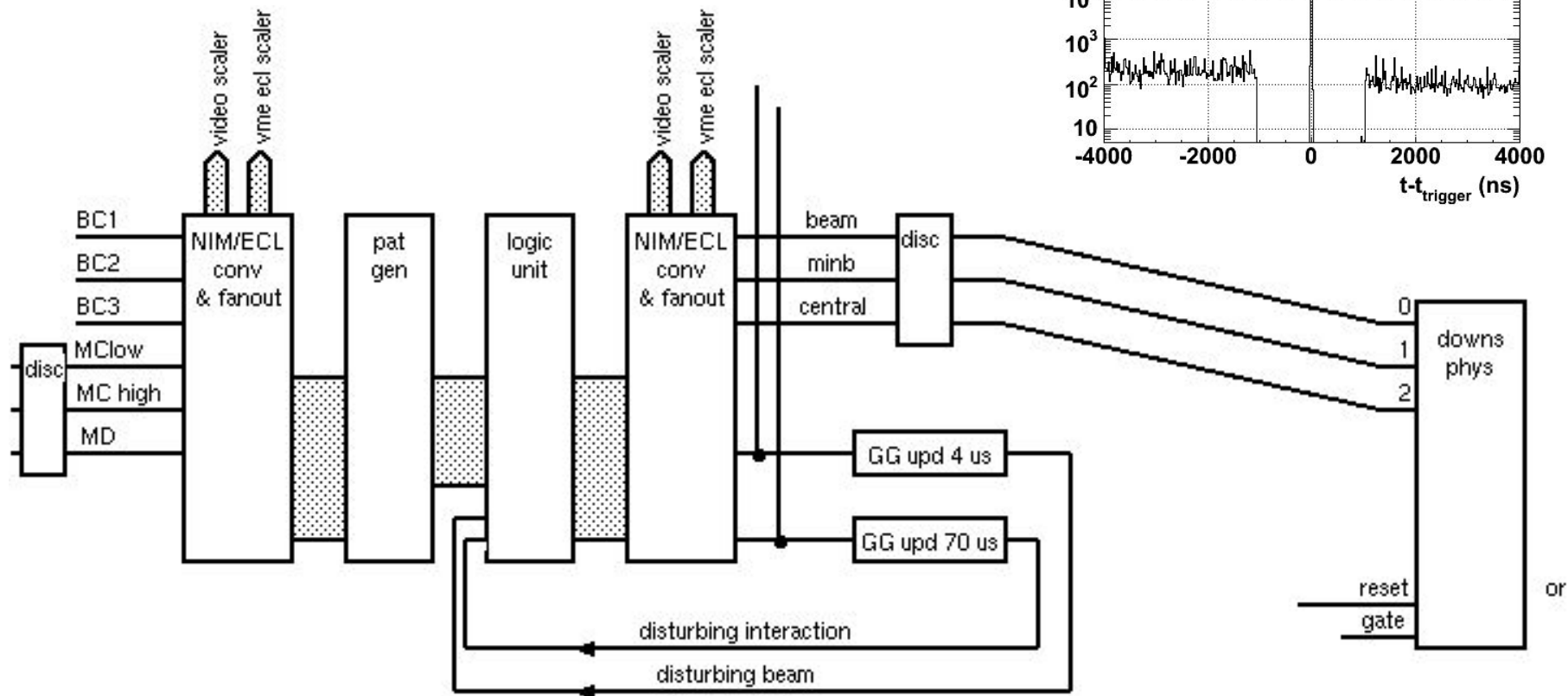
- custom solver of Laplace's equation
- finite width of strips
- E-penetration through wire planes



- **fieldcage resistors changing their R!**
- R(V) tuned to straighten laser tracks
- measurement campaign by CG, DM



trigger 1999-2000



trigger 1999-2000

CERES trigger control

File Expert Help

logic

physics

☒ beam before-prot.
☐ inter. before-prot.

MT/CAL

inb outb

☒ MT
☐ SDD inj
☐ UV1
☐ UV2
☐ laser

enable

downsc

☐ beam 0
☐ minb 0
☒ central 0
☐ SOB 0
☐ EOB 0
☐ MT 0
☐ SDDinj 0
☐ UV1 0
☐ UV2 0
☐ laser 0

require

☐ SDD (for central FLT)
☒ beam after-protection
☐ inter. after-protection

SDD multiplicity threshold downsc

☒ 10 0
☐ 103 99
☐ 150 9
☐ 250 0

wait for

☐ DACOX
☒ SDD
☒ RICH 1
☒ RICH 2
☒ TPC
☐ DAQ
☒ Always on

Diagram:

BC1 563287 beam 262181 0
BC2 524260 minb 652 0
BC3 545308 central 652 272
MD 54682
MD low 246101
5602

physics

burst noburst pulser

SOB EOB MT

MT/CAL

SDD inj UV1 UV2 laser

SDD inj UV1 UV2 laser

FLT

FLT 282

SDD 152
BAP 136
IAP 666

Abort

Abort 130

SLT 152

DACOX
SDD
RICH 1
RICH 2
TPC
DAQ
Always on

Busy

Busy

Reset 282

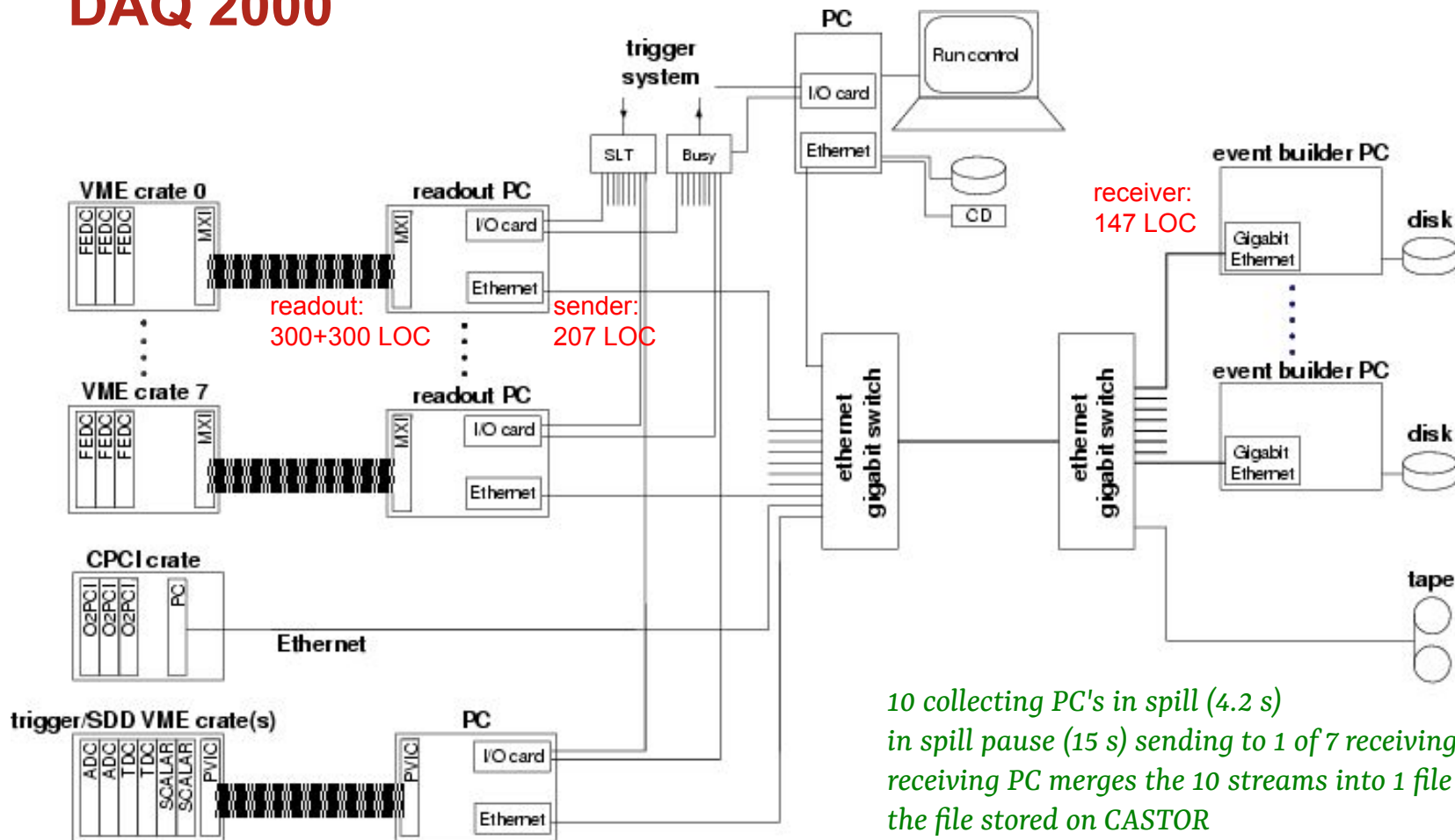
top: click
bottom: see result



CERN IT vs Rene Brun

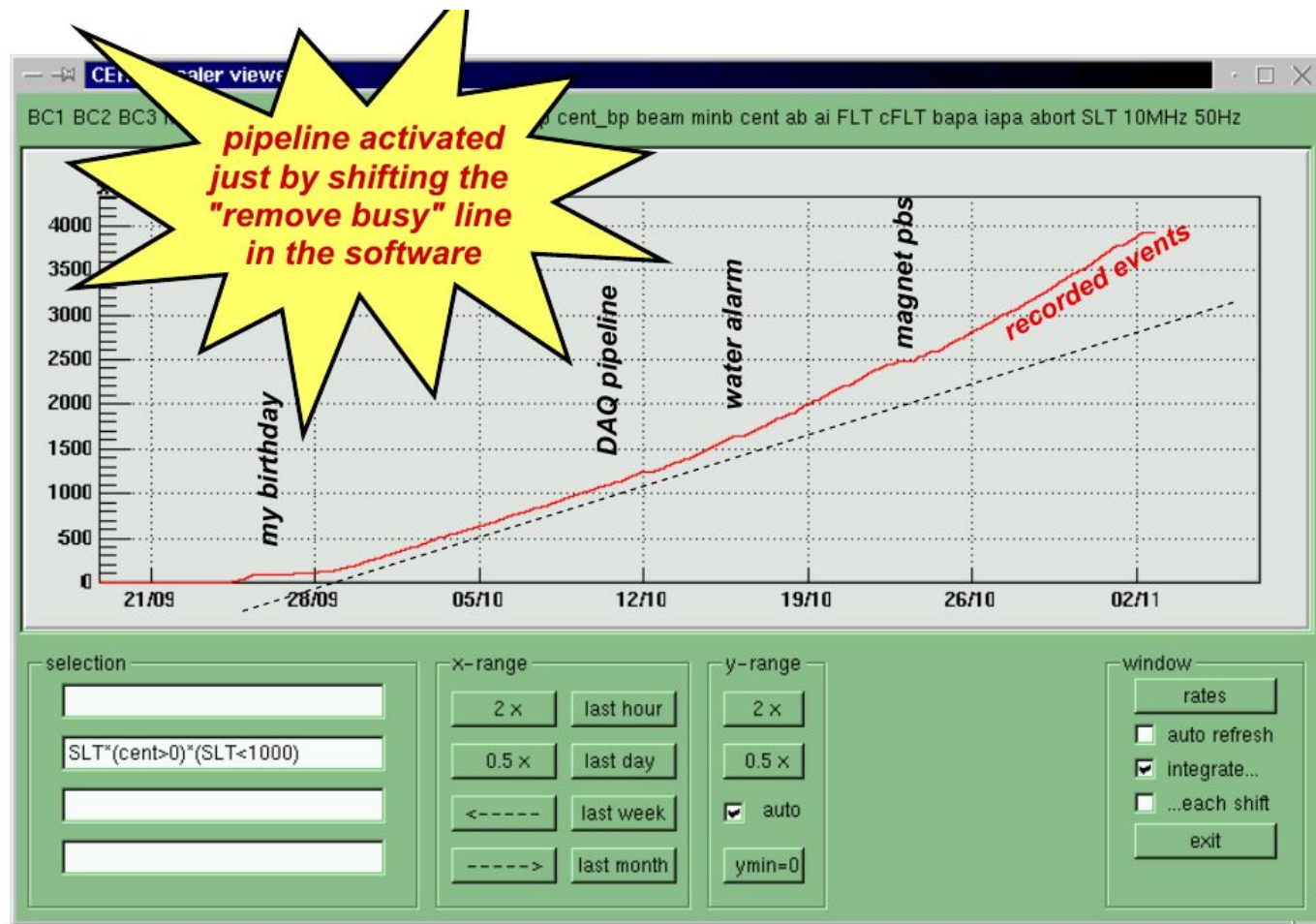


DAQ 2000

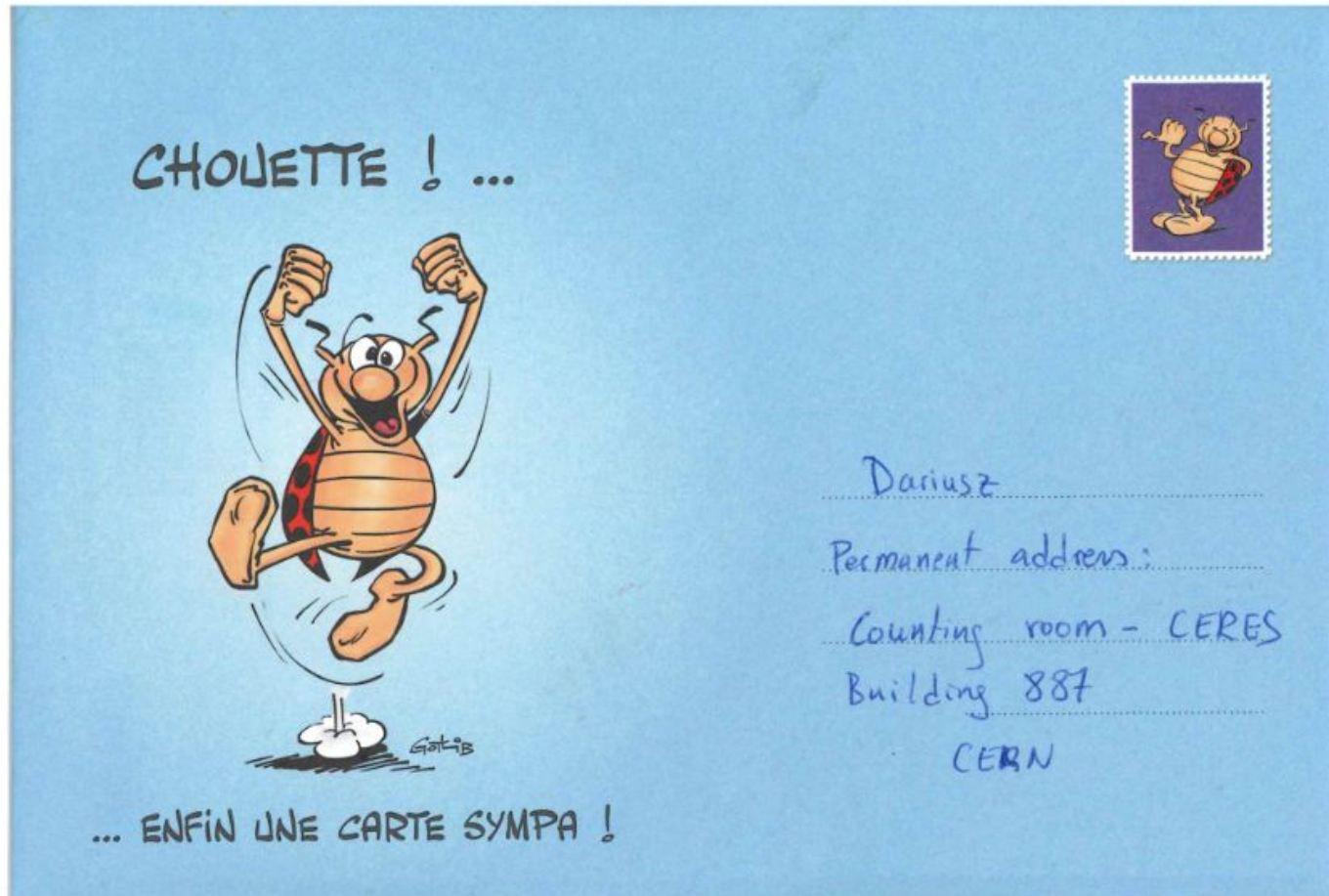


10 collecting PC's in spill (4.2 s)
in spill pause (15 s) sending to 1 of 7 receiving PC's
receiving PC merges the 10 streams into 1 file
the file stored on CASTOR
300-400 event/spill, 200 MB/spill

DAQ 2000



CERES counting room - our second home



sailing





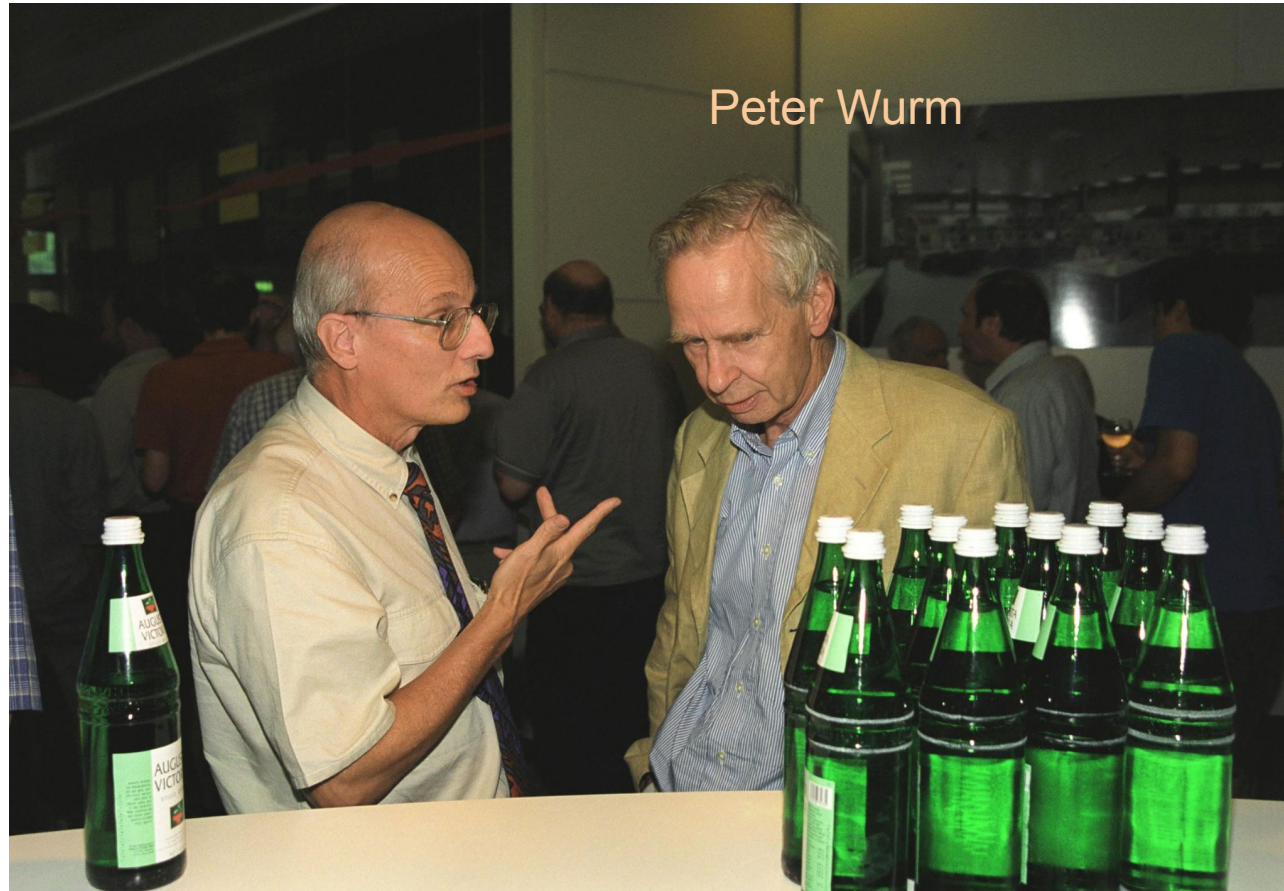


Jan Rak

silicon detector and
football expert in CERES

science and environment
guru in Czech Republic

only WATER for silicon-drift detector experts





PBM80, D. Miskowec, 7-Sep-2026

ALICE

ALICE Time Projection Chamber



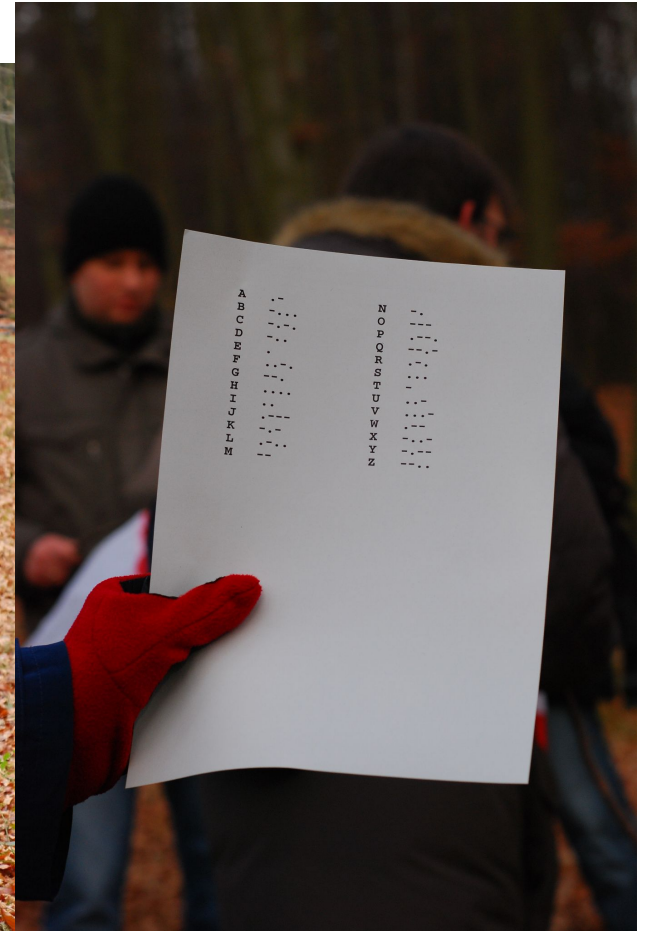
Underground training in Darmstadt breweries, Sep 2007



Frankenstein castle, Nov 2008



data transfer training



TPC chambers

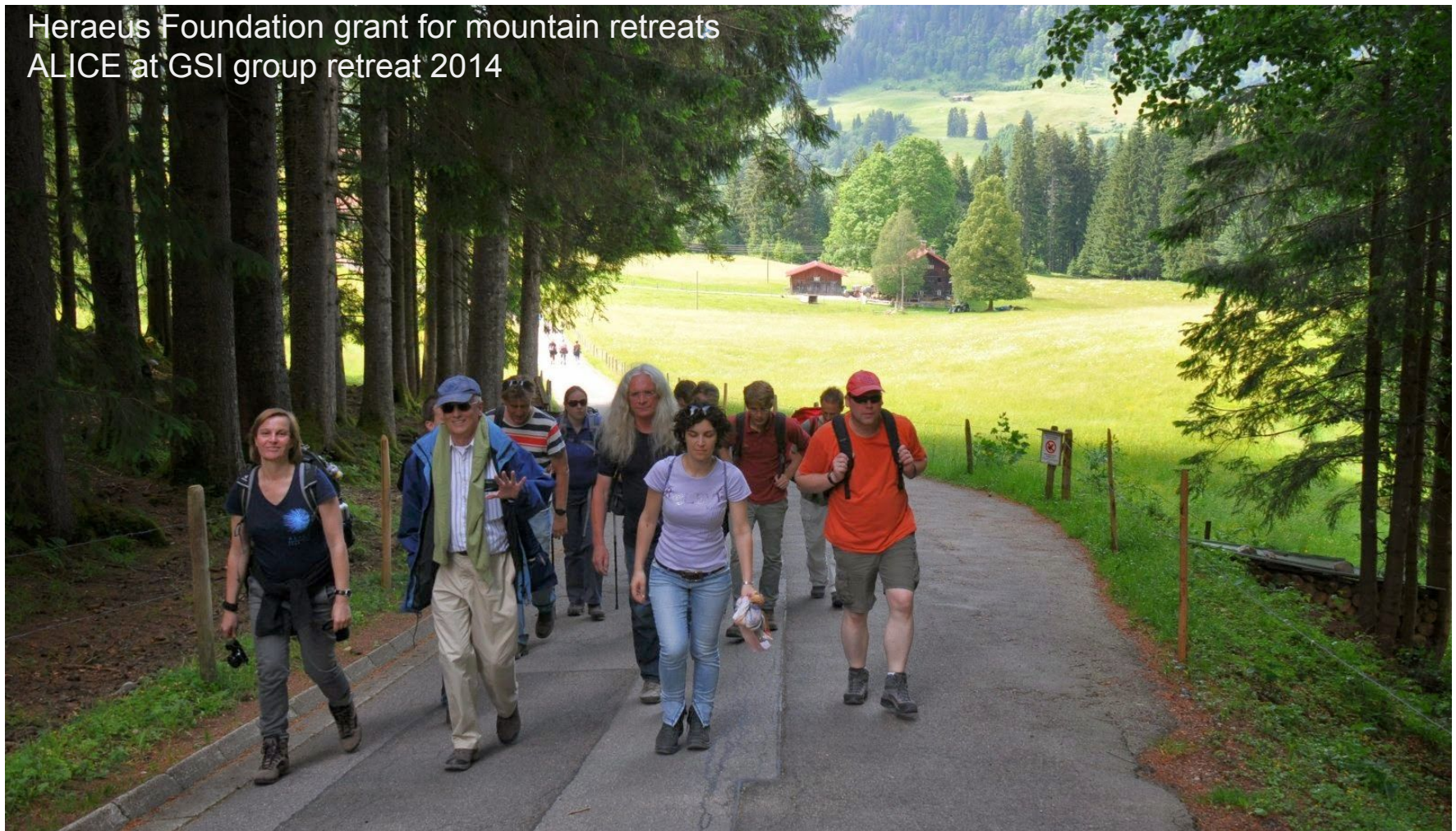


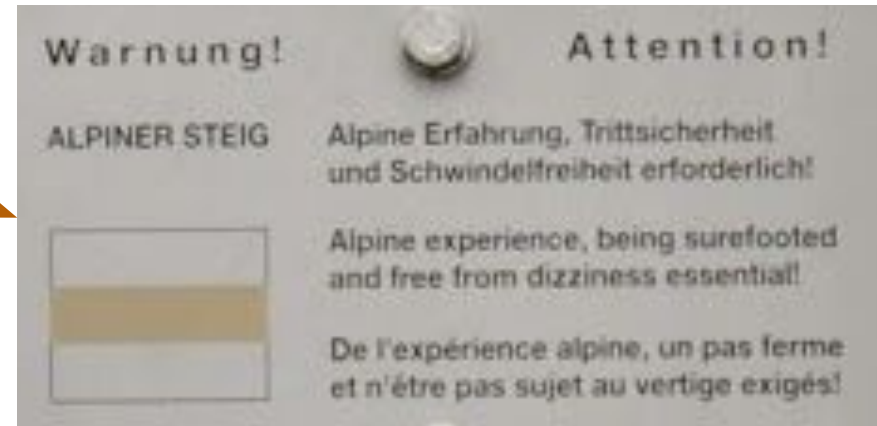


Odenwald hike, July 2013



Heraeus Foundation grant for mountain retreats
ALICE at GSI group retreat 2014







Chinese New Year, February 2019



Stern-Gerlach-Medaille celebration, March 2019



my summary of ALICE results DPG 2014

new insight into the reaction dynamics from LHC

- ❖ proton puzzle: lower yield, lower v_2 than expected
- ❖ flow rather than Mach cone
- ❖ nuclear suppression decreasing at very high p_T (R_{AA} increasing)
- ❖ J/ψ production via statistical regeneration
- ❖ indications of collectivity in high-multiplicity pp and p-Pb collisions

~2 x higher than at RHIC

- ❖ particle production
- ❖ homogeneity volume

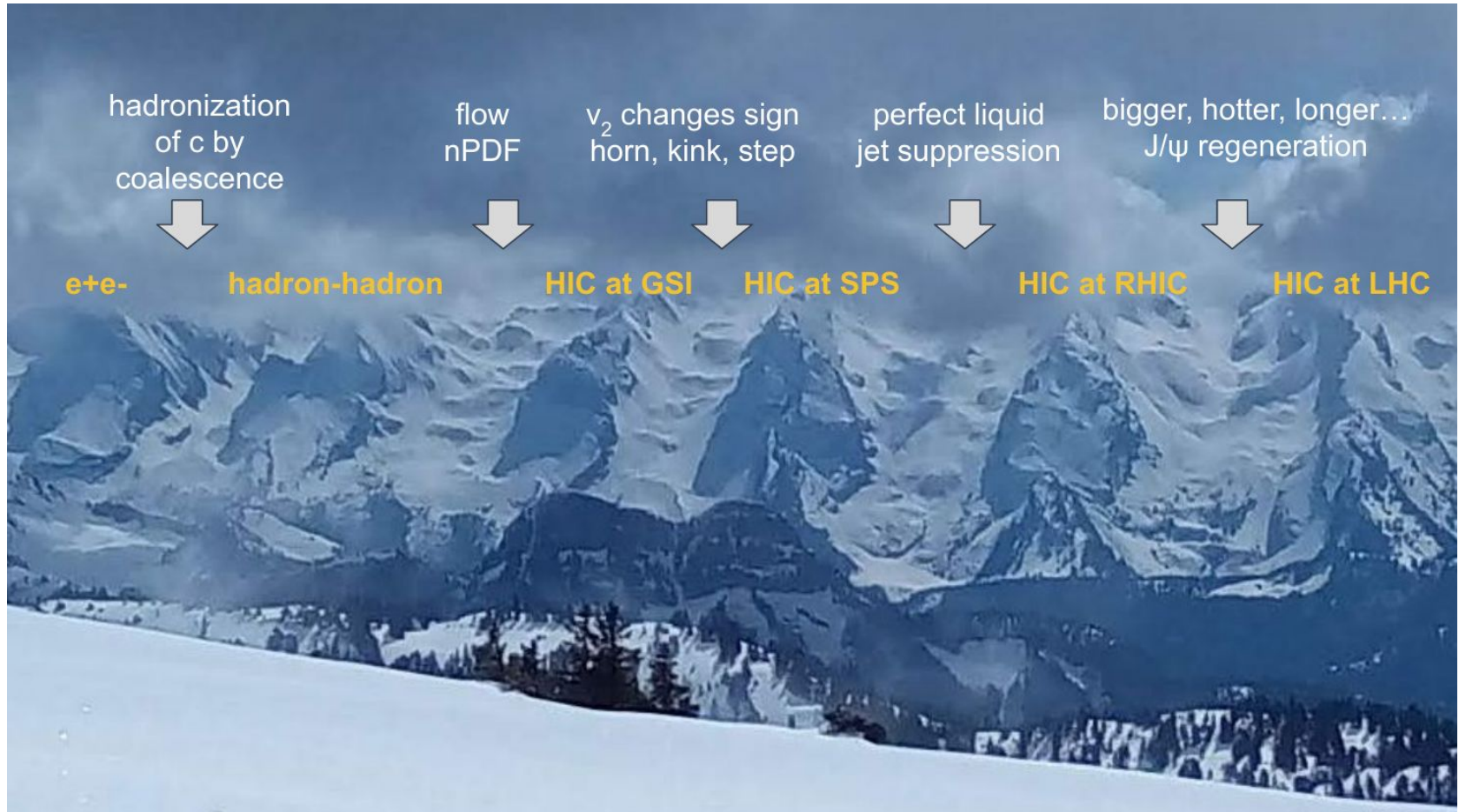
~10-30% higher than at RHIC

- ❖ transverse flow
- ❖ mean transverse momentum
- ❖ integrated elliptic flow
- ❖ mass-splitting of v_2

like at RHIC

- ❖ centrality dependence of particle production
- ❖ centrality dependence of v_2
- ❖ multiplicity dependence of HBT radii
- ❖ transverse momentum dependence of v_2

my summary of ALICE results Moriond 2023





Thank you Peter
for all these adventures.
Happy Birthday!

photos: Anton Andronic, Peter Glassel,
Ilya Selyuzhenkov, ...

end

