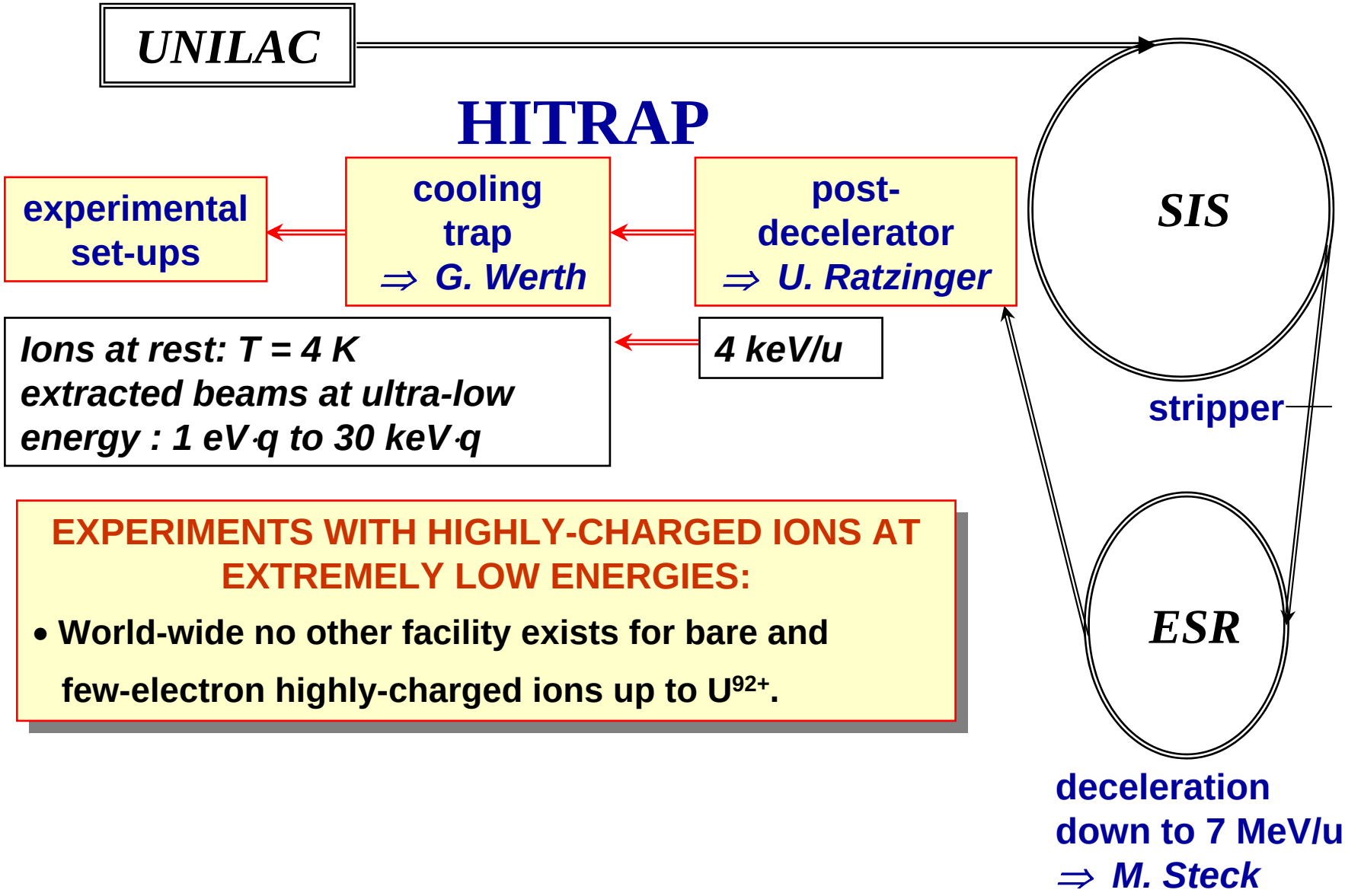
THE HITRAP PROJECT AT GSI

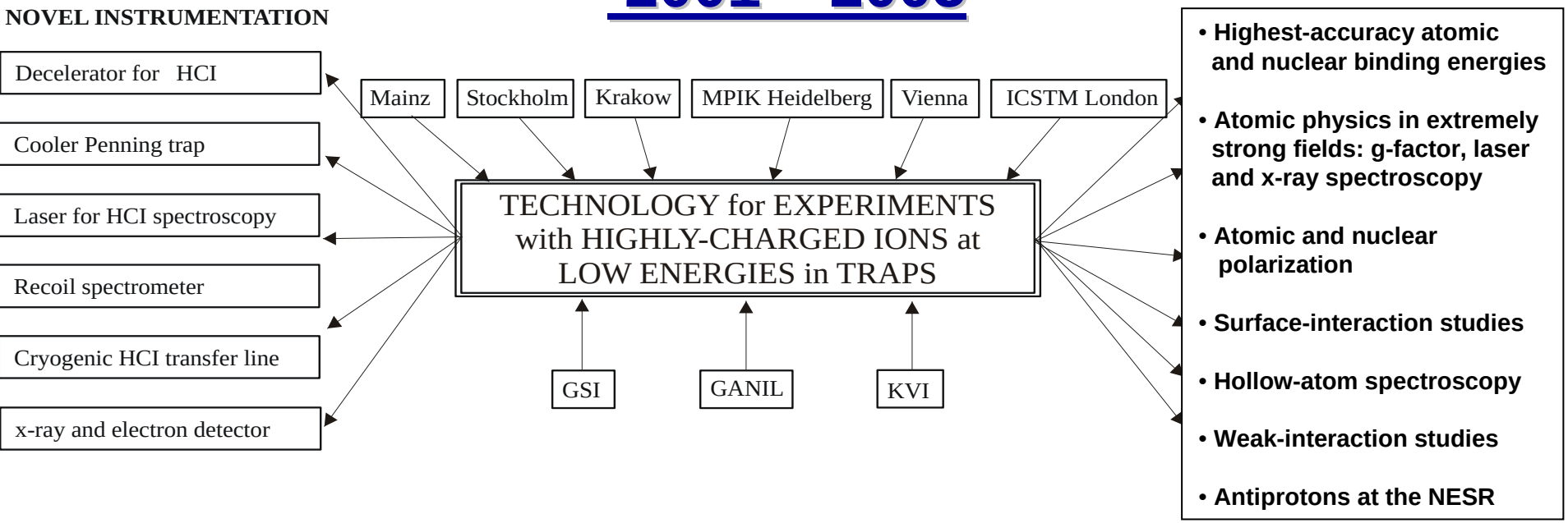
(W. Quint, GSI)



EXPERIMENTS WITH HIGHLY-CHARGED IONS AT EXTREMELY LOW ENERGIES:

- **World-wide no other facility exists for bare and few-electron highly-charged ions up to U^{92+}.**

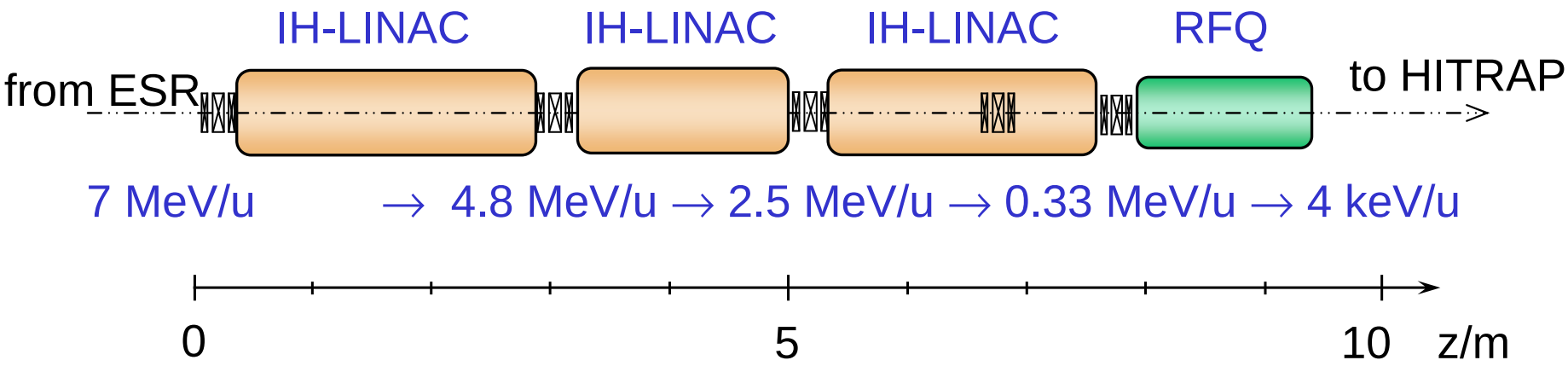
European RTD-Network "HITRAP Facility"
2001 – 2005



- **Total budget for four years (starting Nov. 2001): 1.9 Mio. EUR, mainly for personnel.**
- **Goal: development of novel instrumentation for experiments on HCI, including a decelerator, a cooler Penning trap, experimental set-ups and detectors for the investigation of the interaction of low-energy HCI with matter.**

DECELERATOR LINAC FOR HITRAP AT GSI

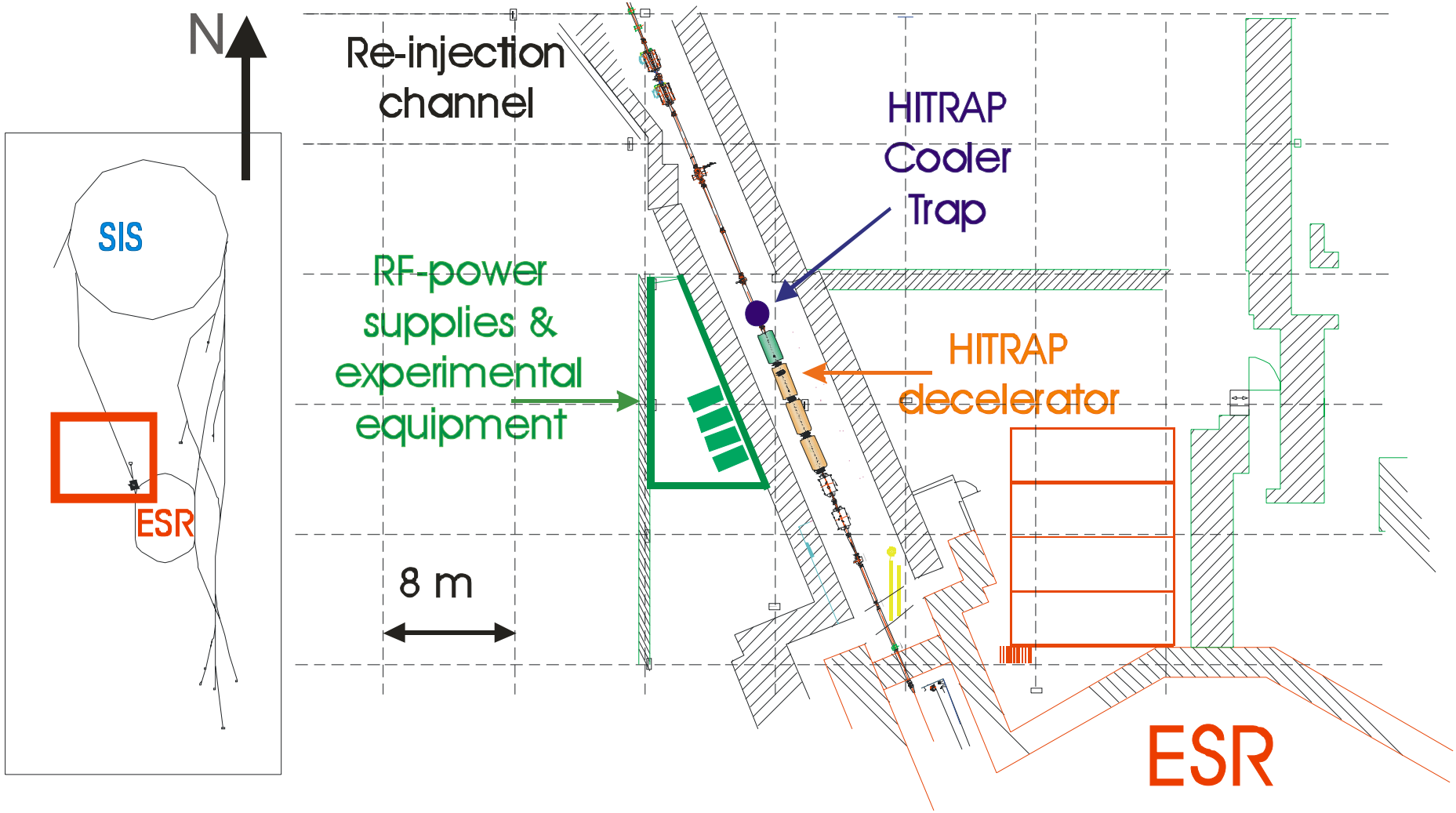
⇒ *U. Ratzinger*



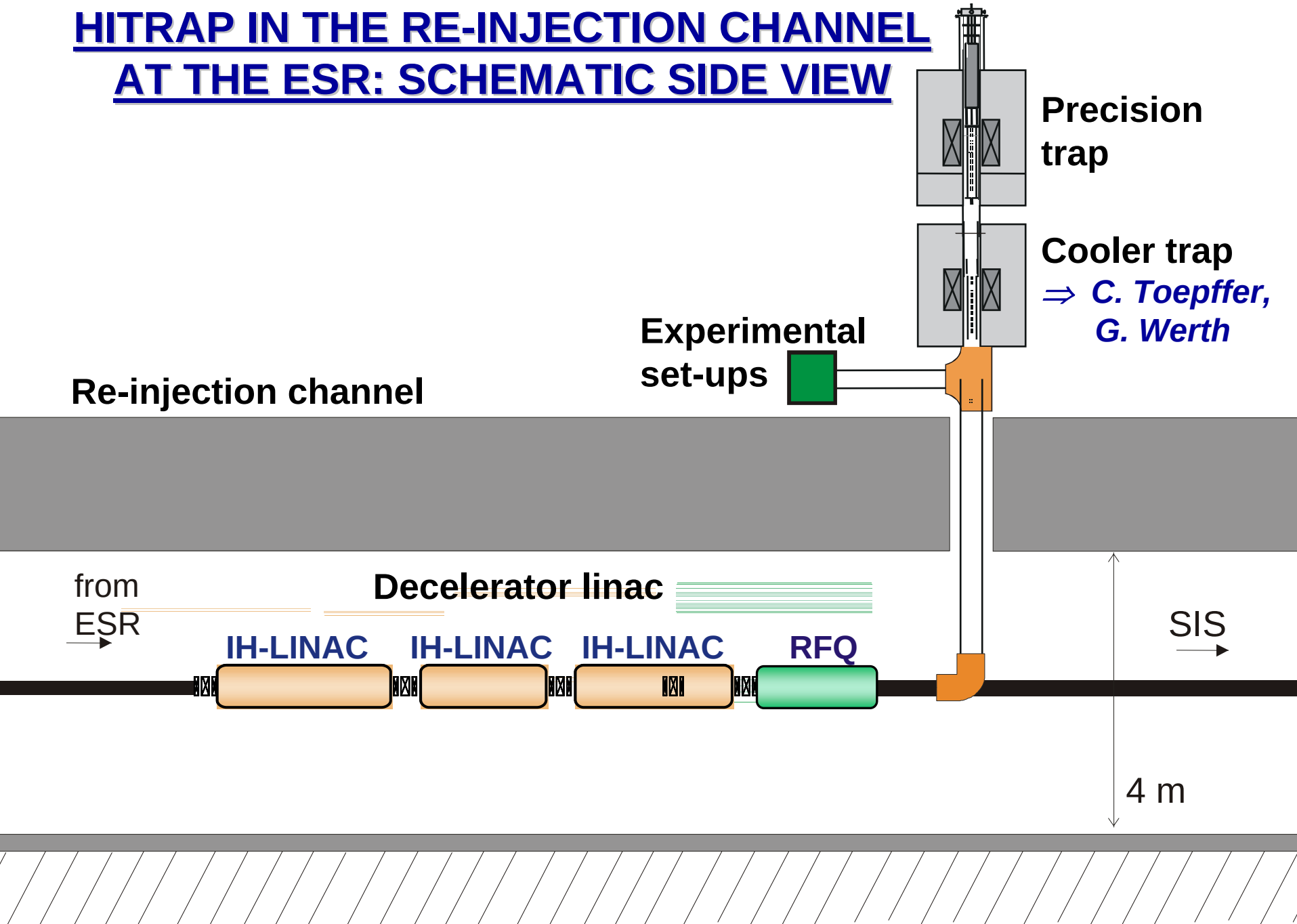
Operational Parameters:

- **Ion mass-to-charge ratio A/q ≤ 3**
- **Allowed emittance of extracted ESR beam ≤ 10π mm mrad**
- **Emittance of decelerated beam ≤ 200π mm mrad**
- **Beam intensity behind decelerator linac: some 10^6 ions/pulse (for U^{92+})**
- **Repetition time of decelerator cycle: 10 s**

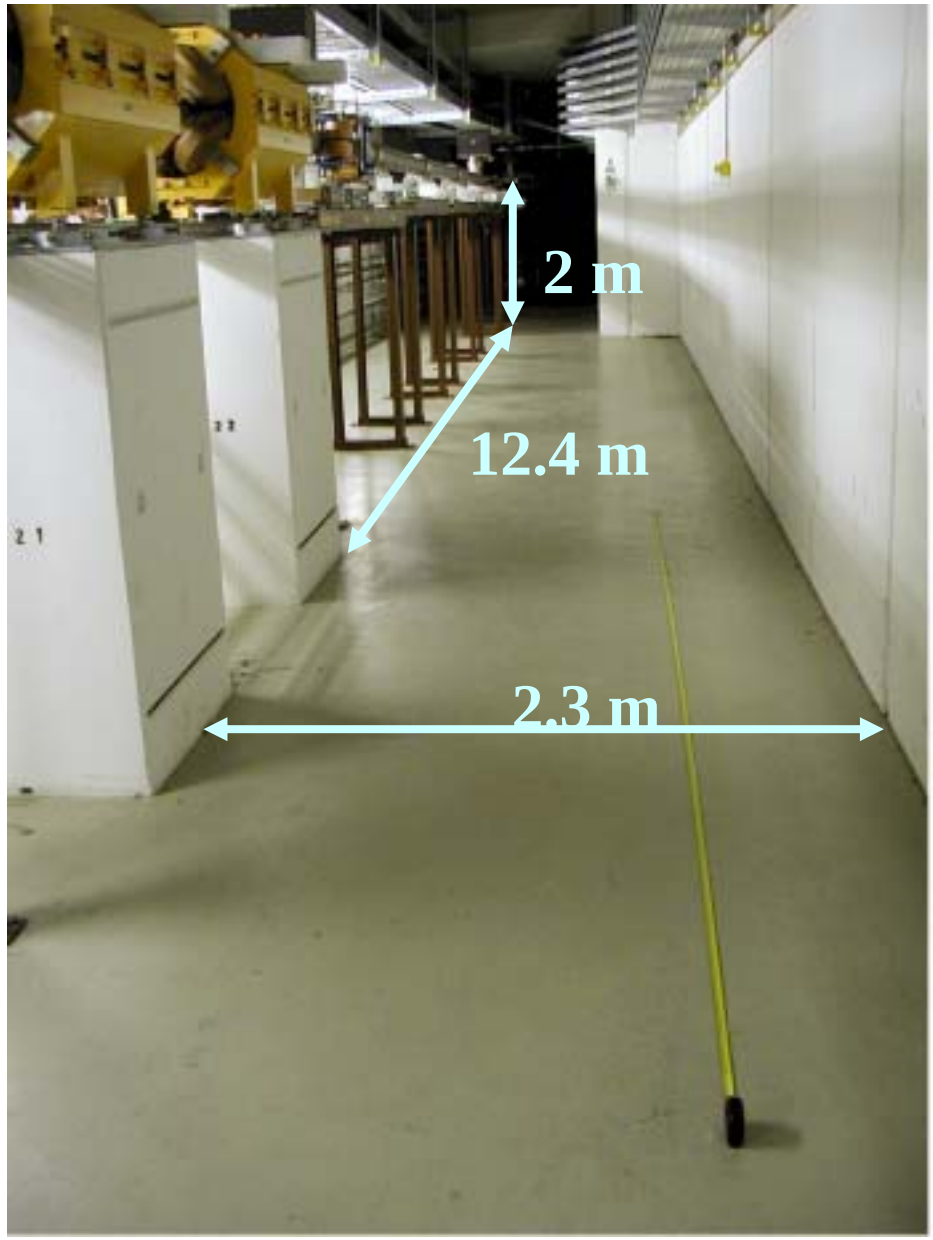
HITRAP IN THE RE-INJECTION CHANNEL AT THE ESR

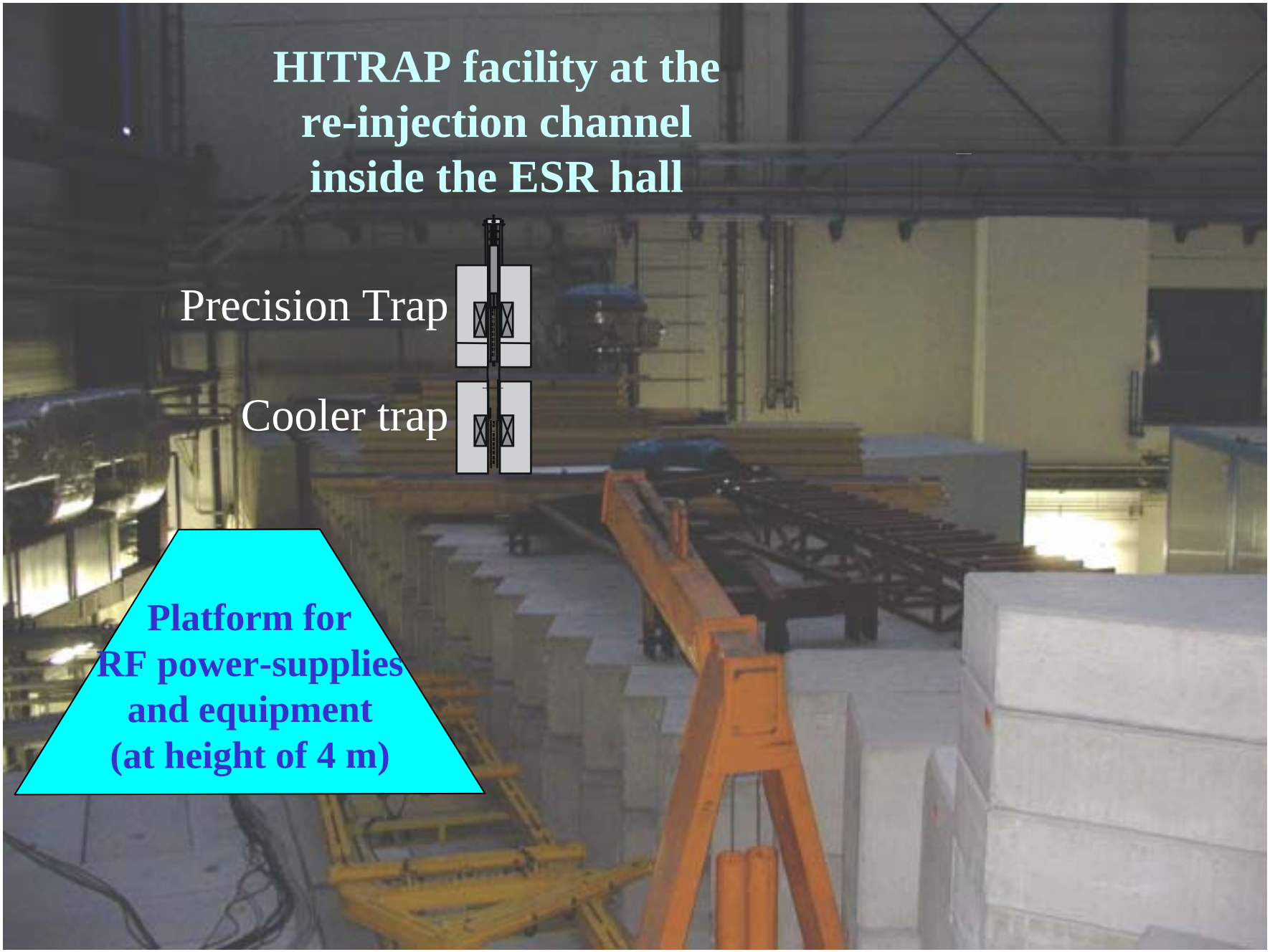


HITRAP IN THE RE-INJECTION CHANNEL AT THE ESR: SCHEMATIC SIDE VIEW



RE-INJECTION CHANNEL AT THE ESR: PRESENT SITUATION

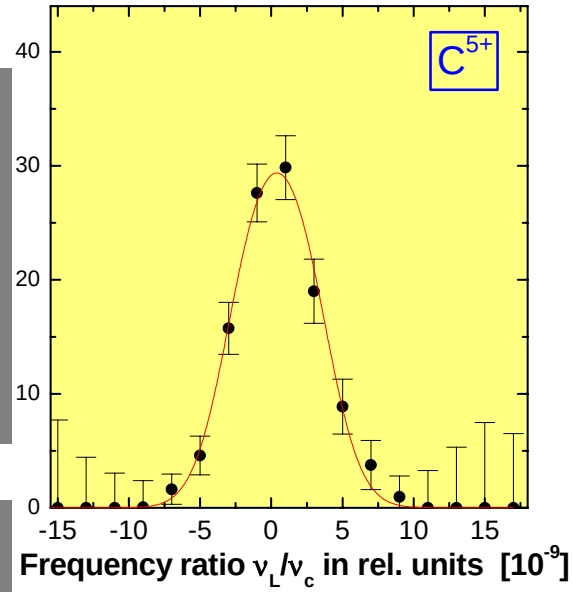



HITRAP facility at the
re-injection channel
inside the ESR hall
Precision Trap
Cooler trap
Platform for
RF power-supplies
and equipment
(at height of 4 m)

Precision Experiments on HCI in Penning Traps

High-Precision Ion Trap Techniques:

- Single highly charged ion stored in Penning trap at T = 4 K
- Measurement of *ion cyclotron frequency* and of *Larmor precession frequency* of the bound electron with an accuracy on the 10^{-10} level



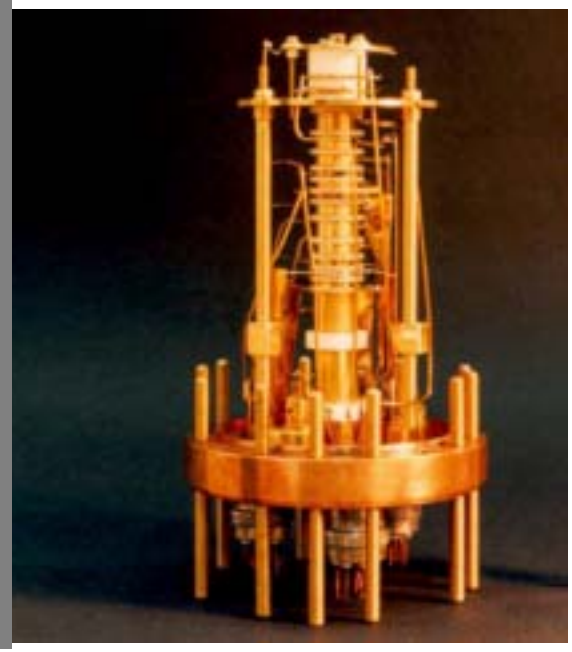
Bound-state QED and atomic-structure investigations:

⇒ G. *Soff*

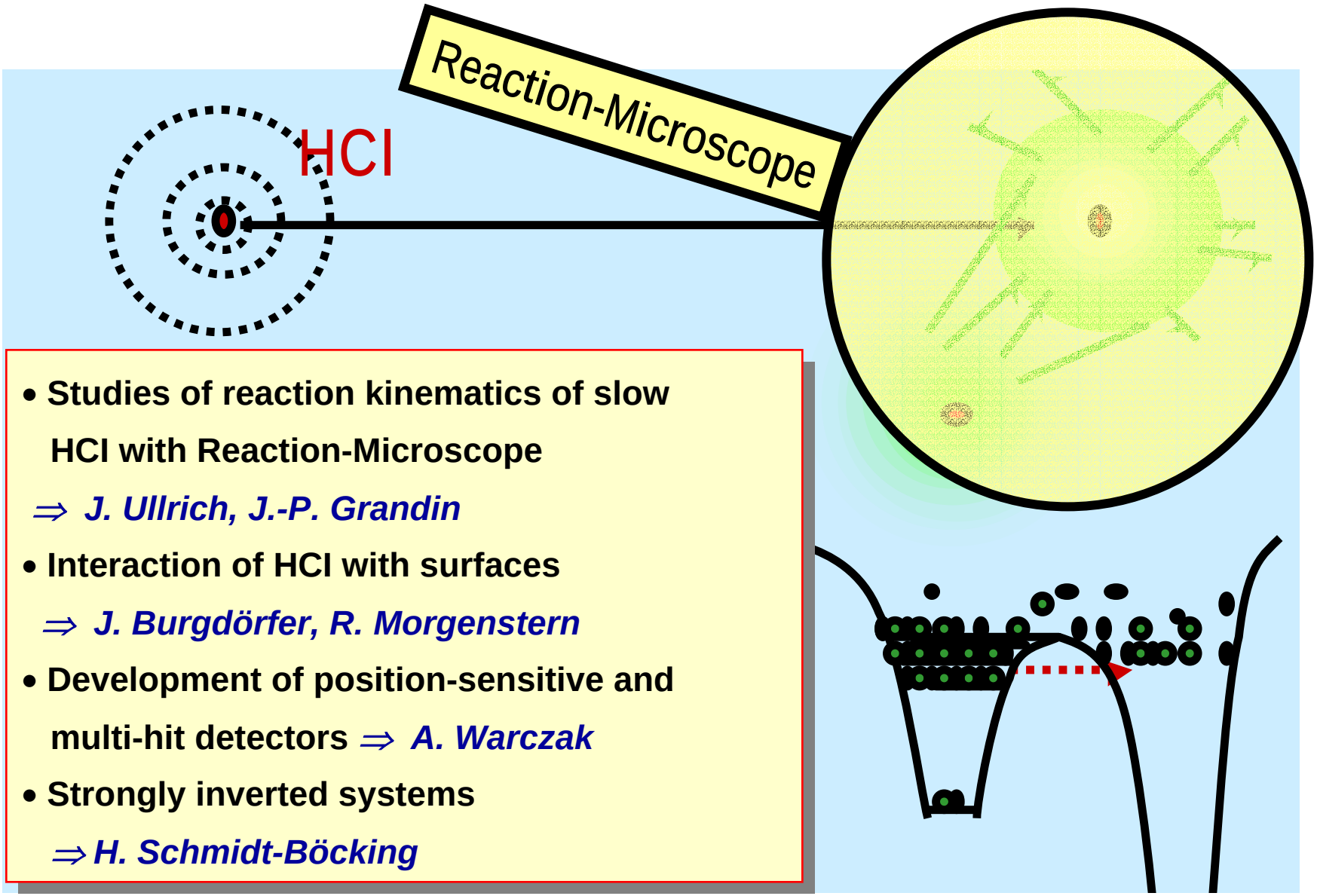
- g-Factor of the bound electron in hydrogen-like ions up to U^{91+}
- Fundamental constants (α, m_e)
- Nuclear moments, diamagnetic shielding, charge radii

} ⇒ *T. Beier*

- Determination of atomic binding energies via *ion cyclotron frequency* measurements in different charge states ⇒ *T. Fritioff*



Collision Studies with Slow Highly Charged Ions up to U^{92+}



- **Studies of reaction kinematics of slow HCI with Reaction-Microscope**
  ⇒ ***J. Ullrich, J.-P. Grandin***
- **Interaction of HCI with surfaces**
  ⇒ ***J. Burgdörfer, R. Morgenstern***
- **Development of position-sensitive and multi-hit detectors ⇒ *A. Warczak***
- **Strongly inverted systems**
  ⇒ ***H. Schmidt-Böcking***

Laser Spectroscopy and X-ray Spectroscopy with HCI

Hyperfine-Transition in H-like Ions: ⇒ ***R. Thompson***

- **Nuclear properties (charge and magnetisation distributions)**
- **QED effects**
- **Atomic and nuclear polarization by optical pumping**

X-ray spectroscopy with HCI: ⇒ ***A. Warczak***

- **Precision Measurements of Lamb shift**
- **Isotope shift, nuclear charge radii**

Advantages of HITRAP as compared to ESR:

- **Clean environment with efficient light collection**
- **Ions nearly at rest, no Doppler-shift**

GSI Future Accelerator Facility: HITRAP at the NESR

In addition:

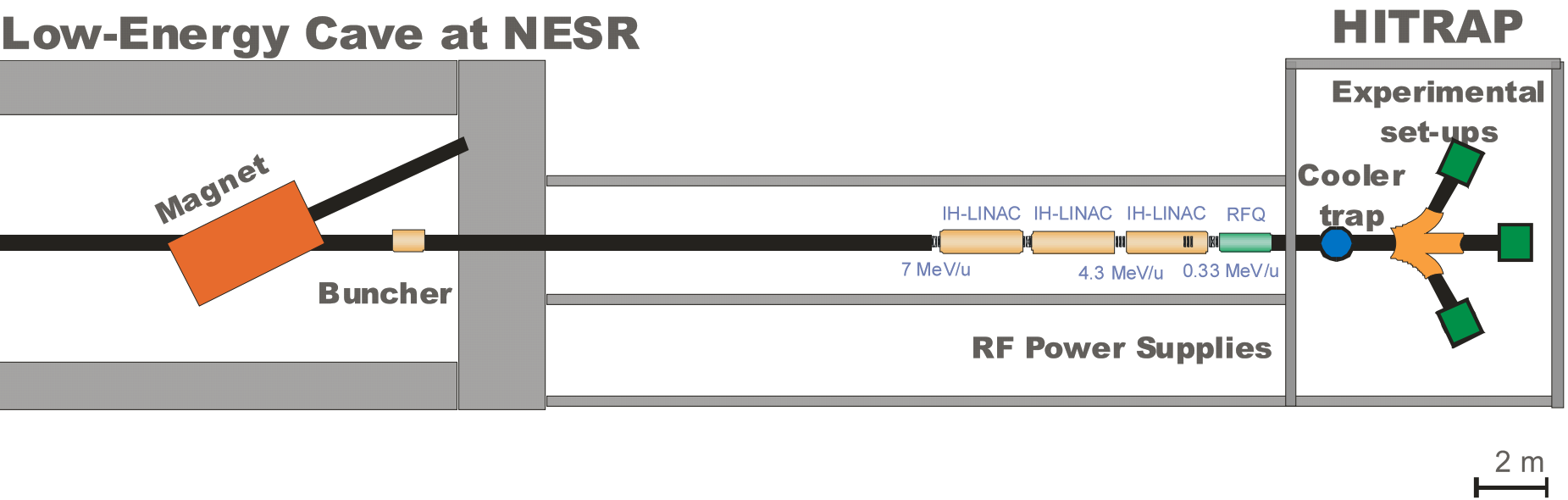
- **Experiments with trapped cold antiprotons:**

  exotic systems, CPT invariance

  ⇒ ***E. Widmann***

- **Gravitational studies with antihydrogen**

  ⇒ ***J. Walz, Poster***



Conclusions:

- **HITRAP will be a unique facility for bare and few-electron highly-charged ions up to U^{92+} at very low energies**
- **The HITRAP Project is embedded in the EU-RTD Network "HITRAP Facility"**
- **Design and construction of decelerator linac and of cooler Penning trap is straightforward and under way.**
- **Installation of HITRAP Facility at re-injection channel in the ESR hall**
- **GSI Future Facility:**

  In addition, low-energy energy antiprotons will be available at NESR