ILIMA Status

Helmut Weick, GSI
ILIMA Open Meeting, 29th Feb 2016

- Administrative and financial status
- Pulsed beam on Super-FRS target
- CR Layout
- Particle detectors in ring
- ToF detector development
- Additional optics correctors

Working Groups

Sub-Project	Group Leader		Institute
Project Manager, Chair	**H**	**Weick**	GSI, Darmstadt
Simulation and Beam Handling	H	Weick	GSI, Darmstadt
Evaluation Software	Yu	Litvinov	GSI, Darmstadt
Physics and Theory Programs	Z	Patyk	Soltan Inst + Univ. Warsaw
ToF Detectors	W	Plaß	GSI + Univ. Giessen
Schottky Detectors	C	Kozhuharov	GSI, Darmstadt
Other Detectors	R	Gernhäuser	TU München

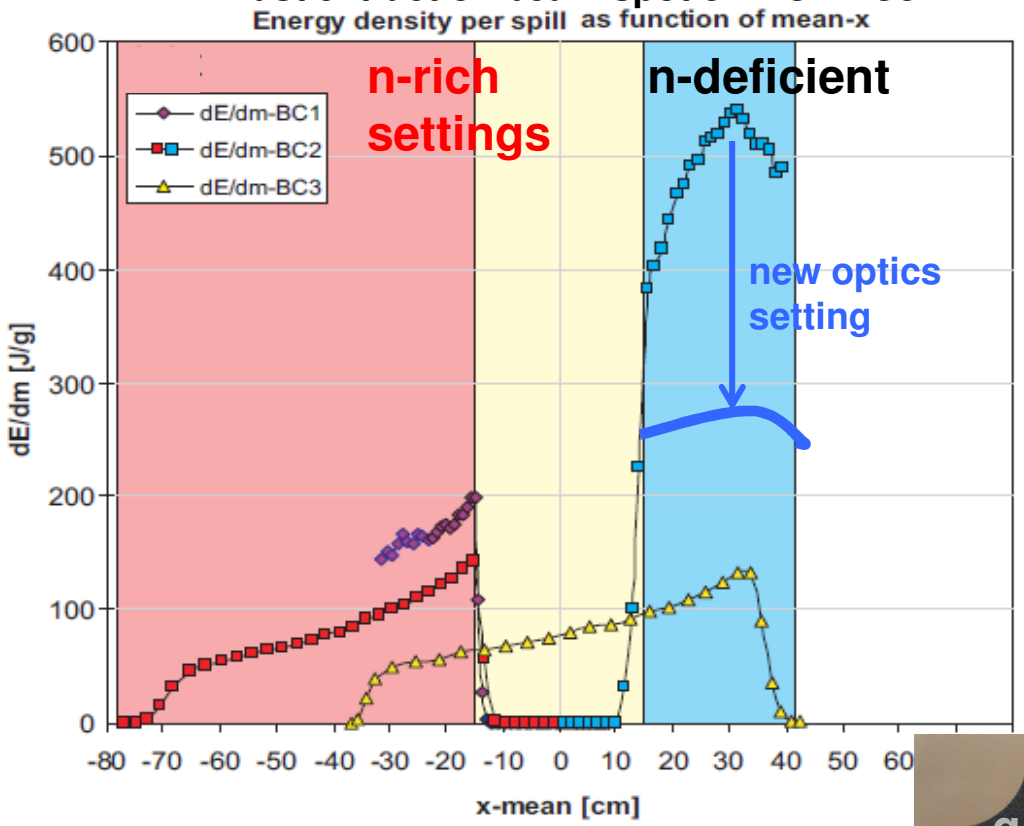
Technical Board

German money (740 k€ in 2005, ~ 933 k€ in 2016)
so far the only safe contribution, available only after approved TDR.

Revised distribution of investment money foreseen for the three subsystems
Schottky 320 k€, ToF 310 k€, particle detectors 120 k€, DAQ+common 183 k€.

Beam Spot on Target / Catcher

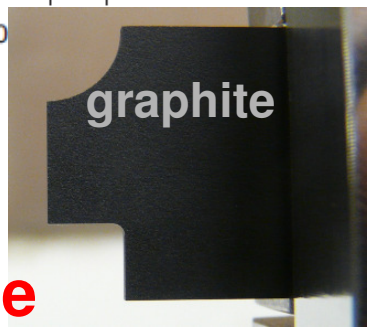
Fast extraction beam spot on BC1-BC3

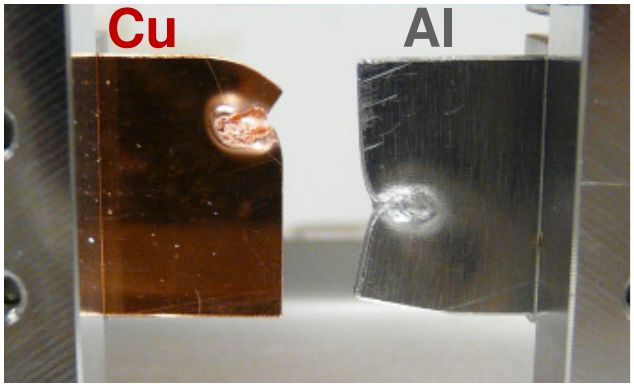


Energy density on beam catchers.
Numbers are more than critical for most materials.
Worst case could be relaxed by factor 2.

Test on smaller spot with existing SIS-18 at GSI, similar energy density.

1mm thick targets from S417 test run (10^{10} U/spill on ~1mm^2 spot)

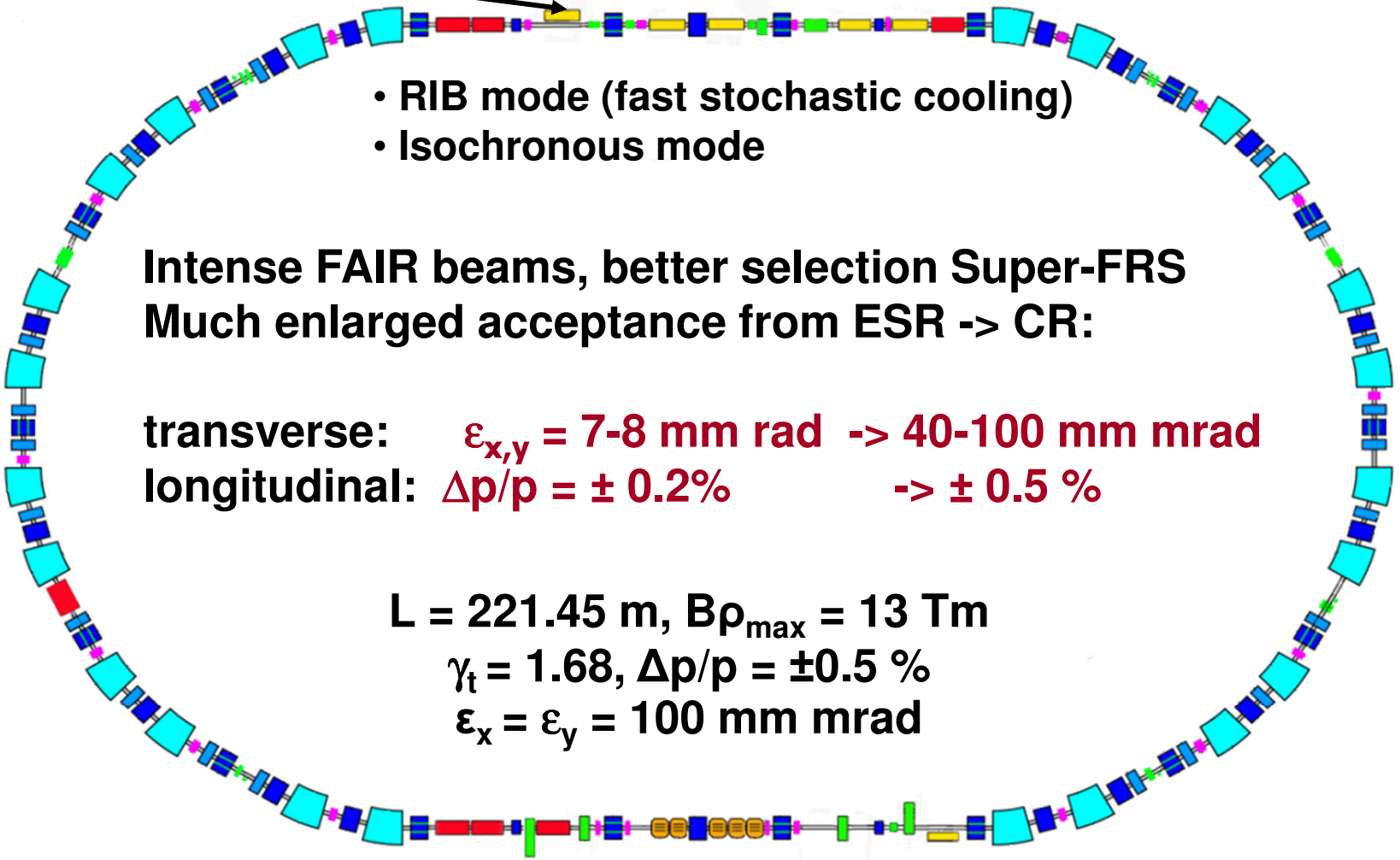




full intensity 5x10^{11} /pulse
but with enlarged beam spot
--> lower transmission/separation

Collector Ring CR

Injection from Super-FRS



- **RIB mode (fast stochastic cooling)**
- **Isochronous mode**

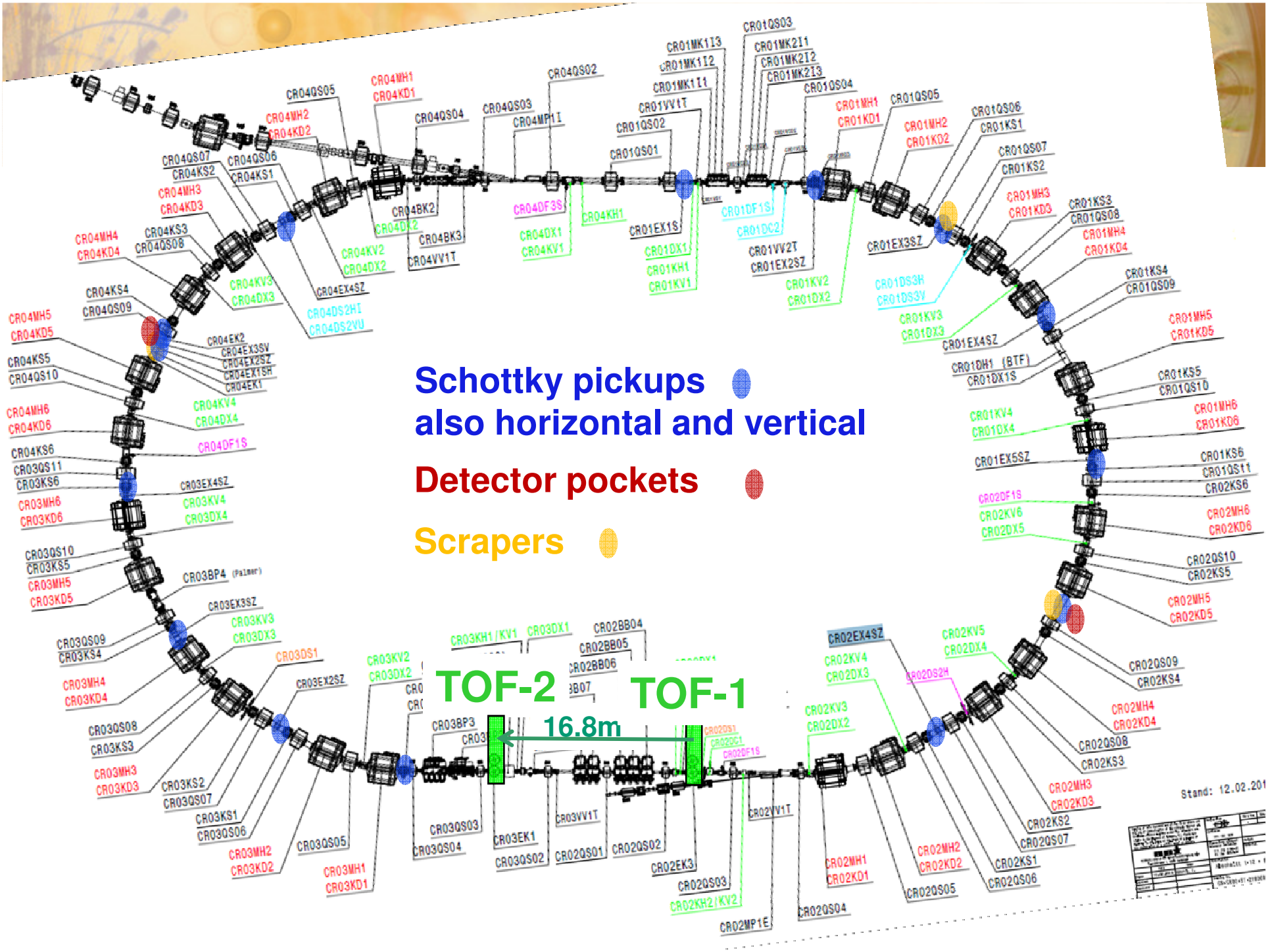
Intense FAIR beams, better selection Super-FRS
Much enlarged acceptance from ESR -> CR:

transverse: $\varepsilon_{x,y}$ **= 7-8 mm rad -> 40-100 mm mrad**
longitudinal: $\Delta p/p = \pm 0.2\%$ **-> ± 0.5 %**

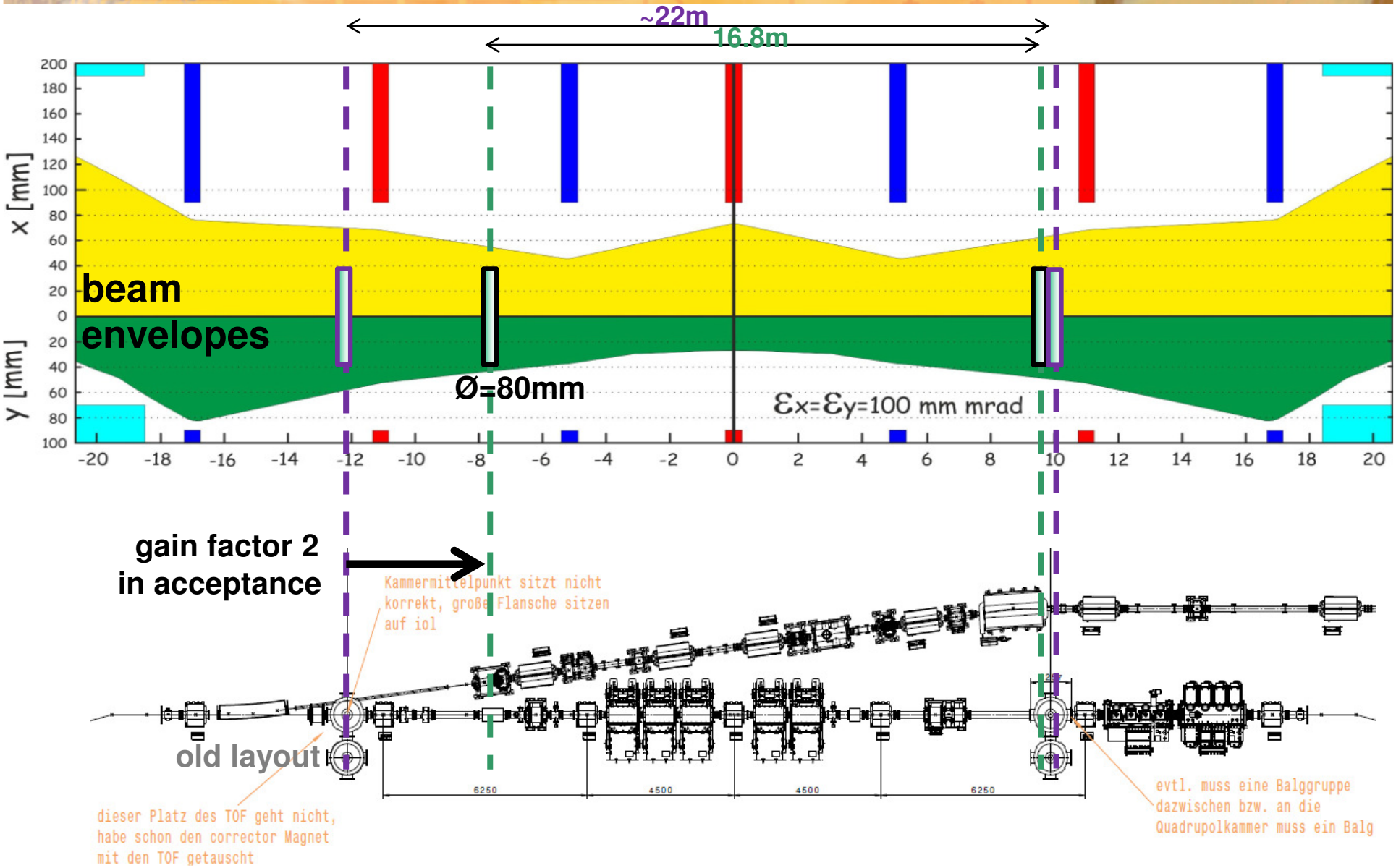
L = 221.45 m, $B\rho_{max}$ **= 13 Tm**
γ_t **= 1.68,** $\Delta p/p = \pm 0.5$ **%**
$\varepsilon_x = \varepsilon_y$ **= 100 mm mrad**

build by BINP Novosibirsk, TDR very soon

Layout: A. Dolinskii, S. Litvinov, I. Koop

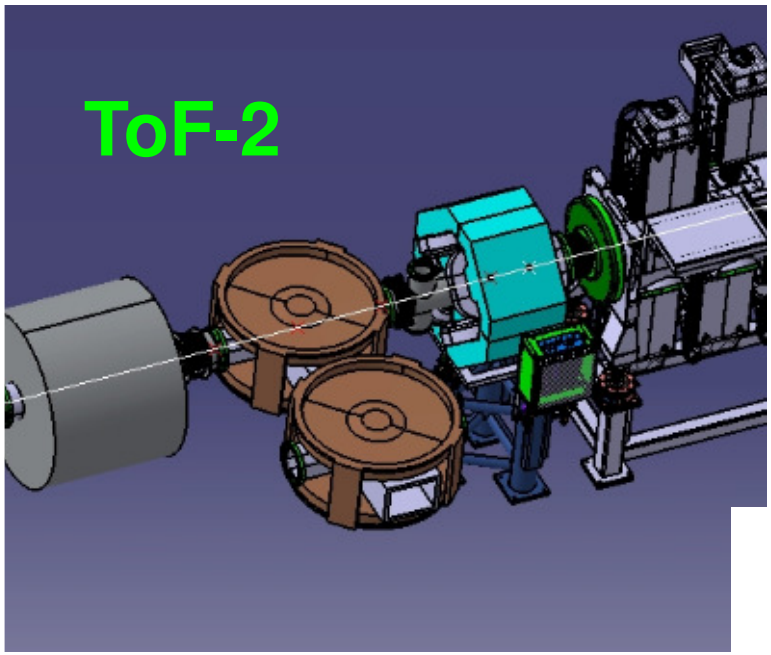

Schottky pickups
also horizontal and vertical
Detector pockets
Scrapers
TOF-2
TOF-1
16.8m
Stand: 12.02.201

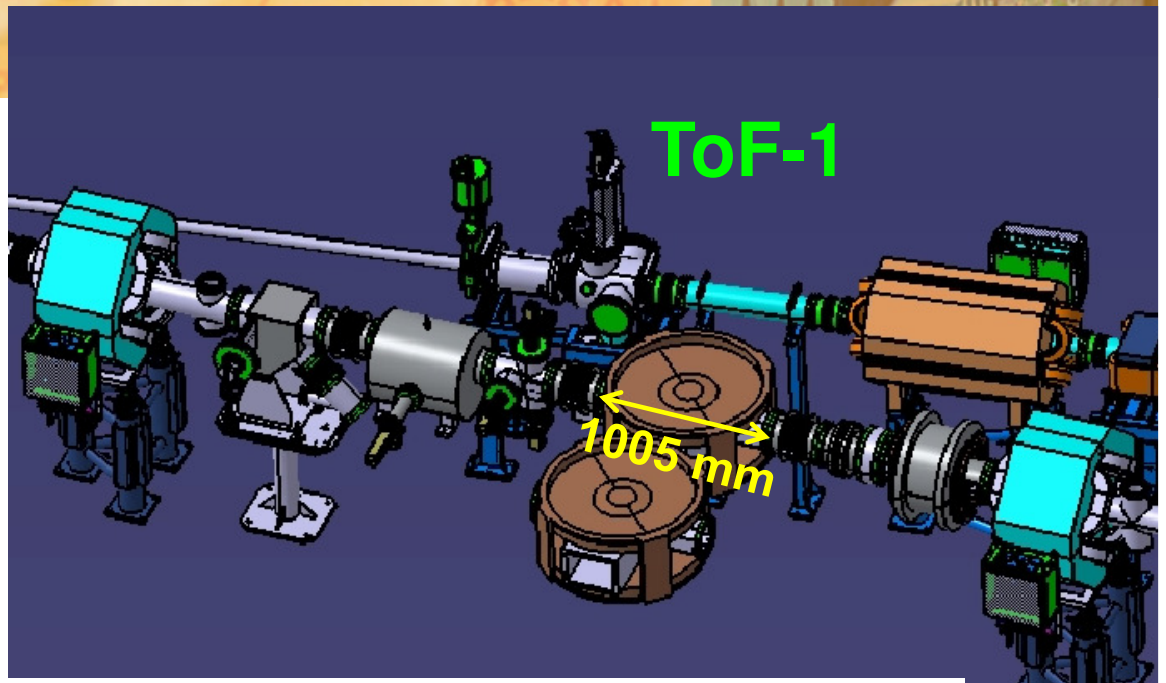
Positon of Detectors

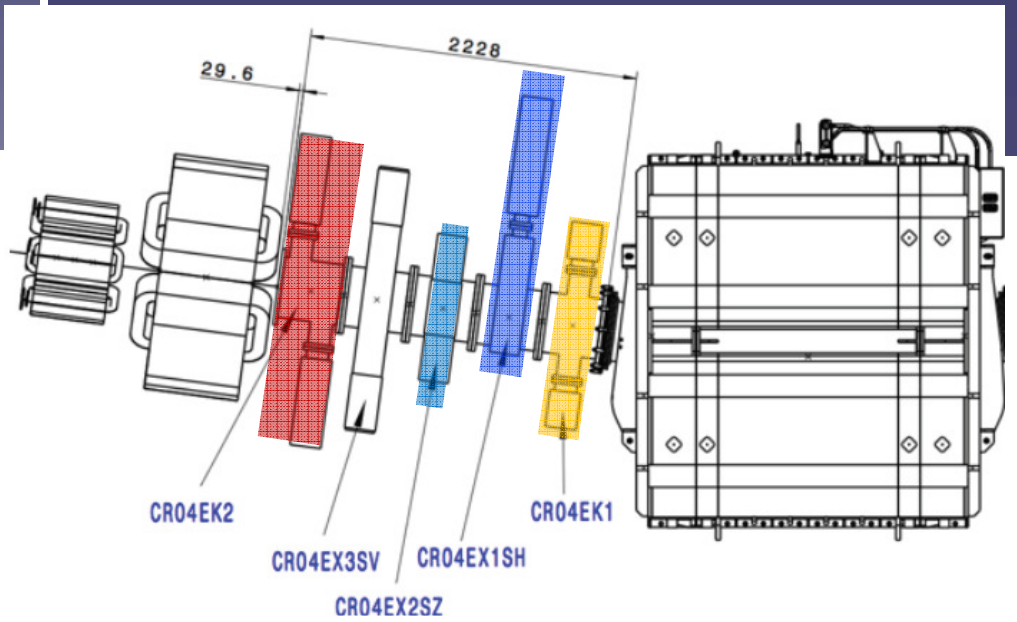


CR Installation Details

ToF detectors



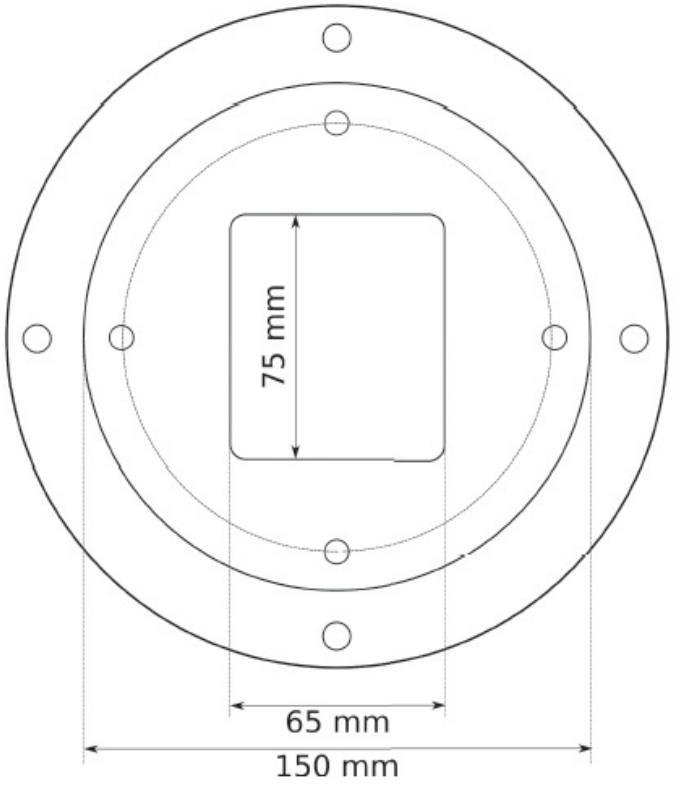




Chamber in arc for:

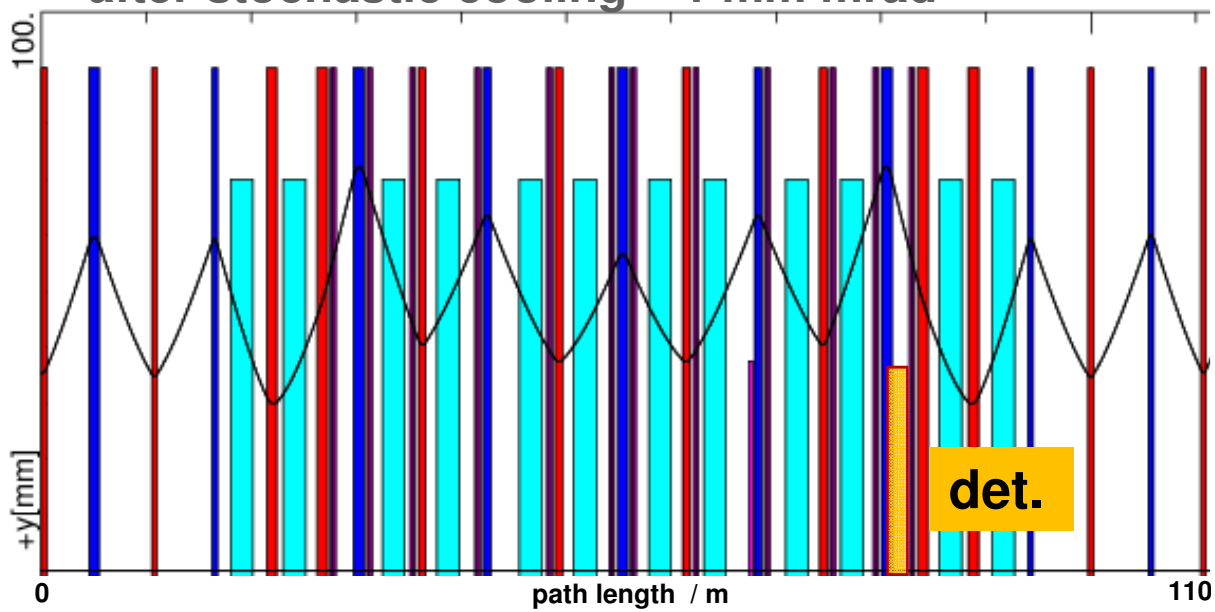
- pocket detectors,
- vert. res. Schottky,
- horizontal pickup,
- scrapers.

CR Installation
Pocket Flange

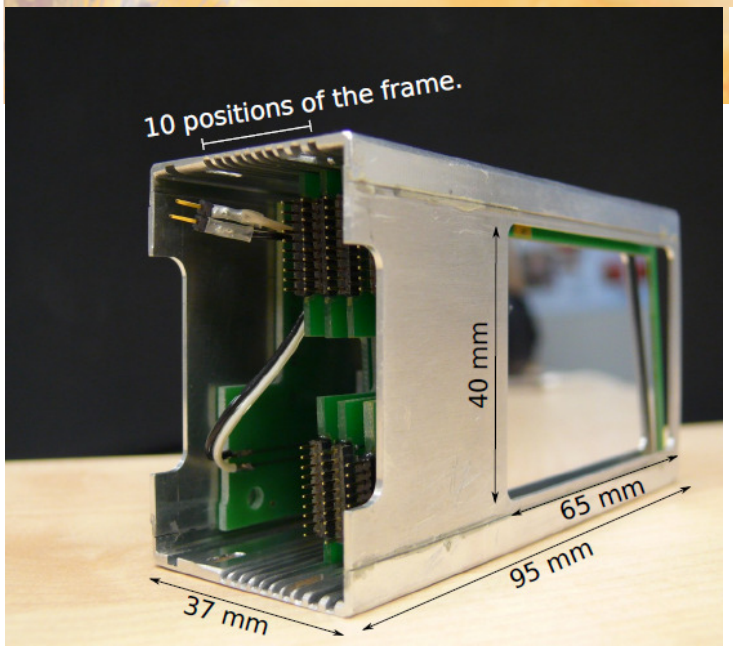


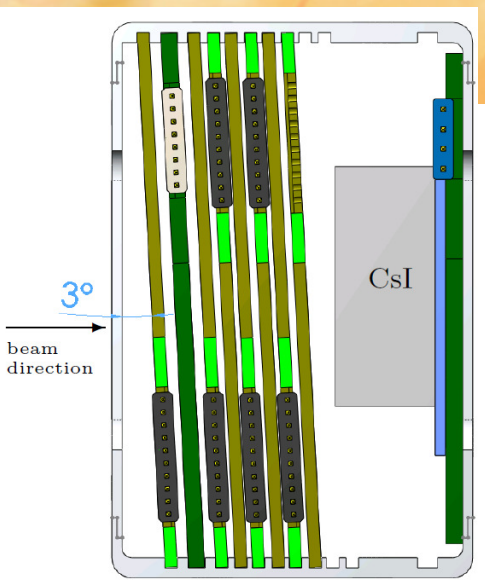
- DN150CF flange
- Dimensions of the pocket:
  65 x 75 x 629 mm³
  (the length of 629 mm is from the current pockets, and it has to be adjusted to the dimensions of the CR)
- Entrance window: 122 x 55 mm²

y beam envelope in RIB mode for 200 mm mrad after stochastic cooling ~ 1 mm mrad



Detector for In-Ring Decay

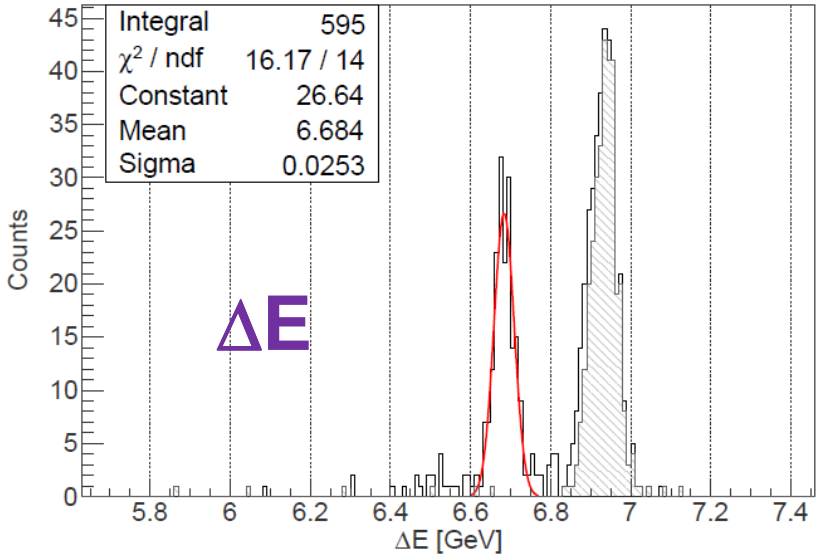


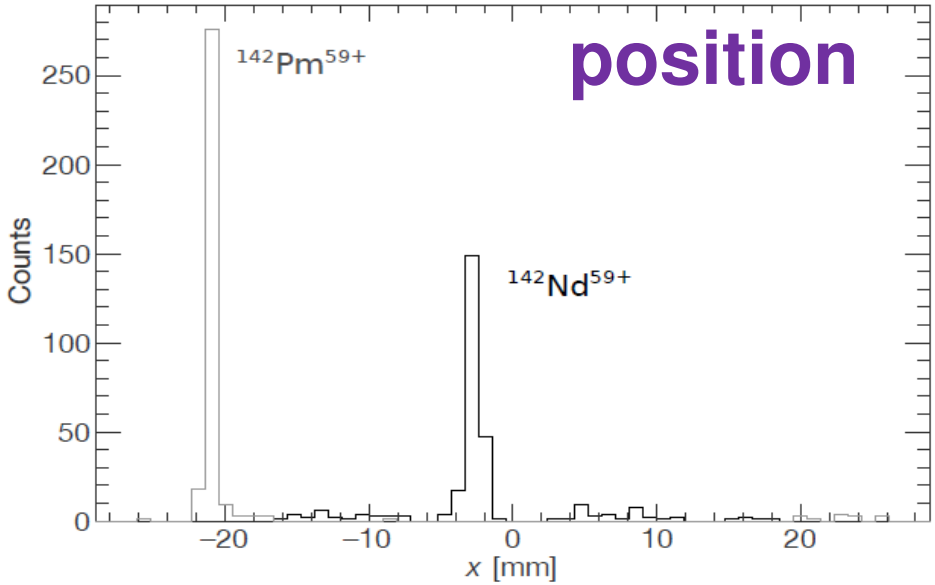


DSSD stack for ΔE-E
active area 40mm x 60mm
also with CsI calorimeter
+ Si photo diode,
to identity Z and A.

Ali Najafi

β+ decay: $^{142}Pm^{60+}$ → $^{142}Nd^{59+}$, electron capture $^{142}Pm^{59+}$





CR Vacuum

Electron capture, electron loss
lifetime of characteristic ions in the CR
for 3x10^{-9} mbar (80% H_2, 20% N_2)

Yuri A. Litvinov[1], Viatcheslav Shevelko[1,2], Thomas Stöhlker[1,3,4]

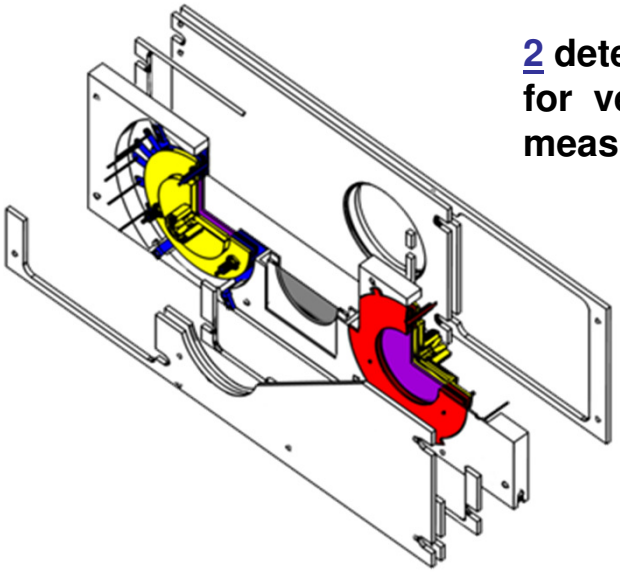
Ion	E MeV/u	τ [s]
U^{88+}	400	374
U^{88+}	740	375
U^{90+}	400	3111
U^{90+}	740	2588
U^{92+}	400	2729
U^{92+}	740	7425
Sn^{49+}	400	855
Sn^{49+}	740	779
Sn^{50+}	400	25168
Sn^{50+}	740	68941

Scale for more N_2, Ar and higher pressure

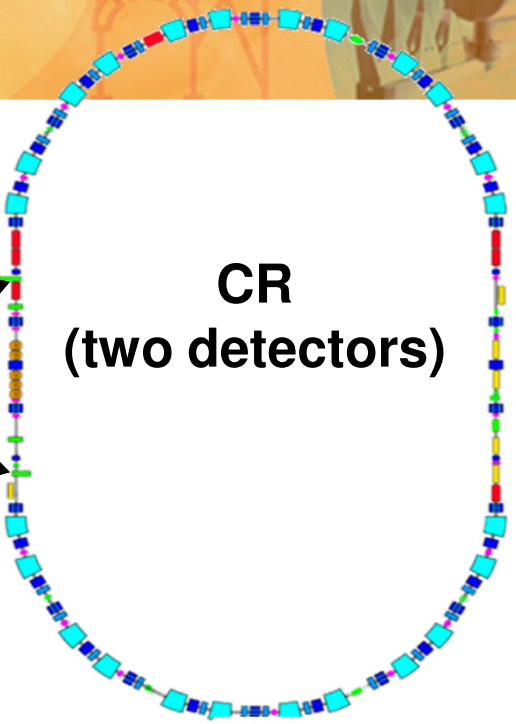
Design value: at least τ = 100s for U^{88+}
-> 3x10^{-9} mbar (N_2), 4x10^{-8} (H_2), no baking

+ no problem for mass measurements
+ long enough for tuning
o measurements with decay in CR could be critical for some cases
  e.g. bound beta.decay in CR, for these bare ions τ > 1000 s.
  long lifetime measurements are done better in HESR

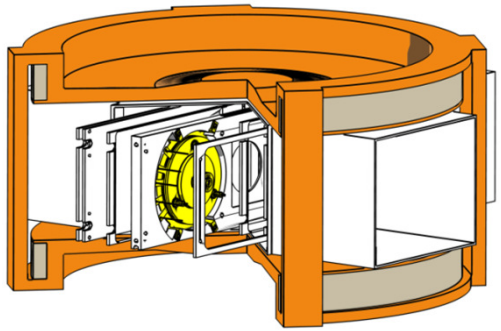
TOF Detector System for CR



2 detectors
for velocity
measurement



Foil diameter 80 mm
Dimensions: 562 mm x 180 mm x 236 mm
Electron transport efficiency ≈ 98%
Timing accuracy ≈ 35 ps (in simulation)



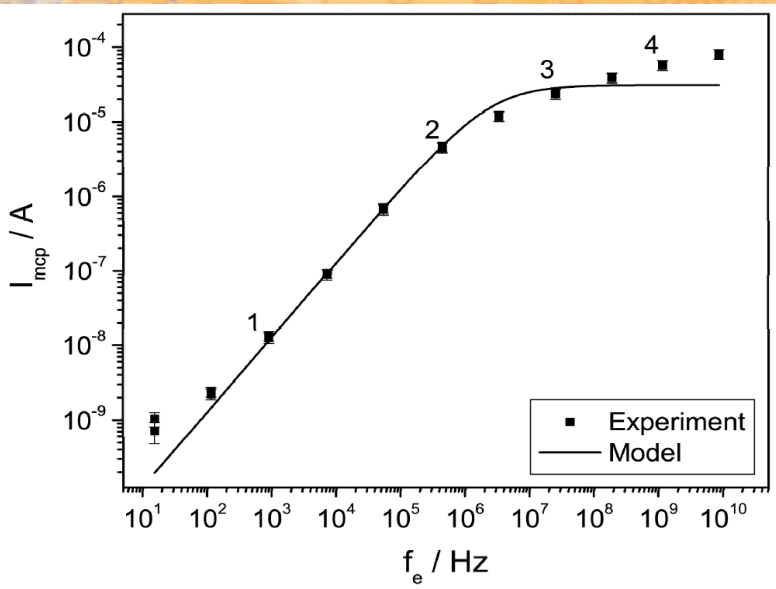
Main challenges for new detector:

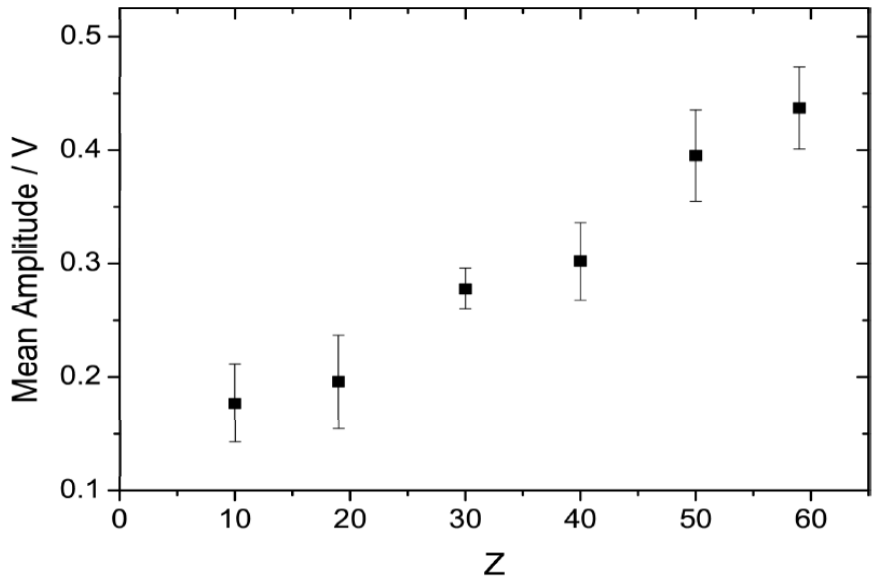
- **Active area x 4 required**
- **Very limited space in the ring**
  → scaling up the detector not possible

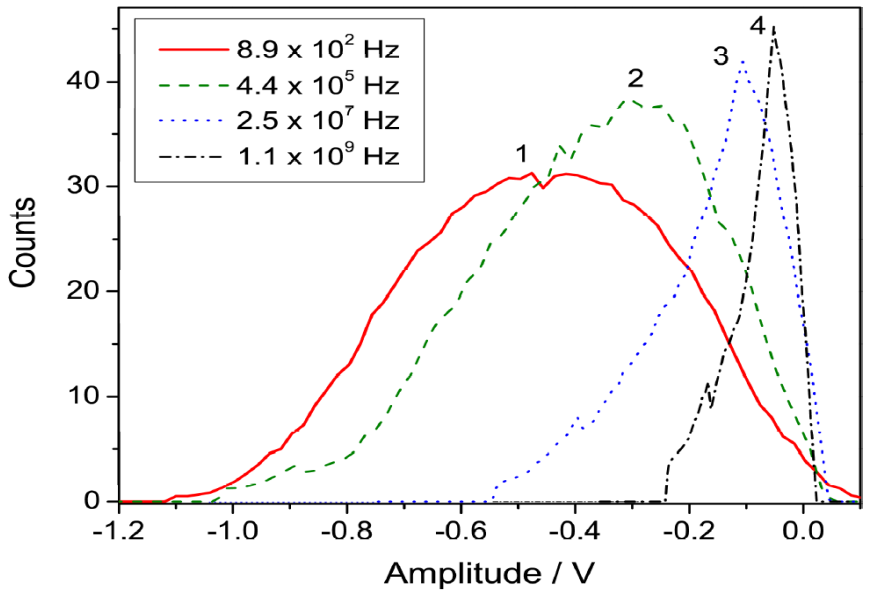
M. Diwisch et al., Phys. Scripta T166, 014058 (2015).

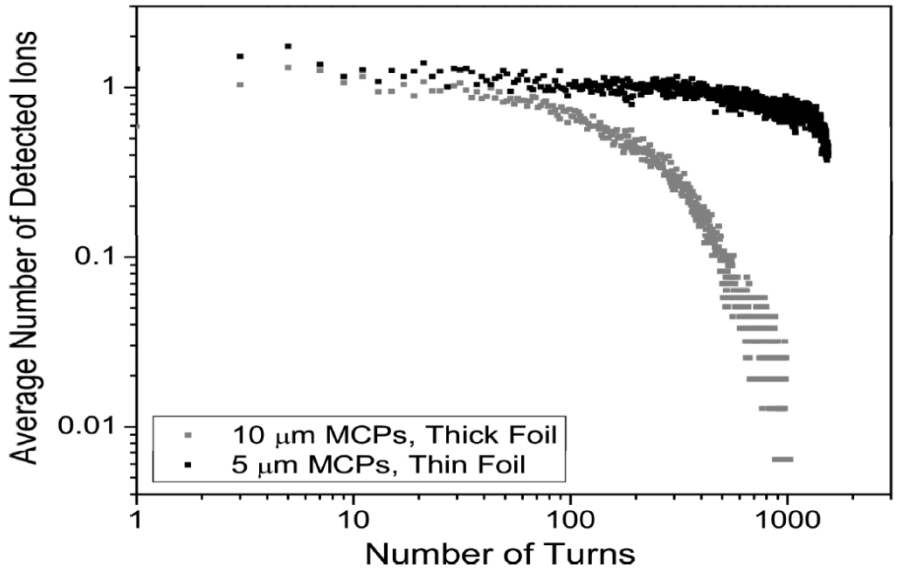
TOF Detector Signals
data from ESR and offline

N. Kuzminchuk-Feuerstein et al., subm. to NIM B

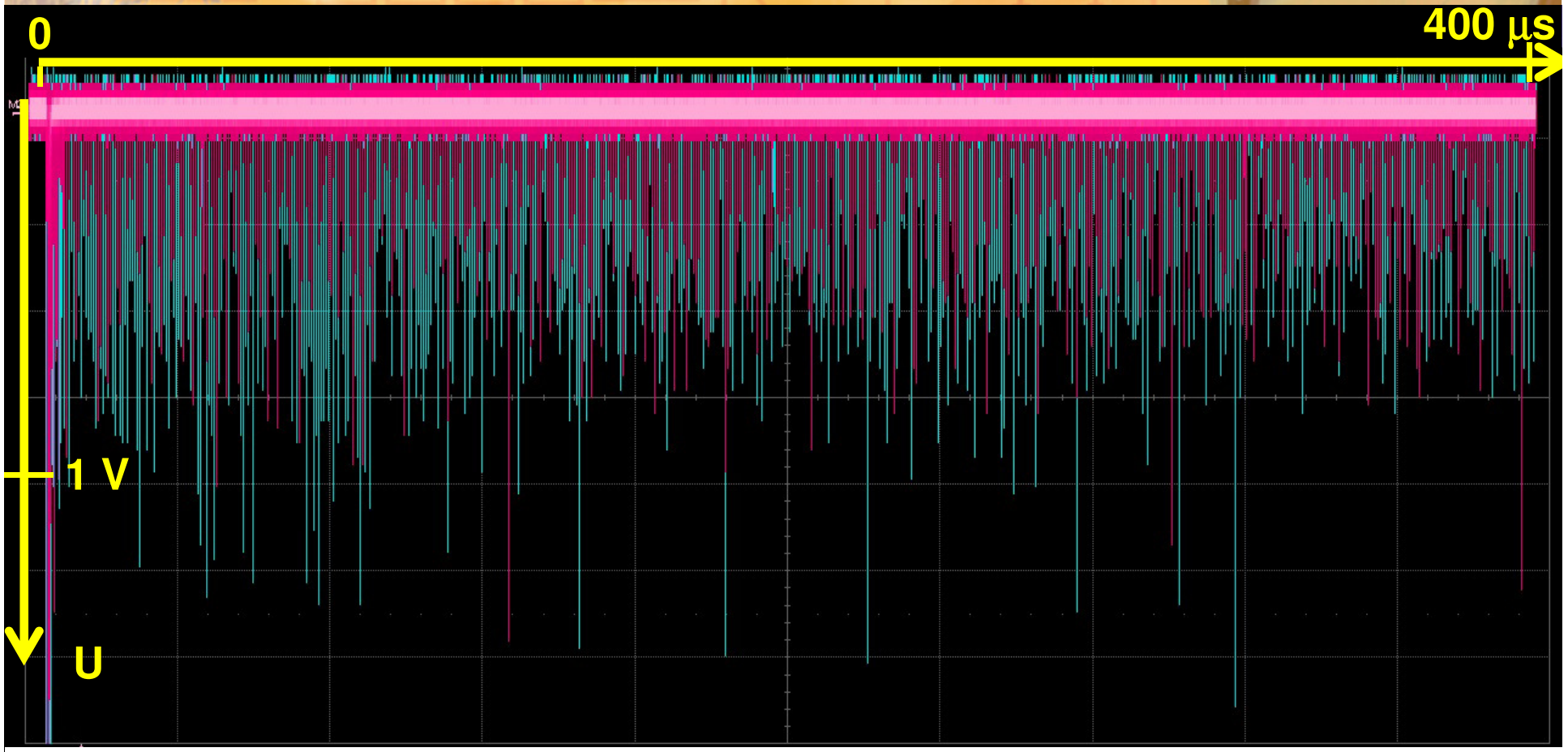






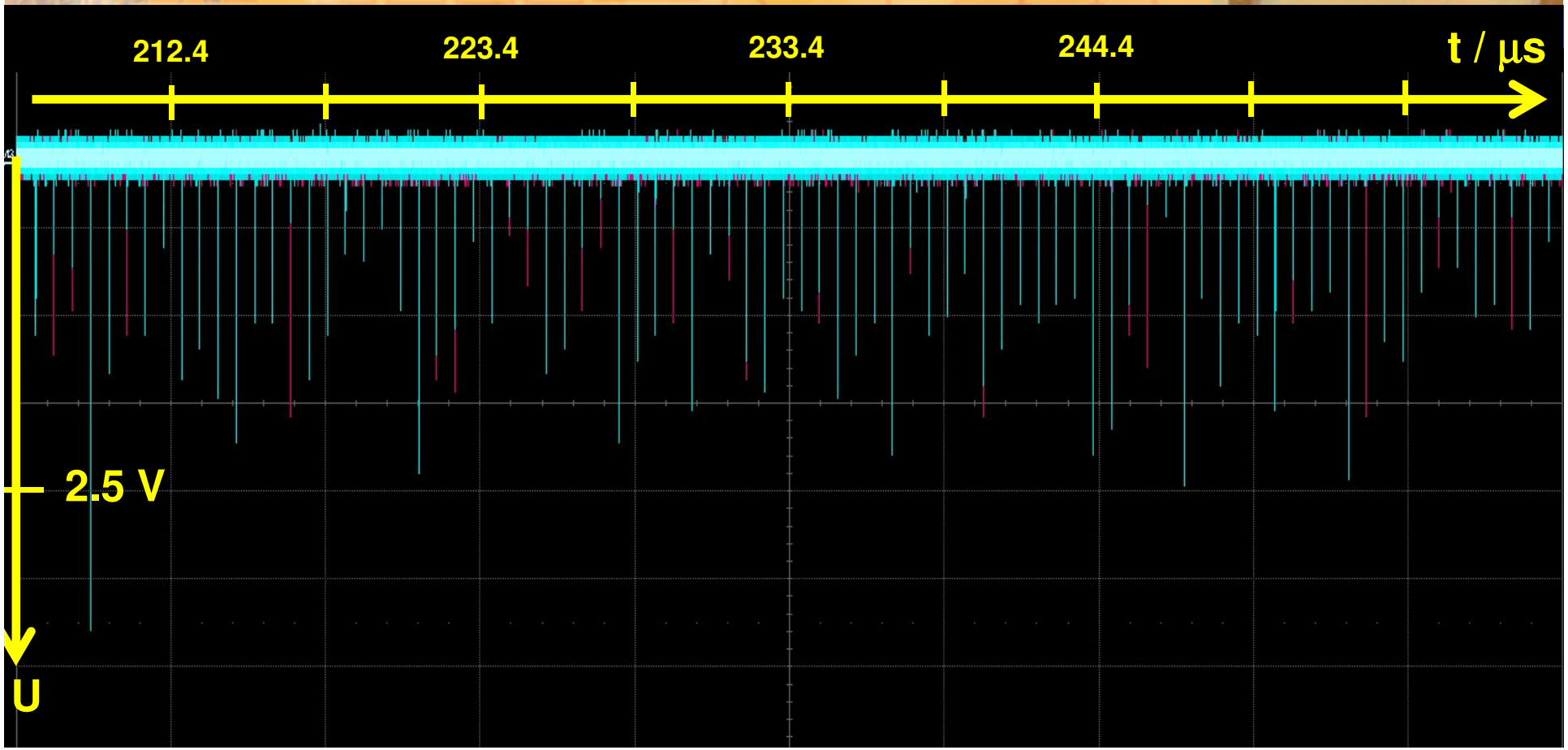


ToF Detector Signals



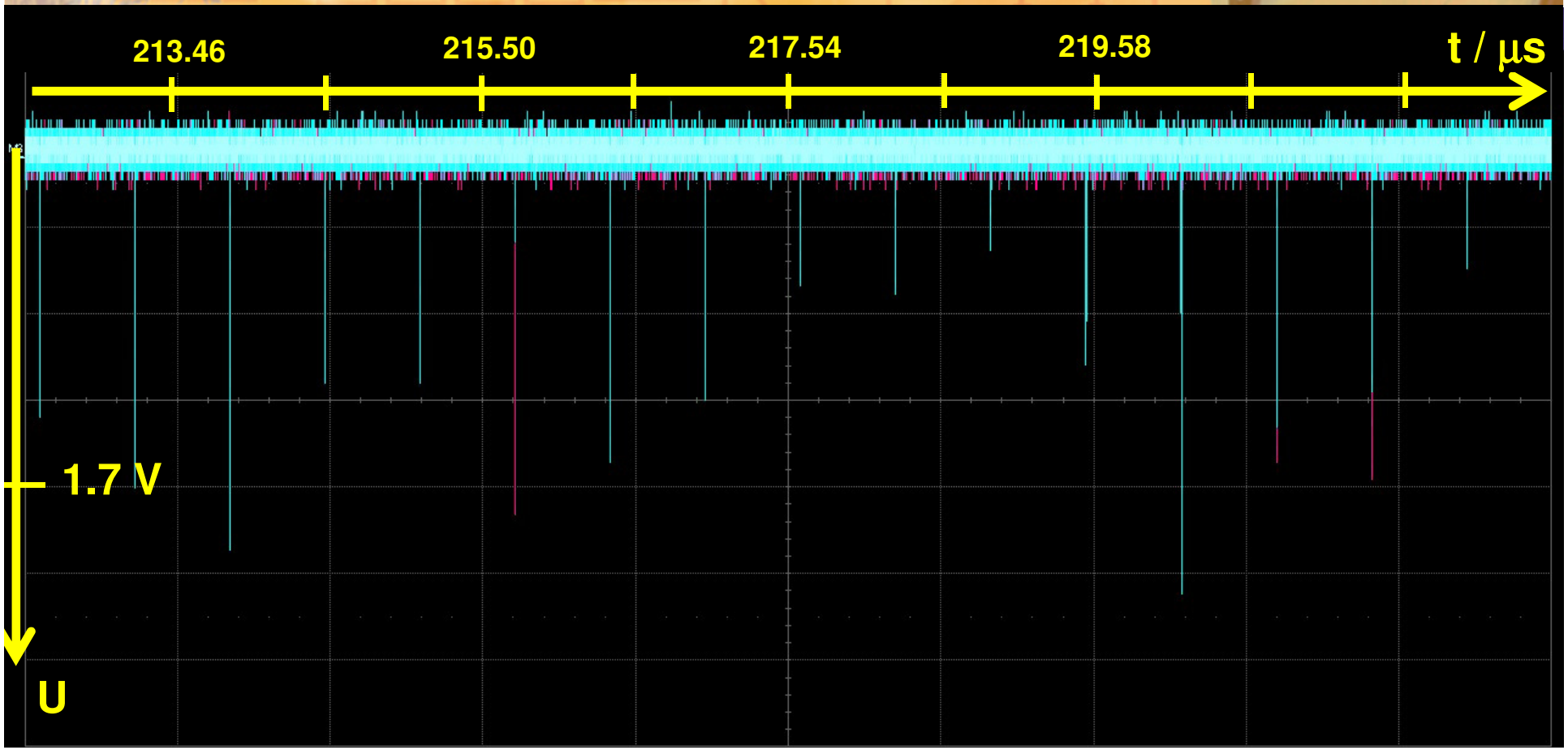
^{238}U beam on improved ToF detector in ESR, Oct 2014
old detector but new channel plates, new field settings,
No big decrease of pulse height even after 800 turns.

ToF Detector Signals 2



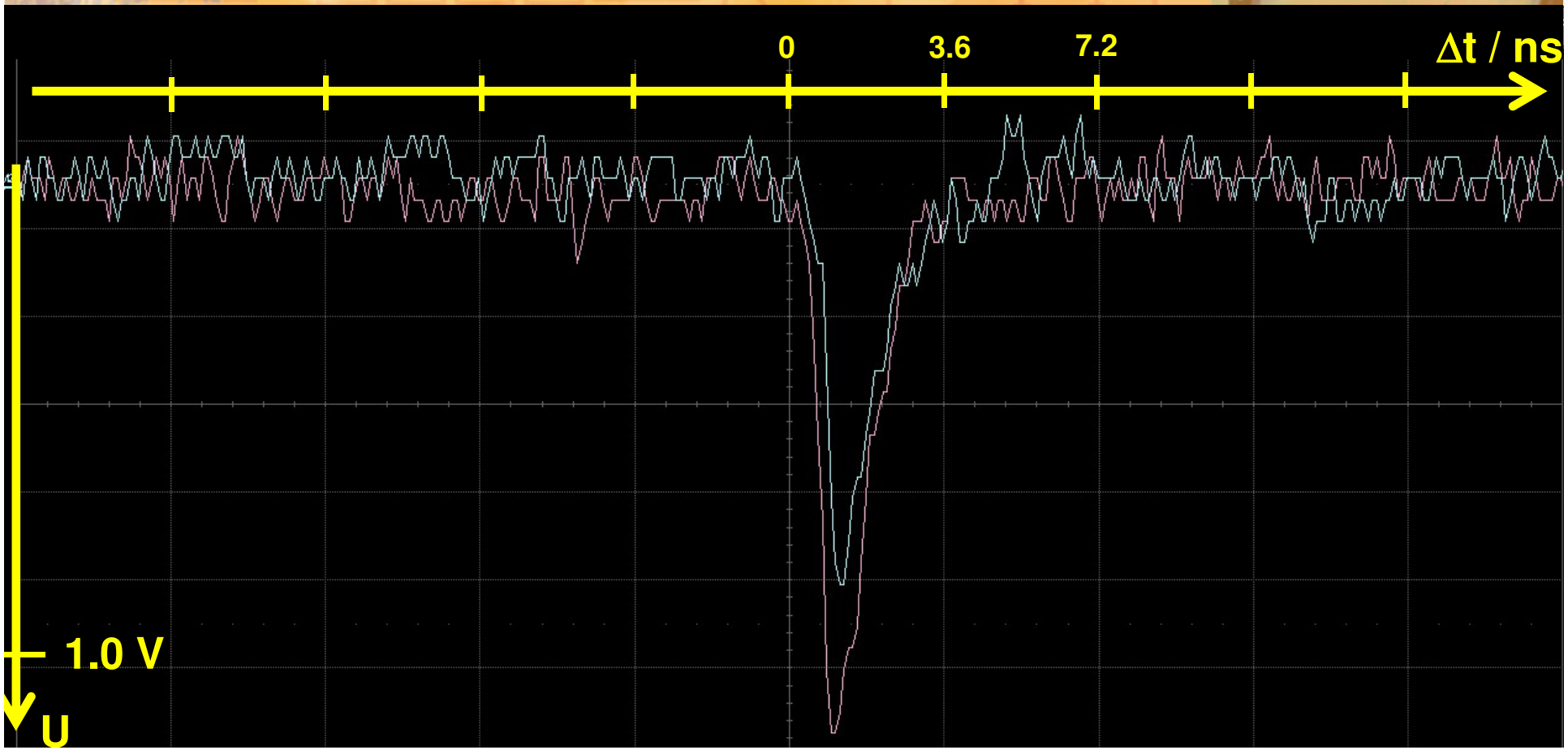
A good signal from every turn on both sides (blue and red), in the past only shorter sequences with gaps.

ToF Detector Signals 3



A good signal from every turn on both sides (blue and red), in the past only shorter sequences with gaps.

ToF Detector Signals 4

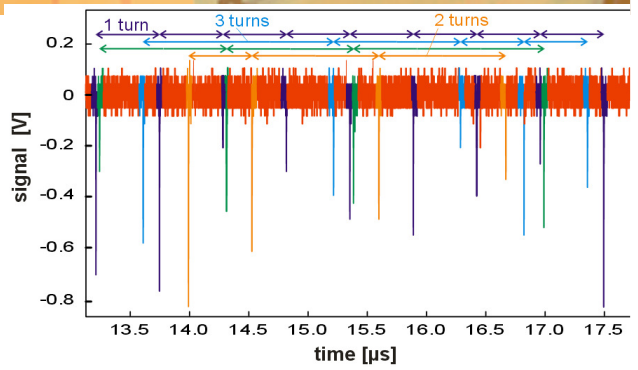


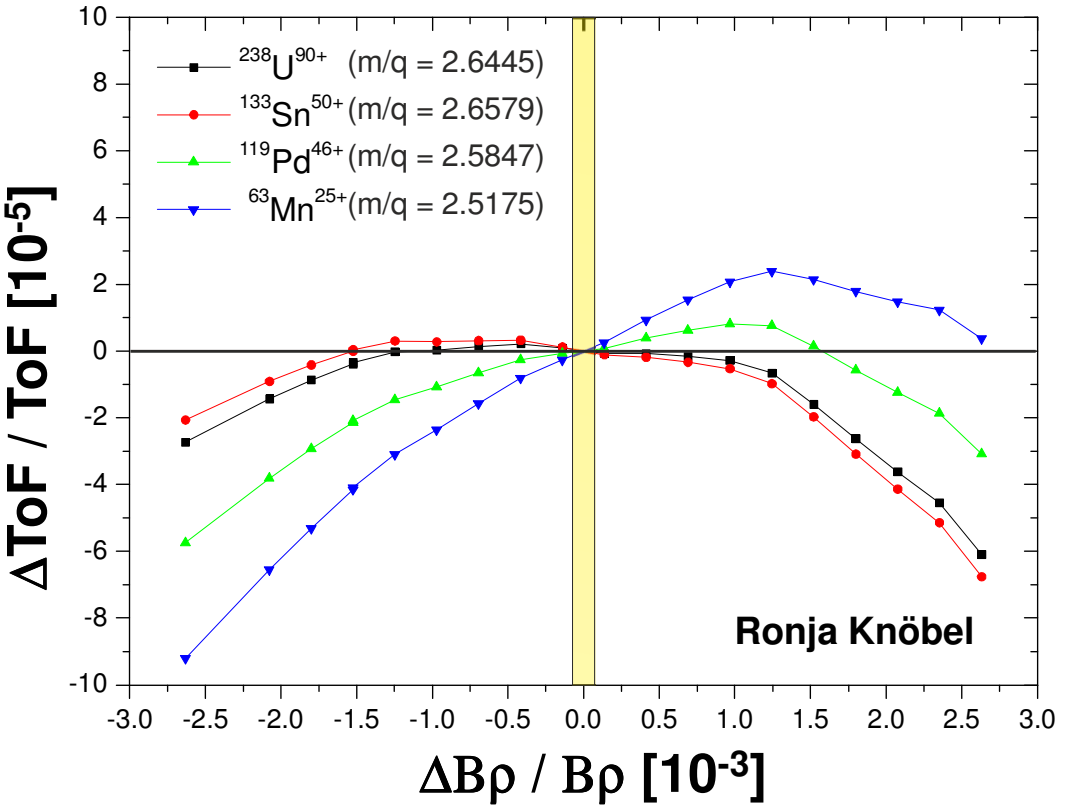
A good signal from every turn on both sides (blue and red).
thin foil only 10 μg/cm² → on average ~ 3 electrons released to both sides.

ToF Analysis with Velocity Measurement

- software correction based on measured data -

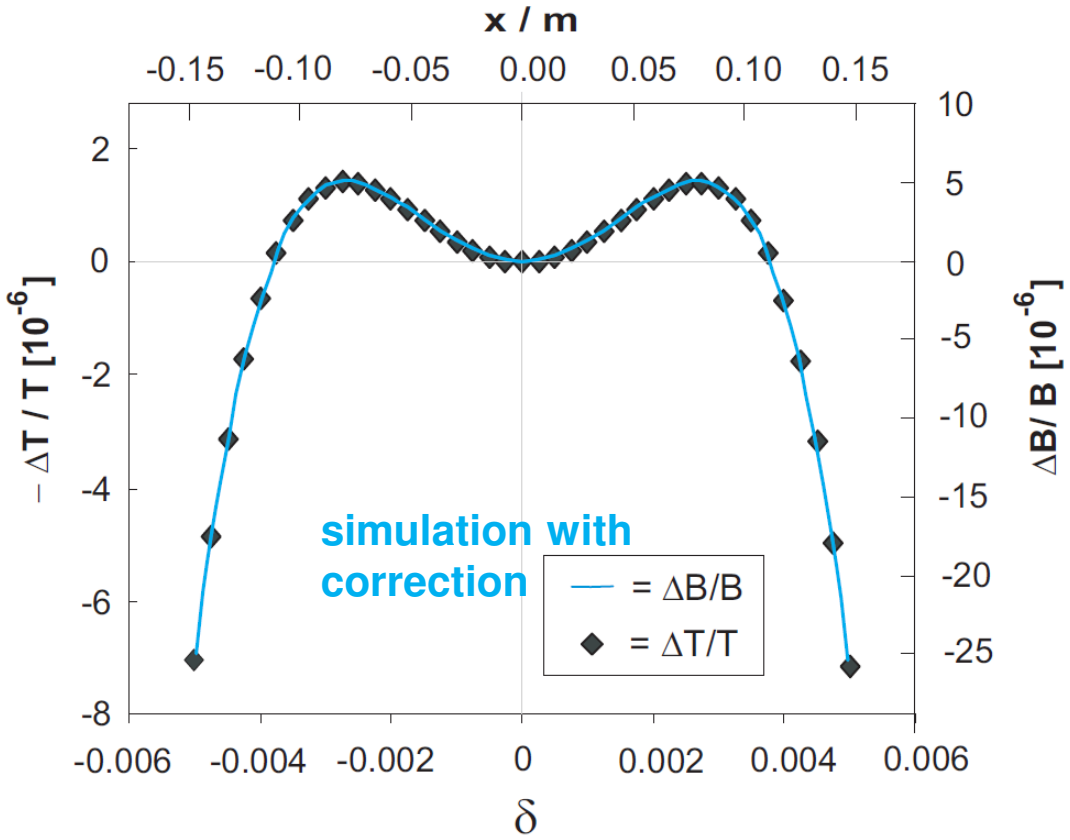
1.) find periodic traces in revolution time
    for each single detector -> ToF
2.) polynomial -> mass spectrum, identify m/q
3.) find matching series from both detectors
    for velocity measurement, efficiency !
4.) establish isochronicity curve
    from these data
5.) shift ToF for single ions
    according to deviation
    from isochronicity.
6.) Do 1.+2. again with
    corrected ToFs
7.) Obtain new masses from
    calibrants and correlations

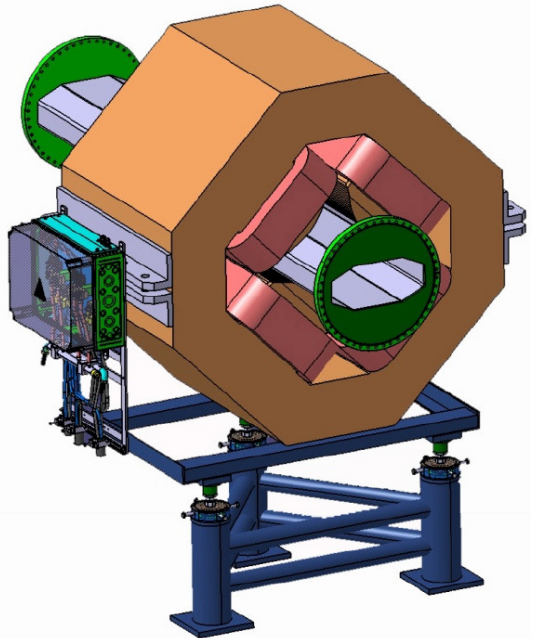




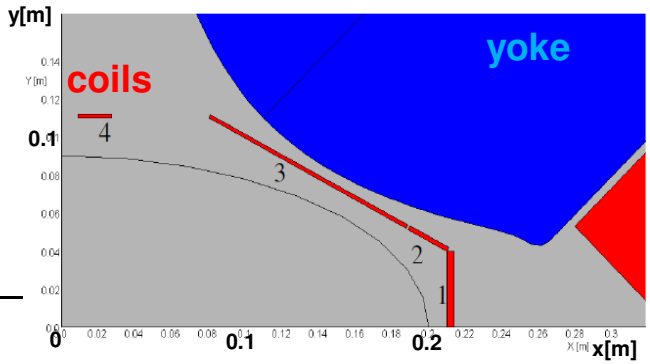
Extra Optics Correctors

Octupoles superimposed to quadrupoles are foreseen, but no higher orders, decapole (4th order) is needed. Compensate inhomogeneities down to ΔB/B ~ 1x10^{-6}.





CR large quadrupole with octupole coils, conceptual design, A. Kalimov



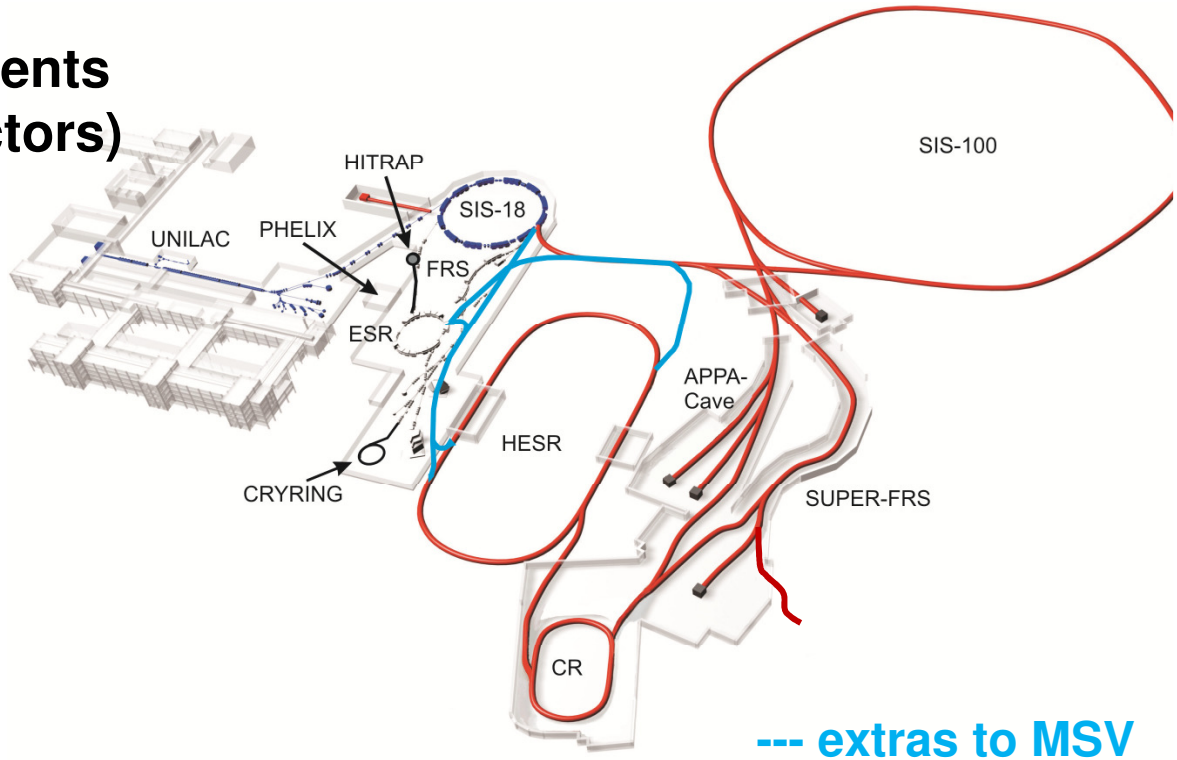
Extras to planned quads + power supply -> costs on experiment

HESR+CRYRING Perspectives

no NESR.

But HESR with stochastic and electron cooling
HESR E_{min} = 740 MeV/u, possible with SIS-18

Good for lifetime measurements
(Schottky and particle detectors)

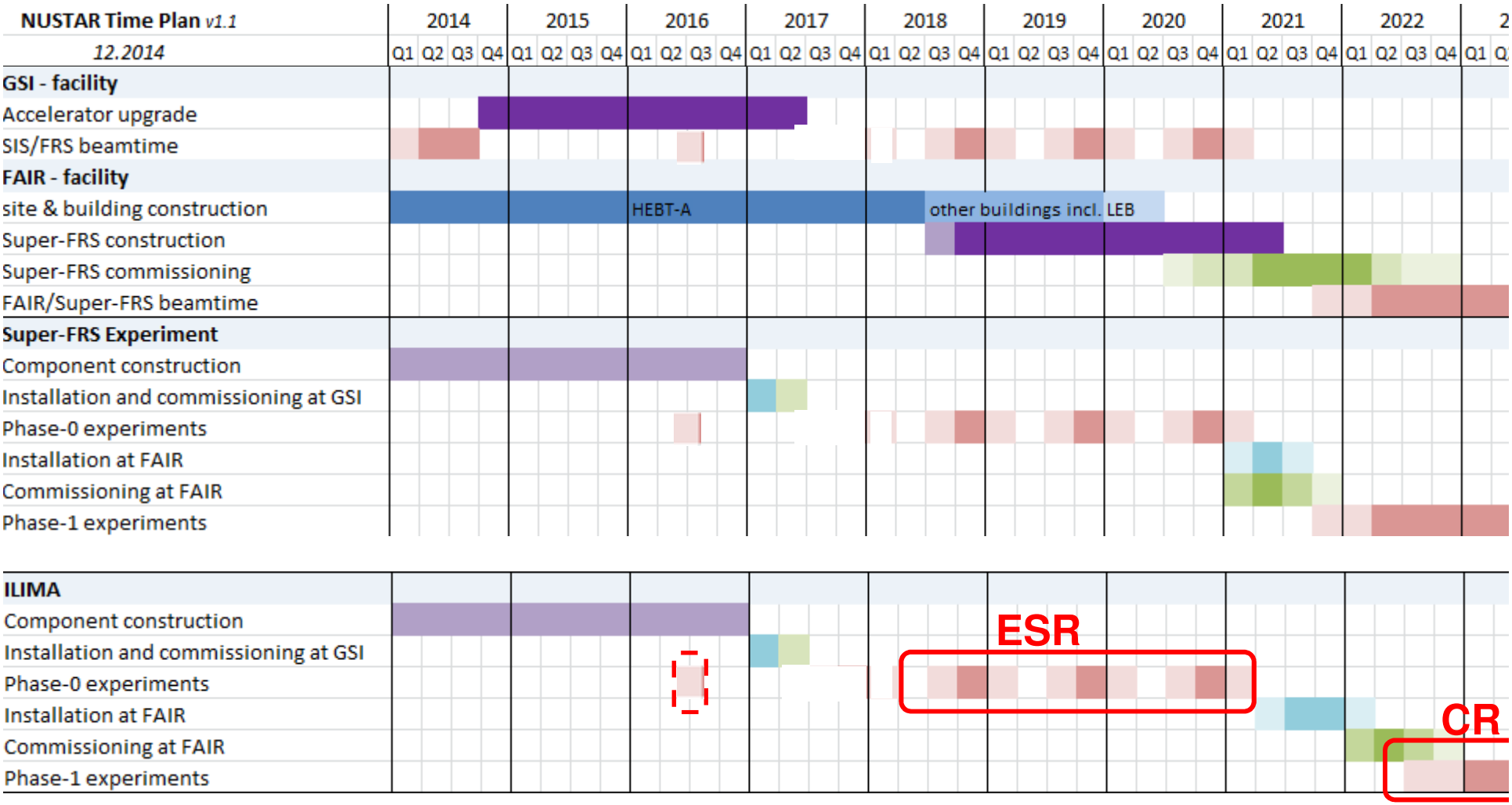


CRYRING coupled to ESR,
physics programme

--- extras to MSV

Time Line

The NUSTAR exploitation plan



Very much dominated by FAIR civil construction, preliminary plans.

Summary

Pulsed beam still critical for ring experiments, but ok for most settings.

CR will be build by BINP Novosibirsk considering our needs,
large acceptance is challenging,
extras for higher order correction are needed.

Development for ToF Detector in progress.
Design to fit it into CR.

Schottky also possible in isochronous CR.
New development for position sensitivity.

Particle detectors can do things not possible otherwise, detector built.

Some experiments are possible in HESR with e-cooler.

Still no TDR, but also buildings not in sight soon.
Think of intermediate time at ESR as ILIMA.