Short status update: Impedance simulations for new flexible bellows

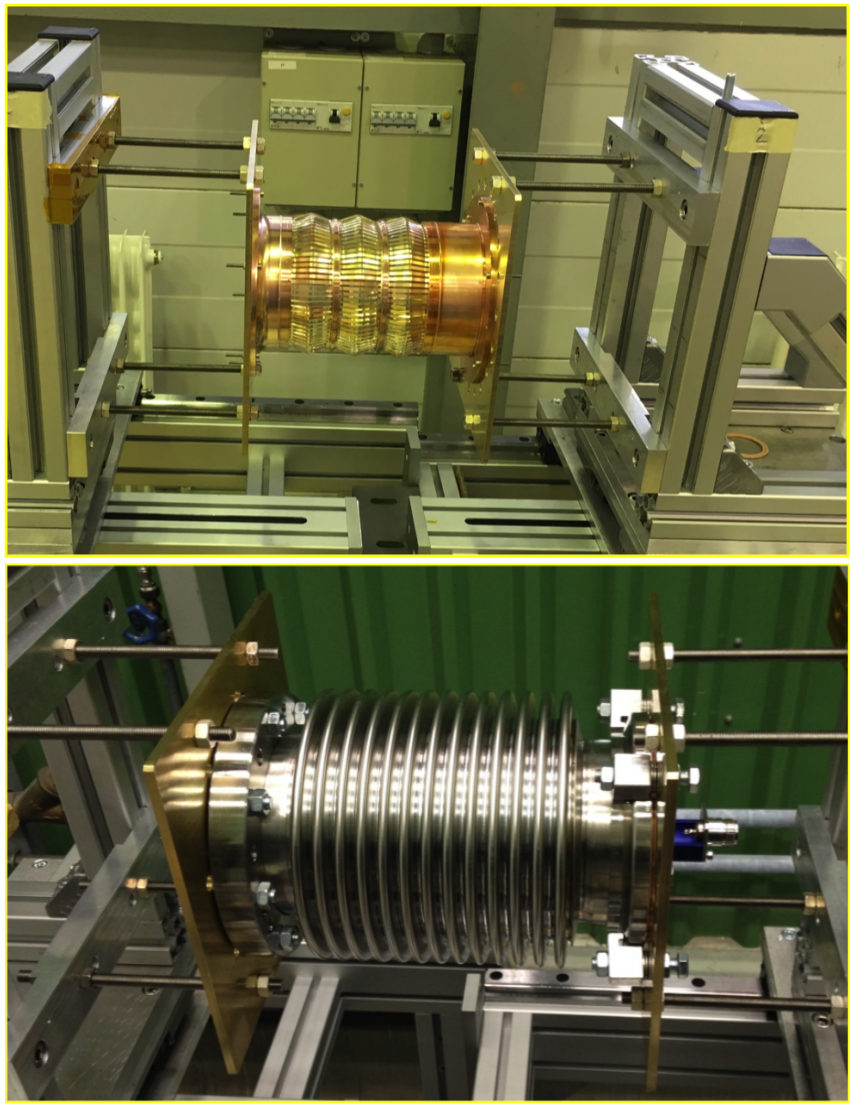
K. Sjobak

WP2 meeting, 10/4-2017

Thanks to B. Salvant and O. Kononenko

New LHC RF shielding

- New RF contacts geometry being considered for HL-LHC
- Design with fixed extremities
  $\Rightarrow$ Reduced risk of nonconformities
- Trapped modes when not completely extended
- Possibility of resonances in the outer volume coupling to the beam



Photos by C. Vollinger

Measurements

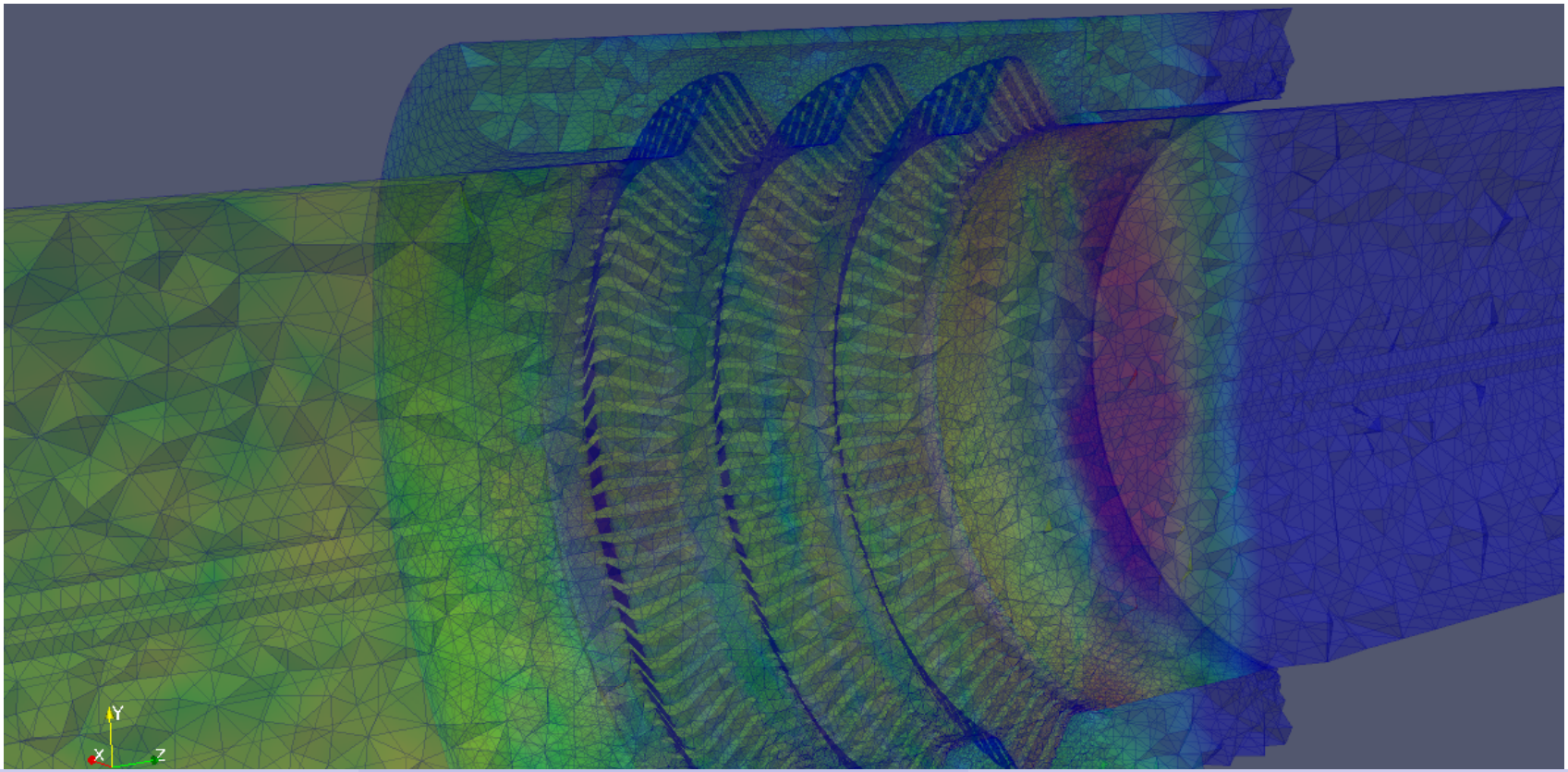
- Wire measurements by C. Vollinger et. al., presented at:
  - WP2 meeting no. 69, Jun 2016
    `https://indico.cern.ch/event/525677/`
  - Impedance meeting Dec. 2014
    `http://indico.cern.ch/event/358583/`
- For 2-convolution bellows, observe that high-Q resonances show up when the outer bellow is mounted.
- For 3-convolution bellows, coupling of resonances to inner volume disappear when bellow is mounted.

Earlier simulations

- Presentations:
  - O. Berrig & B. Salvant: "Beam impedance of 63 mm VM with unshielded bellows", 6/11-2012
  - Na Wang & B. Salvant: "Impedance calculations for the new LHC triplet shielded bellows and the changes linked to 5th axis in the LHC", Impedance meeting 18/06-2015 `http://indico.cern.ch/event/403089/`
  - K. Sjobak & B. Salvant: "ACE3P for RF finger simulation", Impedance meeting 10/08-2015 `http://indico.cern.ch/event/437858/`
  - B. Salvant & E. Metral: "HL-LHC Triplet "RF fingers", WP2 meeting 29/03-2015 `https://indico.cern.ch/event/512380/`
  - K. Sjobak: "Update on simulation of new RF "fingers" using ACE3P", WP2 meeting 16/08-2016 `https://indico.cern.ch/event/556760/`
- Using CST, HFSS, ACE3P, ABCI
- All have problems with the complex geometry

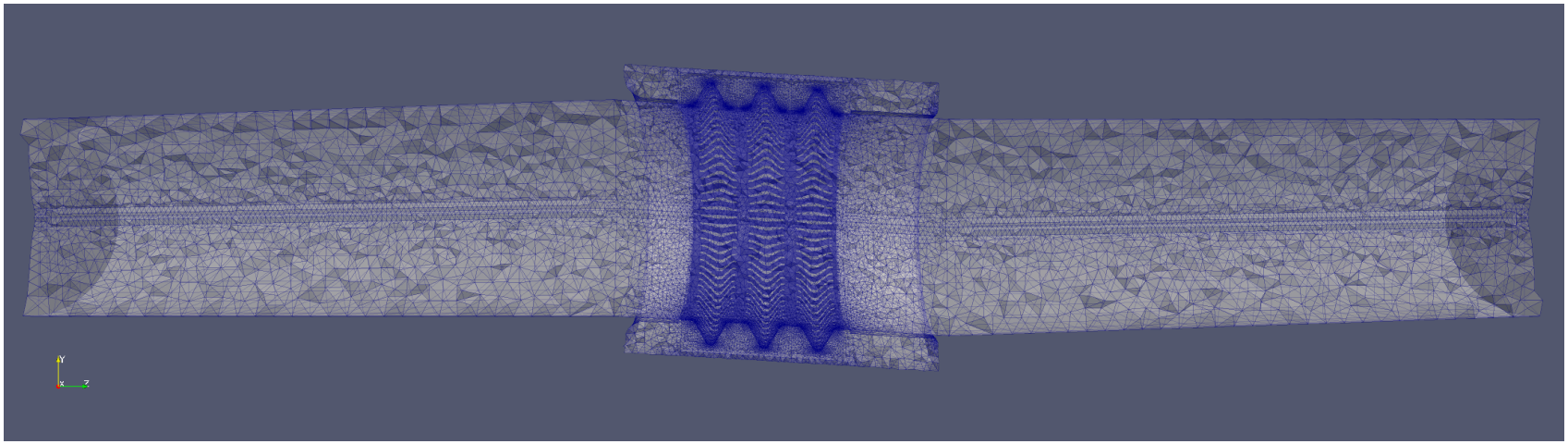
Progress on geometry

- Previously: Approximated fingers as infinitely thin
- Now managed to accurately mesh actual geometry (outer corrugations approximated as straight)
- Avoids manual work to create correct topology
- Many more elements (≈25M vs. 1.4M)



Transverse deflection

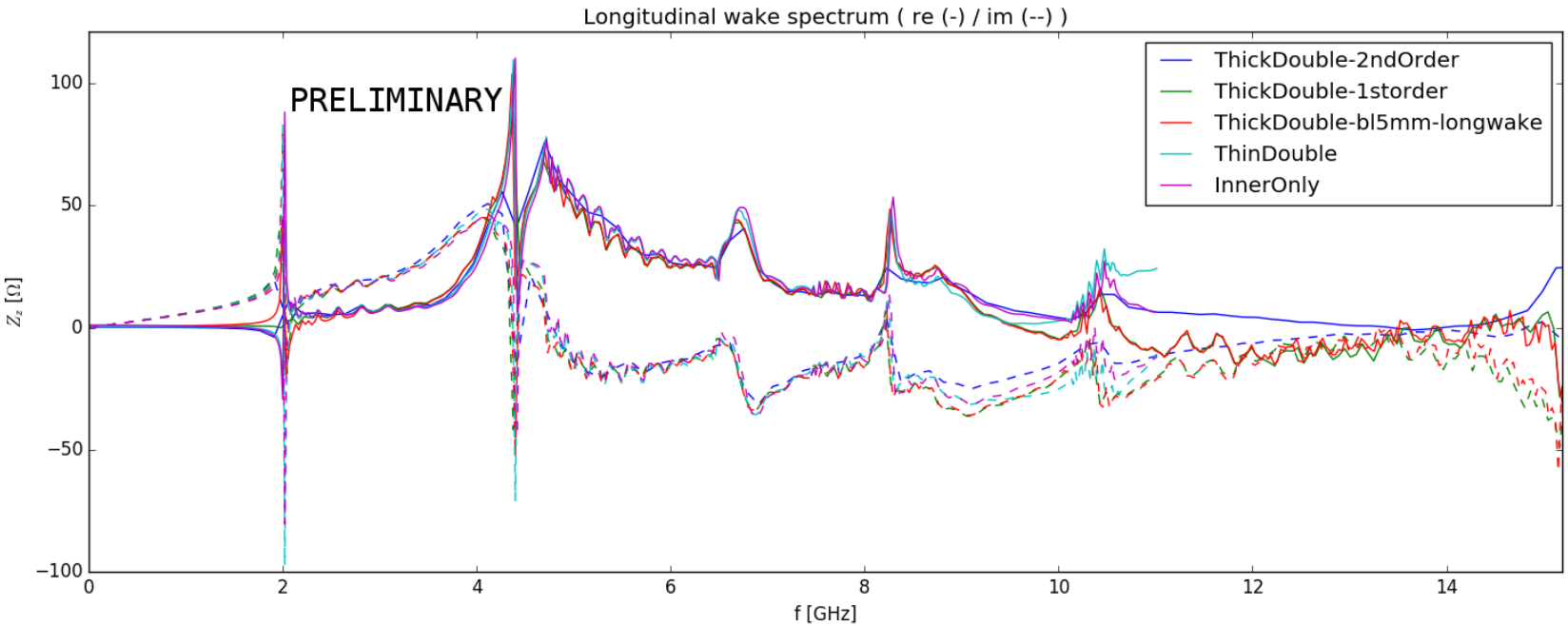
- Study effect of transverse deflection of the fingers
- Do this by morphing the mesh in an external program (mesh is just a NetCDF file)
- Wakefield integration method needs identical apertures on up- and downstream beam port and nothing "sticking in"
  $\rightarrow$ "Shrink" beam apertures slightly
- About to start simulations with this geometry



5 mm deflection up and down (for illustration)

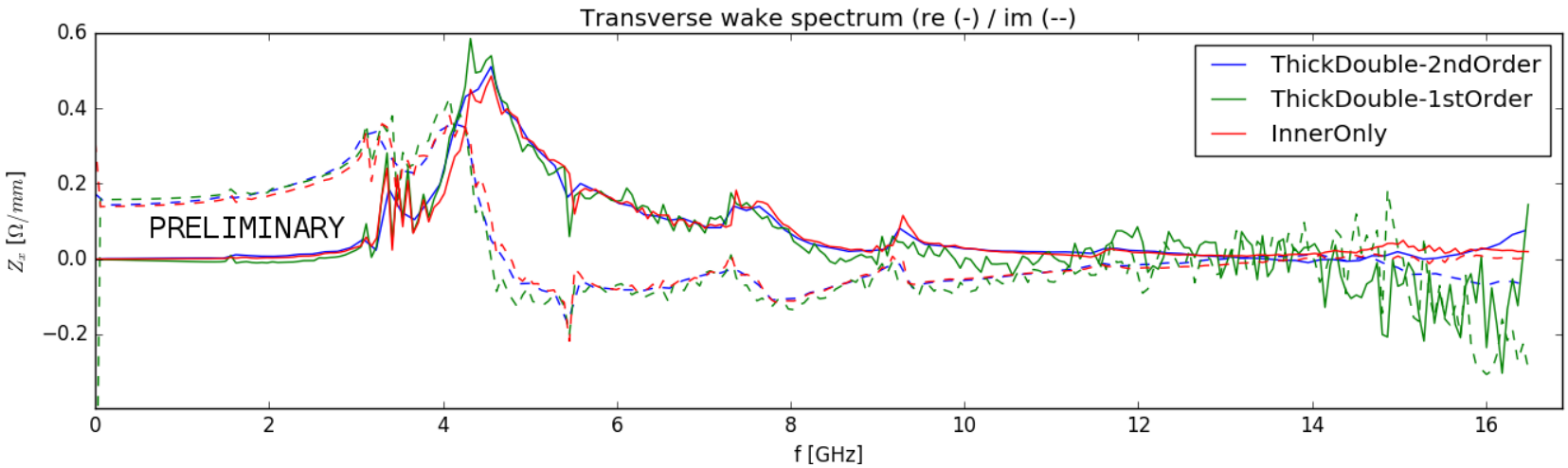
Longitudinal wake

- For "relaxed" geometry (60° fingers, no deflection)
- Agreement between calculation for "Thick", "Thin", and "InnerOnly" geometries ⇒ No coupling to outer volume
- 1st order sufficient, probably due to fine mesh
  ⇒ Saves factor ≈ ×30 of computing time
- Extra "wiggles" due to reflection from beam ports
- ThickDouble-2ndOrder just 2.04 m ⇒ poor frequency resolution



Transverse wake

- Same geometry as above,
  shift beam by 5 mm, calculate $V_\perp(s)$ using Panowsky-Wenzel
- Small impedance ($<1\ \Omega/\mathrm{mm}$ for the whole structure)
- Little effect of outer volume
- 1st order calculation sufficient



Outlook

- Further validation – crosscheck simplified geometry with CST
- Simulation with transverse deflection
- Simulate 2-corrugation finger geometry:
  Wire measurements showed resonance
  when outer bellow was installed
- Simulate wire scan (S-parameter)
  and compare with experiment
- More realistic (corrugated) outer bellow shape,
  variation of bellow radius
- Evaluate impact on beam and heating

Conclusions

- Big progress on geometry modelling
- Results in agreement with what was previously shown
- For 3-corrugation bellows:
  - Confirmed that effect of “gaps” between fingers is small
  - Transverse impedance looks very small
- More simulations (cross-checks and more geometries) in progress or will start soon